Program and Abstracts

17th Annual Meeting of the Pacific Northwest Chapter of the Society of Environmental Toxicology and Chemistry (PNW-SETAC)

Mary's Peak from Corvallis

Oregon State University
CH2M Hill Alumni Center
Corvallis, Oregon
March 27-29, 2008

PNW-SETAC ANNUAL MEETING

March 27 to 29, 2008

Meeting Program

PNW-SETAC Chapter
Meeting Program

Thursday, March 27, 2008

12:00 PM - 6:00 PM	Conference Check-in, Foyer of Alumni Center (after 6:00 PM, check-in at Hilton Garden Inn University Club)
1:00 PM - 5:00 PM	Short Course: *"The Biotic Ligand Model,"* Conf. room 111, Alumni Center
5:00 PM - 9:00 PM	On-site Housing Check-in, Cauthorn Hall (5:00-6:00 and 8:00-9:00)
6:00 PM - 7:00 PM	PNW-SETAC Board Meeting, Hilton Garden Inn University Club
6:00 PM - 9:00 PM	Welcome Reception, Heavy Appetizers & Libations, Hilton Garden Inn University Club

Friday, March 28, 2008

7:30 AM - 8:30 AM	Conference check-in, poster setup, Foyer of Alumni Center
7:30 AM - 8:30 AM	Continental Breakfast (all attendants), Conf. Room 110B, Alumni Center
8:30 AM - 9:00 AM	Welcome address, Conf. Room 110A, Alumni Center
9:00 AM - 12:00 PM	Platform sessions with 20-30 min break for refreshments and poster viewing
12:00 PM - 1:30 PM	Buffet Lunch, Conf. Room 110B, Alumni Center
1:30 PM - 5:00 PM	Platform sessions with 20-30 min break for refreshments and poster viewing
5:30 PM - 8:30 PM	River Front Experience! Iovino's Restaurant, Downtown Corvallis (round trip shuttle service from campus)

Saturday, March 29, 2008

7:20 AM - 8:20 AM	Continental Breakfast (all attendants), Conf. Room 110B, Alumni Center
7:20 AM - 8:20 AM	PNW-SETAC Business Meeting, Conf. Room 110B, Alumni Center
8:20 AM - 12:00 PM	Platform sessions with 20-30 min break for refreshments and poster viewing
10:10 AM - 10:40 AM	Student Award Presentations
12:00 PM	Adjourn

PNW-SETAC

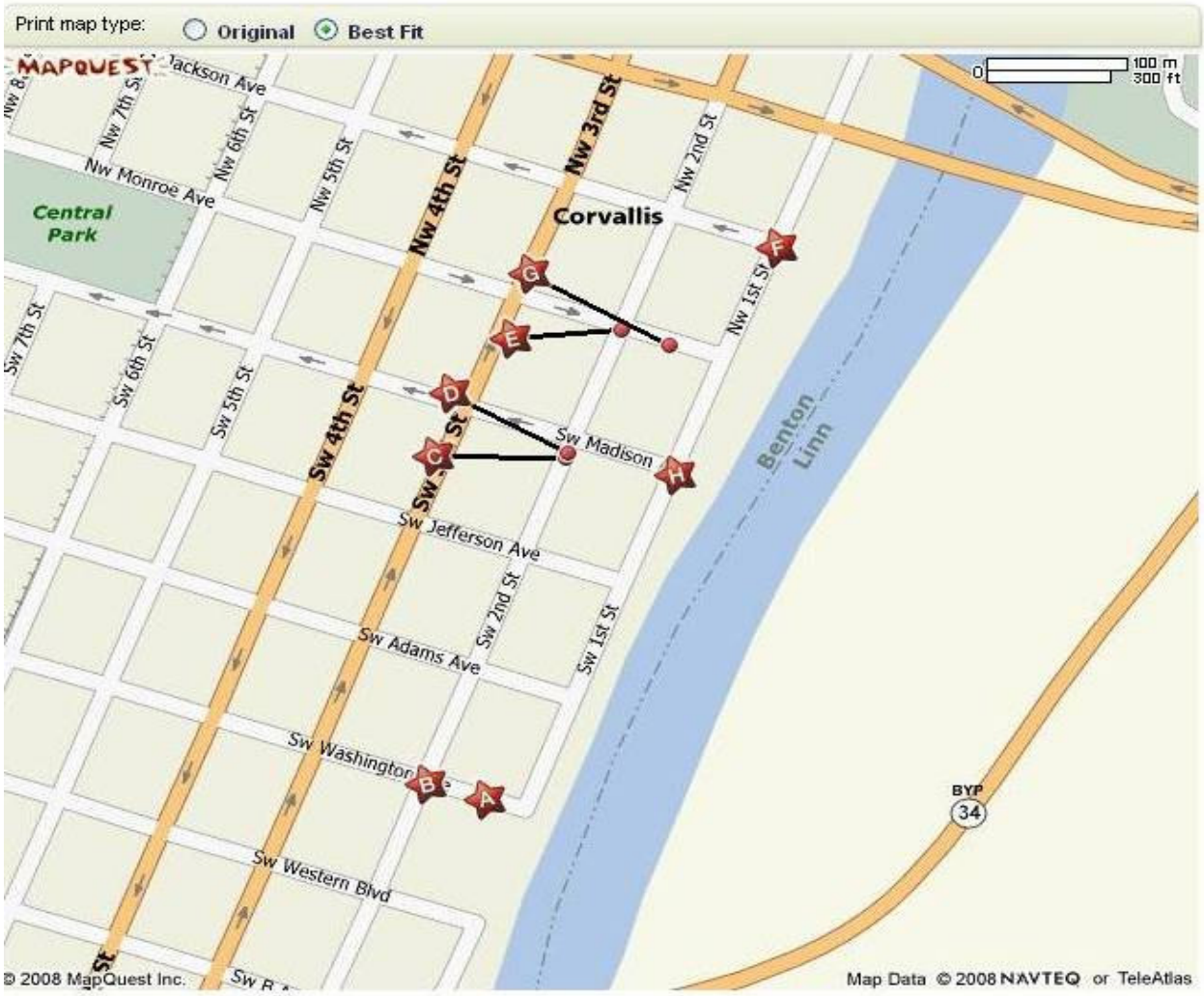
Acknowledgements

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

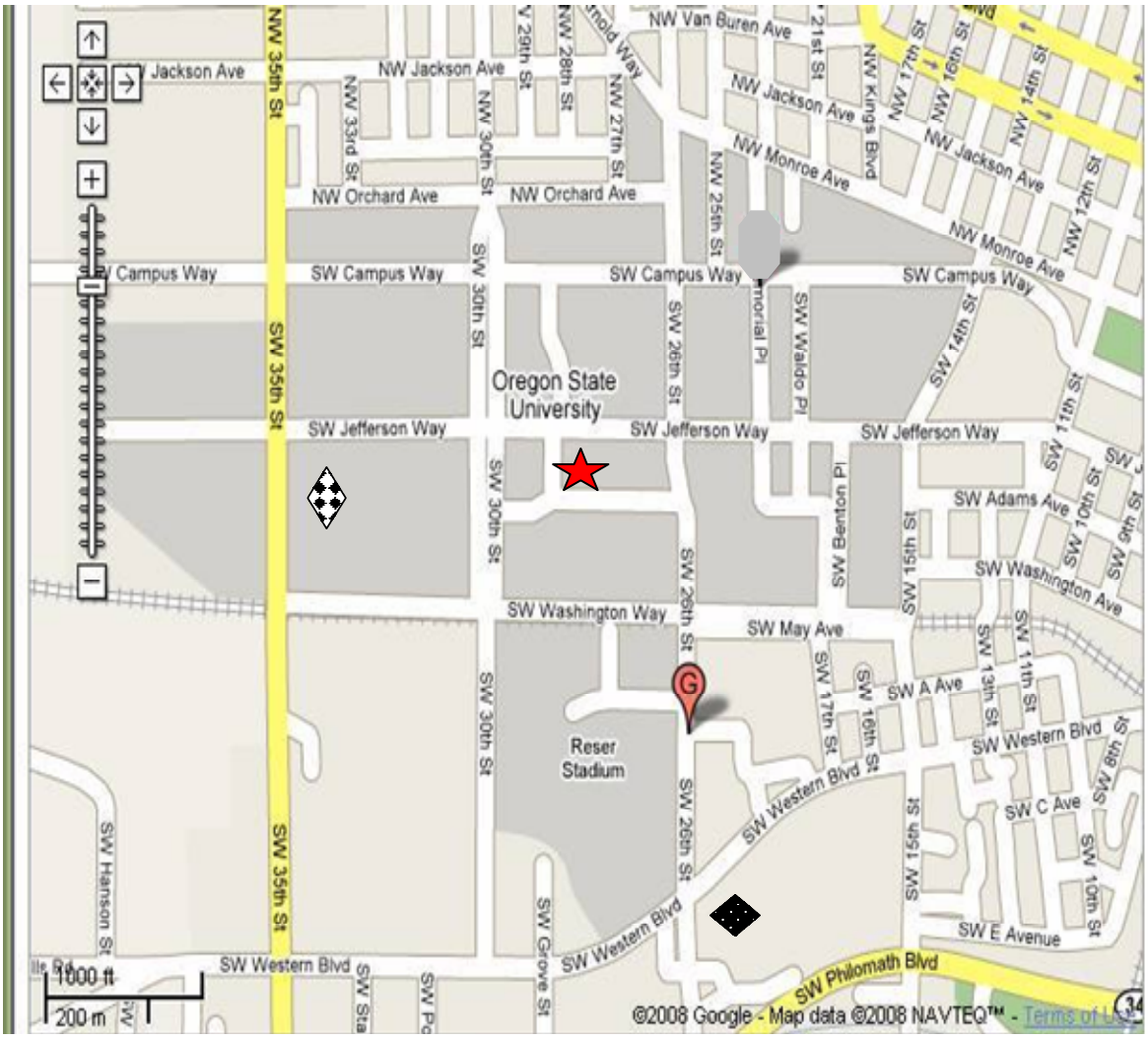
Conference Organization:	Eric Van Genderen, Parametrix Wendy Hillwalker, Oregon State University
Abstract Review:	Carrie Smith, Parametrix Jeff Wirtz, Parametrix
Meeting Program:	Carrie Smith, Parametrix Jeff Wirtz, Parametrix
Meeting Registration:	Tom Gries, Washington Department of Ecology
Volunteer Coordinator:	Kara Warner, Oregon State University
Sponsorships:	Taku Fuji, Kennedy Jenks
Student Awards:	Karen Watanabe, Oregon Graduate Institute
Session Chairs:	Robert Tanguay, Oregon State University Julann Spromberg, NOAA Fisheries MaryAnn Rempel-Hester, Nautilus Environmental
Student Funding Application Reviews:	Bob Gensemer, Parametrix
Cover Photograph:	Meg Sodano, Sodano Art

RIVER FRONT EXPERIENCE

A:Iovino's: 136 SW Washington Ave. Corvallis, OR 97333
B: Beanery: 500 SW 2nd St, Corvallis, OR 97333
C: Crowbar: 214 SW 2nd St, Corvallis, OR 97333
D: Francesco's: 208 SW 2nd St, Corvallis, OR 97333
E: Squirrels Tavern: 100 SW 2nd St, Corvallis, OR 97333
F: Big River Restaurant & Bar: 101 NW Jackson Ave, Corvallis, OR 97330
G: Sahalie Wine Cellar: 151 NW Monroe Ave # 101, Corvallis, OR 97330
H: Fox & Firkin: 202 SW 1st St, Corvallis, OR 97333



OSU CAMPUS MAP



◆ = Hilton Garden Inn ★ = Cauthorn Hall G = CH2M Hill Alumni Center

PNW-SETAC Annual Meeting
Platform Presentation Schedule
Friday, March 27, 2008

Friday Morning (March 27, 2008))

Session Chair: Robert Tanguay, Oregon State University

Developmental Toxicology / Zebrafish Model

9:00	Wendy Hillwalker, Oregon State University	Human Health Assessment Approach Bridges Environmentally Relevant Contaminant Mixtures and Zebrafish Developmental Toxicity Model
9:20	Lisa Duong, Oregon State University	*In Vivo* Assessment of Perfluorinated Chemicals (PFC's) Induced Developmental Toxicity using Embryonic Zebrafish
9:40	Katerine Schletz Saili, Oregon State University	Toxicity Associated with Leflunomide Exposure in Early Life Stage Zebrafish (*Danio rerio*)
10:00	Abby Benninghoff, Oregon State University	Multiple Perfluoroalkyl Acids Enhance Aflatoxin B1-Initiated Hepatocarcinogenesis in Rainbow Trout via Possible Estrogen-Like Mechanism of Action
10:20	**Break/Poster Viewing**	

Biomarkers

10:40	Aurea C. Chiaia, Oregon State University	Determination of Illicit Drugs and Human Biomarkers by Large Volume Direct Injection HPLC/MS/MS: A New Tool for Drug Epidemiology
11:00	Ashley Schneider, Lewis-Clark State College	Biomarkers of Organophosphate Exposure and Effect in *Lumbricus terrestris* and *Eisenia foetida*
11:20	Patrick Moran, U.S. Geological Survey	Tissue Contaminants and Associated Transcriptional Response in Trout Liver from Remote High Elevation Lakes of Western Washington, USA
11:40	Christian Grue, University of Washington	Using Tissue Concentrations for Correlating Known Exposures of Imidacloprid with Overt Effects in Juvenile Chinook
12:00	**Lunch**	

PNW-SETAC Annual Meeting
Platform Presentation Schedule
Friday, March 27, 2008

Friday Afternoon (March 27, 2008)

Session Chair: Julann Spromberg, NOAA Fisheries

Sediment Contamination and Toxicity

1:30	Gregory Sower, Oregon State University	Use of Passive Sampling Devices to Evaluate the Effectiveness of Superfund Remediation Projects in an Urban River
1:50	Sandra Aasen, Washington Department of Ecology	Ecology's Urban Waters Initiative – Assessing Changes in Sediment Quality in Urban Bays
2:10	Kerri A. Stanley, Oregon State University	Tadpole Exposure to Pesticides in the Mountains of California and Associated Biota-Sediment Accumulation Factors
2:30	Anthony Paulson, U.S. Geological Survey	Contrasting Aqueous Geochemistries of Elements in Contact with Contaminated Sediments from Lake Roosevelt, Washington

2:50 **Break/Poster Viewing**

Modeling Approaches

3:20	Zhenhong Li, Oregon Health & Science University	A Computational Model for Steroid Hormone and Vitellogenin profiles in Unexposed and EE_2-Exposed Male FHMs
3:40	Eric Van Genderen, Parametrix	Validation of Nickel Biotic Ligand Model Predictions for Selected Non-Standard Organisms
4:00	Peter Bryant, Western Washington University	Analysis of the Decline of the Puget Sound Pacific Herring (*Clupea pallasi*) Stocks
4:20	Brad Bessinger, Exponent Consulting	Simulation of Tidal Effects on Contaminant Fate and Transport Near the Sediment-Water Interface

4:40 **Poster Social**

PNW-SETAC Annual Meeting
Platform Presentation Schedule
Saturday, March 28, 2008

Saturday Morning (March 28, 2008)

Session Chair: Mary Ann Rempel-Hester, Nautilus Environmental

Aquatic Toxicology

8:20	Jason Fortner, Western Washington University	Shedding Light on Toxicity Testing: UV Light and PAH-Contaminated Groundwater
8:40	Katherine Palmquist, Exponent Consulting	Effects of Dietary Esfenvalerate Exposures on Three Aquatic Insect Species Representing Different Functional Feeding Groups
9:00	Alexandra de Jong Westman, University of British Columbia	Assessing the Impact of Pesticides on the Survivorship and Development of Different Life Stages of *Spea intermontana* and *Pseuacris regilla*

Emerging Issues

9:20	Jenifer McIntyre, University of Washington	Olfactory-Impairment By Copper Affects Juvenile Salmon Behavior and Survival With Cutthroat Trout Predators
9:40	**Break/Poster Viewing**	
10:10	Student Award Presentations	

Emerging Issues continued

10:40	Fred Tilton, University of Washington	Copper Alters the Transcription of Genes Involved in Normal Olfactory Signal Transduction and Di-Valent Ion Homeostasis Within the Olfactory System of Zebrafish
11:00	Burt Shephard, U.S. Environmental Protection Agency	Copper Effects on Fish Behavior: A Review and Synopsis of Existing Studies
11:20	Stacey Harper, Oregon State University	Comparative Nanotoxicology – Strategies to Evaluate Nanomaterial-Biological Interactions
11:40	Michael Paine, Paine Ledge and Associates (PLA)	Diagnosing and Analyzing Triangular Relationships in Environmental Toxicology
12:00	**Wrap Up**	

PNW-SETAC Annual Meeting
Poster Presentations

Sandra Aasen, Washington Department of Ecology	Relationships Between Sediment Quality, Dissolved Oxygen, and Benthic Invertebrates in Hood Canal
Helle Andersen, Windward Environmental LLC	Assessment of the Bioavailability of Sediment-Associated Metals and Toxicity to Benthic Organisms
Eva Browne, University of Washington	*In Vitro* Hepatic Metabolism of a Brominated Flame Retardant (BDE 99) by Chinook Salmon
Daniel Dugger, Washington Department of Ecology	Marion Drain Intensive Surface Water Sampling for Pesticides in Salmonid-Bearing Streams
Susie Genualdi, Oregon State University	Use of Chiral Signatures of Historic-Use Pesticides in Air and Soil to Apportion Source Regions to the Western U.S.
Basant Giri, Oregon State University	Particle Phase Polycyclic Aromatic Hydrocarbons in the Atmosphere of Raipur, India
Kevin Hobbie, Oregon State University	Protecting the Nation's Food Supply: Use of Chemical Profiling to Determine the Origin of Food Commodities
Rachel Huber, Oregon State University	Semi-Volatile Organic Compounds Measured in Sediment and Tadpole Samples from the Sierra Nevada and California Cascade Mountain Range
Kersensa King, University of Washington	Brain AChE Inhibition in Juvenile Rainbow Trout Exposed to Pesticide Mixtures Within Urban Streams in Western Washington: Reasons for Non-Additive Effects
Kersensa King, University of Washington	Effects of Pesticides in Urban Streams in Western Washington on Coho Salmon Eggs and Sac Fry

PNW-SETAC Annual Meeting
Poster Presentations

Matt Luxon, Windward Environmental LLC	Practical Considerations in Deriving Dose-Response-Based TRVs from the Toxicological Literature
Jenner McCloskey, ENTRIX, Inc.	Seasonal Factors and the Sensitivity of *Mytilus edulis* Embryos to Copper Exposure
Patrick Moran, U.S. Geological Survey	Bioavailability and Toxicity of Metals in Sediments from Lake Roosevelt, Columbia River, Washington USA
Patrick Moran, U.S. Geological Survey	A Nutrient Budget for a Large, Oligotrophic Lake in the Olympic National Park
Jessica R. Murray, Oregon State University	Seasonal Variations of Semi-Volatile Organic Compounds in Urban and Rural China 2002-2003
Debora Morera, Parametrix	Effects of Nickel to Marine Organisms: Compilation of Available Data and Derivation of a Marine PNEC
Edmond O'Donnell, Oregon State University	AH Receptor – An Unknown Target of Immuno-Modulatory Drugs?
Angela Pérez, Oregon State University	DGT-Based Partition Coefficients Reflect Long-Term Metal Accumulation in Soils from Fertilizer Application and are Predictive of Cadmium and Nickel Concentrations in Edible Plant Tissue
Lance Petersen, CDM	Derivation of a Bioassay Based Site-Specific Cleanup Value for Weathered Bunker C-Contaminated Soils
Valerie Pettebone, University of Washington	Utilizing Zebrafish as a Tier One Model for Human Health Concerns: Unraveling the Mechanisms of PBDE Developmental Toxicity
Janet Pickard, CANTEST, Ltd.	The Effect of Artificial Sea Salt Preparation on *Strongylocentrotus purpuratus* Fertilisation Success
James Plante, Western Washington University	Development of a Benthic Index to Assess Metals Contamination Associated with Mining Waste in Canyon Creek (Coeur D' Alene)

PNW-SETAC Annual Meeting
Poster Presentations

Lucas Quarles, Oregon State University	Validation and Modified Methods for Lipid-Free Polyethylene Membrane Passive Sampler
Mary Ann Rempel-Hester, Nautilus Environmental	Uptake of Estradiol by Hornyhead Turbot (*Pleuronichthys verticalis*) and Effects on Oxidative DNA Damage in Gonads
Andrew Ryan, Western Washington University	Development of a Polychlorinated Biphenyl (PCB) Bioaccumulation Model for the Puget Sound, WA Ecosystem
Julann Spromberg, NOAA Fisheries	Estimating the Decline of Wild Coho Salmon Populations Due to Recurrent Die-Offs of Adult Spawners Returning to Pacific Northwest Urban Streams
John Stark, Washington State University	Population-Level Effects of Adjuvant and Pesticide Mixtures to *Ceriodaphnia dubia*
Ian Stupakoff, Integral Consulting Inc.	A Survey of Cadmium in Pacific Oysters (*Crassostrea gigas*) of the United States West Coast: Accumulation Pathways, Subcellular Distribution, and Implications for the Shellfish Industry.
Waverly Thorsen, Exponent Consulting	Using Effective Solubility as an Indicator of the Risk of Oily Soil to Groundwater: The Impact of Weathering
Elizabeth Tobin, Nautilus Environmental	Germination of *Alexandrium catenella* Cysts from Surface Sediments in Quartermaster Harbor, WA
Amber Young, Parametrix	Cobalt: Application of an International Approach for Developing Environmental Criteria/Guidelines/Standards for Metals
Amy Yahnke, University of Washington	Environmental Factors Governing Amphibian Reproduction in Stormwater Detention Ponds

Pacific Northwest Chapter
Society of Environmental Toxicology and Chemistry
(PNW-SETAC)

17th Annual Meeting

Platform Presentation Abstracts

HUMAN HEALTH ASSESSMENT APPROACH BRIDGES ENVIRONMENTALLY RELEVANT CONTAMINANT MIXTURES AND ZEBRAFISH DEVELOPMENTAL TOXICITY MODEL

Hillwalker, WE*, Corvi, ME; Shorey, LE, Tanguay, R, Anderson, KA, Oregon State University, Corvallis, OR.

The unique bio-analytical approaches of passive sampling devices (PSD) and the zebrafish (*Danio rerio)* developmental model have been combined to bridge measurements of environmental contaminants with their potential biological responses. For these preliminary experiments, a range of dilutions from extracts of PSD deployed within, and upriver of, the Portland Harbor Superfund site, Willamette River during Spring 2006 were used to expose early life stage zebrafish embryos to determine if these environmentally relevant mixtures were developmentally toxic. Dilutions of the extracts were nominally equivalent to a contaminant concentration range from 1 to 1/100 times that of the river water. Initial experiments for repeated exposures (n>3) demonstrate concentration-response increases in the appearance of a diverse collection of toxic endpoints including: notochord malformations, growth retardation, pericardial edema, delayed hatching, and gene induction. These initial experiments indicate that environmentally relevant concentrations of mixtures have the potential to adversely impact early-life stage vertebrate development. Most importantly, these studies highlight the utility of bridging environmental passive sampling with in vivo assessments as a tool to better protect human and environmental health.

Contact author: Kim Anderson, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-8501, F 541-737-0497, kim.anderson@orst.edu

IN VIVO ASSESSMENT OF PERFLUORINATED CHEMICALS (PFCs) INDUCED DEVELOPMENTAL TOXICITY USING EMBRYONIC ZEBRAFISH

Duong, L[1]*, Benninghoff, A[1,2], Tanguay, RL[1,2]

[1] Oregon State University, Corvallis, OR
[2] Environmental Health Sciences Center, Corvallis, OR

Perfluorinated chemicals (PFC) have been used since the 1950s in many industrial and commercial applications because of their unique properties such as chemical inertness, resistance to heat and their ability to repel water and oils. Concerns regarding potential environmental or human health risk from PFCs exposure have emerged as these chemicals are persistent in the environment and can bioaccumulate in animal tissues. Early life stages are often sensitive to chemical insult, so it is essential to determine if PFCs are developmentally toxic. 41 structurally diverse PFCs, including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), were screened for potential developmental toxicity using an embryonic zebrafish bioassay. In initial studies, developmental responses to waterborne exposure to PFCs were determined using a range of concentrations (0.01-200 ng/mL), including levels that are relevant to the environment. The majority of the PFCs tested did not elicit any adverse developmental responses. However, increased embryonic malformations were observed in animals exposed to 17 PFCs. Since the embryonic dose cannot be inferred from waterborne exposures, six PFCs that are most commonly studied were also microinjected with three concentrations (10, 100, 100 ng/mL). Three of these six PFCs (PFOA, PFDA and PFHxA) elicited embryonic malformations, including mortality and head defects only at more narrow concentrations. A follow up microinjection study at closer concentrations was conducted to determine if a structure- response relationship exist. Exposure to three carboxylated and two eight-carbon backbone PFCs did lead to embryonic malformations, but not a definite structure-response relationship. These results demonstrate that PFCs are generally not overtly developmentally toxic. Collectively these studies indicate the power of the zebrafish model to conduct structure- and dose- response relationships and developmental toxicity studies.

Contact author: Lisa Duong, Oregon State University
2042 Cordley Hall, Corvallis, OR 97331
T 541-737-2791, duongl@onid.orst.edu

TOXICITY ASSOCIATED WITH LEFLUNOMIDE EXPOSURE IN EARLY LIFE STAGE ZEBRAFISH (*DANIO RERIO*)

Saili, KS*; Mathew, LK; Sengupta, S; Kerkvliet, NI; Kolluri, SK; Tanguay, RL, Dept. of Environmental & Molecular Toxicology, Environmental Health Sciences Center, Oregon State University, Corvallis, OR, USA.

We identified leflunomide as a potent aryl hydrocarbon receptor (AHR) agonist by conducting a search for molecules that lead to increased expression of AHR target genes. The primary metabolite of leflunomide (A77 1726) inhibits proliferation by blocking *de novo* pyrimidine synthesis. This mechanism is believed to be the key to leflunomide's efficacy as both an anti-cancer drug and a treatment for rheumatoid arthritis. Previously, we reported that TCDD-induced AHR activation leads to developmental toxicity in early life stage zebrafish (*Danio rerio*). We exposed zebrafish to leflunomide or its metabolite at 6 hours post fertilization (hpf) and 48hpf to determine the lowest observed adverse effect level (LOAEL). Both leflunomide and A77 1726 produced toxic responses resembling (but not exclusive to) classic responses to TCDD exposure (*e.g.* yolk sac edema, pericardial edema, and craniofacial malformations). The LC_{50} for leflunomide was approximately 17uM (tenfold higher LC_{50} compared to published values for TCDD) and the LC_{50} for A77 1726 was between 10uM and 100uM. The LOAEL for both compounds was approximately 1uM. Since much of the toxicity associated with TCDD exposure has been reported to be AHR-dependent, we tested whether leflunomide and its metabolite also induced CYP1A *in vivo*. Only leflunomide induced CYP1A protein expression at concentrations as low as 2.5uM. A77 1726 did not lead to induced CYP1A expression at any concentration tested, suggesting that A77 1726 is not an AHR ligand. To determine whether the toxic effects of leflunomide were AHR-dependent, the expression of AHR2 was suppressed using AHR2 morpholino oligonucleotides. We found that yolk sac edema, pericardial edema, and craniofacial malformations were not rescued by AHR2 suppression, suggesting these toxic responses are independent of AHR expression.

Contact Author: Katerine Schletz Saili, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-2791, F 541-737-7966, sailik@onid.orst.edu

MULTIPLE PERFLUOROALKYL ACIDS ENHANCE AFLATOXIN B1-INITIATED HEPATOCARCINOGENESIS IN RAINBOW TROUT VIA POSSIBLE ESTROGEN-LIKE MECHANISM OF ACTION

Benninghoff, AD*, Buchner, C, Orner, GA, Hendricks, JD, and Williams, DE, Oregon State University, Corvallis, Oregon.

Previous studies have shown that perfluorooctanoic acid (PFOA) promotes liver cancer in manner similar to that of 17β-estradiol (E2) in rainbow trout (*Oncorhynchus mykiss)*, an animal model that represents human insensitivity to peroxisome proliferators. In addition to PFOA, other structurally related perfluoroalkyl acids (PFAAs) bind to the trout hepatic estrogen receptor. In the present study, we investigated the tumor-promoting potential of these estrogenic PFAAs utilizing the well-established trout model of liver carcinogenesis. Fry were initiated with 10 ppb aflatoxin B1 (AFB1) and fed experimental diets for 30 weeks at a 2 to 5% daily ration: 2000 ppm PFOA, 1000 ppm perfluorononanoic acid (PFNA), 200 ppm perfluorodecanoic acid (PFDA), 100 ppm perfluorosulfonate (PFOS), 2000 ppm 8:2 fluorotelomer alcohol (8:2FtOH), 5 ppm E2 or 2000 ppm clofibrate (CLOF), a classic peroxisome proliferator. Incidence, multiplicity and size of liver tumors in trout fed diets containing E2, PFOA, PFNA and PFDA were significantly higher compared to AFB1-initiated animals fed control diet only. PFOS and 8:2 FtOH exposures caused minor enhancement of tumorigenesis, whereas CLOF was without effect. To elucidate the mechanism by which these chemicals promote liver cancer in trout, a custom rainbow trout oligo DNA microarray was used to obtain hepatic gene expression profiles for each experimental diet after two weeks of exposure. Hierarchical clustering and Pearson correlation analyses showed that the expression profiles for E2 and PFOA, PFNA, PFDA and PFOS were highly similar ($r > 0.7$); common transcripts included genes associated with vitellogenesis, regulation of transcription, signal transduction and immune response. Overall, these data suggest that multiple PFAAs can promote liver cancer via a mechanism similar to that for E2. These findings highlight the need for further research to better assess the risk these environmental chemicals may pose to human health.
Supported by NIH grants ES07060, ES03850 and ES00210.

Contact author: Abby Benninghoff, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-1779, F 541-737-7966

DETERMINATION OF ILLICIT DRUGS AND HUMAN BIOMARKERS BY LARGE VOLUME DIRECT INJECTION HPLC/MS/MS: A NEW TOOL FOR DRUG EPIDEMIOLOGY

Chiaia Aurea C[1]*, Sudakin Daniel L[2], Banta-Green Caleb [3], and Field Jennifer A[1,2]

[1]Department of Chemistry, Oregon State University, Corvallis, OR
[2]Environmental and Molecular Toxicology, Oregon State University, Corvallis, OR
[3]Alcohol and Drug Abuse Institute, University of Washington

The synthesis and abuse of illicit drugs is a widespread public health problem. Current techniques in drug-use epidemiology are limited by time lags, poor geographic resolution, substantial under-reporting bias, and an over reliance on morbidity and mortality data. To address these limitations, we have initiated a program that links analytical measurements for illicit drugs, key metabolites and precursors with population indicators including residents served by sewer districts as well as human population biomarkers. A sensitive and selective analytical method based on large-volume injection and liquid chromatography/tandem mass spectrometry was developed to quantify abuse drugs and human biomarkers in raw sewage influents with a goal of obtaining high throughput and accuracy. Illicit drugs, metabolites, and precursor concentrations measured in 24 hr flow-normalized composites of raw influents from municipal wastewater treatment plants are normalized against population indicators for use as a low-cost tool to estimate community burdens of illicit drugs.

Contact Author: Aurea C. Chiaia, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-2267, F 541-737-2267, chiaiaa@onid.orst.edu

BIOMARKERS OF ORGANOPHOSPHATE EXPOSURE AND EFFECT IN *LUMBRICUS TERRESTRIS* AND *EISENIA FOETIDA*

Henson-Ramsey H[1], Schneider A[1]*, Kennedy-Stokopf S[2], Levine J[2], Taylor SK[3], Shea D[2], Stoskopf MK[2]

[1]Lewis-Clark State College, Lewiston, ID
[2]North Carolina State University, Raleigh, NC
[3]United States Fish and Wildlife Service, Carlsbad, CA

Preliminary work with *Lumbricus terrestris* and *Eisenia foetida* has revealed significant differences in acetylcholinesterase activity in these two earthworm species. After exposure to 5 µg /cm^2 malathion by filter paper contact, *E. foetida* exhibited twice the degree of cholinesterase suppression as exposed *Lumbricus terrestris*. Additionally, *L. terrestris* had significantly higher basal cholinesterase enzyme activity. Multiple hypotheses have been posed to account for these discrepancies. The acetylcholinesterase assay (Ellman et al. 1961) used during the preliminary work is non-specific. *E. foetida* and *L. terrestris* may have proportionally different cholinesterase activities (acetylcholinesterase, butyrylcholinesterase, carboxylesterase) which may result in an appearance of increased sensitivity to organophosphate exposure in *Eisenia*. Additionally, *Eisenia* was exposed to malathion at a temperature that is normal for *Lumbricus* but not for *Eisenia*, which also could have resulted in the observed differences. Another hypothesis is that anatomical differences in the integument of the two species may have caused differential malathion absorbance. The aim of our current research is to explore these hypotheses, focusing on the effect of malathion exposure on acetylcholinesterase, butyrylcholinesterase (Barata et al. 2004), and carboxylesterase (Mastropaolo and Younro 1981) activities in both *Lumbricus terrestris* and *Eisenia foetida* while measuring the resultant tissue burdens of malathion. An additional aim will be to determine, which of these cholinesterase enzymes appears to be the most sensitive and reproducible biomarker of organophosphate exposure in each species.

References:

Barata C, Solayan A, Porte C (2004) Role of b-esterases in assessing toxicity of organophosphorus (chlorpyrifos, malathion) and carbamate (carbofuran) pesticides to *Daphnia magna*. Aquatic Toxicology 66:125-139

Ellman G, Courtney KD, Andres VJ, Featherstone RM (1961) A new and rapid colorimeteric determination of acetylcholinesterase activity. Biochemical Pharmacology 7:88-95

Mastropaolo W, Younro J (1981) An ultraviolet spectrophotometric assay for napthylacetate and naphthyl esterases. Analytical Biochemistry 115:188-193

Contact Author: Ashley Schneider, Lewis-Clark State College
500 8th Avenue, Lewiston, ID 83501
alschneider@lcwarriormail.com

TISSUE CONTAMINANTS AND ASSOCIATED TRANSCRIPTIONAL RESPONSE IN TROUT LIVER FROM REMOTE HIGH ELEVATION LAKES OF WESTERN WASHINGTON, USA

Moran, PW[1]*, Aluru, N[2], Black, RW[1], Vijayan, MM[2]

[1]U.S. Geological Survey, Tacoma, Washington, USA
[2]Department of Biology, University of Waterloo, Waterloo, Ontario, Canada

The consistent cold temperatures and large amount of precipitation in the Olympic and Cascade ranges of Washington State are thought to enhance atmospheric deposition of contaminants. However, little is known about contaminant levels in organisms residing in these remote high altitude lakes. We measured total mercury and 28 organochlorine compounds in trout collected from 14 remote lakes in the Olympic, Mt. Rainer, and North Cascades National Parks. Mercury was detected in trout from all lakes sampled (15 to 262 μg/kg ww), while two organochlorines, total polychlorinated biphenyls (tPCB) and dichlorodiphenyldichloroethylene (DDE), were also detected in these fish tissues (<25 μg/kg ww). In sediments, organochlorine levels were below detection, while median total and methyl mercury were 30.4 and 0.34 μg/kg dry weight (ww), respectively. Using fish from two lakes, representing different contaminant loading levels (Wilcox lake: high; Skymo lake: low), we examined transcriptional response in the liver using a custom-made low density targeted rainbow trout cDNA microarray. We detected significant differences in liver transcriptional response, including significant changes in metabolic, endocrine, and immune-related genes, in fish collected from Wilcox Lake compared to Skymo Lake. Overall, our results suggest that local urban areas contribute to the observed contaminant patterns in these high elevation lakes, while the transcriptional changes point to a biological response associated with exposure to these contaminants in fish. Specifically, the gene expression pattern leads us to hypothesize a role for mercury in disrupting the metabolic and reproductive pathways in fish from high elevation lakes in western Washington.

Contact Author: Patrick Moran, U.S. Geological Survey
934 Broadway, Suite 300, Tacoma, WA 98402
T 253-552-1646, F 253-552-1681, pwmoran@usgs.gov

USING TISSUE CONCENTRATIONS FOR CORRELATING KNOWN EXPOSURES OF IMIDACLOPRID WITH OVERT EFFECTS IN JUVENILE CHINOOK

Frew, JA, Grue, CE*, University of Washington, Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, Seattle, WA.

Imidacloprid (IMI) has been proposed as a viable alternative to carbaryl for controlling burrowing shrimp within commercial oyster beds in Willapa Bay and Gray's Harbor, Washington. Attention has been given towards the potential toxicity of IMI to non-target species, including juvenile Chinook salmon (*Oncorhynchus tshawytsha*) residing in Willapa Bay. Neither an indicator of exposure, nor an effects biomarker – a linkage between exposure to a toxicant and a distinctive biochemical effect indicating impairment– exist for IMI. Using an HPLC-UV/DAD assay for measuring the concentration of IMI in tissue of exposed Chinook, we are determining correlations among IMI concentrations in seawater, tissues, and overt effects. These studies will establish relationships that can be used to assess the hazards IMI applications pose to juvenile Chinook in the field. IMI concentrations were measured in brain tissue of exposed juvenile Chinook following a 96-hour acute toxicity test. The results of the measured tissue concentrations were then linked to known water concentrations and overt effects. An ELISA protocol is being developed for the measurement of IMI in tissues. This assay will provide lower detection limits, require smaller sample sizes, and cost less than the HPLC-UV/DAD assay.

Contact Author: John Frew, University of Washington
PO Box 355020, Seattle, WA 98195
T 206-685-4195, F 206-616-9012, frew.john@gmail.com

USE OF PASSIVE SAMPLING DEVICES TO EVALUATE THE EFFECTIVENESS OF SUPERFUND REMEDIATION PROJECTS IN AN URBAN RIVER

Sower, GJ*, Anderson, KA, Oregon State University, Corvallis, OR.

Many Superfund remediation projects cap contaminated sediments limiting post-remediation access to evaluate effectiveness. Passive sampling devices (PSDs) positioned in the water column may provide a method to determine time-integrated averages at previous contamination hotspots. To determine the ability of PSDs to assess remediation efforts concentrations and loads of 15 biologically available priority pollutant polycyclic aromatic hydrocarbons (PAHs) were measured before, during, and after two major projects on the lower Willamette River in Portland, Oregon. The study area includes the Portland Harbor Superfund megasite (river miles, or RM, 3.5 to 9.2), a heavily industrialized stretch of the Willamette. This area contains major PAH contamination remediation work including coal tar removal at RM 6.5, the GASCO site, and an additional Superfund site, McCormick and Baxter (RM 7, east bank) consisting largely of creosote contamination. Remediation techniques differed at each site. The GASCO site utilized a silt curtain containment system during excavation of coal tar and a pilot cap after removal. The McCormick and Baxter sediment remediation used an organoclay layer capped with articulated concrete blocks to prevent creosote seepage from sediment. Results from samplers at RM 7 west, upstream of GASCO and across the river from McCormick and Baxter suggest a third major PAH contamination source. The PAH concentrations, loads, and congener profiles at RM 7 west change significantly depending on river flow, precipitation, and contaminant removal activities. Remediation practices at the GASCO site appear to have had a direct effect on RM 7 west samplers. Post-remediation sampler concentrations and loads at the McCormick and Baxter site are on par with upstream sites representing "background" levels demonstrating the 23 –acre sediment cap is effective. Our results indicate that PSDs are suitable tools for assessing the effectiveness of remediation work as well as having the potential for use in contaminant source apportionment.

Contact Author**:** Gregory Sower, Oregon State University
11555 East Speedway Blvd Unit #9, Tucson, AZ 85748
T 503-851-7082, F 541-737-0497, gsower@gmail.com

ECOLOGY'S URBAN WATERS INITIATIVE – ASSESSING CHANGES IN SEDIMENT QUALITY IN URBAN BAYS

Partridge, VA, Aasen*, S, Dutch, ME, Washington Department of Ecology, Olympia, Washington.

In conjunction with its source control and cleanup efforts in urban bays of Puget Sound, the Washington State Department of Ecology is conducting sediment monitoring in urban bays to: assess the extent of sediment contamination in each bay, compare existing baseline, current, and 5-year assessments of sediment quality, and determine whether sediment quality is improving, deteriorating, or remaining unchanged. These urban embayment surveys are nested within the Puget Sound Assessment and Monitoring Program annual Sediment Monitoring surveys, which use a probability-based sampling design to assess sediment quality at multiple scales, from bay-wide to Puget Sound-wide. Sediment chemistry, toxicity, and sediment-dwelling invertebrates are sampled to characterize the spatial extent of degraded sediment quality. By incorporating urban-bay surveys into Puget Sound sediment monitoring, we can assess how collective clean-up efforts are affecting the overall sediment quality in these bays and Puget Sound. Thirty stations in Elliott Bay and the Duwamish Waterway were sampled in 2007, and thirty stations will be sampled in Commencement Bay and associated waterways in 2008. We present changes in Elliott Bay/Duwamish Waterway sediment quality from 1998 to 2007 (e.g., decrease in sediment mercury) and compare sediment quality in Elliott Bay/Duwamish Waterway to Puget Sound baseline conditions.

Contact Author: Sandra Aasen, Washington Department of Ecology
300 Desmond Drive, Olympia, WA
T 360-407-6980, F 360-407-6884, sgei461@ecy.wa.gov

TADPOLE EXPOSURE TO PESTICIDES IN THE MOUNTAINS OF CALIFORNIA AND ASSOCIATED BIOTA-SEDIMENT ACCUMULATION FACTORS

Stanley, KA*[1], Huber RC[1], Bradford, DF[2], Davidson, C[3], Tallent-Halsell, N[2], and Simonich, SL[1]

[1]Oregon State University, Corvallis, OR
[2]United States Environmental Protection Agency, Las Vegas, NV
[3]San Francisco State University, San Francisco, CA

Pesticides applied in the Central Valley of California are atmospherically transported to the adjacent Sierra Nevada and Cascade Mountains. Agrochemicals have been implicated in the declines of several amphibian species native to California, including the mountain yellow-legged frog (*Rana muscosa*) and the Cascades frog (*Rana cascadae*). The sediment in high elevation lakes can accumulate pesticides deposited to the surrounding ecosystem over several decades. In addition, sediment may be an important route of exposure for tadpoles because they come into contact with the sediment while feeding and hiding from predators. Tadpole and sediment samples were collected during the summer of 2005 from 28 lakes in the Sierra Nevada Mountains and 32 lakes, ponds, and wetlands in the Cascade Mountains. Pacific tree frog tadpoles (*Pseudacris regilla*) were used as a surrogate species in the Sierras for mountain yellow-legged frog, and in the Cascades where the Cascades frogs are no longer common. Tissue and sediment samples were processed and analyzed for several classes of pesticides using methods developed in our laboratory. The most frequently detected pesticides, measured in the highest concentrations in tadpole tissue and sediment, were the current-use pesticides endosulfan and dacthal. Biota-sediment accumulation factors will be discussed and the relationship between pesticide concentrations and pesticide application data will be presented.

Contact Author: Kerri A. Stanley, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-9208, F 541-737-0497, stanleke@onid.orst.edu

CONTRASTING AQUEOUS GEOCHEMISTRIES OF ELEMENTS IN CONTACT WITH CONTAMINATED SEDIMENTS FROM LAKE ROOSEVELT, WASHINGTON

Paulson, AJ* and Cox, SE, U.S. Geological Survey, Washington Water Science Center, Tacoma, WA 98402

Aqueous concentrations of elements in contact with sediments from Lake Roosevelt, Washington State, USA, that have been contaminated with smelter waste discharged into the Columbia River, British Columbia, Canada, were examined under varying degrees of physical mixing and time scales. The dominant geochemical processes affecting aqueous concentrations were inferred from the release of major ions (Ca, Si, Ba), elements enriched in the slag (cationic Cu and anionic Sb), and redox-sensitive species (Fe, Mn, Mo and U). Releases of major ions reflected the differences in geology along the 240-km long reservoir with slag and carbonate minerals releasing more Ca near the slag source, while the importance of glacial sediments increased downstream and contributed to the release of more Si. Sb seemed to be the best indicator of slag weathering, possibly because its anionic nature inhibits re-adsorption onto metal oxides. Several observations suggest that Cu was re-adsorbed once released from the sediments. The initial release rates of aqueous Ca, Mn and Cu from sediments during core incubation experiments were correlated with their concentrations in the weakly adsorbed fraction. The releases of Mo and U appeared to be affected more by sediment redox conditions rather than by total or weakly adsorbed concentrations.

Contact Author: Anthony J. Paulson, U.S. Geological Survey
934 Broadway, Suite 300, Tacoma, WA 98402
T 253 552-1681, F 253 552-1581, apaulson@usgs.gov

A COMPUTATIONAL MODEL FOR STEROID HORMONE AND VITELLOGENIN PROFILES IN UNEXPOSED AND EE_2-EXPOSED MALE FHMs

Li Z[1]*, Kroll KJ[2], Reyero NG[2], Szabo NJ[2], Ekman DR[3], Collette TW[3], Denslow ND[2], Ankley GT[3], Watanabe KH[1]

[1]Oregon Health & Science University, Beaverton, OR 97006
[2]Center for Environmental and Human Toxicology, University of Florida, Gainesville, FL 32611,
[3]U.S. EPA, ORD/NHEERL/Mid-Continent Ecology Division, Duluth, MN 55804

Endocrine disrupting chemicals (e.g., estrogens) discharged into the aquatic environment are known to affect reproductive endpoints in fish. 17α-ethynylestradiol (EE_2), a synthetic estrogen used in birth control pills, is discharged from sewage treatment plants into water bodies throughout the United States. A goal of our research is to understand how exposure to EE_2 affects reproductive endpoints such as concentrations of steroid hormones (i.e., 17β-estradiol (E_2), testosterone (T), and 11-ketotestosterone (KT)) and vitellogenin (Vtg, a precursor to an egg yolk protein) in male fathead minnows (FHM, *Pimephales promelas*). In this study, we developed a physiologically based computational model comprising six tissue compartments. Mass balances were used to formulate a set of differential equations describing E_2, T, KT, EE_2, and Vtg kinetics. The model was calibrated with data from 75 unexposed control FHMs and 9 FHMs exposed to 10 ng/L and 50 ng/L EE_2 for 48 hours. Data from unexposed FHMs included measurements of E_2, T, KT, and Vtg plasma concentrations; and data from exposed FHMs included plasma concentrations of Vtg and T, and EE_2 concentrations in pooled liver and carcass. The model successfully predicted the medians and variances of EE_2 and Vtg concentrations in both unexposed and EE_2-exposed FHMs; and successfully predicted the medians of E_2, T and KT in both unexposed and EE_2-exposed FHMs, but underestimated the variances of E_2, T and KT. Our model only simulated one major pathway of E_2, T and KT metabolism, which might lead to the underestimated variances. The model may be used to estimate the effects of EE_2 exposure in male FHMs, and may also be used to study the biochemical processes related to steroidgenesis.

Contact Author: Zhenhong Li, Oregon Health & Science University
20000 NW Walker Rd., Beaverton, OR 97006
T 503-748-4075, F 503-748-1464, liz@ebs.ogi.edu

VALIDATION OF NICKEL BIOTIC LIGAND MODEL PREDICTIONS FOR SELECTED NON-STANDARD ORGANISMS

Van Genderen, EJ[1], Stubblefield, W[1], De Schamphelaere, KA[2], Schlekat, CE[3]

[1]Parametrix, Albany, OR
[2]Laboratory of Environmental Toxicology and Aquatic Ecology, Ghent University, Ghent, Belgium
[3]Nickel Producers Environmental Research Association, Durham, NC

The current approach in the European Union for regulating metals concentrations in surface waters has acknowledged the consideration of site-specific influences (e.g., hardness, pH, dissolved organic matter, etc.) on toxicity to aquatic organisms. As such, Biotic Ligand Models (BLM) have been developed and validated for several organisms that represent different trophic levels within natural waters. In the case of nickel (Ni), chronic BLMs have been developed and validated for an algae (Pseudokirchneriella subcapitata), two invertebrates (Ceriodaphnia dubia and Daphnia magna), and a fish (Oncorhynchus mykiss). However, to justify full cross species BLM extrapolation, quantitative evidence is needed to confirm the applicability of the existing BLMs to predict toxicity to several dissimilar taxonomic groups. The goal of this study was to determine if the C. dubia and D. magna chronic nickel BLMs could validate/confirm intra-species difference in chronic nickel toxicity for invertebrate species for which no BLM exists. To facilitate this objective, five natural waters with varying levels of hardness, pH and dissolved organic carbon were used to conduct chronic toxicity tests with an insect (Chironomus tentans), a snail (Lymnaea stagnalis), and a rotifer (Brachionus calyciflorus). Test results illustrated that L. stagnalis was the most sensitive of the three species with effective concentrations for decreased growth (EC10 and EC20) ranging from 2 to 70 µg/L dissolved Ni. Effective concentrations for C. tentans (biomass) and B. calyciflorus (population growth rate) ranged from 100 to > 1000 µg/L dissolved Ni. Modeling results showed that the nickel BLMs developed for C. dubia and D. magna predicted toxicity for the three non-BLM organisms within a factor of two. The capacity of the BLMs to predict toxicity for non-covered species over a wide range of abiotic and bioavailability conditions supports the extrapolation of the crustacean BLMs to the other invertebrates in the nickel ecotoxicity database.

Contact Author: Eric Van Genderen, Parametrix, Inc.
33972 Texas St. SW, Albany, OR 97321
T 541-791-1667, F 541-791-1699, evangenderen@parametrix.com

ANALYSIS OF THE DECLINE OF THE PUGET SOUND PACIFIC HERRING (*CLUPEA PALLASI*) STOCKS

Bryant, PB*, Landis, WG

Institute of Environmental Toxicology, Western Washington University, Bellingham, WA.

Cherry Point and all other Puget Sound stocks now exhibit a collapsed age structure and a rate of reproduction generally below 1.0. The onset of this trend can be detected in the early 1970s for all stocks for which data are available. The timing of the changes in population correspond to the switch in the PDO, but other large scale factors such as persistent contaminants or disease may be contributing. The modeling effort described here is an attempt to answer the question of the magnitude of the effect during this period. Using RAMAS® GIS software the normalized equilibrium age structure and intrinsic rate of increase were calculated for each stock with available data. Each stock was evaluated individually and no metapopulation effects were considered. The normalized equilibrium age structure results demonstrate that even in the late 1970s when individuals were living to Age 9 they were headed to the reduced survivorship observed where individuals do not live past Age 4. The intrinsic rate of increase (lambda) results suggest that the causative agent went into effect in the timeframe between 1982 and 1987. Prior to 1982 the intrinsic rate of increase was well above 1 while after 1987 the rate was consistently below 1. This time period lacks data for all Puget Sound stocks except Cherry Point where the switch in lambda occurred in 1984. For Cherry Point the survivorship and fecundity were reduced and normalized equilibrium age structure and intrinsic rate of increase were calculated to estimate magnitude of the effects. The results of the simulations suggest that a reduction in survivorship at 50% in individuals Age 3 and up would be required to achieve the patterns observed in Puget Sound.

Contact Author: Peter Bryant, Western Washington University
516 High Street ES518, Bellingham, WA 98225-9180
T 360-650-6136, F 360-650-6556, petertbryant@gmail.com

SIMULATION OF TIDAL EFFECTS ON CONTAMINANT FATE AND TRANSPORT NEAR THE SEDIMENT-WATER INTERFACE

Bessinger, BB*, Mohsen, MFN, Exponent Consulting, Bellevue, WA

A numerical fate and transport model was developed to simulate the effects of tidal fluctuations on the migration of a contaminant plume in a tidally-influenced aquifer. Model simulations for a conservative contaminant demonstrate that tidal fluctuations promote relatively high advective and dispersive fluxes near the sediment-water interface. This, in turn, causes potential contaminant concentrations in shallow sediment to be significantly diluted by infiltrating surface-water. Model predictions additionally show that tidal effects increase the rate that contaminants are transported from the aquifer, at least within a narrow region influenced by tidal oscillations. For a non-conservative contaminant, modeled in this case as an adsorbing substance, analyses reveal that adsorption can greatly delay the time for a plume to reach the surface water, although tidal velocities rather than contaminant sorptivity may control exit concentrations. Finally, for redox-sensitive contaminants such as arsenic, model simulations show that tidal exchange may alter the distribution of iron and sulfide mineral phases, thus affecting arsenic mobility and the concentrations to which benthic ecological receptors are exposed.

Contact Author: Brad Bessinger, Exponent Consulting
15375 SE 30th Place, Suite 250, Bellevue, WA 98007
T 360-210-5350, F 425-519-8799, bbessinger@exponent.com

SHEDDING LIGHT ON TOXICITY TESTING: UV LIGHT AND PAH-CONTAMINATED GROUNDWATER

Fortner, JC*[1],Harper, RM[1], Sternberg, D[2]

[1]Western Washington University, Bellingham,WA
[2]Washington Department of Ecology, Olympia,WA

In this study, the acute toxicity of PAH-contaminated groundwater to *Daphnia magna* and *Pimephales promelas* were characterized under both standard laboratory fluorescent light and ultraviolet light (UV) test conditions using USEPA WET test methods. Previous studies have demonstrated the potential of UV light and natural sunlight to increase the toxicity of PAHs to many aquatic organisms. Based on these studies, the discharge of PAH-contaminated groundwater to adjacent surface waters may result in increased acute groundwater toxicity due to the effect of photoenhanced toxicity of PAHs under natural sunlight. Though photoenhanced toxicity testing of PAH-contaminated groundwater is not typically conducted using acute USEPA WET test methods, WET test methods may represent a means to characterize the toxicity of PAH-contaminated waters. Under standard WET test protocol, USEPA recommends the use of ambient laboratory lighting during WET toxicity tests (10-20µE/m^2/s or 50-100 ft-c). No recommendations are made for the specific spectral distribution or relative wavelength irradiance of these ambient lighting conditions. This lack of specific recommendation for laboratory lighting may result in inaccurate *in situ* toxicity estimates when photoactive PAHs are present. In this study, we characterized acute groundwater toxicity under the following two lighting treatments: 1) ambient laboratory lighting and 2) ambient laboratory lighting plus UVA (320-400nm) and UVB (290-320nm). In the second treatment, cool white fluorescent (CWF) and ultraviolet bulbs were combined to create a light source that produces UVA and UVB light with a spectral distribution similar to that of natural sunlight and produces ecologically-relevant irradiance levels of UVA and UVB. Preliminary results suggest that the acute toxicity of PAH-contaminated groundwater increases when testing is conducted under standard laboratory lighting supplemented with UV light.

Contact author: Jason Fortner, Western Washington University
MS 9180, 516 High Street, Bellingham, WA 98225
T 360-738-8023, F 360-650-7284, jama2ciel@msn.com

EFFECTS OF DIETARY ESFENVALERATE EXPOSURES ON THREE AQUATIC INSECT SPECIES REPRESENTING DIFFERENT FUNCTIONAL FEEDING GROUPS

Palmquist KR*[1,2], Jenkins JJ[2], Jepson, PC[2,3]

[1]Exponent Consulting, Bellevue, WA 98007
[2]Department of Environmental and Molecular Toxicology, Oregon State University, Corvallis, Oregon, 97331, USA
[3]Integrated Plant Protection Center, Oregon State University, Corvallis, Oregon, 97331, USA

Given the chemical properties of synthetic pyrethroids, it is probable that compounds, including esfenvalerate, that enter surface waters may become incorporated into aquatic insect food sources. We examined the effect of dietary esfenvalerate uptake in aquatic insects representing different functional feeding groups. We utilized three field-collected aquatic insect species: a grazing scraper *Cinygmula reticulata* McDunnough (Ephemeroptera: Heptageniidae), an omnivorous filter feeder *Brachycentrus americanus* Banks (Trichoptera: Brachycentridae), and a predator *Hesperoperla pacifica* Banks (Plecoptera: Perlidae). Laboratory-cultured algae were pre-exposed for 24h to esfenvalerate concentrations of 0, 0.025, 0.05, and 0.1 µg/L and provided to two *C. reticulata* age classes, small and final-instar nymphs. Reduction in small nymph growth was observed following three weeks feeding on algae exposed to 0.05 and 0.1 µg/L esfenvalerate, and the highest dietary exposure reduced egg production in final-instar nymphs. The diet for *B. americanus* and *H. pacifica* insects consisted of dead third-instar *Chironomus tentans* larvae pre-exposed for 24h to esfenvalerate concentrations ranging between 0.1 and 1.0 µg/L. Consumption of larvae exposed to 0.5 to 1.0 µg/L esfenvalerate caused case-abandonment and mortality in *B. americanus* caddisfly larvae. Although *H. pacifica* nymphs readily consumed esfenvalerate-exposed larvae, no adverse effects were observed during the course of this study. Further, there was no evidence of esfenvalerate-induced feeding deterrence in any of the species tested, suggesting that aquatic insects may not be able to distinguish between pyrethroid-contaminated and uncontaminated food sources. These findings indicate that feeding deterrence is not a factor in regulating aquatic insect dietary exposures to synthetic pyrethroids.

Contact Author: Katherine Palmquist, Exponent Consulting
15375 SE 30th Place, Suite 250, Bellevue, WA 98007
T 425-519-8778, F 425-519-8799, kjohnson@exponent.com

ASSESSING THE IMPACT OF PESTICIDES ON THE SURVIVORSHIP AND DEVELOPMENT OF DIFFERENT LIFESTAGES OF *SPEA INTERMONTANA* AND *PSEUDACRIS REGILLA*

de Jong Westman, A*[1]; Elliott, J[2]; Cheng, K[1]; Bishop, CA[2]; Sullivan, T[1]

[1]University of British Columbia, Vancouver, BC
[2]Canadian Wildlife Service, Delta, BC

Amphibian populations are declining globally, and pesticides have been suggested as one of the contributing factors. Field experiments involving ponds immersed in agricultural environments have been observed to have dramatically lower biodiversity and amphibian abundance than ponds located in non-agricultural settings. There has been much work involving *in situ* pond experiments, and a plethora of laboratory pesticide experiments often involving test concentrations much higher than those observed in the field. To determine which pesticides impact amphibian embryo survivorship and tadpole development, three insecticides currently used in British Columbia were tested at their detected field concentrations in a laboratory environment. The commercial formulations of endosulfan, azinphos-methyl and diazinon were tested alone and in combination. Embryos of the Great Basin Spadefoot (*Spea intermontana* and Pacific Treefrog (*Pseudacris regilla*) were collected from reference sites in the South Okanagan of BC, and transported to a federal laboratory facility in North Vancouver, BC. Here, 8-day LC20 experiments were conducted on the young embryos and young tadpoles with the following toxicological endpoints: acute mortality, behavioral abnormalities, morphological abnormalities and developmental abnormalities. Overall, endosulfan ($LC20_{8d}$ = 77.10 ng/L) was the most toxic pesticide to both species in the tadpole stage, causing acute mortality, behavioral abnormalities and morphological abnormalities. Embryos were observed to be very resilient to the low test concentrations, with the majority of mortalities occurring post-hatch ($LC20_{8d}$ = 2872.65 ng/L). The second most toxic insecticide was found to be azinphos-methyl ($LC20_{8d}$ > 50 000 ng/L); and lastly, diazinon was found to be the least toxic ($LC20_{8d}$ > 175 000 ng/L) to both life stages of amphibians.

Contact Author: Alexandra de Jong Westman, University of British Columbia
3685 W12th Avenue, Vancouver, BC, V6R 2N5
T 604-267-2250, adjw@telus.net

OLFACTORY-IMPAIRMENT BY COPPER AFFECTS JUVENILE SALMON BEHAVIOR AND SURVIVAL WITH CUTTHROAT TROUT PREDATORS

McIntyre, JK*[1], Baldwin, DH[2], Beauchamp, DA[1], Scholz, NL[2]

[1]University of Washington, School of Aquatic and Fishery Sciences, Seattle, WA
[2]NOAA-Fisheries, Northwest Fisheries Science Center, Seattle, WA

Copper is a pervasive contaminant of urban stormwater, the leading contributor to water quality pollution of urban waterways in Washington State. At low, environmentally-relevant concentrations, copper impairs olfaction and olfactory-mediated behaviors in juvenile salmon. One such behavior is the anti-predation 'freezing' in response to an olfactory alarm cue (*Schreckstoff*) present in conspecific skin extract. Previous research shows that copper reduces or eliminates 'freezing' at concentrations also known to impair olfaction. Does this translate into reduced survival for juvenile salmon in the presence of predators? We have been exploring the effect of olfactory impairment from low-level, short-term copper exposure on juvenile coho salmon (*Oncorhynchus kisutch*) behavior and survival with cutthroat trout (*Oncorhynchus clarki*) predators. These experiments show that copper-exposed juvenile coho are less cautious in the presence of predators and are preyed upon more quickly than juvenile coho not exposed to copper.

Contact Author: Jenifer K. McIntyre, University of Washington
PO Box 355020, 1122 NE Boat St., Seattle, WA 98105
T 206-616-3660, F 206-616-9012, jmcintyr@u.washington.edu

COPPER ALTERS THE TRANSCRIPTION OF GENES INVOLVED IN NORMAL OLFACTORY SIGNAL TRANSDUCTION AND DI-VALENT ION HOMESTATSIS WITHIN THE OLFACTORY SYSTEM OF ZEBRAFISH

Tilton F*, Tilton S, Stapleton P, Bammler T, Beyer R, Farin F, Gallagher EP, University of Washington, Seattle WA USA 98105.

The trace metal copper (Cu) and the organophosphate chlorpyrifos (CPF) have been shown to cause olfactory and neurobehavioral impairment in Pacific salmonids and several other fish species. In the current study, we utilized the superior genetic and experimental tractability of zebrafish to establish it as a molecular model to study neurobehavioral impairment and the mechanisms of olfactory injury in fish. Adult zebrafish (5 fish/replicate, N=3) were exposed for 24 hrs to Cu (6, 16, 40 ppb), CPF (35, 88, 220 ppb), or three binary mixtures containing 16 ppb Cu with 35, 88, or 220 ppb CPF. We analyzed the gene expression in the olfactory tissues (olfactory rosettes, olfactory bulb, and telecephalon) using the Affymetrix zebrafish array platform to explore the mechanisms underlying olfactory injury. In the copper and chlorpyrifos treatments, a maximum of 455 genes were differentially regulated > 1.5 fold, ($p \leq 0.05$) at any concentration. However, exposure to the binomial mixtures resulted in 844-988 differentially regulated genes. The majorities of the transcriptional signatures from the mixture groups were shared but still unique relative to the individual constituents of the mixture. Principal components analysis and hierarchal clustering revealed that the transcriptional signatures associated with the mixture exposures were more similar to those observed with copper, than for chlorpyrifos. From the gene lists we identified several specific biomarkers of olfactory injury which were confirmed using real-time qPCR. Finally, we have used pre-defined gene sets and pathways to interrogate all genes in the experiment to identify coordinated changes in gene expression. Using this approach, copper appears to be impacting the g-protein coupled olfactory receptor signaling whereas chlorpyrifos may be activating inhibitor genes involved in olfactory signal transduction. Collectively, our results are elucidating the mechanisms of chemical-induced olfactory system and generating specific biomarkers of olfactory injury. Supported by NIH grants P42ES04696 and P42ES07033.

Contact Author: Fred Tilton, University of Washington
4225 Roosevelt Way, Suite 100, Seattle, WA 98105
T 206-353-6443, ftilton@u.washington.edu

COPPER EFFECTS ON FISH BEHAVIOR: A REVIEW AND SYNOPSIS OF EXISTING STUDIES

Shephard, B.K., U.S. Environmental Protection Agency, Seattle, Washington 98101 USA.

Concerns have been raised regarding the potential adverse effects of copper on fish behavior at concentrations lower than U.S. Environmental Protection Agency water quality criteria. To evaluate these concerns, a literature review of copper effects on the behavior of both freshwater and marine fish was performed. Copper effects information on the behavior of 49 freshwater and 15 marine fish species was found, with a combined total of 155 LOEC's and 43 NOEC's. Of these, 59 LOEC's and 19 NOEC's are for salmonid species, with rainbow trout being by far the most studied species. Laboratory studies with copper alone, as part of mixtures, and field behavioral studies were all reviewed. Of the LOEC values for laboratory studies with copper in freshwater alone, 97% were higher than the EPA hardness adjusted chronic copper criterion. None of the 15 laboratory LOEC's for marine fish exposed to copper alone were lower than the marine chronic criterion. Avoidance behavior is the most commonly studied behavioral endpoint, is reported as affected by copper concentrations as low as 0.1 µg/L, and is the only behavioral endpoint with LOEC's lower than the chronic copper criterion. Other behavioral endpoints with available copper effects data include voluntary and involuntary movements, swimming, feeding, social and respiratory behaviors. To date none of the mixture or field studies have attributed observed responses solely or primarily to copper unless the chronic copper criterion is exceeded within the mixture. Numerous studies have demonstrated that acclimation to low copper concentrations occurs within a period ranging between a few hours to months, with behaviors returning to baseline responses. Comparison of the behavioral LOEC's to chronic LOEC's for reproduction and growth indicate that behavior is generally not a more sensitive endpoint, at least for copper, than are reproductive and growth endpoints.

Contact Author: Burt Shephard, U.S. Environmental Protection Agency
1200 6th Avenue, Suite 900, Seattle, WA 98101
T 206-553-6359, F 206-553-0119, Shephard.Burt@epa.gov

COMPARATIVE NANOTOXICOLOGY – STRATEGIES TO EVALUATE NANOMATERIAL-BIOLOGICAL INTERACTIONS

Harper, SL*[1,2], Saili, KS[1,3], Rohlman, D[1,3], Duong, L[1], Lee, S[4], Tanguay, RL[1,2,3]

[1] Oregon State University, Corvallis, OR.
[2] Oregon Nanoscience and Microtechnologies Institute, Corvallis, OR.
[3] Environmental Health Sciences Center, Corvallis, OR.
[4] iFusion Laboratory, Corvallis, OR.

The rapid rate of discovery and development in nanotechnology will undoubtedly increase the potential for both human and environmental exposures to novel nanomaterials. While numerous applications promise benefit to human health or the environment, the potential health and environmental risks associated with the unique properties of nanoscale materials are unknown and may lead to unintended health and safety consequences. The current gap in nanoparticle toxicological data dictates the need to develop rapid, relevant and efficient testing strategies to assess these emerging materials of concern prior to large-scale exposures. Here we present an alternative approach that utilizes a dynamic whole animal (*in vivo*) assay to reveal whether a nanomaterial is potentially toxic at multiple levels of biological organization (i.e. molecular, cellular, systems, organismal). Early developmental life stages are often uniquely sensitive to environmental insult, due in part to the enormous changes in cellular differentiation, proliferation and migration required to form the required cell types, tissues and organs. Molecular signaling underlies all of these processes. Most toxic responses result from disruption of proper molecular signaling, thus, early developmental life stages are perhaps the ideal life stage to determine if chemicals or nanomaterials are toxic. Therefore, the embryonic zebrafish model was chosen to investigate nanomaterial biological activity and toxic potential. Investigations using this model system can reveal subtle interactions at multiple levels of biological organization (i.e. molecular, cellular, systems, organismal) so we have developed an 'EZ (embryonic zebrafish) metric for nanomaterial toxicity' (EZMNT) that takes into account the types and frequency of sublethal effects in addition to overt mortality. The EZMNT was used to compare morbidity and mortality elicited from exposure to over 100 novel engineered nanomaterials using the Nanomaterial-Biological Interactions knowledgebase at Oregon State University.

Contact Author: Stacey Harper, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-2791, F 541-737-7966, harpers@science.oregonstate.edu

DIAGNOSING AND ANALYZING TRIANGULAR RELATIONSHIPS IN ENVIRONMENTAL TOXICOLOGY

Paine, MD, Paine, Ledge and Associates (PLA), North Vancouver, BC

In triangular relationships, *Y* values vary over a wide range at one end of the *X* scale, but variance of Y decreases and *Y* values approach a minimum or maximum at the other end of the *X* scale. Distributions of *Y*-*X* points resemble a right triangle. Triangular relationships are common in environmental toxicology, particularly in field studies. Typically, a wide range of responses (*Y*) in laboratory toxicity tests or field surveys from "Good" to "Bad" occurs at low *X* values (e.g., low contaminant concentrations or exposure levels), but a narrower range of mostly "Bad" responses occurs at higher *X* values. Variance of predicted *Y* values from parametric regressions increases or decreases as *X* increases (=heterogeneity of variance). The parametric regressions also predict mean or median responses, which may not be of interest. Possible causes of triangular relationships are considered, and examples and methods for diagnosing and analyzing triangular relationships are provided. Responses in laboratory toxicity tests conducted on field samples can often be dichotomized into "Bad/toxic" versus "Good/non-toxic" based on reasonably objective regulatory guidance or "rules", with little loss of information. Logistic regression can then be used to analyze frequencies of "Good/Bad" versus *X*. Dichotomizing continuous responses in field invertebrate or fish surveys is rarely effective. There is usually no objective single value that separates "Good" from "Bad". In those cases, triangular relationships can best be diagnosed and analyzed by regressing percentiles of *Y* on *X*. The simplest approaches can be conducted in Excel; more complex methods require specialized statistical programs. The "best" approach depends on the project purpose and the robustness of the available data. Simple methods are adequate to diagnose and describe triangular relationships, especially for large data sets. Complex methods are often required for quantitative purposes (e.g., hypothesis testing, risk assessment, modelling) and/or smaller data sets.

Contact Author: Michael D. Paine, Paine, Ledge and Associates (PLA)
302-1050 Bowron Court, North Vancouver, BC V7H 2X6
T/F 604-924-8126, paine.ledge.pla@telus.net

Pacific Northwest Chapter

Society of Environmental Toxicology and Chemistry
(PNW-SETAC)

17th Annual Meeting

Poster Presentation Abstracts

RELATIONSHIPS BETWEEN SEDIMENT QUALITY, DISSOLVED OXYGEN, AND BENTHIC INVERTEBRATES IN HOOD CANAL

Dutch, ME[1], Long, ER[1], Partridge, VA[1], Aasen, S*[1], Welch, K[1], Shull, D[2]

[1]Washington Department of Ecology, Olympia, Washington
[2]Western Washington University, Bellingham, Washington

Sediment quality data and concentrations of water-column dissolved oxygen (DO) collected in Hood Canal from 1932 to 2005 were evaluated as part of the Hood Canal Dissolved Oxygen Program to determine the effects of DO on benthos. Sediment contamination and toxicity were low, and confined to Port Gamble, Port Ludlow, and Dabob Bay. Coarse sands were found in northern Hood Canal and along shorelines. Fine-grained silts and clays were found in central and southern regions, at depth, and in shallow bays. Organic carbon concentrations increased in fine-grained sediments. DO concentrations decreased from north to south and from shallow to deep water. Minimum DO levels measured from 1932 through 2005 decreased over time. Benthic assemblages were identified for three regions and nine sub-regions of Hood Canal. The number of individuals and species decreased and stress-tolerant species became dominant southward as grain size and near-bottom DO decreased, and organic carbon content and depth increased. These factors, in this order, acting together may have influenced the composition of the benthos. A recent report presents steps taken to develop initial critical DO values for the protection of the benthos and a summary of data gaps and associated recommendations for future work on this topic.

Contact Author: Sandra Aasen, Washington Department of Ecology
300 Desmond Drive, Olympia, WA 98504
T 360-407-6980, F 360-407-6884, sgei461@ecy.wa.gov

ASSESSMENT OF THE BIOAVAILABILITY OF SEDIMENT-ASSOCIATED METALS AND TOXICITY TO BENTHIC ORGANISMS

Andersen, HB*,[1] Hurley, K,[1] Mitchell, M,[1] Toll, JE,[1] Skinner, KJ (Esq.), Wynkoop, J,[2] Seidel, P[3]

[1]Windward Environmental LLC, Seattle, WA
[2]Landau Associates, Portland, WA
[3]Oregon Department of Environmental Quality, Gresham, OR.

Metals concentrations that exceeded Oregon Department of Environmental Quality (ODEQ) Level II screening level values (SLVs) for freshwater sediments were detected during sediment and water quality investigations conducted in a fourth-order urban stream in Washington County, Oregon. Additional characterization was needed to assess the bioavailability of the sediment-associated metals and their toxicity to benthic organisms. Surface sediment samples were collected from 20 onsite and 2 upstream stations across a stream reach of approximately 1.25 miles. Sampling stations were selected to provide good spatial coverage and represent the ranges of total metals concentrations previously measured in sediments. Samples were analyzed for acid volatile sulfides and simultaneously extracted metals (AVS-SEM), total metals, grain size, total solids, and total organic carbon (TOC). Two toxicity tests, the 10-day *Hyalella azteca* mortality sediment toxicity test and the 10-day *Chironomus dilutus* growth and mortality sediment toxicity test, were performed on a subset of 13 surface sediment samples collected from 11 onsite and 2 upstream stations, which were selected to provide good spatial coverage and a range of SEM minus AVS (SEM − AVS) concentrations. None of the sediment samples had an adverse effect on amphipods or midges based on the *Hyalella* mortality endpoint and *Chironomus* growth endpoint. Increased *Chironomus* mortality was observed in seven samples when compared with one of the upstream locations or the negative control. The bioavailability of the sediment-associated metals and the likelihood that these chemicals would have caused the observed toxicity was assessed using guidelines provided in *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Metal Mixtures* (EPA 2004). The assessment found that the surface sediment metals concentrations exceeding ODEQ Level II SLVs were unlikely to be responsible for *Chironomus* mortality, and the metals concentrations did not pose potential risks to the benthic community.

Contact Author: Helle B. Andersen, Windward Environmental LLC
200 West Mercer Street, Suite 401, Seattle, WA 98119
T 206-577-1287, F 206-217-0089, hellea@windwardenv.com

IN VITRO HEPATIC METABOLISM OF A BROMINATED FLAME RETARDANT (BDE 99) BY CHINOOK SALMON

Browne EP[1]*, Tilton SC[1], Stapleton H[2], Gallagher EP[1]

[1]University of Washington, Dept. of Environmental and Occupational Health Sciences, Seattle, WA
[2]Duke University, Nicholas School of the Environment, Durham, NC

Polybrominated diphenyl ethers (PBDEs) are a class of brominated flame retardants that persist in the environment and whose residues are increasing in humans and wildlife. Of particular concern in the Pacific northwest are the PBDE residues in resident Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), which are among the highest in salmonids and are dominated by low molecular weight congeners, primarily BDE-47. However, PBDE production and use are dominated by higher brominated PBDEs, suggesting that the congeners detected in Puget Sound salmon may result from *in vivo* debromination. We are investigating hepatic debromination of PBDEs in Chinook microsomal fractions *in vitro* under incubation conditions supporting thyroxine deiodinase (DI)-mediated activities and in the presence or absence of Cytochrome P450 (CYP450) co-factors. Incubation studies with BDE 99 resulted in a 1.2 picomole/hour/mg protein debromination of BDE 99 to BDE 49. Additional studies were conducted in the absence of CYP450 co-factors, in which similar conversion to BDE 49 was observed. The slow rate of conversion from BDE 99 to BDE 49, as well as the similarity between reactions with or without CYP450 co-factors, suggests that CYP450s may not play a major role in debromination of BDE 99 in Chinook. In all studies, no conversion of BDE 99 to BDE 47 was observed. Our experiments suggest that the high levels of BDE 47 found in resident Chinook may not be due to enzymatic debromination of BDE 99. Future work will continue to evaluate hepatic metabolism and debromination of BDE 209 and BDE 99, with an emphasis on elucidating the mechanisms of BDE debromination in Chinook via quantitative PCR (qPCR). Preliminary work has been completed verifying gene specific primers for Chinook salmon biotransformation enzymes by qPCR. Supported by NOAA NA05NS4781253.

Contact Author: Eva Browne, University of Washington
PO Box 357234, Seattle, WA 98105
T 206-543-1005, F 206-685-4696, ebrowne@u.washington.edu

MARION DRAIN INTENSIVE SURFACE WATER SAMPLING FOR PESTICIDES IN SALMONID-BEARING STREAMS

Dugger, DJ*[1], Burke, CB[2], Jorden, JD[1], Anderson, PD[2], Norton, D[2], and Cowles, J[3]

[1]Washington Department of Ecology, Yakima, WA
[2]Washington Department of Ecology, Olympia, WA
[3]Washington Department of Agriculture, Olympia, WA

The Washington State Departments of Ecology and Agriculture conducted an intensive surface water monitoring study to compare daily and weekly sampling frequencies using conventional grab samples to two types of passive samplers, Semi-Permeable Membrane Devices (SPMD) and Polar Organic Chemical Integrative Samplers (POCIS). The study was carried out over 22 days in the spring of 2007. The study site was the Marion Drain, a heavily cropped 19-mile drainage ditch that discharges into the Yakima River. Marion Drain is used by salmonids including: Chinook, Coho, and endangered Steelhead. A total of 21 pesticide compounds were detected during the study. Daily grab sampling detected one more pesticide than the number observed during four pre-scheduled weekly sampling events. Weekly sampling failed to detect the highest concentrations of several compounds detected in the daily samples. The daily grab sampling detected 6 compounds that were not found in the SPMD analysis; all with an octanol-water partition co-efficient (log $K_{o/w}$) $\leq$ 3.21. The SPMDs detected five compounds that were not found by grab sampling; all with log $K_{o/w} \geq$ 3.83. Results from the POCISs were compromised by positive detections in the sample blank and by inconsistent detections between sample replicates. SPMDs complemented grab sampling activities by increasing the detection rate for hydrophobic pesticides. The difference in the quantity of detections between daily and weekly grab sampling was small. However, daily samples detected more potentially harmful peaks in pesticide concentration.

Contact Author: Daniel Dugger, Washington Department of Ecology
15 W. Yakima Ave, Ste. 200, Yakima, WA 98902
T 509-454-4183, F 509-575-2809, ddug461@ecy.wa.gov

USE OF CHIRAL SIGNATURES OF HISTORIC-USE PESTICIDES IN AIR AND SOIL TO APPORTION SOURCE REGIONS TO THE WESTERN U.S.

Genualdi, S[1]*, Primbs, T[1], Simoneit, B[1], Ryoo, KS[2], Bidleman, T[3], Jantunen, L[3], Simonich, S[1]

[1]Oregon State University, Corvallis, OR
[2]Andong National University, Seoul, South Korea
[3]Centre for Atmospheric Research Experiments, Egbert, Canada

The goal of this research was to use the enantiomer fractions of chiral pesticides measured in soils and air to apportion the relative contributions of regional and Asian source regions to air masses in the Western United States. Re-volatilization of pesticides from agricultural soil is a major source of organochlorine pesticides to the environment. Since the Pacific Northwest is influenced by both regional and trans-Pacific atmospheric transport, soil samples were collected from four agricultural areas in China, in South Korea, and also from agricultural areas in Oregon. During the spring of 2004, hi-volume air samples were collected during an intensive air sampling campaign in Okinawa Japan. Hi-volume air samples were also collected at three different air sampling locations in the Pacific Northwest from 2003 to 2006: Cheeka Peak, a coastal site on the Olympic Peninsula of Washington at 500m, Mary's Peak, a 1250m site in Oregon's Coastal range, and Mt. Bachelor, a 2300m site located in the Oregon Cascades. The enantiomer fractions of α-hexachlorocyclohexane, cis and trans chlordane, and o'p'DDT were measured in both the soil and the hi-volume air samples using GC-MS in electron capture negative ionization mode. The enantiomers were separated using a 30m DB-5 column in tandem with a 15m BGB Analytik chiral column. The enantiomer fractions were determined in both the air and soil samples, and were further used to asses the source regions of chiral historic-use pesticides to the Pacific Northwestern United States.

Contact Author: Susie Genualdi, Oregon State University
1007 ALS, Corvallis, OR 97333
T 541-737-7672, susie.genualdi@gmail.com

PARTICLE PHASE POLYCYCLIC AROMATIC HYDROCARBONS IN THE ATMOSPHERE OF RAIPUR, INDIA

Giri, B*[1]; Simonich, SL[1,2] and Simoneit, BR[3]

Oregon State University, Corvallis OR
[1]Department of Chemistry
[2]Department of Environmental and Molecular Toxicology
[3]College of Oceanic and Atmospheric Sciences

Polycyclic aromatic hydrocarbons (PAHs) are atmospheric pollutants and well known human carcinogens. Particle phase PAHs were measured in the ambient air of Raipur, one of largest cities in India with a growing number of steel and thermal power plants. 17 PAHs were measured in the particulate matter (PM10) from urban and industrial areas of the city, representing three different seasons in 2006. Samples were collected on glass microfiber filters, extracted with dichloromethane using accelerated solvent extraction (ASE) and analyzed using gas chromatography-mass spectrometry for quantification. Preliminary results showed seasonal variation, with higher PAH concentrations during the winter and lower PAH concentrations during the summer and rainy season. Higher molecular weight PAHs had greater contribution to the total PAH concentration. The concentration of total PAHs in the atmosphere of Raipur was lower by two orders of magnitude in the summer and rainy season and lower by a factor of 3 in the winter as compared to atmospheric concentration of PAHs in Delhi, the capitol city of India.

Contact Author: Basant Giri, Oregon State University
Gilbert Hall 153, Corvallis, OR 97330
T 541-207-8610, girib@onid.orst.edu

PROTECTING THE NATION'S FOOD SUPPLY: USE OF CHEMICAL PROFILING TO DETERMINE THE ORIGIN OF FOOD COMMODITIES

Hobbie, KA*, Perez, AL, Smith, BW, Anderson, KA, Oregon State University, Dept. of Environmental & Molecular Toxicology, Corvallis, OR.

The accurate labeling of the origin of food is crucial for securing the nation's food supply to increase public health security and bioterrorism preparedness. Truth in labeling also boosts consumer confidence, where food origin is used as an economic marketing tool to convey the agricultural practices, quality, and value of foods. Isotope ratio analysis, elemental analysis, and computational evaluation provide scientific foundations to cost effectively authenticate the geo-location of a broad range of foods based upon their chemical signature. Our lab has successfully used elemental analyzer-isotope ratio mass spectrometry and inductively coupled plasma spectroscopy, as well as classification techniques; such as principal component analysis, canonical discriminant analysis, discriminant analysis, and neural network modeling; to classify origin of potatoes, coffee, pistachios, pears, blueberries and strawberries. These tools provide multiple lines of evidence to not only successfully differentiate food origin by continental growing location with greater than 95% certainty, but also differentiate to finite scales, such as regional location; independent of variety, cultivar and growing season.

Contact Author: Kevin Hobbie, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-1766, F 541-737-0497, kevin.hobbie@oregonstate.edu

SEMI-VOLATILE ORGANIC COMPOUNDS MEASURED IN SEDIMENT AND TADPOLE SAMPLES FROM THE SIERRA NEVADA AND CALIFORNIA CASCADE MOUNTAIN RANGE

Huber, RC*[1], Stanley, KA[1], Bradford, DF[2], Davidson, C[3], Tallent-Halsell, N[2], and Simonich, SL[1]

[1]Oregon State University, Corvallis, OR
[2]United States Environmental Protection Agency, Las Vegas, NV
[3]San Francisco State University, San Francisco, CA

California's Central Valley is bordered by the Sierra Nevada Mountain Range and the California Cascades. The Central Valley is a large agricultural production area that uses a variety of pesticides on its crops. Many of these pesticides, and other semi-volatile organic compounds (SOCs), can travel by atmospheric transport to high elevation lakes in the Sierra Nevadas and the California Cascades. Sediment and tadpole samples were collected from 28 sites in the Sierra Nevada Mountain Range and the 32 sites in the California Cascades. The samples were extracted using on-column extraction and accelerated solvent extraction and analyzed by gas chromatography / mass spectrometry. Endosulfan and dacthal were consistently measured in the tadpole and sediment samples. The endosulfan concentration was nearly five times greater in the Sierra Nevada samples then in the Cascade samples, while the cis-nonachlor concentration in the Sierra Nevadas was three times the concentration in the Cascade samples. The concentration of pesticides and polychlorinated biphenyls (PCBs) were higher in the tadpole samples than in the sediment samples on a dry weight basis, likely because of bioconcentration. However, the concentration of polycyclic aromatic hydrocarbons (PAHs) was higher in the sediment samples than the tadpole samples, likely because of metabolism of PAHs by cytochrome P450s in the tadpoles. The higher pesticide, PAH, and PCB concentrations in the Sierra Nevadas relative to the Cascade Mountains is likely due to regional land use differences.

Contact Author: Rachel Huber, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-9208, F 541-737-0497, huberr@onid.orst.edu

BRAIN AChE INHIBITION IN JUVENILE RAINBOW TROUT EXPOSED TO PESTICIDE MIXTURES WITHIN URBAN STREAMS IN WESTERN WASHINGTON: REASONS FOR NON-ADDITIVE EFFECTS

King, KA[1]*, Ayres, KL[2], Frew, JA[3], Saito, R[4], Slipper, JM[5], Thompson, AM[4], Yahnke, AE[6], Grassley, JM[1], Grue, CE[1], Hooper, MJ[7]

[1]University of Washington, Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, Seattle, WA
[2]University of Washington, Department of Biology, Seattle, WA
[3]University of Washington, College of Engineering, Seattle, WA
[4]University of Washington, School of Aquatic and Fishery Sciences, Seattle, WA
[5]University of Washington, Program on the Environment, Seattle, WA
[6]University of Washington, College of Forest Resources, Seattle, WA
[7]Texas Tech University, Institute of Environmental and Human Health, Lubbock, TX

Recent efforts have documented pesticide concentrations within surface waters of urban streams in western Washington. Although levels reported are low (most <1.0 ppb), the presence of these chemicals has generated concerns, particularly their potential effects on salmonids. Previously, we exposed juvenile (ca. 10 g) rainbow trout (*Oncorhynchus mykiss*) to a chemical cocktail representative of urban streams in western Washington. Nominal concentrations (ppb active ingredient) of 9 herbicides, 3 insecticides (ChE-inhibitors, carbaryl, diazinon, and malathion), an insecticide breakdown product, and a fungicide were the maximum reported during peak storm flow events (hereafter 1X). With the exception of the fungicide and the breakdown product, formulated products (FP, single AI) were used and if possible were selected from those available at retail outlets. Brain AChE activity was not inhibited in fish exposed to the 1X cocktail, but was in the 3.3X (23%) and 10X (84%) cocktails. Enzyme activity was not affected by the 10X concentrations of the individual cholinesterase inhibitors as AIs or FPs, but was inhibited 59 and 78 percent in fish exposed to the mixtures, respectively. Recently, we exposed juvenile rainbow trout of the same size to the same individual cholinesterase inhibitors (10X) as AIs or FPs as well as binary and tertiary mixtures in an effort to identify the combination responsible for the potentiation of AChE inhibition and the underlying physiological mechanisms. Results for the AIs and FPs were similar and indicated that the combination of diazinon + malathion (AChE inhibition = 85-88%) was responsible. Results of complementary studies of the relationships between effects on plasma BuChE and carboxylesterases and the interaction between the two AChE inhibitors will be presented. The implications of these results to urban streams, the regulation of pesticide mixtures, and assessments of the hazards pesticides pose to non-targets will be discussed.

Contact Author: Kersensa King, University of Washington,
PO Box 355020, Seattle, WA 98195
T 206-685-4195, F 206-616-9012, kerensa@u.washington.edu

EFFECTS OF PESTICIDES IN URBAN STREAMS IN WESTERN WASHINGTON ON COHO SALMON EGGS AND SAC FRY

King, KA*, Grue, CE, Grassley, JM, Fisk, RJ, Hearsey, JW, University of Washington, Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, Seattle, WA

The research presented represents the third year of a five-year effort to determine the effects of a chemical cocktail, present in urban streams in Western Washington, on different life stages of Coho salmon (*Oncorhynchus kisutch*). The cocktail consisted of 8 herbicides, 2 insecticides, a fungicide, and a common breakdown product; nominal concentrations were the maximums reported after storm-water events in fall. With the exception of the fungicide and breakdown product, formulated products (single AI) were used, and if possible were selected from those available at retail outlets. In 2004 and 2005-06, research focused on adult Coho; recent monitoring efforts had suggested that pre-spawn mortality of Coho salmon had increased in natural waters, particularly urban streams in Western Washington. We found no effects on time to death, brain cholinesterase activity, sperm motility, or hatching success and growth of fry (from exposed adults) for 35 d. In 2006-07, our objective was to determine if there were effects on fertilization and eggs/sac fry as a result of a pulsed exposure to the chemical cocktail, simulating storm flows. The first part of the study examined effects on fertilization of the eggs and subsequent survival of the sac fry. Endpoints included fertilization success, hatching success, and viability through swim-up (emergence). The second part examined the effects on hatching success of exposed eggs, sac fry survival, fry survival, and subsequent growth of fry for 35-d. Results suggest that there were no effects on the endpoints examined. Overall, results suggest that other factors (general water quality, habitat, or other contaminants) may be responsible for the reproductive effects observed in the field.

Contact Author: Kersensa King, University of Washington,
PO Box 355020, Seattle, WA 98195
T 206-685-4195, F 206-616-9012, kerensa@u.washington.edu

PRACTICAL CONSIDERATIONS IN DERIVING DOSE-RESPONSE-BASED TRVS FROM THE TOXICOLOGICAL LITERATURE

Luxon M*, Toll J, Tear L, Replinger S, Windward Environmental LLC, Seattle, WA.

The use of dose-response data, rather than no-observed-adverse-effect levels (NOAELs) and lowest-observed-adverse-effect levels (LOAELs), to derive toxicity reference values (TRVs) for ecological risk assessment has been recommended as a way to improve risk predictions. The true test of a TRV's utility is whether it can reliably predict adverse effects of a magnitude acceptable to risk managers, or whether variability around the effect estimate renders risk estimates meaningless. This study evaluates the adequacy of toxicity data available in published literature for use in deriving dose-response-based TRVs for fish. Fish studies that relate dietary doses and whole-body tissue-residues to adverse effects were included in the study. Data for a variety of chemicals, including metals, polycyclic aromatic hydrocarbons (PAHs), butyltins, polychlorinated biphenyls (PCBs), and pesticides, were evaluated. For each chemical-receptor pair, dose-response or tissue-residue-response data were compiled for the species and the endpoint associated with the lowest LOAEL. The adequacy of the data to derive dose-response relationships was evaluated.

Contact Author: Matt Luxon, Windward Environmental LLC
200 West Mercer Street, Suite 401, Seattle, WA 98119
T 206-577-1293, F 206-217-0089, mattl@windwardenv.com

SEASONAL FACTORS AND THE SENSITIVITY OF *MYTILUS EDULIS* EMBRYOS TO COPPER EXPOSURE

McCloskey JM, Entrix, Inc., Olympia, WA.

The blue mussel, *Mytilus edulis*, has long been recognized as a sensitive indicator organism tests to quantify contamination in coastal waters and sediments. In this study, bioassay results using *M. edulis* larvae, from two separate laboratories taken over the period of 2000 to 2006 (n= 30, 40, repectively), were examined to determine whether the observed sensitivity to copper during gametogenesis correlated with temperature, salinity, and/or food availability. Thus, water temperature and salinity during culture of the parent mussels were examined to assess whether they impacted gamete formation and hence the observed response of the embryos to environmental stressors, with copper used as a model stressor. Chlorophyll levels were used as a measure of phytoplankton biomass to assess the effects of seasonal nutrient availability during gamete formation on the robustness of mussel embryos to copper exposure. No correlation was found between embryo copper sensitivity and either temperature or salinity levels during oogenesis. However, a weak positive correlation was observed between chlorophyll levels one week and eight weeks prior to spawning and the embryo mortality endpoint, suggesting that embryo copper sensitivity decreases as food availability increases during gametogenesis.

Contact Author: Jenner McCloskey, ENTRIX, Inc.
148 Rogers St. NW, Olympia, WA 98502
T 360-352-3225, jmccloskey@entrix.com

BIOAVAILABILITY AND TOXICITY OF METALS IN SEDIMENTS FROM LAKE ROOSEVELT, COLUMBIA RIVER, WASHINGTON USA

Besser, JM[1], Brumbaugh,WB, Ivey, CD, Ingersoll, CG, and Moran, PW*[2]

[1]U.S. Geological Survey, Columbia Missouri USA
[2]U.S. Geological Survey, Tacoma Washington

We studied the bioavailability and toxicity of copper, zinc, arsenic, cadmium, and lead in sediments from Lake Roosevelt (LR), a reservoir on the Columbia River in Washington, USA, that receives inputs of metals from an upstream smelter facility. We characterized chronic sediment toxicity, metal bioaccumulation, and metal concentrations in sediment and pore water from eight study sites: one site upstream in the Columbia River, six sites in the reservoir, and a reference site in an uncontaminated tributary. Total recoverable metal concentrations in LR sediments generally decreased from upstream to downstream in the study area, but sediments from two sites in the reservoir had metal concentrations much lower than adjacent reservoir sites and similar to the reference site, apparently due to erosion of uncontaminated bank soils. Concentrations of acid-volatile sulfide in LR sediments were too low to provide strong controls on metal bioavailability, and selective sediment extractions indicated that metals in most LR sediments were primarily associated with iron and manganese oxides. Oligochaetes (*Lumbriculus variegatus*) accumulated greatest concentrations of copper from the river sediment, but accumulated greatest concentrations of arsenic, cadmium, and lead from reservoir sediments. Chronic toxic effects on amphipods (*Hyalella azteca*; reduced survival) and midge larvae (*Chironomus dilutus*; reduced growth) in whole-sediment exposures were generally consistent with estimates of metal toxicity risk based on empirical and equilibrium partitioning-based sediment quality guidelines. Elevated metal concentrations in pore waters of some LR sediments suggested that metals released from iron and manganese oxides under anoxic conditions contributed to metal bioaccumulation and toxicity. Results of chemical and biological assays indicate that metals in sediments from both riverine and reservoir habitats of Lake Roosevelt are available to benthic invertebrates. These findings will be used as part of an ongoing ecological risk assessment to determine remedial actions for contaminated sediments in Lake Roosevelt.

Contact Author: Patrick Moran, U.S. Geological Survey
934 Broadway, Suite 300, Tacoma, WA 98402
T 253-552-1646, F 253-552-1681, pwmoran@usgs.gov

A NUTRIENT BUDGET FOR A LARGE, OLIGOTROPHIC LAKE IN THE OLYMPIC NATIONAL PARK

Moran,PW*[1], Cox, SE[1], Fradkin, S[2]

[1]U.S. Geological Survey, Tacoma, WA
[2]Olympic National Park, Port Angeles, WA

A multi-year effort by the U.S. Geological Survey and the Olympic National Park to develop a nutrient budget for a large oligotrophic lake on the Olympic Peninsula is nearing completion. Lake Crescent is an 18 km long oligotrophic to ultra-oligotrophic lake covering 1,880 hectares near the northern border of the Olympic National Park. Despite its trophic status, concerns over increased algal growth, especially in the lake outlet or Lyre River, have spurred the development of a nutrient budget. Unique, cost-effective methods are being applied as precipitation, surface water, septic fields and groundwater are each being evaluated for low level nutrients (as Nitrogen and Phosphorous) with detection limits in the 1-10 ppb range. Concentrations and loads from each of these sources will be estimated; however nutrients are consistently below the detection limits in both the lake and outlet river. Two large (1.5-2 m) sediment cores from the lake bottom have been collected and are being evaluated for sedimentation rates, nutrient burial, and shifts in diatom communities. Such basic learning about a watershed will allow the pursuit of multiple future research questions and will provide managers with ratios and trends of anthropogenic to non-anthropogenic nutrient sources.

Contact Author: Patrick Moran, U.S. Geological Survey
934 Broadway, Suite 300, Tacoma, WA 98402
T 253-552-1646, F 253-552-1681, pwmoran@usgs.gov

EFFECTS OF NICKEL TO MARINE ORGANISMS: COMPILATION OF AVAILABLE DATA AND DERIVATION OF A MARINE PNEC

Morera, D*[1], Stubblefield, W, Van Genderen, EJ, Schlekat, CE[2]

[1]Parametrix, Albany, OR
[2]Nickel Producers Environmental Research Association, Durham, NC

Chronic ecotoxicity data for nickel are relatively scarce; chronic toxicity tests were conducted to assess nickel toxicity to a broad range of marine organisms. New and historic data were used to construct a Species Sensitivity Distribution (SSD) to determine a predicted no effect concentration (PNEC) for nickel in saltwater. The compiled chronic nickel toxicity database contained endpoints for fourteen marine species which included a broad taxonomic representation including unicellular algae (diatom and flagellate), macroalgae (giant kelp and red algae), invertebrates (echinoderms, mollusks, mysid, and annelid) and fish (topsmelt and minnow). PNECs were calculated using both the assessment factor (AF) approach and the species sensitivity distribution (SSD) approach. In the AF approach the PNEC was calculated by dividing the lowest chronic effect concentration (EC10) by 10 since there were more than three taxonomic groups for which chronic data was available. In this case the lowest EC10 value (2.8 µg/L) was reported for the sea urchin, *Diadema antillarum*; therefore, the calculated PNEC was 0.28 µg/L dissolved Ni. Given that the chronic database was sufficiently large, the PNEC was also calculated by means of statistical extrapolation (i.e., SSD analysis), using available chronic values (EC10 or no observable effect concentration). Several statistical distribution functions were used in analyzing the extant chronic data including log-normal distribution and a best-fit model. The resulting PNEC concentrations estimated to not effect 5% (HC5) of the species ranged from 4.04 to 20.6 µg Ni/L.

Contact Author: William Stubblefield, Parametrix, Inc.
33972 Texas St. SW, Albany, OR 97321
T 541-791-1667, F 541-791-1699, stubblew@onid.orst.edu

SEASONAL VARIATIONS OF SEMI-VOLATILE ORGANIC COMPOUNDS IN URBAN AND RURAL CHINA 2002-2003

Murray, J[1], Primbs, T[1], Simoneit, B[2], Tilt, B[3], and Simonich, S[1,4]

[1]Department of Chemistry, Oregon State University Corvallis, OR
[2]Department of Oceanic and Atmospheric Sciences Oregon State University, Corvallis, OR
[3]Department of Anthropology, Oregon State University Corvallis, OR
[4]Department of Environmental and Molecular Toxicology Oregon State University, Corvallis, OR

Air Samples from urban and rural regions of China from 2002 to 2003 were collected and analyzed to determine their anthropogenic semi-volatile organic compound (SOC) profiles. Urban samples were collected in Guangzhou, a large metropolis located in southeast China, using a high volume air sampler. Rural samples were collected in Futian, a small rural township with some local industry, using a personal monitoring pump. All samples were extracted by accelerated solvent extraction (ASE) and analyzed using gas chromatography-mass spectrometry (GC-MS). High concentrations of polycyclic aromatic hydrocarbons (PAHs) were observed in samples from both sites and the highest concentrations occurred during the winter months. PAH ratios indicate that combustion is a dominant source of PAHs while the average winter ratios are elevated in rural samples relative to those from the urban area. High concentrations of levoglucosan, a known biomarker for biomass burning, were also observed in the samples, and concentrations of levoglucosan were higher in the urban as compared to the rural environment. Meteorological data and air mass back trajectories were also used to determine potential impacts from regional and long-range atmospheric transport.

Contact Author: Jessica R. Murray, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-9208, F 541-737-0497, murrajes@onid.orst.edu

AH RECEPTOR – AN UNKNOWN TARGET OF IMMUNO-MODULATORY DRUGS?

O'Donnell, EF*; Farrer, DG; Koch, DC; Saili, KS; Kerkvliet, NI; Tanguay, RL; Kolluri, SK, Oregon State University, Corvallis, OR

Dioxins are potent mammalian toxins that affect cellular proliferation and differentiation. The aryl hydrocarbon receptor (AhR) is a ligand activated transcription factor belonging to the basic-helix-loop-helix (bHLH)-Per-AhR/Arnt-Sim (PAS) protein family and mediates the toxicity of dioxins and related chemicals. During a search for molecules that activate AhR, Leflunomide®, an immunomodulatory drug used to treat a number of diseases, was identified to potently activate AhR transcription. A known mechanism of action of Leflunomide is through one of its metabolites, A771726, which inhibits de novo pyrimidine synthesis. Interestingly, CYP1A2, an AhR inducible gene has been implicated in the metabolism of Leflunomide to A771726. Leflunomide, but not A771726, activated AhR transcriptional activity in cell based reporter assays, and up-regulated a number of genes (CYP1A1, CYP1A2, UDP-glycosyl transferase, and NADPH quinone oxidoreductase) strictly in an AhR-dependent manner. Proliferation of T cells expressing AhR was inhibited by exposure to Leflunomide. Studies are in progress to determine the requirement of AhR in mediating Leflunomide-induced inhibition in proliferation. AhR may mediate biological activity of Leflunomide by two different means (i) by controlling the metabolism of Leflunomide and/or (ii) by directly mediating the effects of Leflunomide. It is well known that AhR mediates dioxin-induced immune suppression. This raises the intriguing possibility of targeting AhR for controlling hyperimmune disorders.

Contact Author**:** Edmond O'Donnell, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-1802, F 541-737-0497, odonneed@onid.orst.edu

DGT-BASED PARITION COEFFICIENTS REFLECT LONG-TERM METAL ACCUMULATION IN SOILS FROM FERTILIZER APPLICATION AND ARE PREDICTIVE OF CADMIUM AND NICKEL CONCENTRATIONS IN EDIBLE PLANT TISSUE

Pérez, AL*, Anderson, KA, Food Safety Environmental Stewardship Program, Department of Environmental & Molecular Toxicology, Oregon State University, Corvallis, OR, USA.

A multitude of soil sampling techniques have been utilized to predict human health risk from metal toxicity. Unfortunately, no simple test captures the chemical speciation of metals, particularly in the rhizosphere, where reactivity can be predictive of metal mobility and bioavailability to plants. In this study, we used Diffusive Gradients in Thin Films (DGT) to capture the labile metal fraction in the rhizosphere. In addition, successful correlation of a novel function of a distribution coefficient, Kd_{DGT}, or the distribution between DGT measured labile metal and a total recoverable metal fraction, to edible plant tissue metal concentrations was seen. Crops were grown in four agricultural soils, utilizing standard agricultural practices. Commercially available phosphate fertilizers containing elevated levels of Cd and Ni were applied at three agronomically relevant doses for three years. Total recoverable Cd increased with dose and Cd and Ni accumulated in soils over three years. Predictive variables of Cd_{plant} were Kd_{DGT}, NO_3, K, $Cu_{solution}$, and precipitation. Regression models accounted for 82% of the variability of predicting plant Cd and Ni concentrations. We report the use of Kd_{DGT} as a successful prediction tool of Cd and Ni in the edible portion plants grown in variable soil types.

Contact Author: Angela Pérez, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-1766, F 541-737-0497, pereza213@gmail.com

DERIVATION OF A BIOASSAY BASED SITE-SPECIFIC CLEANUP VALUE FOR WEATHERED BUNKER C-CONTAMINATED SOILS

Peterson, LE*, Gendusa, TC[1], Tobiason, KL[2], Auster, L[3], Sternberg, DC[4]

*CDM, Bellevue, Washington
[1]CDM, Little Rock, Arkansas
[2]Nautilus Environmental, Tacoma, Washington
[3]King County Solid Waste Division, Seattle, Washington
[4]Washington Department of Ecology, Olympia, Washington

The Ellisport Creek Greenspace Project site on Vashon Island, Washington contains Bunker C oil contamination from past industrial use, complicating transfer of this wetland site for use as open space. A site-specific Terrestrial Ecological Evaluation (TEE) was performed pursuant to the Washington State Model Toxics Control Act (MTCA) to ensure protection of plants and animals from exposure to environmental contamination at levels likely to cause significant or adverse toxic effects. In the absence of available ecotoxicity data for Bunker C, bioassay testing was used to determine potential impacts to ecological receptors. Earthworms (*Eisenia fetida*) and lettuce (*Lactuca sativa*) represented indigenous soil invertebrates and terrestrial plants in laboratory bioassay tests that measured toxic effects from exposure to samples of contaminated soil collected at the site. Earthworm exposure to soil samples containing the highest concentrations of Bunker C (18,000 milligrams per kilogram [mg/kg]) produced a mean survival rate of 26.7% over the 14-day exposure, but exposures at all other test concentrations produced survival rates of 80% or higher, and no significant effect at exposures of 6,700 mg/kg or less. After consulting with the Washington State Department of Ecology it was agreed that the soil cleanup value for Bunker C be based on protection of apparently more sensitive soil invertebrates represented by earthworms. The no effect level of 6,700 mg/kg Bunker C in soil is a conservative threshold at which adverse effects may begin to be observed in resident soil invertebrates and, as such, would adequately protect soil organisms at the site. This study represents the first use of bioassays under MTCA to develop a site-specific soil cleanup level for a weathered hydrocarbon. The 6,700 mg/kg site-specific cleanup level for Bunker C is significantly higher than the 200 mg/kg default ecological indicator soil concentration in MTCA which may be used as cleanup level.

Contact Author: Lance Peterson, CDM
PO Box 3885, Bellevue, WA 98009
T 425-453-8383, F 425-646-9523, petersonle@cdm.com

UTILIZING ZEBRAFISH AS A TIER ONE MODEL FOR HUMAN HEALTH CONCERNS: UNRAVELING THE MECHANISMS OF PBDE DEVELOPMENTAL TOXICITY

Pettebone, V*, Tilton, F, and Gallagher,E, University of Washington, Seattle WA USA 98105.

Polybrominated diphenyl ether (PBDE) flame retardant concentrations are increasing in the environment, wildlife, and humans. Although there is evidence to indicate that developing organisms are particularly susceptible to PBDE exposures, little is known about the potential developmental toxicity of these compounds. The zebrafish provides an unparalleled high-throughput *in vivo* model to assess the potential ramifications of PBDEs to developing vertebrates. The aim of these studies was to complement ongoing human fetal stem cell studies by investigating the ramifications of PBDE developmental exposure in zebrafish. Embryo and larval zebrafish were exposed to some of the major congeners found in biological tissues and environmental matrices (i.e. BDE 47, 49, 99 and 100). Embryos were exposed from either 5 hours post fertilization (hpf) to 120 hpf, or from 24 hpf to120 hpf (dechorinated) at concentrations from 0.78 μM to 50 μM. We observed a number of effects to embryo morphology between 120 and 168 hpf at ≥ 3.1 μM in both exposure windows. All PBDE congeners elicited some degree of lethality by 168 hpf at 12.5 μM. There was no developmental delay from exposure as indicated from hatching and developmental milestones. Exposure to BDE 47, 49 and 99 caused significant dorsal curvatures of the tail at 12.5 μM between 120 and 144 hpf. However, only BDE 47 caused significant cardiac arrhythmias at 144 hpf between 6.25 μM and 12.5 μM. Larval zebrafish exposed to BDE 47 and 49 ≥ 6.25 μM exhibited a decreased touch and escape response by 120 hpf. Similar to reports in mammalian models, all the congeners tested caused noticeable behavioral impairments. Our studies provide the framework to identify conserved molecular mechanisms of PBDE developmental toxicity and suggest a structure-activity relationship among congeners with regards to developmental toxicity. Supported by NIH grants P42ES04696, P42ES07033 and NOAA NA05NOS4781253.

Contact Author: Valerie Pettebone, University of Washington
4225 Roosevelt Way, Suite 100, Seattle WA USA 98105
T: 206-543-1005 vep@u.washington.edu

THE EFFECT OF ARTIFICIAL SEA SALT PREPARATION ON *STRONGYLOCENTROTUS PURPURATUS* FERTILISATION SUCCESS

Pickard, J, Stavroff, LA*, Wilson, M, Howes, P, Sullivan, C, Eickhoff, C, CANTEST, Ltd, Vancouver, British Columbia, Canada.

An echinoderm fertilisation assay is frequently used for the evaluation of a sublethal effect from sediments, effluents, or chemicals. The type of artificial sea salt and its preparation can produce different fertilisation results when using *Strongylocentrotus purpuratus* (Purple Sea Urchin). The fertilisation success of *S. purpuratus* was compared among treatments of different types of artificial sea salt and the preparation techniques used. Six commercial brands (Instant Ocean, Crystal Sea Marine Mix, Kent, SeaChem Reef Salt, Ocean Pure Sea Salt, and Red Sea Salt) were prepared using six different combinations: with or without aeration; in dechlorinated, hardened Vancouver city tap water or Type II deionised water; and aging for 24 or 48 hours. In general, the greatest fertilisation success occurred in salts that were prepared with aeration in Vancouver city tap water, and allowed to age for 48 hours. Fertilisation success with sea salts prepared without aeration was generally lower than when aerated. Overall, OceanPure provided the most comparable results to the control (filtered and sterilised Vancouver Aquarium sea water). Red Sea treatments that were aerated had similar results to that of Ocean Pure, while non-aerated treatments gave variable results depending on water type and aging period. When aerated for 48 hours Crystal Sea showed comparable results in either water type. Fertililsation success with remaining brands and treatments was significantly varied and markedly lower.

Contact Author: Leslie-Anne Stavroff, CANTEST, Ltd.
4606 Canada Way, Burnaby, BC V5G 1K5
T 604-734-7276, F 604-638-0501, lstavroff@cantest.com

DEVELOPMENT OF A BENTHIC INDEX TO ASSESS METALS CONTAMINATION ASSOCIATED WITH MINING WASTE IN CANYON CREEK (COEUR D' ALENE)

Plante, J*, Bollinger, C, Lenaker, P, and Harper, RM, Western Washington University, Bellingham, WA.

Previous mining activities in the Coeur d'Alene river valley, Idaho, have left many of the region's lakes, rivers and streams contaminated with elevated levels of heavy metals. The effects of this prolonged contamination have resulted in a decrease, and in some cases elimination, of aquatic benthic macroinvertebrates from many areas. As macroinvertebrates play an essential role in nutrient cycling, their reduced numbers can have impacts on many organisms in the aquatic environment. Benthic macroinvertebrates were collecteded from several sites on Canyon Creek in the Coeur d'Alene valley. Metals analysis of the water, sediment and a subsample of organisms were conducted and a gradient of contamination determined. Taxonomic identification of the collected macroinvertebrates is used to determine the diversity of the populations in addition to an identification of metals tolerant species present at the sites. This information will ultimately be used in conjunction with an assessment of genetic diversity at the sites to contribute to an understanding of metal exposure effects on different levels of biological organization. We plan to present a single Canyon Creek Benthic Index (CCBI) that was developed specifically for Canyon Creek.

Contact Author: James Plante, Western Washington University
1213 Whatcom St. #4, Bellingham, WA 98229
T 360-778-3741, plantej2@cc.wwu.edu

VALIDATION AND MODIFIED METHODS FOR LIPID-FREE POLYETHYLENE MEMBRANE PASSIVE SAMPLER

Quarles, LW*, Ackerman, A., Anderson, KA, Oregon State University, Corvallis, OR.

The need for an inexpensive and simple time-integrative passive sampling device (PSD) for dissolved hydrophobic contaminants in water is growing. In response, we have further developed the lipid-free polyethylene membrane tubing (LFT) sampler. The LFT sampler works on the premise that dissolved hydrophobic target compounds diffuse through the aqueous boundary layer and into the polyethylene membrane, thus mimicking the uptake by organisms. We have demonstrated through laboratory and field validation studies that LFT proved reliable and have similar benefits as other PSDs without the analytical interference potential of lipid impurities. Modeling can be used in conjuncture with ratios and *in situ* calibration to estimate LFT sampling rates. In the field, the effects of environmental conditions on the sampling rates of the device are indicated by the *in situ* calibration using a simple internal surrogate spiking method. For this study, PAHs and pesticides were the focus. Also, an alternative preparation and extraction method was developed for LFT to significantly reduce solvent by more than half with respect to other organic PSD methods as well as eliminating the use of all chlorinated solvents. The method still maintains sensitivities in the ng/ml range. Extraction time has also decreased by more than four times. The direct result of using this updated method is reduced solvent waste, laboratory and labor costs, and use of less toxic solvents.

Contact Author: Lucas Quarles, Oregon State University
1007 ALS, Corvallis, OR 97331
T 541-737-1781 or 541-737-4529, F 541-737-0497, quarlesl@onid.orst.edu

UPTAKE OF ESTRADIOL BY HORNYHEAD TURBOT (*PLEURONICHTHYS VERTICALIS*) AND EFFECTS ON OXIDATIVE DNA DAMAGE IN GONADS

Rempel-Hester, MA*[1], Gully, J[2], Armstrong, J[3] and Schlenk, D[4]

[1]Nautilus Environmental, Tacoma, WA
[2]Los Angeles County Sanitation District, Whittier, CA
[3]Orange County Sanitation District, Fountain Valley, CA
[4]University of California Riverside, Riverside, CA

Previous field studies off the coast of southern California showed a direct relationship between plasma 17β-estradiol (E2) and DNA damage in the gonads of hornyhead turbot (*Pleuronichthys verticalis*). To evaluate whether E2 exposure via sediment would be effective in eliciting feminizing effects as well as DNA damage, the bioavailability of E2 in sediment to hornyhead turbot collected from a reference location was examined by measuring effects on plasma E2 levels, plasma vitellogenin levels, and oxidative DNA damage. Though significant increases in E2 and vitellogenin levels were observed, the correlation between plasma E2 concentrations and oxidative DNA damage in gonads seen in the field could not be reproduced. Two possible reasons were that the effects were transient and therefore could not be measured with the study design used, or there is a difference in response between fish residing near an outfall versus fish from a reference location. To address these issues fish collected from both an outfall and a reference location were exposed in tandem to E2 in a time-course experiment. The results indicated a differential response in the two populations of fish. Fish collected from the outfall location produced vitellogenin earlier than fish from the reference location. DNA damage appeared to be transient in reference fish but possibly longer-term in outfall fish. Results indicated that fish from a wastewater outfall might be more susceptible to estrogen exposure than fish from less impacted sites.

Contact author: Mary Ann Rempel-Hester, Nautilus Environmental
5009 Pacific Highway East, Suite 2, Tacoma, WA 98424
T 253-922-4296, F 253-922-5814, mary.ann@nautilusenvironmental.com

DEVELOPMENT OF A POLYCHLORINATED BIPHENYL (PCB) BIOACCUMULATION MODEL FOR THE PUGET SOUND, WA ECOSYSTEM

Ryan, AR*[1], Stern, JH[2], Nairn, B[2], Schock, K[2]

[1]Huxley College of the Environment, Western Washington University, Bellingham, WA
[2]King County Department of Natural Resources and Parks, Seattle, WA

Understanding the movement and fate of persistent organic pollutants in ecosystems is a key goal in the remediation of toxic contaminants. The goals of this work are to develop a bioaccumulation model for the transport of polychlorinated biphenyls (PCBs) through the marine food web of the central basin of Puget Sound, WA. A food web conceptual model for major trophic interactions has been developed through the analysis of feeding guild data, relative biomass, and the percent composition of predator species' diet. These interactions have been modeled using a steady-state computer model developed by Frank Gobas and Jon Arnot (2004) that utilizes chemical partitioning from sediment and water to derive tissue wet weight body burdens. The initial form of this model is concerned with total PCBs; however, congener specific forms of the model may be developed later. Currently five of the nine organisms modeled are performing within a factor of two difference from empirical concentrations, with two other estimates being within a factor of three. This model is currently under development, and uncertainty and sensitivity analysis have yet to be performed.

Contact Author: Andrew Ryan, Western Washington University
516 High Street. Bellingham, WA, 98225
T 360-650-7324, F 360-650-6556, ryan.andrew23@gmail.com

ESTIMATING THE DECLINE OF WILD COHO SALMON POPULATIONS DUE TO RECURRENT DIE-OFFS OF ADULT SPAWNERS RETURNING TO PACIFIC NORTHWEST URBAN STREAMS

Spromberg, JA*, McCarthy, S, Scholz, NL, Northwest Fisheries Science Center, Seattle, WA.

Recent field investigations evaluating the effectiveness of urban stream habitat restoration projects in the greater metropolitan area of Seattle, Washington have detected a high rate of die offs or pre-spawn mortality (PSM) among returning adult coho salmon, (*Oncorhynchus kisutch*). Adult coho in several lowland Puget Sound streams have shown a consistent suite of symptoms (e.g., disorientation, lethargy, loss of equilibrium, gaping, fin splaying) that ultimately progressed to the death of the affected animals. Over several years of monitoring, annual rates of PSM have ranged from ~20% to 90%. The weight of evidence to date suggests that PSM is caused by non-point source stormwater runoff from urban areas. We constructed life-history models to forecast effects of PSM related to urban growth into watersheds supporting viable wild coho populations and metapopulations. Population-level impacts were estimated by using scenarios simulating changes in land use or stormwater management in nonurban watersheds. Scenarios depicting a gradual increase of PSM to 25% over 30 years to an otherwise viable population resulted in 100% extinction of localized solitary populations within 115 years and constant impacts of 90% resulted in extinction in an average of 8 years. Metapopulation models predicted large reductions in the abundance of populations experiencing PSM but not extinction as long as unaffected populations were available to provide migrant sources. The abundance of source populations declined when surrounding PSM-affected populations became migrant sinks. These basic models demonstrate the potential for rapid loss or depression of localized populations in urban streams from non-point source stormwater runoff.

Contact Author: Julann Spromberg, NOAA Fisheries
2725 Montlake Blvd. E., Seattle, WA 98112
T 206-302-2426, F 206-860-3335, Julann.Spromberg@noaa.gov

POPULATION-LEVEL EFFECTS OF ADJUVANT AND PESTICIDE MIXTURES TO *CERIODAPHNIA DUBIA*

Stark, JD, Washington State University

The effects of the agricultural adjuvants, Destiny and R-11 and the pesticides, Ultor (spirotetramat) and Admire Pro (imidacloprid) were evaluated on the Cladoceran *Ceriodaphnia dubia* by developing acute mortality estimates and population-level measures after chronic exposure. The chemicals were tested singly and as binary mixtures of pesticide and adjuvant (mixture 1 = Ultor and Destiny, mixture 2 = Admire Pro and R-11). Acute mortality estimates (48h) were developed as well as the effects on several population parameters after chronic 8 day exposure. Acute LC50 estimates for Destiny and Ultor were 27 mg/l and 27 mg/l, respectively. Acute LC50 estimates for R-11 and Admire Pro were 9.2 mg/l and 0.002 mg/l, respectively. Daphnids were exposed to 0, 1, 10, 20, 30, 40mg/l of Destiny or Ultor singly and as a mixture for 8 days. Population growth rates were significantly lower in the mixture treatment compared to either chemical alone indicating that these chemicals interacted synergistically. Mixtures of Admire Pro and R-11 also produced synergistic effects at the population level. These results indicate that adjuvant and insecticide mixtures can cause greater damage to populations of cladocerans than either product alone.

Contact Author: John D. Stark, Washington State University
7612 Pioneer Way East, Puyallup, WA 98371
T 253-445-4519, starkj@wsu.edu

A SURVEY OF CADMIUM IN PACIFIC OYSTERS (*CRASSOSTREA GIGAS*) OF THE UNITED STATES WEST COAST: ACCUMULATION PATHWAYS, SUBCELLULAR DISTRIBUTION, AND IMPLICATIONS FOR THE SHELLFISH INDUSTRY

Stupakoff, I*; Chuang, C-Y[2]; Christy, AE[3]; Cheney, DP[3]; Middleton, M[3]; Ng, TYT[2]; Wang, W-X[2]

*Integral Consulting, Olympia, WA
[2]Hong Kong University of Science and Technology, Kowloong, Hong Kong
[3]Pacific Shellfish Institute, Olympia, WA.

The international public health organization Codex Alimentarius has recently proposed lowering the maximum level for cadmium in molluscan shellfish tissue to 1 µg/g in an attempt to protect consumers from long-term exposure to low levels of this metal. Limited testing of farmed shellfish worldwide indicates that it is common for certain species and growing areas to exceed both the proposed action level and the United States Food and Drug Administration's 3.7 µg/g level of concern. We hypothesize that regional geochemistry can have a profound influence on bioavailability and accumulation of cadmium in certain shellfish and in turn affect the viability of regional fisheries. The primary objective of this project was to elucidate factors that affect cadmium concentrations in Pacific oysters (*Crassostrea gigas*) in order to focus efforts to minimize cadmium residues in this species. This study reports 1) the spatial and seasonal distribution of cadmium tissue concentrations in the Pacific oyster harvested from the United States west coast commercial, recreational and tribal shellfish growing areas from California to Alaska, 2) controlled laboratory measurements of uptake and efflux kinetics of cadmium in oysters from ingested radio-labeled sediments, surface water and phytoplankton, 3) subcellular distribution of cadmium (cell organelles, metallothionein-like proteins, heat sensitive proteins, metal-rich granules and cell debris), 4) the use of a bioenergetic-based kinetic model to determine exposure pathways (sediment, solute and seston) for cadmium accumulation in oysters, and 5) field trials of shellfish growing methods to assess effects on cadmium body burdens. We use insights from these results to discuss ways to help minimize cadmium residues in oyster products. This material is based upon work supported by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under the Agreement No. 2004-51110-02156.

Contact Author: Ian Stupakoff, Integral Consulting Inc.
1205 West Bay Drive NW, Olympia, WA 98502
T 360-705-3534, F 360-705-3669, istupakoff@integral-corp.com

USING EFFECTIVE SOLUBILITY AS AN INDICATOR OF THE RISK OF OILY SOIL TO GROUNDWATER: THE IMPACT OF WEATHERING

Thorsen, WA*, O'Reilly, KO, Exponent Consulting, Bellevue, WA.

Hydrocarbon contamination of groundwater is a major driver for the remediation of oiled soils. The ability to predict areas where contaminated soils may pose a threat to groundwater has the potential to reduce sampling numbers, excavation volumes, and overall costs. We tested a method to screen oily soil samples by calculating the effective solubilities of 20 aromatic hydrocarbons (including BTEX and PAHs) in 8 fresh oils and 734 oiled soil samples from Ecuadorian production sites with varying degrees of weathering. We then compared the predicted values to health-based goals. Calculating effective solubilities can serve as a screening method to quickly eliminate low-risk sites from sites that may require more attention to determine if groundwater is being negatively impacted. For fresh oil, only benzene and toluene exhibited effective solubilities greater than health-based goals. But, because of weathering, benzene and toluene were not detected in most of the soil samples. Effective solubility analysis indicated that only 9 of the 734 samples exceeded the goal for benzene. The goals were not exceeded for any of the other aromatic compounds.

To further evaluate the impact of weathering, concentrating factors were calculated for the aromatic hydrocarbons by comparing individual concentrations in weathered soil samples versus fresh oil. The mean concentrating factors ranged from less than 1, indicating that the compound is readily degraded (i.e., naphthalene), to approximately 12, indicating that the compound is not readily degraded (e.g., benz[a]anthracene). Despite the fact that weathering of the oil resulted in an increase in the effective solubilities of the larger PAHs, none of the PAHs exceeded health-based goals.

Contact Author: Waverly A. Thorsen, Exponent Consulting
15375 SE 30th Place, Suite 250, Bellevue, WA 98007
T 425-519-8750, F 425-519-8799, wthorsen@exponent.com

GERMINATION OF *ALEXANDRIUM CATENELLA* CYSTS FROM SURFACE SEDIMENTS IN QUARTERMASTER HARBOR, WA

Tobin, ED*, Horner, RA, Grünbaum, D, University of Washington, Seattle, WA.

Paralytic shellfish poisoning (PSP) has a long-term history in the Pacific Northwest of causing regulatory closures of shellfish harvesting. Toxins produced by the causative organism, *Alexandrium catenella,* accumulate in benthic shellfish, and when consumed by humans can lead to illness, paralysis and possibly death. Occurrences of these toxic outbreaks within the Puget Sound have been documented as increasing over the last four decades, however little is known about the biology of *A. catenella*. *A. catenella* has a dual-stage life cycle consisting of motile vegetative cells in the water column and cysts that rest in the sediments. Cyst formation is thought to be influential in bloom dynamics, but the transitions into and out of the cyst phase is poorly understood. Previous studies have reported a wide range in dormancy period durations from one week to over three months for *A. catenella*. This emphasizes the need to determine specific cyst dynamics for geographically distinct populations. A survey of *A. catenella* cysts in the Puget Sound, funded by NOAA ECOHAB, has found that of 32 sites sampled, Quartermaster Harbor, in south Puget Sound, has the highest concentrations. *A. catenella* cysts collected from surface sediments in Quartermaster Harbor in October 2006 were used in a time-series germination experiment to evaluate the duration of the dormancy period of Puget Sound populations. A unique method of staining with Calcofluor White was developed and used to identify the presence of both cysts and motile cells of *A. catenella* in surface sediment samples. Germination can occur year round and within 24 hours of being restored to conditions that support growth. These findings differ from earlier observations of germination for Puget Sound *A. catenella* cysts occurring in 3-6 days. This suggests that cyst germination in the Puget Sound population may occur more rapidly than previously thought.

Contact Author: Elizabeth Tobin, Nautilus Environmental
5009 Pacific Hwy East, Ste. 2, Tacoma, WA 98424
T 253-922-4296, F 253-922-5814, liz@nautilusenvironmental.com

COBALT: APPLICATION OF AN INTERNATIONAL APPROACH FOR DEVELOPING ENVIRONMENTAL CRITERIA/GUIDELINES/STANDARDS FOR METALS

Young, A*[1], Stubblefield, W[1], Van Genderen, EJ[1], Brock,T[2]

[1]Parametrix, Albany, OR
[2]The Cobalt Development Institute (consultant), located at: Division of Occupational and Environmental Medicine, Dept of Community and Family Medicine, Duke Medical Center, Durham, NC

Water quality standards for cobalt have yet to be developed for the European Union, Canada, or the United States. As such, efforts have been made towards characterizing the toxicity and influence of various water quality parameters on the toxicity of cobalt to several freshwater species. Ceriodaphnia dubia and rainbow trout were among the species most sensitive to cobalt. Acute median-lethal concentrations (LC50s) for the species tested ranged from 0.7 to 140 mg Co/L for C. dubia and Chironomus tentans, respectively. Chronic test results indicate that invertebrate and plant species are substantially more sensitive to cobalt chronic exposure than are fish. Acute-chronic ratios were low for fish species (typically <5), moderate for plants (6-18), but were substantially greater for invertebrates (>100). Tests using a range of water quality parameters were conducted and initial results suggest an important protective effect of Ca on acute and chronic toxicity of Co. The results of these tests will contribute to the development of Biotic Ligand Models (BLMs) for site-specific criteria derivation. Calculations of water quality standards/guidelines/criteria derived using procedures for the European Union, Canada, and the United States will be presented, compared, and contrasted.

Contact Author: William Stubblefield, Parametrix, Inc.
33972 Texas St. SW, Albany, OR 97321
T 541-791-1667, F 541-791-1699, stubblew@onid.orst.edu

FACTORS GOVERNING AMPHIBIAN REPRODUCTION IN STORMWATER DETENTION PONDS

Yahnke, AE*, Grue, CE, University of Washington, Washington Cooperative Fish and Wildlife Research Unit, and College of Forest Resources, Wildlife Science Program, Seattle, WA.

Stormwater detention ponds are installed in developing landscapes to mitigate for the effects of increased impervious surfaces. They are designed to attenuate water flows and pollutants entering wetlands and streams from precipitation. However, even when not designed for ecological functions, stormwater ponds self-seed with wetland plants and wildlife often use them as habitat. Five native pond-breeding amphibian species in King County, Washington, use stormwater ponds for breeding. Species such as Northern red-legged frogs (*Rana aurora*) and Northwestern salamanders (*Ambystoma gracile*) lay egg masses on available wetland plants or over-hanging woody material, but large water-level fluctuations, a frequent phenomenon in stormwater ponds, can strand egg masses, often desiccating them. Additionally, the pollution abatement function of the ponds may expose amphibians in vulnerable life stages to a suite of pollutants (including pesticides, petroleum, and heavy metals) that are components of stormwater runoff. Stormwater pond selection as breeding sites may result from development-related wetland loss and degradation, or because water and/or air temperatures associated with stormwater ponds are more attractive to amphibians breeding during the cooler late winter-early spring. Stormwater pond management, including dredging to increase storage capacity and mowing pond edges for aesthetics and access, reduces available cover and food resources for amphibians, and is reflected in reduced amphibian abundance. However, amphibians will continue to lay eggs on available substrates such as fallen branches in ponds that were recently dredged. Our research will focus on evaluating the relative effects of contaminants on amphibian reproduction within stormwater ponds. Ultimately, the role of stormwater ponds either as viable habitat or attractive sinks for amphibian populations needs to be evaluated in order to inform stormwater pond management and design.

Contact Author: Amy Yahnke, University of Washington,
PO Box 355020, Seattle, WA 98195
T 206-685-4195, F 206-616-9012, aey@u.washington.edu