Program and Abstracts

Pacific Northwest Chapter

Society of Environmental Toxicology and Chemistry

(PNW-SETAC)

22nd Annual Meeting

Northern Quest Resort and Casino

April 18-20, 2013

Northern Quest Resort and Casino
100 N. Hayford Rd.
Airway Heights, WA 99001

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http://www.northernquest.com/hotel/photo-gallery

PNW-SETAC ANNUAL MEETING

April 18 to 20, 2013

Meeting Program

PNW-SETAC
Chapter Meeting Agenda

Thursday, April 18, 2013

7:30 AM - 5:00 PM	**Mining Tour**, breakfast provided (*meet at Spa entrance*)
12:00 PM - 7:30 PM	**Conference/Registration Check-in** (*Kalispel prefunction area*)
1:00 PM - 5:00 PM	**Short Course**: *An Overview of "Omics" Technology* by Amanda Carew, University of Victoria (*Kalispel A/C*)
5:30 PM - 8:00 PM	**Welcome Reception** with Refreshments

Friday, April 19, 2013 *(in Kalispel Ballroom unless otherwise noted)*

7:30 AM - 5:30 PM	**Conference/Registration Check-in** (*Kalispel prefunction area*)
7:30 AM - 8:30 AM	**Poster setup** (*Kalispel N/S*)
8:30 AM - 9:00 AM	**Welcome address**, Chapter President Heather Henson-Ramsey
9:00 AM - 9:20 AM	**Report from SETAC NA**, SETAC NA Board member John Elliott
9:20 AM - 11:40 AM	**Platform Sessions** w/20-min break for refreshments, poster viewing
11:40 AM - 1:50 PM	**Lunch,** on your own and/or in ballroom (see activities below)
1:00 PM - 1:50 PM	**Chapter Business Meeting**, All Welcome to Attend!!
1:50 PM - 5:00 PM	**Platform sessions** w/30 min break for refreshments and poster viewing
5:00 PM - 6:00 PM	**Poster Social** (*Kalispel N/S*)
6:00 PM - 8:30 PM	**Buffet Dinner**

Saturday, April 20, 2013 *(in Kalispel Ballroom unless otherwise noted)*

7:30 AM - 9:00 AM	**PNW-SETAC Board Meeting**, breakfast provided (*Chief Victor Boardroom*)
9:00 AM - 11:30 PM	**Platform sessions** with 20 min break for refreshments and poster viewing
11:30 AM	**Student Award Presentations**
12:00 noon	**Adjourn**

PNW-SETAC
Meeting Sponsors

Special thanks to all our meeting sponsors!!

Program Printing

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Thursday Evening Welcome Reception

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Friday Morning Refreshments

Maxxam Analytics

Friday Afternoon Refreshments

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Student Presentation Awards

Northwestern Aquatic Sciences

PNW-SETAC
Sustaining Members

Please join us in welcoming our Sustaining Members!!

We would like to extend a special thank-you to our first individual sustaining member, **Julann Spromberg**. Julann is a Research Toxicologist currently working in the Ecotoxicology Program of the Environmental Conservation Division at the Northwest Fisheries Science Center (aka NOAA Fisheries) in Seattle. Her interests are in integrating toxicology with ecological factors to find feasible ways of protecting biodiversity from chemical and anthropogenic impacts.

Julann's current research uses life-history modeling to investigate how toxicity endpoints, such as growth or fecundity, differ in population-level effects. Population responses will be modified by the life history characteristics of the species of interest. Life history models are applied to NMFS toxicity data regarding important or endangered fish species to determine how toxicity-induced biological responses may translate to population-level impacts. Applications of Julann's research could provide guidance for various remediation practices, and also help scientists identify sensitive stages in the species of interest.

Julann has been attending PNW-SETAC meetings since she was a student at Western Washington University (Western) in the mid-1990s. She earned her B.S. in Environmental Science from Huxley College of the Environment at Western in 1995 where she worked on the effects of toxic impacts on metapopulation dynamics with Dr. Wayne Landis as her advisor.

In 2002 she earned her PhD in Toxicology from the University of Kentucky where she worked with Dr. Wes Birge on modeling how life-history strategies influence the population-level effects of sublethal contaminant impacts. Based on her research Julann was honored to be invited to attend the SETAC Pellston Workshop entitled "*Population-Level Ecological Risk Assessment*" in Roskilde, Denmark in August 2003.

In 2006 she was elected as the Vice President of PNW-SETAC and served as its President in 2007 and Past President in 2008. Julann remains active in the Pacific Northwest Chapter of SETAC and became our first Sustaining Member this year. It's the dedication and service of individuals like Julann that have helped to make PNW-SETAC the highly successful regional chapter it is today.
(Photo - Julann modeling the coveted PNW-SETAC fleece)

Nautilus Environmental (http://www.nautilusenvironmental.com) is an environmental services company focused on providing high quality scientific data in the field of environmental toxicology.

Our team of environmental scientists has expertise in the fields of environmental toxicology, chemistry, biology, and ecology, which ensures that studies conducted by our company are designed, implemented and interpreted in a manner that maximizes the value of the data. Nautilus has developed a renowned program that applies both standardized and innovative methodologies to address a range of toxicological concerns.

At the core of the business are our accredited environmental toxicology laboratories in Vancouver, B.C. and San Diego, CA, each offering a wide range of toxicity testing services. Please explore our site or contact us to learn more about how we can assist you.

This is Nautilus's second year as a Sustaining Corporate Sponsor, thank you! This level of giving goes a long way toward making our conferences both affordable and high quality.

Teck is Canada's largest diversified resource company, committed to responsible mining and mineral development with major business units focused on copper, steelmaking, coal, zinc, and energy.

Teck has provided a generous donation to the PNW-SETAC student travel fund, one of our highest priorities as a chapter.

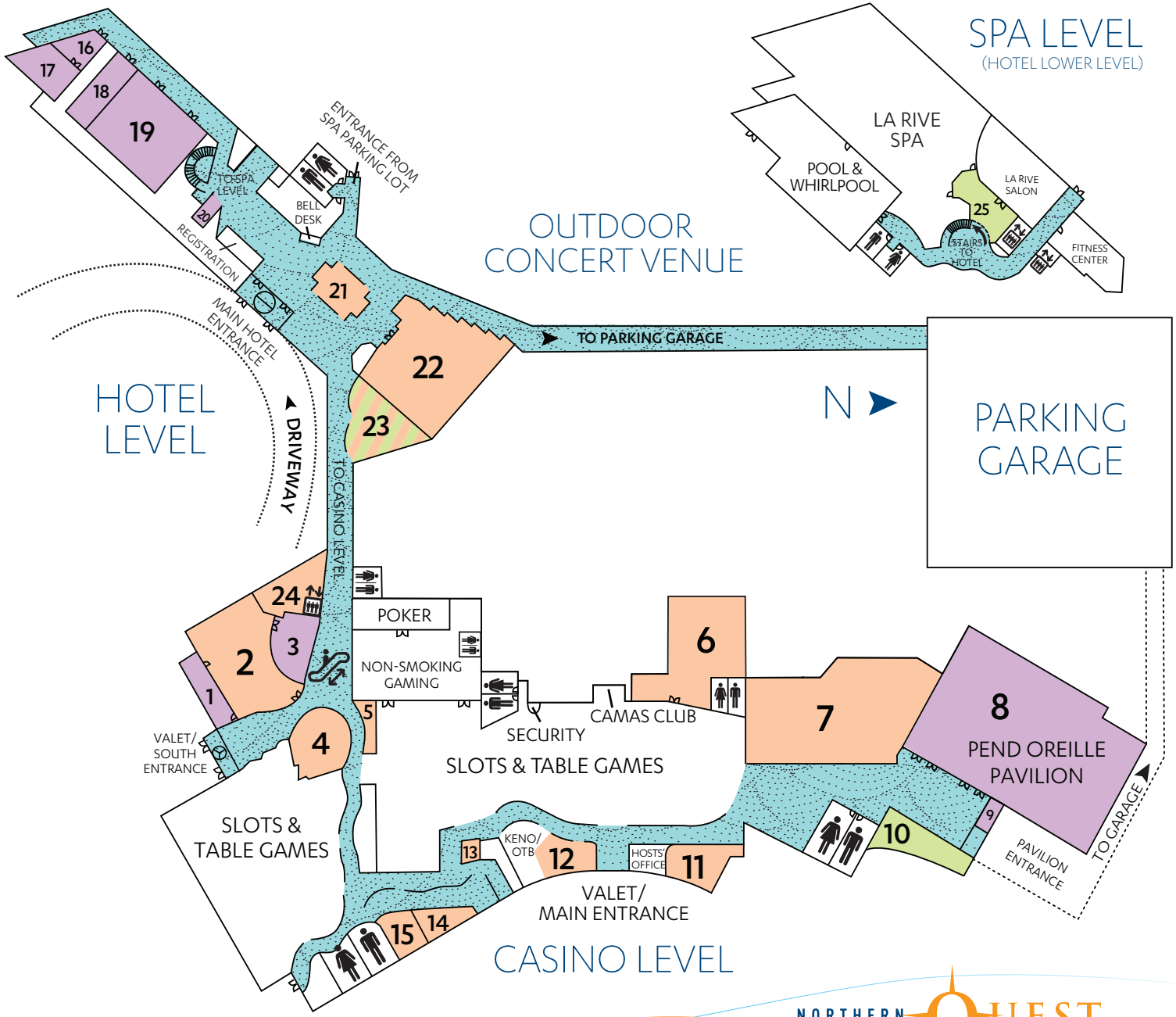
To learn more about the benefits of becoming a Sustaining Corporate or Individual Member, please visit our web site at http://www.pnw-setac.org/Sustaining.htm

PNW-SETAC
Acknowledgments

Thanks to all of the following who volunteered their time to make this meeting possible:

Conference Organization:	Heather Henson-Ramsey, Lewis-Clark State College
Short Course:	Amanda Carew, University of Victoria
Mining Tour:	Roger Thomas, Tetra Tech
Reservations/Food:	Heather Henson-Ramsey, Lewis-Clark State College
On-Site Coordinators:	Heather Henson-Ramsey, Lewis-Clark State College Ryan Loveridge, CH2M Hill
Abstract Review:	Vicki Marlatt, University of the Fraser Valley Lindsay Du Gas, Simon Fraser University
Meeting Program:	Teresa Michelsen, Avocet Consulting
Meeting Registration:	Ryan Loveridge, CH2M Hill Teresa Michelsen, Avocet Consulting
Volunteer Coordinator:	Lindsay Du Gas, Simon Fraser University
Student Awards Coordinator:	Ruth Sofield, Western Washington University
Fundraising:	PNW-SETAC Board of Directors
Session Chairs:	Rachel Jameton, Lewis-Clark State College Maggie Dutch, Washington Department of Ecology Roger McGinnis, Hart Crowser

Student Award Judges:	Bonnie Bailey, Applied Exergy Stephan Dent, CDM Smith Lindsay Du Gas, Simon Fraser University Rachel Jameton, Lewis-Clark State College Wayne Landis, Western Washington University Sydney Love, Simon Fraser University Daniel Lybbert, Lewis-Clark State College Patrick Moran, US Geological Survey Matthew Slattery, Western Washington University Phil Wiescher, Maul, Foster & Alongi John Stark, Washington State University
Student Travel Review:	Ruth Sofield, Western Washington University Burt Shephard, USEPA



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Legends of Fire	24

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PUBLIC WALKWAY

NORTHERN QUEST RESORT & CASINO

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Pacific Northwest Chapter

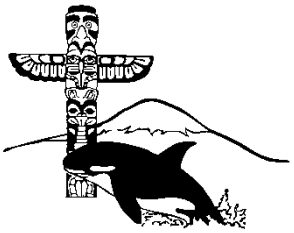
Society of Environmental Toxicology and Chemistry

(PNW-SETAC)

22nd Annual Meeting

Pre-Meeting Events

PNW-SETAC
Mining Tour



7:30 AM, Thursday, April 18, 2013

Meet at Spa Entrance for breakfast and bus tour

Western Idaho Mining Sites Tour

Tour Leader: Roger Thomas, Tetra Tech

Tour Description:
This all-day tour will leave from in front of the Casino at 8:00 am - come early at 7:30 for coffee and breakfast-to-go. We will travel to Wallace, ID located in the "Silver Valley." The tour will include visits to the Bunker Hill Mining and Metallurgical Superfund Site, one of the largest in the country, and the Coeur d'Alene Basin Superfund Site. The focus of the tour will be on the historical, toxicological, and remediation aspects of mining, with stops along the way at both historical and new mining sites, as well as sites undergoing remediation. Ed Moreen, USEPA, will speak on the history of mining in the region and related toxicological issues. Jerry Cobb, Public Health Program Manager, will also be joining us as a speaker on the tour to discuss human health and blood lead levels. The bus trip back to Spokane will be reserved for group discussion.

Lunch is not included, but there will be a stop for lunch in Wallace, ID, or you can bring your own. Due to the early departure time from Spokane, out-of-town attendees should plan on arriving Wed evening, so please plan your room reservations accordingly.

PNW-SETAC
Short Course

1:00 PM, Thursday, April 18, 2013

Kalispel A/C

An Overview of "Omics" Technology

Instructor: Amanda Carew, University of Victoria

Short Course Overview

Objective: The goal of this short course is to provide a general understanding of the basic theory, application, and pros/cons of various "Omics" technologies.

Course Summary:
Transcriptomics are the most familiar and are already considered in some risk assessments. Microarrays have been used frequently in combination with quantitative polymerase chain reaction (QPCR) when investigating changes to the transcriptome. An overview will be given of QPCR primer design with consideration of minimum recommended information guidelines for QPCR (MIQE) and microarray (MIAME). Next-generation sequencing technology and its application for quantitative analysis using RNA-seq will be discussed. Proteomics and metabolomics make use of mass spectrometry to quantify proteins and small molecules, respectively. This technology can be very useful in profiling sublethal effects of chemicals, and potential applications and analytical considerations will be described.

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Schedule of Platform and Poster Presentations

Friday Platform Presentations
Morning Session

Friday, April 19, 2013

Session Chair: Rachel Jameton, Lewis-Clark State College

Burning the Midnight Oil – Fossil Fuels

9:20	Spromberg, J.A.	Experimental Exposure to Road Runoff Produces Pre-Spawn Mortality Symptomology in Adult Coho Salmon
9:40	Crawford, M.	Filling the Tank: An Empirical Fugacity and Activity-Based Approach to Risk Assessment of Petroleum Hydrocarbons
10:00	Perkins, M.	LVI-LC-MS/MS Analysis of Corexit in GOM Water Column and Sediments

10:20 Break/Poster Viewing

Developments in the Management, Fate and Toxicology of Mercury

10:40	Dent, S.D.	Controlling Mercury Accumulation in the Water Column and Aquatic Foodweb of Freshwater Lakes with Hypolimnetic Oxygenation
11:00	Jackson, A.K.	Mercury Bioaccumulation in Songbirds: Using Findings from Eastern U.S. for Western Studies
11:20	Saddler, T.	Assessment of Methylmercury Exposure in Women of Childbearing Age on the Flathead Reservation, MT, USA

11:40 Lunch

1:00 PNW-SETAC Business Meeting

Friday Platform Presentations
Afternoon Session

Friday, April 19, 2013

Session Chair: Margaret Dutch, Washington Department of Ecology

Ecological Risk Assessment: Monitoring, Modeling and Uncertainty

1:50	Dutch, M.E.	Changes in Puget Sound Sediments as Seen with Four New Indices: 1997-Present
2:10	Landis, W.G.	The Exposure-Response Curve: A Response to Those Advocating Hypothesis Testing or Single Point Estimates
2:30	Johns, A.F.	Assessing Uncertainty in Response Through Dose-Response Model Fitting
2:50	**Break/Poster Viewing**	

From Birds to Worms - Ecotoxicology Developments in the Pacific Northwest

3:20	Henson-Ramsey, H.	Modeling as a Tool For Toxicologists, the Use of STELLA
3:40	Patmont, E.	Modeling Bioaccumulation of Contaminants in Puget Sound: an Analysis of Site-Specific Parameters
4:00	Lybbert, D.T.	A 'Spaghetti Junction'? Combining Ecoimmunology & Disease Biology For Immunotoxicology's Sake
4:20	Brown, L.Y.	Effects of Ibuprofen Exposure on Underyearling Rainbow Trout and Caenorhabditis elegans – Exploring the Utility of RNA-SEQ in Ecotoxicology
4:40	Wojnarowicz, P.	Removal of Contaminants of Concern in Successive Levels of Municipal Wastewater Treatment: Effects on Amphibian Gene Expression
5:00	**Poster Social**	
6:00	**Dinner**	

Saturday Platform Presentations
Morning Session

Saturday, April 20, 2013

Session Chair: Roger McGinnis, Hart Crowser

The Impacts of Mining on the Environment

9:00	Clark, G.M.	Occurrence and Transport of Selected Trace Metals in the Coeur D'Alene and Spokane River Basins, Idaho and Washington
9:20	Mebane, C.	Effects of Cd, Pb, Zn and their Mixtures to Aquatic Life in the South Fork Coeur d'Alene River, Idaho
9:40	Lester, G.T.	Benthic Invertebrate Response to Heavy Metal Contamination in Panther Creek Drainage (Idaho): A Case Study Using McGuire's Metal Tolerance Index
10:10	Michelsen, T.C.	Predicting Toxicity of Freshwater Sediments in Areas Impacted by Mining Wastes
10:30	**Break/Poster Viewing**	
10:50	Lefcort, H.	Pre-exposure to Heavy Metal Pollution and the Odor of Predation Reduce the Ability of Snails to Avoid Stressors
11:10	Shephard, B.	Upper Columbia River Site: Early Findings of the Ecological Risk Assessment
11:30	**Student Award Presentations**	
12:00	**Wrap Up/Adjourn**	

PNW-SETAC
Poster Presentations

Presenter	Title
Brendan Dowling, Washington Department of Ecology	An Update to the Washington State Department of Ecology's Evaluation of a Benthic Sediment Biomass Endpoint
Lindsay Du Gas, Simon Fraser University	The Effects of Current-Use Pesticides on Early Developmental Success, Timing and Growth to the Hatch Stage of Sockeye Salmon (*Onchorhynchus nerka*)
Margaret Dutch, Washington State Department of Ecology	2011 Sediment Quality Assessment of the South Puget Sound Region and Budd Inlet, Including Comparisons with 1999 Regional Conditions
Stephanie Eckard, Western Washington University	Analysis of Pollutants in the High Alpine Aquatic Systems of the Cordillera Blanco Mountain Range of Central Peru
Julie Fix, Western Washington University	Investigation of Biochemical Responses of Lichens to Air Pollutants Originating from Trains in Northwestern Washington
Adam Pfleeger, Oregon State University	Capturing a Signal: Mercury Bioaccumulation through Food-Webs in Remote Alpine Lakes
Klair Phillipoff, University of the Fraser Valley	Investigating Howe Sound Water Quality Post-Industrial Activity using a Giant Kelp (*Macrocystis pyrifera*) Toxicity Assay
Jody Pope, Western Washington University	Investigation of Gene Expression in the Livers of Hatchery-Raised Chinook Salmon (*Oncorhynchus tshawytscha*) and Resident Cutthroat Trout (*Oncorhynchus clarki*) in the Stillaguamish Watershed
Burt Shephard, USEPA	Acute Sensitivity of Freshwater Mussels to Select Chemicals with Various Toxic Modes of Action
Tasha Sorensen, Western Washington University	Silver Concentration Detection with Modified Environmental Factors using Ion Selective Electrodes
Katerina Vassilenko, University of British Columbia	Water Column Accumulative Monitoring using Mussels and Passive Samplers

Francine Venturini, Federal University of São Carlos	Effects of Pyrethroid Single-Pulse Exposure on the Swimming Performance of Juvenile Rainbow Trout (*Onchorhynchus mykiss*)
Eric Wallace, Lewis-Clark State College	Evaluating the Effects of Antihistamines on an Aquatic Snail, *Lymnaea stagnalis*

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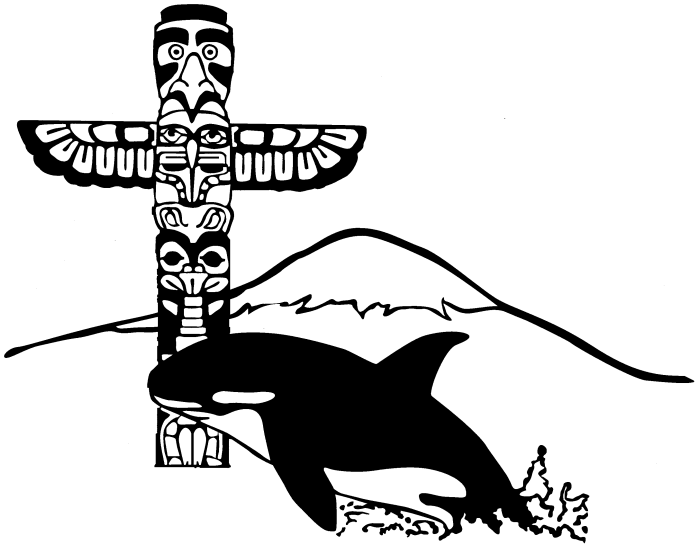

Platform Presentation Abstracts

EXPERIMENTAL EXPOSURE TO ROAD RUNOFF PRODUCES PRE-SPAWN MORTALITY SYMPTOMOLOGY IN ADULT COHO SALMON

Spromberg, J.A.*[1]; Baldwin, D.H.[1]; McIntyre, J.K.[2]; Damm, S.[3]; Davis, J.[3] and Scholz, NL[1]. [1]NOAA NMFS/NWFSC, Seattle, WA USA. [2] Washington State University, Puyallup, WA, USA. [3]US Fish and Wildlife Service, Lacey, WA USA.

Several urban streams in the Seattle area were the focus of habitat restoration projects in the 1990s. Post-project effectiveness monitoring surveys revealed anomalous behaviors among adult coho salmon returning to spawn in these restored streams. Behaviors included erratic surface swimming, gaping, fin splaying, and loss of orientation and equilibrium. Affected fish died within hours, and female carcasses showed high rates (> 90%) of egg retention. This phenomenon was termed coho pre-spawn mortality (PSM). From 2002-2008, rates of coho PSM ranged from ~ 30-90% in monitored urban streams. The severity of PSM was closely associated with both the timing and amount of fall rains. Coho also showed evidence of exposure to metals and petroleum hydrocarbons, both of which commonly originate from motor vehicles. The weight of evidence suggests that an as-yet unidentified toxic contaminant or contaminant mixture in urban stormwater runoff is killing coho spawners. Geospatial analyses point to urban land uses, impervious surfaces and specifically road density to be related to the levels of PSM across watersheds. During the autumns of 2011 and 2012, we exposed adult coho recently returned to freshwater to various mixtures of PAHs and metals to simulate vehicle runoff, or to collected road runoff. The PAH and metal mixtures did not produce PSM symptomology. Road runoff collected from an elevated highway produced typical PSM symptomology in all exposed fish. The results suggest that while the contaminants in the simulated mixtures cannot be ruled out as being necessary to cause coho PSM the tested mixtures were not sufficient to cause the phenomenon. Contaminants sufficient to cause PSM are present in the road runoff, but have not been identified. Tissue samples from experimentally exposed fish and field collected symptomatic fish will be used to identify the physiological impairments leading to PSM and which contaminants may be involved.

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FILLING THE TANK: AN EMPIRICAL FUGACITY AND ACTIVITY-BASED APPROACH TO RISK ASSESSMENT OF PETROLEUM HYDROCARBONS

Crawford, M.* and Gobas, F.A.P.C., Simon Fraser University, Burnaby, BC, Canada.

Petroleum hydrocarbons (PHCs) are a group of chemicals present in the environment from petrogenic, pyrogenic, and biogenic sources. Organisms living in aquatic and terrestrial environments face potential risks from exposure to PHCs, and are typically exposed to complex mixtures of individual PHCs each with different physical-chemical properties that determine their distribution between the different environmental compartments. However, describing this risk from exposure to PHC mixtures in multiple media can be a challenge because most toxicity data are based on individual PHCs in a single medium. Non-polar narcosis as a mode of toxic action thought to be shared by all PHCs, implying that the internal concentration of chemicals eliciting this response will be equal regardless of chemical, media, or species. This research proposes the use of fugacity and activity, two thermodynamic properties, to describe bioavailable quantities of PHCs in organisms. Fugacity (expressed in units of pressure; e.g., pascals) and activity (a unitless ratio describing how close chemical concentrations are to saturation in a particular medium) are two complementary ways of normalizing concentration and toxicity data and expressing all data in the same units so that they may be compared directly. This research converts existing PHC toxicity endpoints and exposure concentrations (e.g., LC50s, NOELS, LOELs) for individual PHCs into fugacity and activity terms. Toxicity data of PHC mixtures expressed as fugacity and activity will also be compared to individual PHC data to test the hypothesis that fugacity and

activity are additive. Ultimately, this approach is evaluated as a potential method to enhance ecological risk assessments by allowing a weight of evidence approach that integrates toxicity and exposure data from multiple media, multiple species, and multiple PHC chemicals.

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LVI-LC-MS/MS ANALYSIS OF COREXIT IN GOM WATER COLUMN AND SEDIMENTS

Perkins, M.*, Place, B., Field, J.A., Oregon State University, Corvallis OR.

Approximately 200 million gallons of Corexit was applied in the Gulf of Mexico in response to the Macondo oil spill of 2010. Corexit, a surfactant, is capable of reducing the interfacial tension between aqueous and oil phases, reducing oil droplet size and potentially mitigating some environmental impacts of the spill. The scale of such environmental dispersion of surfactants is unprecedented and little knowledge of the ultimate fate of Corexit in the marine environment has been reported. The environmental presence of the major constituents of Corexit, Span 80, Tween 80, Tween 85, as well as, DOSS and its primary hydrolysis products, is reported for depth specific water column samples collected from priority sites in the Gulf of Mexico in 2012. These values are compared to those for samples collected from similar sites in 2010 and 2011. Additionally, a preliminary method for the extraction and quantification from marine sediment, of DOSS and its degradates, using LVI-LC-MS/MS, is presented.

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CONTROLLING MERCURY ACCUMULATION IN THE WATER COLUMN AND AQUATIC FOODWEB OF FRESHWATER LAKES WITH HYPOLIMNETIC OXYGENATION

Dent, S.D.[1]; Beutel, M.W.[2]. [1]CDM Smith, Portland, OR, [2]Washington State University, Pullman, WA.

The accumulation of methylmercury (MeHg) in freshwater aquatic food webs is widespread with nearly one-third of lakes in the US having fish consumption advisories in place due to elevated concentrations of mercury found in fish tissue. Hg typically enters freshwater aquatic ecosystems as ionic Hg (Hg(II)), both as atmospheric deposition from major sources like coal fired power plants and as watershed runoff. Given the right anaerobic conditions, Hg(II) is converted to the bioavailable organic species methylmercury (MeHg). MeHg can partition to organic seston such as algae, and subsequently biomagnify up the aquatic food web, where seemingly harmless levels in the water (< 1 ng/L) can concentrate into potentially toxic levels in fish tissue (> 1 mg/kg). This study evaluated a hypolimnetic oxygenation line diffuser system that was installed in North Twin Lake (northeastern Washington), a moderately deep, dimictic lake that experiences severe hypolimnetic anoxia during summer stratification. MeHg enrichment in the water column and in zooplankton was monitored throughout the summer stratification period for the first three years of system operation. MeHg enrichment above the sediment was considerably less in North Twin Lake than a nearby and similar, yet untreated, reference lake during each treatment year. However, due to system irregularities, oxygen delivery was inconsistent from year to year, resulting in peaks and valleys in the oxygen concentration above the sediments. MeHg enrichment in hypolimnetic waters was low during peak oxygen periods and high during low oxygen periods. Hypolimnetic mixing, induced by the oxygenators bubble plume, transported MeHg into the upper waters of

the hypolimnion, in periods of enhanced MeHg efflux, which increased accumulation in zooplankton. This study sheds light on the complexity in managing the mercury cycle in aquatic ecosystems and demonstrates the potential lake treatment technologies like hypolimnetic oxygenation have for either effectively managing or exacerbating MeHg enrichment.

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MERCURY BIOACCUMULATION IN SONGBIRDS: USING FINDINGS FROM EASTERN U.S. FOR WESTERN STUDIES

Jackson, A.K.*[1], Eagles-Smith, C.[2], and Evers, D.C.[3]. [1] Oregon State University, Corvallis, OR, [2] U.S. Geological Survey, Corvallis, OR, [3] Biodiversity Research Institute, Gorham, ME

Mercury (Hg) contamination and its associated effects in terrestrial songbirds has recently gained scientific attention, with research showing that aquatic subsidies facilitate the transfer of Hg out of aquatic environments and into terrestrial food webs. Songbirds are excellent bioindicators of terrestrial Hg exposure, because they occur widely across many different habitats and their blood offers a non-lethal metric of recent dietary exposure to Hg. Additionally, evidence suggests that songbirds may be uniquely sensitive to the toxicological effects of Hg exposure. Despite their potential utility, few studies have examined broad-scale factors influencing Hg exposure across songbird species, leaving important gaps in our understanding of songbird exposure and bioaccumulation dynamics. We compiled a large database of songbird blood Hg concentrations (N = 5089) across the eastern U.S. Our preliminary results suggest that songbird blood Hg concentrations varied among habitats, ages, and guilds, and that there were interactions among these three factors. After conducting separate analyses for adults and juveniles, our preliminary results indicate that for adults a) invertivores had generally higher blood Hg concentrations than omnivores, and b) blood Hg concentrations were higher in aquatic-based habitats (riparian, freshwater wetland, saltwater wetland) than upland habitats in both invertivore and omnivore guilds. Interpretation of Hg concentrations in juveniles is more difficult. Although much is unknown about Hg in western songbirds, we compared the findings from the eastern U.S. to a limited dataset in the western states, to understand how Hg risk may vary between the broad geographic regions.

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ASSESSMENT OF METHYLMERCURY EXPOSURE IN WOMEN OF CHILDBEARING AGE ON THE FLATHEAD RESERVATION, MT, USA

Saddler, T.*[1], Smiley, W[1]., Kuntz[2], S., Stevens, D[1]. [1]Salish Kootenai College, Pablo, MT; [2]Montana State University, Bozeman, MT

Methylmercury has been linked to neurodevelopmental deficits in young children and children exposed in utero, as well as cardiovascular disease in adults. Pregnant women, women who may become pregnant, women who are nursing and young children represent the most sensitive population to the negative neurodevelopmental effects of mercury through consumption of fish. Thousands of lake trout from Flathead Lake are donated to Flathead Reservation food banks each year. Previous studies have shown elevated levels of methylmercury in these fish. Participants in the

Women, Infant and Children program (WIC) are eligible to receive free fish from local food banks, which may include these lake trout. A previous survey of local women in the WIC program showed that approximately 50% eat fish, however, the majority were not aware of potential adverse effects of mercury or of any fish consumption advisories. Since dietary surveys are frequently inaccurate, follow-up hair mercury analysis was necessary to determine if any of these participants were at risk from elevated methylmercury exposure. In this study, hair samples were collected from 183 women of childbearing age (18-40) from the Flathead Indian Reservation, most of whom were WIC participants. Mercury levels were determined in samples of hair 3 cm in length from the scalp, representing a 3-month integrated exposure, using EPA method 7473. Results demonstrate that the hair levels in ~90% of the participants sampled were below the national average of 200-300 ppb mercury. None were above the 1000 ppb threshold of concern. This shows that, although some women on the reservation are offered free fish, many do not take advantage of this resource. The data suggests that lack of dietary omega-3 oils from not eating enough fish may pose a greater risk than the deleterious effects of mercury from eating too much fish.

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CHANGES IN PUGET SOUND SEDIMENTS AS SEEN WITH FOUR NEW INDICES: 1997-PRESENT

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Four sediment quality indices were developed recently by the Washington State Department of Ecology Marine Sediment Monitoring Team to characterize regional and urban bay sediments collected for the Puget Sound Ecosystem Monitoring Program. These include indices of sediment contamination (Chemistry Index), laboratory toxicity tests (Toxicity Index), sediment-dwelling invertebrate community condition (Benthic Index), and a combined Sediment Quality Triad Index. Each index was calculated for eight Puget Sound sediment monitoring regions and six urban bays, sampled since 1997. Changes over time are noted for those areas which have been resampled at roughly decadal intervals since 1997. While no significant changes have been observed in the Chemistry Index, statistically significant declines have been observed in both the Toxicity and Benthic Index for many regions and bays, likely responses to variables other than the individually measured chemicals. Changes in the benthic community structure are highlighted for several locations, and thoughts about what environmental stressors may be triggering these changes will be discussed.

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THE EXPOSURE-RESPONSE CURVE: A RESPONSE TO THOSE ADVOCATING HYPOTHESIS TESTING OR SINGLE POINT ESTIMATES

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In the last 20 months there has been a great deal of discussion regarding the proper analysis tools for the description of the exposure-response relationship in environmental toxicology. Peter Chapman and I have advocated the elimination of hypothesis testing (NOECs, LOECs and similar results) from the literature. A number of other Learned Discourses and articles in the SETAC literature have commented on this position. In a reply to this position Green. Springer and Stavely (IEAM 2012) calls the drive to ban the NOEC/LOEC "misguided and misinformed". The specific arguments of Green et al and comments made by other authors indicate that there is still a fundamental lack of understanding of the science reviewed by Landis and Chapman. There are four major points that will be presented in this paper. First, Landis and Chapman (2011) advocates the use of curve fitting as the fundamental description of the exposure-response relationship and did not advocate any specific ECx value. Second, while a number of models can produce acceptable results, however a fundamental issue in environmental toxicology is the lack of mechanistic models that provide baseline functions for describing exposure-response curves. Third, the choice of an ECx value is dependent on the type of decision being made and thereby no toxicologically defensible universal ECx point or value exists. Fourth, the continued use of hypothesis testing in making decisions regarding risk are fundamentally flawed from a decision-science perspective and represent the suppression of science by policy.

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ASSESSING UNCERTAINTY IN RESPONSE THROUGH DOSE-RESPONSE MODEL FITTING

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Recently there has been a call to use regression based analyses as a means of assessing dose-response curves. Toxicity endpoints, such as NOEC (no observed effect concentration) and LOEC (lowest observed effect concentration), do not capture overall shape of the dose response curve and ignore the uncertainty in the response. Historically, uncertainty in dose-response relationships has been examined by determining the dose level that will produce a given response. We propose that it is imperative to include the uncertainty in a response to a chemical dose. In this study we have addressed this uncertainty by generating frequency distributions of a response at varying doses of a variety of chemicals from a regression-based model fit. Dose-response curves used in this study were fit with different regression models including two, three and four parameter log-logistic, Weibull and probit models with 95% confidence intervals. The use of multiple models for each curve allowed us to assess the impact model choice may have on the resulting frequency distributions. Frequency distributions for each model fit were calculated assuming a triangle distribution as well as a normal distribution to determine the impact the sampling distribution would have on our results. We found that the response of an organism to a chemical dose may result in a wide range of possible responses. For example, a fitted dose-response curve may predict 40% mortality from a dose, but the frequency distribution at that dose reveals that there is a significant probability 20% or 60% mortality may occur. These results have serious implications for ecological risk assessment, especially at the population level.

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MODELING AS A TOOL FOR TOXICOLOGISTS, THE USE OF STELLA

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Model systems can be used to decrease the need for large numbers of experimental animals in toxicological studies. This is especially helpful when working with species that are threatened or endangered. STELLA made by isee systems is a modeling tool that allows for the use of a dynamic model that can be varied across a wide array of possible inputs in a quick and efficient manner. STELLA was used to model an earthworm-salamander bioaccumulation system with the system having been exposed to malathion. The model was built upon laboratory experiments that assessed the depuration, degradation, and uptake of malathion from soil into earthworms. This base data was used to develop a model that could assess the bioaccumulative risk to salamanders across a wide array of possible parameters.

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MODELING BIOACCUMULATION OF CONTAMINANTS IN PUGET SOUND: AN ANALYSIS OF SITE-SPECIFIC PARAMETERS

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The industrial activity in the Puget Sound region necessitates understanding the bioaccumulation of contaminants to achieve protective levels for aquatic life and safe fish consumption. Considerable progress has been made in modeling the bioaccumulation of contaminants in aquatic organisms; because of this, there are improved theory and methods to assess the contributing parameters and identify data gaps. In the current study, the extensive data for Puget Sound biological and environmental characteristics were compiled from the Washington State Department of Ecology's Environmental Information Management System (myEIM) and The National Status and Trends' Mussel Watch program (Mussel Watch) for input parameters. The AQUAWEB model of Gobas and Arnot was built into the STELLA modeling environment (ISEE Systems, Inc., Lebanon, New Hampshire; www. iseesystems.com). As a preliminary modeling step, the distribution of each input parameter was determined using Oracle Crystal Ball. The median and standard deviation of each parameter was used for the site-specific inputs of the STELLA® model. STELLA was also used to run a sensitivity analysis, this helped guide model calibration. After calibration, a total model bias of all 14 congeners (PCB 18, 44, 49, 52, 70, 99, 105, 118, 128, 151, 180, 183, 187) was calculated at 1.52. The model performance was tested by plotting the model bias of each congener versus its chemical specific input values. The model was shown to predict PCB concentration more accurately for less hydrophobic molecules (low log Kow values). Other significant findings will be presented will be presented at the conference.

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A 'SPAGHETTI JUNCTION'? COMBINING ECOIMMUNOLOGY & DISEASE BIOLOGY FOR IMMUNOTOXICOLOGY'S SAKE

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A significant problem with immunotoxicological investigations is the high number of uncertainties associated with positive results. For instance, if a contaminant suppresses the mitogenic proliferation and trafficking of cells to the patagium of a bird's wing web after antigenic exposure, how does this relate to the animal's response to antigens relevant to its life history? Ecoimmunology has begun to offer theoretical constructs and practical solutions to address these and other confounding variables, as the many ecological and evolutionary drivers of immunity are investigated. However, ecological immunology also suffers from an unknown relevance of results from experimental studies not focused on a particular microbial agent. Given these issues, we have been undertaking an investigation of the avian immune response to West Nile virus (WNV). With the mechanism in hand, we would be equipped with a means to investigate the influence of contaminants on the functioning of key immune parameters associated with WNV in wild birds. Here we report on a compendium of immunologic findings including a recent demonstration of the relationship between mannan-binding lectin and WNV titer in chickens. Despite our current progress and the work of other avian immunologists, much work remains to identify specific measurement targets in WNV reservoir host species applicable to field studies.

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EFFECTS OF IBUPROFEN EXPOSURE ON UNDERYEARLING RAINBOW TROUT AND CAENORHABDITIS ELEGANS – EXPLORING THE UTILITY OF RNA-SEQ IN ECOTOXICOLOGY

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Ibuprofen is a commonly used nonsteroidal anti-inflammatory drug (NSAID) and one of the most abundant pharmaceuticals found in sewage and surface water worldwide. Recent toxicology studies have shown that ibuprofen exposure negatively impacts the spawning behaviour of medaka and egg hatching in **Daphnia magna**. Ibuprofen is known to inhibit prostanglandin synthesis by targeting cyclooxygenase enzymes; however, the mechanisms of action are not well understood. Underyearling rainbow trout were exposed to ibuprofen for 96 hours (plus a 24 hr recovery) at environmentally relevant and higher concentrations. RNA-Seq was conducted on fish liver mRNA and differential gene expression was examined at the gene and pathway level. Both expected and novel gene expression changes were observed in rainbow trout in response to ibuprofen - findings subsequently validated by qPCR. As expected, there were statistically significant changes in prostaglandin pathway-associated genes. More surprisingly, vitellogenin gene expression was down-regulated in male fish. This analysis of rainbow trout RNA-Seq data highlighted the benefits and challenges of using RNA-Seq in the context of ecotoxicogenomics. This work also illustrated the benefit of using genetic markers to identify sex-specific responses to toxicants. In addition to fish bioassays, **Caenorhabditis elegans** worms were exposed to ibuprofen at the same environmentally relevant, and higher, concentrations for 3 days. The results showed decreased egg-laying within 24 hrs of exposure. These observations suggest that ibuprofen may have negative impacts on egg production and further experimentation with both rainbow trout and **C. elegans** is needed. This also highlights the potential benefits of studying the effect of toxicants not just on large animals such as fish, but also on more microscopic organisms, as part of efforts to better assess toxicity on an entire ecosystem.

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REMOVAL OF CONTAMINANTS OF CONCERN IN SUCCESSIVE LEVELS OF MUNICIPAL WASTEWATER TREATMENT: EFFECTS ON AMPHIBIAN GENE EXPRESSION

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Municipal wastewater treatment plants are struggling to efficiently remove endocrine disrupting compounds (EDCs) from plant effluents. EDCs have the potential to cause chronic effects on aquatic wildlife at low, environmentally relevant levels. Typical municipal wastewater treatment consists of multiple levels of processing but the efficacy of each successive step in removing biological effects of EDCs is under-researched. Much of the focus of EDC research to date has been on sex hormones. Thyroid hormone (TH) effects, although more broad-ranging than sex hormones, are often overlooked in ecotoxicology. Frogs are environmental sentinels and excellent model organisms for the study of hormone action. TH is the sole hormone that causes amphibian metamorphosis. Our lab has developed an assay to rapidly screen for EDC-like effects in complex mixtures such as wastewaters in *Rana catesbeiana* tadpoles using the cultured tailfin (C-fin) assay. The C-fin assay uses eight, functionally athyroid, premetamorphic tadpoles. Six 4-mm tailfin biopsies are collected from each tadpole and placed into tissue culture wells containing serum-free medium. Each biopsy is then exposed to different treatment conditions of various wastewater concentrations in the presence or absence of TH. After 48 h, the biopsies are collected, the RNA is isolated, and quantitative real time polymerase chain reaction (QPCR) is performed. mRNA transcript abundance of TH-target genes (TH-receptors alpha and beta – *thra* and *thrb*) and stress responsive genes (superoxide dismutase – *sod*, catalase – *cat*, and heat shock protein 30 – *hsp30*) is analyzed. We used the C-fin assay to compare the potential TH-disrupting and stress-inducing effects of real municipal wastewater from successive levels of the City of Guelph's municipal wastewater treatment plant. Influent, primary treated, and secondary treated (conventional activated sludge) waters were analyzed using the C-fin. Our results detected TH-disrupting effects and modest stress induction in influent and primary treated effluents that were abated by secondary treatment.

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OCCURRENCE AND TRANSPORT OF SELECTED TRACE METALS IN THE COEUR D'ALENE AND SPOKANE RIVER BASINS, IDAHO AND WASHINGTON

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Mining and ore-processing activities conducted since the late 1800s in the South Fork Coeur d'Alene River (SFCDR) Basin have altered the water quality, aquatic biological, and hydrologic conditions in the 6,680-mi^2 Spokane River Basin of northern Idaho and eastern Washington. Historical ore-processing activities resulted in large quantities of metal-rich tailings that were placed in and along streams. The tailings have produced, and continue to produce, trace-metal-contaminated water and extensive deposits of trace-metal-contaminated sediment throughout the SFCDR Basin, the channel and flood plain of the main-stem Coeur d'Alene River and the lakebed of Coeur d'Alene Lake. Annual

snowmelt runoff, frequent rain-on-snow events, and occasional floods continue to transport and redistribute trace-metal-contaminated sediments throughout the Coeur d'Alene Basin and into the Spokane River of eastern Washington. With funding from the USEPA, the U.S. Geological Survey implemented a network of surface water monitoring stations in the Coeur d'Alene Basin as part of a Basin Environmental Monitoring Program (BEMP). The monitoring program provides data to assess long-term status and trends of surface water conditions in the Basin, evaluate the effectiveness of remedial actions in the Basin, and improve understanding of sources, sinks, and transport of trace metals in the Basin.

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EFFECTS OF CD, PB, ZN AND THEIR MIXTURES TO AQUATIC LIFE IN THE SOUTH FORK COEUR D'ALENE RIVER, IDAHO

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Cadmium (Cd), lead (Pb), and zinc (Zn) are elevated in the South Fork Coeur d'Alene River (SFCdAR) in northern Idaho. The apparent responses of fish and invertebrates in aquarium tests and in the field to these metals differed. In acute testing with Cd and Zn, resident cutthroat trout and shorthead sculpin were roughly similar to each other in sensitivity, and the sculpin and trout in turn were about 10X more sensitive than invertebrates to Cd and Zn. The mean cutthroat trout EC50÷2 was used to define thresholds of toxicity for cutthroat trout that provide comparative benchmarks for other responses. Relative to these cutthroat trout toxicity benchmarks, hints of decline in total benthic macroinvertebrate taxa richness and abundances of selected metals intolerant taxa occurred at sites with mean Cd or Zn concentrations at about 0.3X the cutthroat trout based thresholds. Despite apparent initial declines in these metrics at very low Cd or Zn concentrations, major declines did not appear until Cd or Zn reached at least 2X the cutthroat-trout based thresholds. Sculpin had a dramatic all-or-no effect pattern relative to Cd or Zn concentrations. At sites with mean Cd or Zn concentrations <1X the cutthroat trout acute toxicity thresholds, sculpin invariably dominated the fish collections; at sites with only slightly greater than 1X the Cd and Zn thresholds, sculpin were absent. In contrast, no declines in cutthroat trout abundance were obvious until about 5X the cutthroat trout acute toxicity thresholds. This disparity is attributed to life history differences and possibly different chronic sensitivities between the sculpin and trout. In the SFCdAR, Zn and Cd occur in mass ratios close to 150:1, which is also close to the mass ratio of Zn to Cd EC50s with trout. This makes attributing primary effects to Cd vs. Zn difficult. The patterns with field data suggest that Cd+Zn toxicity is less than additive on a concentration addition basis, an observation supported by toxicity testing with cutthroat trout.

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BENTHIC INVERTEBRATE RESPONSE TO HEAVY METAL CONTAMINATION IN THE PANTHER CREEK DRAINAGE (IDAHO): A CASE STUDY USING MCGUIRE'S METAL TOLERANCE INDEX.

Lester, G.T.

Heavy metal discharges from legacy mining activities in the Panther Creek drainage (Idaho) continue to impact water quality. Benthic invertebrate sampling at several sites in this drainage yielded diagnostic results attributable to heavy metal contamination. A Metal Tolerance Index (MTI) developed in the Clark Fork River (Montana) was tested in the Idaho drainage. Results showed that the MTI was correlated with copper concentrations within the drainage. Dilution of copper concentrations in a downstream direction was identified by the benthic invertebrate community MTI score. Results of this study suggest that this index may be applicable to other western streams experiencing similar contamination issues.

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PREDICTING TOXICITY OF FRESHWATER SEDIMENTS IN AREAS IMPACTED BY MINING WASTES

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Developing sediment quality criteria for predicting toxicity in freshwater sediments is more challenging than in marine environments, because there is less geochemical buffering. Metals, in particular, have widely varying biological availability in environments that can range from acid to alkaline, from oxic to anoxic, and from organic-rich and fine-grained to the coarse sands of the lower Columbia River. These challenges are exacerbated in mining areas, where metals may be in much more or less bioavailable forms than normal when associated with mining wastes and where background concentrations of many metals may be high. The Department of Ecology has developed new freshwater sediment criteria for predicting benthic toxicity, recently promulgated as part of the revisions to the Sediment Management Standards. A multivariate model was developed to optimize the criteria state-wide, using a large field-collected data set of synoptic chemistry and bioassay data. To address questions raised during the peer review and public review process, Ecology conducted a series of analyses to assess the ability of these criteria to predict toxicity at various scales (from individual stations to large geographical areas) in areas impacted by mining activities. A particular focus was substantially higher criteria concentrations for Cu, Pb, and Zn established by the multivariate model compared to existing sediment quality values (e.g., TECs/PECs). The results of these analyses demonstrated that the results of the multivariate model performed equally well at identifying areas that were toxic (similar false negative rate), while avoiding identifying areas that were actually non-toxic (lower false positive rate) compared to existing values. However, in areas heavily impacted by mining (e.g., areas with substantial slag in the sediments), none of the sediment quality values performed as well as would be desired for regulatory purposes. Possible reasons for this disparity and alternative approaches to assessing these sites will be discussed.

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PRE-EXPOSURE TO HEAVY METAL POLLUTION AND THE ODOR OF PREDATION REDUCE THE ABILITY OF SNAILS TO AVOID STRESSORS

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Many organisms appear to exhibit adaptive cost/benefit behaviors that balance foraging, safety, and pollution avoidance. However, what if the cognitive facilities needed to make these decisions are compromised by industrial pollutants; are the resulting decisions altered? Similarly, does exposure to kairomones from predators alter an organism's ability to avoid toxicants? Further, how long an exposure is necessary - a few minutes, hours, a lifetime? We wondered if there was an interaction between the ability to respond to a predatory event and the ability to avoid heavy metals. We examined the aquatic pulmonate snails *Physella columbiana* and *Lymnaea palustris* that are found in the Coeur d'Alene drainage of northern Idaho State downstream from arsenic, cadmium, lead, and zinc mines. We sought to determine: 1) If short-term prior exposure to predator odor affected a snail's ability to detect metals, 2) If short-term prior exposure to heavy metal pollutants affected a snail's ability to detect fright odor, and 3) If fright response (avoidance) declined as a function of time. We found that a brief exposure to heavy metals impaired the snails' ability to avoid predacious cues, and a brief exposure to predacious cues impaired their ability to avoid a stream of heavy metal-treated water. These results have important ecological ramifications in that the concentrations of heavy metals that we used are even below levels found in the Coeur d'Alene drainage. Snails that have recently encountered evidence of predation may not be able to detect and/or move away from concentrations of heavy metals that they are normally capable of detecting. Similarly, heavy-metal exposure may impair antipredatory behaviors.

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UPPER COLUMBIA RIVER SITE: EARLY FINDINGS OF THE ECOLOGICAL RISK ASSESSMENT

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The Upper Columbia River (UCR) site extends for 150 miles of the Columbia River, between the Grand Coulee Dam and the U.S. – Canadian border. Although the UCR site receives the drainage from the Coeur d'Alene basin via the Spokane River, the major source of metal contamination is one of North America's largest smelters, located on the Columbia River nine miles north of the U.S. – Canadian border in Trail, British Columbia. Both the river and surrounding upland areas are under evaluation in the study. Within the Columbia River, the UCR consists of the large reservoir behind Grand Coulee Dam (Lake Roosevelt), and an approximately 40 mile stretch of river between the lake and the Canadian border. The site is unusual among hazardous substance sites in that it is not formally listed on the National Priorities List, but instead is being evaluated under a three party settlement agreement. Remedial investigation / feasibility study work at the site is being performed using the same guidance and procedures used at Superfund sites. Samples collected and evaluated to date include sediments, surface water, fish, sediment toxicity samples, and beach sediments. Contaminants of potential concern in the UCR include arsenic, cadmium, copper, lead, mercury, and zinc, as well as other chemicals including dioxins, furans, and PCBs. Findings to date indicate that metal concentrations in sediment and toxicity to benthic invertebrates tend to be highest in the riverine portion of the site, lower in Lake Roosevelt. Metals in fish tissue are also higher in the riverine portion of the site, or in demersal species such as largescale sucker, and lower in pelagic species from Lake Roosevelt such as kokanee. Future sampling includes additional sediment and benthic toxicity tests, sediment porewater analyses, and upland soil sampling.

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Poster Presentation Abstracts

AN UPDATE TO THE WASHINGTON STATE DEPARMENT OF ECOLOGY'S EVALUATION OF A BENTHIC SEDIMENT BIOMASS ENDPOINT

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The Washington State Department of Ecology (Ecology) has recently updated its Sediment Management Standards (SMS). During this review process, standards for conducting freshwater-sediment bioassays with benthic invertebrates and their interpretation criteria were adopted that utilized the endpoints of mortality and growth for *Hyalella azteca* and *Chironomus dilutus*. Comments received during the rule-making process recommend Ecology consider a biomass endpoint calculated from mortality and growth for *H. azteca* and *C. dilutus*. As a result of this recommendation, Ecology has initiated an evaluation of the biomass endpoint derived from paired growth and mortality data for *H. azteca* (28-day) and *C. dilutus* (10-day). Ecology will assess the different formulae for calculating biomass and the appropriate statistical methods for comparing test sediments to control or reference. The data to be used in this evaluation is the same that was used to develop the recently adopted freshwater sediment chemical and biological criteria. This includes approximately 520 paired *C. dilutus* (10-day growth and mortality) and 75 paired *H. azteca* (28-day growth and mortality) stations. Outcomes for growth, mortality and biomass will be compared and differences between the endpoints will be explored to discern the basis for these and the benefits each endpoint provides. Based on these determinations, Ecology will determine next steps regarding potential use of the biomass endpoint among the other tools for assessing toxicity in freshwater sediments. The results of this endpoint evaluation will be presented at a Sediment Management Annual Review Meeting which provides the public review process for the State's sediment management program.

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THE EFFECTS OF CURRENT-USE PESTICIDES ON EARLY DEVELOPMENTAL SUCCESS, TIMING AND GROWTH TO THE HATCH STAGE OF SOCKEYE SALMON (*ONCORHYNCHUS NERKA*)

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The steady decline of Fraser River sockeye salmon (*Oncorhynchus nerka*) stocks over the last two decades has been an issue of special concern to British Columbians. Stock declines continue to be closely monitored and are generally considered a cumulative result of a number of factors, including the effects of contaminants such as pesticides on many aspects of salmonid fitness. To examine the effects of two current-use commercial formulations of atrazine and chlorothalonil on the early-life stages of sockeye salmon, eggs and milt were collected from wild spawning adults and incubated at Simon Fraser University, sustaining constant exposure to either a high or low, environmentally relevant concentration throughout development. The effects on success to the eyed and hatch developmental stages, as well as the difference in time to hatch of the treatment groups will be presented. Physical growth at the hatch stage will also be compared among treatment groups, accompanied by measured triglyceride and protein levels in alevin at this stage to provide further insight into growth and future growth potential. Examining the developmental success of early-life stages exposed to current-use pesticides provides important

insight into understanding how these aquatic contaminants may affect populations of sockeye salmon and how to ensure effective species protection.

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2011 SEDIMENT QUALITY ASSESSMENT OF THE SOUTH PUGET SOUND REGION AND BUDD INLET, INCLUDING COMPARISONS WITH 1999 REGIONAL CONDITIONS

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Sediments were sampled throughout South Puget Sound in 2011 for characterization of current sediment quality region-wide and for comparison with 1999 South Puget Sound baseline conditions. Samples were also collected in Budd Inlet for determination of a sediment quality baseline in that bay. Analyses were conducted for over 130 chemical contaminants, two toxicity tests, and to characterize sediment-dwelling invertebrate community structure. Ecology's new Chemistry Index and Toxicity Index values were calculated for each station, for the South Sound region, and for Budd Inlet. Regional Chemistry Index values for 1999 and 2011 and for Budd Inlet 2011 all surpassed the target value of the new Puget Sound Partnership Sediment Quality Dashboard Indicator, indicating high sediment quality with respect to contaminants. The regional values did not differ significantly between years. The Chemistry Index value for Budd Inlet for 2011 was slightly lower than that for the region. Chemistry Index results were categorized as "minimum exposure" at the majority of regional and bay stations, and as "low exposure" at a small number of stations at the heads of Budd Inlet and Shelton Harbor. No 2011 chemical concentrations exceeded the Washington State Sediment Quality Standards at either the regional or bay-wide scale, meeting the Dashboard Indicator target value for that measure, an improvement from 1999. The incidence and spatial extent of Toxicity Index values increased significantly region-wide from 10% of stations, representing 3% of area, in 1999 to 56% of stations, representing 52% of area, in 2011. The Toxicity Index for Budd Inlet in 2011 categorized 93% of stations and area as toxic. Thus, the indications of sediment quality in South Puget Sound and Budd Inlet in 2011 are mixed, with low contamination by priority pollutants, but considerable toxicity.

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ANALYSIS OF POLLUTANTS IN THE HIGH ALPINE AQUATIC SYSTEMS OF THE CORDILLERA BLANCO MOUNTAIN RANGE OF CENTRAL PERU

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Rapid development of open-pit mining activities in the Andes in Peru has prompted concerns about their impacts to the alpine ecosystem. Metals and other contaminants can potentially reach higher-altitude alpine snow and surface waters by wind deposition. Furthermore, low hardness levels typical in snow can cause metals to be more toxic to aquatic organisms when snow melts and enters streams and lakes; this is particularly problematic when the melt water carries metals. Snow, stream, and lake samples collected from the Cordillera Blanco Mountain Range in 2012 are currently being analyzed. Parameters include dissolved organic carbon, metal and anion concentrations. This work will provide a picture of the environmental chemistry and the extent of metal contamination in potentially impacted sites. Peruvian scientists and managers will also be able to use this data to make informed decisions on land use policies and natural resource management.

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INVESTIGATION OF BIOCHEMICAL RESPONSES OF LICHENS TO AIR POLLUTANTS ORIGINATING FROM TRAINS IN NORTHWESTERN WASHINGTON.

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There is little scientific data regarding the biological effects of air pollution originating from train traffic. With the potential development of North America's largest coal shipping terminal just north of Bellingham, Washington, train traffic in Whatcom County is likely to increase. A study utilizing transplanted lichens was conducted using a gradient approach with samples deployed at increasing distances away from the Chuckanut rail corridor in Whatcom County. Lichens of the species *Ramalina farinacea* were collected from Sehome Hill Arboretum in Bellingham, WA and subsequently deployed in October 2012. Samples were recollected from the field after five months. Accumulated metal concentrations since the start of deployment as well as oxidative stress and chlorophyll degradation assays are currently being assessed for each sample. Oxidative stress due to interactions between cellular components and certain pollutants, such as heavy metals, is being quantified by measuring concentrations of malondialdehyde (MDA), a breakdown product of lipid peroxidation. Phaeophytin, a degradation product of chlorophyll, is being measured to evaluate the extent of chlorophyll degradation by using the ratio OD435 nm/OD415 nm (chlorophyll *a* to phaeophytin *a*). Completed results will be presented. The results of these analyses can help characterize local air quality by quantifying pollution exposure in transplanted lichens as well as show effects associated with the observed exposure.

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CAPTURING A SIGNAL: MERCURY BIOACCUMULATION THROUGH FOOD-WEBS IN REMOTE ALPINE LAKES

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Mercury (Hg) contamination is a global conservation threat to freshwater ecosystems, commonly detected in even the most pristine remote lakes of Olympic National Park (ONP). Mercury contamination in alpine lakes can impair the health of sensitive ecological communities already subjected to multiple stressors, such as climate change and non-native fish introductions. The pathway of Hg bioaccumulation in lake systems is dependent upon many factors, including atmospheric deposition, wetting-drying cycles, primary productivity, and food web structure. Food web structure is particularly important in systems that have introduced species because of changes in energy flow and trophic linkages. In order to study these changes we are measuring Hg bioaccumulation in alpine lakes across ONP to evaluate the effects of fishes on Hg bioaccumulation in historically fishless lakes. We hypothesize that the effect of non-native trout species will rearrange the food-web structure by altering trophic levels, energy flow, and thus Hg bioaccumulation. Specifically, introduced fish compete with native amphibians for their prey base, forcing amphibians to change their foraging ecology. As result, we predict Hg to be different in amphibian species in fish-containing lakes versus fishless lakes. To address these questions, we have sampled organisms spanning multiple trophic levels from numerous lakes in ONP, where fish are either present or absent. Preliminary data indicate that Hg levels in fish from ONP are at or near human health consumption advisory. Additionally, we have developed a nonlethal index of salamander whole body Hg concentrations using tail clips, reducing the need for future destructive sampling. Ultimately, we plan to compare food web structure and energy flow in these lakes using stable isotope analysis and calorimetry. We anticipate that our results will help resource managers better evaluate the potential impacts of Hg and non-native fishes on aquatic communities and will facilitate conservation of these important ecosystems.

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INVESTIGATING HOWE SOUND WATER QUALITY POST-INDUSTRIAL ACTIVITY USING A GIANT KELP (*MACROCYSTIS PYRIFERA)* TOXICITY ASSAY

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The objective of this study was to examine the chronic toxicity of seawater collected from sites adjacent to historical mining and pulp mill operations to zoospores and embryonic gametophytes of giant kelp, *Macrocystis pyrifera*. Shore seawater samples were collected at two locations, Britannia Mine and Darrell Bay, within Howe Sound, British Columbia, a 43 km long fjord that opens into the Georgia Strait. Howe Sound was selected for this study due to the availability of historic intertidal biodiversity data along pollution gradients from the Woodfibre pulp mill (active 1920-2006, adjacent to Darrel Bay) and the Britannia copper mine (active 1905-1974, reclamation 2001-08). Dilutions of seawater collected from Britannia mine (100, 80, 60, 30, 20%) and a single undiluted seawater sample collected from Darrell Bay were tested in the 48 hour Giant kelp Germination and Germ-Tube Growth Test Method (USEPA). A significant decrease in % germination of gametophyte spores (range: 25-53%) in a concentration

dependent manner was observed for the Britannia Mine seawater dilutions tested compared to the control seawater sample. The undiluted Darrell Bay seawater sample also resulted in a significant decrease in % germination of gametophyte spores (56%) relative to the control seawater. These results support the previously established pollution gradients based on intertidal biodiversity surveys that indicated significant reductions in intertidal biodiversity near the Britannia mine and Woodfibre pulp mill. In addition, these studies suggest that persistent water-borne contaminants associated with these historic industrial activities may be important factors impeding the recovery in biodiversity of these areas.

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INVESTIGATION OF GENE EXPRESSION IN THE LIVERS OF HATCHERY-RAISED CHINOOK SALMON (*Oncorhynchus tshawytscha*) AND RESIDENT CUTTHROAT TROUT (Oncorhynchus clarki) IN THE STILLAGUAMISH WATERSHED

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Emergent contaminants and toxicants are unregulated, potentially toxic substances discharged to aquatic or terrestrial ecosystems via human activities (e.g., in wastewater effluent, urban and agricultural runoff). The abundance and effects of these are poorly understood and are studied here for their endocrine-related effects in fish. The objectives of this study are to determine the strongest physiological signals expressed in the gene response and evaluate if any of those responses were predictable after reviewing chemical exposures in water and fish tissue. In support of this, gene expression was measured in liver tissue after in situ exposures to emergent contaminants at various sites throughout the Stillaguamish river watershed, Washington. In year one, juvenile, hatchery-reared Chinook salmon were housed in stationary cages for 28 days at four sites representing varied contaminant exposures. In year two, feral resident Cutthroat trout were sampled by electroshocking from the same select sites. Polar organic chemical integrative samplers (POCIS) were used in both years of the study to quantify chemical concentrations and presence at the same sites. Liver, gallbladder, and blood plasma samples were collected from fish and used for chemical and physiological measurements. Polyaromatic hydrocarbons (PAHs) metabolites were evaluated in composite gall bladder tissues from the caged Chinook salmon; however, most analytes were not detected above the reporting limits of 6-22 ng/mL. Vitellogenin (Vtg) was assessed in blood plasma from male cutthroat trout, but showed few measurable detections. cDNA microarray technology was used with RNA extracted from the liver tissues. Analyses are still in progress, but preliminary results suggest weak responses, relative to the controls, and similar gene response patterns from caged Chinook and free-swimming cutthroat trout.

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ACUTE SENSITIVITY OF FRESHWATER MUSSELS TO SELECT CHEMICALS WITH VARIOUS TOXIC MODES OF ACTION

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The objectives of this ongoing study are (1) to evaluate sensitivity of several species of mussels, snails, and commonly tested invertebrate species in acute water exposures with 10 chemicals (Tier 1 testing), and (2) to "screen" acute sensitivity to additional chemicals with a commonly tested mussel species (Tier 2 testing). We describe the Tier 1 testing with mussels selected to be representative of four tribes of the family Unionidae widely distributed in the midwestern and the southeastern United States, and the family Margaritiferidae from the Pacific Northwest. The chemicals were chosen based on the US Environmental Protection Agency (USEPA) ambient water quality criteria (AWQC), availability of toxicity data for non-mollusks, other non-unionid mollusks sensitivity to the chemicals, and toxic mode of action. The EC50s for each of the 10 Tier 1 chemicals generally differed by less than about a factor of 2 among the different mussel groups. Species mean acute values for mussels based on the current study and previous studies were mostly in the lower 30th percentiles of the species sensitivity distributions for all tested chemicals, except for metolachlor. The ranks of mussels from different groups were generally similar in the species sensitivity distribution. The ammonia, sodium chloride, and nickel EC50s for mussels were about equal to or less than the final acute value used to derive USEPA AWQC. Preliminary indicate that (1) mussels representing different tribes or families have similar sensitivity to the tested chemicals despite differing toxic modes of action, (2) mussels are sensitive to 9 of the 10 tested chemicals, (3) the AWQC may not be protective of mussels from acute exposures of ammonia, chloride, and nickel, and (4) AWQC may need to be derived or updated for sodium chloride, potassium chloride, and sulfate, common pollutants to which mussel are sensitive.

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SILVER CONCENTRATION DETECTION WITH MODIFIED ENVIRONMENTAL FACTORS USING ION SELECTIVE ELECTRODES

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Silver nanoparticle (AgNP) toxictity to several aquatic organisms has been studied. Currently, there is not a consensus as to whether the free ion silver (Ag+) or the AgNP in an aquatic system is responsible for measured toxicity. Predictions as to whether a sample is toxic are reliant on this understanding. The predictions are further complicated in natural waters by presence of natural organic matter (NOM). An Ion Selective Electrode (ISE) was used to determine the percent of Ag+ in water samples with and without fulvic acids (a model NOM). The change in Ag+ was also assessed over a 48 hour period and in light and dark conditions. The results are used in support of a related study on the toxicity of the AgNP to *Daphnia magna* under the same environmental conditions. The ISE results will be reported here.

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WATER COLUMN ACCUMULATIVE MONITORING USING MUSSELS AND PASSIVE SAMPLERS

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Traditional water column monitoring using discrete sampling methods can only provide a snapshot of the conditions. This data not only suffers from significant fluctuations associated with tides and currents, but is unique and non repeatable. Even a well planned program using multiple samples taken over one or more tide cycles does not provide the best data set to represent the water quality in the receiving environment being studied. Monitoring of marine near-shore areas in and around receiving environments can be performed using specially designed caged mussel moorings. These mussel moorings can be augmented with accumulative non-biological samplers designed to target specific contaminants in the water column. This accumulative monitoring mooring provides continuous, time-averaged data for water column monitoring. Using mussels in combination with standard chemical and physical analysis provides information about the biological effect of contaminants in receiving water. Mussels *Mytilus trossulus*, a key species in marine intertidal communities on the Canadian west coast and is prone to a blood cell disorder called haemic neoplasia, which is at least in part associated with environmental conditions and which develops much faster than human cancers and cancers in model organisms. Including cancer-related biomarkers in environmental monitoring programs is important to provide early warning of potential population-level changes and health risk. We discuss a suite of analysis methods, that combines standard tests and newly developed methods that are designed to provide comprehensive and repeatable data set for environmental impact assessment in the case of either newly proposed facilities or existing facilities that discharge into the marine environment.

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EFFECTS OF PYRETHROID SINGLE-PULSE EXPOSURE ON THE SWIMMING PERFORMANCE OF JUVENILE RAINBOW TROUT (*Oncorhynchus mykiss*)

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Growth in agricultural practices has led to a continuous increase in the use of pesticides worldwide and a preference for using less persistent and toxic products. Synthetic pyrethroids are such an option, owing to their high efficacy, biodegradability and low toxicity to both birds and mammals; albeit fish appear to be highly sensitive to these compounds. The main mode of action of pyrethroids is neurotoxic, and so physiological functions that rely heavily on a properly functioning nervous system (e.g. swimming

performance) may be affected at low pyrethroid concentrations. Due to the contamination of the aquatic environment by agricultural and domestic wastes, the aim of this study was to evaluate the effects of varying concentrations (0.0, 0.06 µg/L, 0.12 µg/L and 0.17 µg/L, which corresponds to 0, 20, 40 and 60% of the 96-h LC50 value, respectively) of the pyrethroid insecticide lambda-cyhalothrin on the swimming performance of juvenile rainbow trout. Fish were exposed to a single pulse of each concentration for 48 h in a static exposure system. Swim trials were performed immediately following exposure to assess both critical (Ucrit measurement) and burst (Umax measurement) swimming speeds. At all pyrethroid concentrations, Ucrit was impaired in a concentration-dependent manner, resulting in decreases in Ucrit of 10%, 15% and 23%, respectively. Umax was not affected by lamba-cyhalothrin exposure at any of the concentrations tested. The reductions caused by lambda-cyhalotrhin exposure in critical swimming speeds are significant sub-lethal effects, even though the burst swimming was not decreased, and could influence several parameters relating to fish swimming that could directly impact species fitness.

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EVALUATING THE EFFECTS OF ANTIHISTAMINES ON AN AQUATIC SNAIL, *LYMNAEA STAGNALIS*

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The concentration of antihistamines, found in our natural water sources, are currently rising due to the lack of removal methods at waste water treatment facilities. The goal of this research is to establish the environmental and toxicological affects that elevating Benadryl (diphenhydramine HCl) and Zyrtec (Cetrizine dihydrochloride) levels may present. Aquatic snails were chosen as a model species because of their threatened status. The LC_{50} of Benadryl was calculated to be 77.41 mg/L. and for Zyrtec, the LC_{50} was between 460mg/L and 500mg/L. When observed in mixture, the presence of both antihistamines appeared to be protective against acute toxicity. Currently, water and snail tissue samples are being analyzed to determine antihistamine loads. Methodology is being developed using a GC-FID for analysis and SPE extractions devices for sample cleanup.

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