Program and Abstracts

Pacific Northwest Chapter

Society of Environmental Toxicology and Chemistry

(PNW-SETAC)

23rd Annual Meeting

April 24-26, 2014

Holiday Inn Express and Suites
2102 South C Street
Tacoma, WA 98402

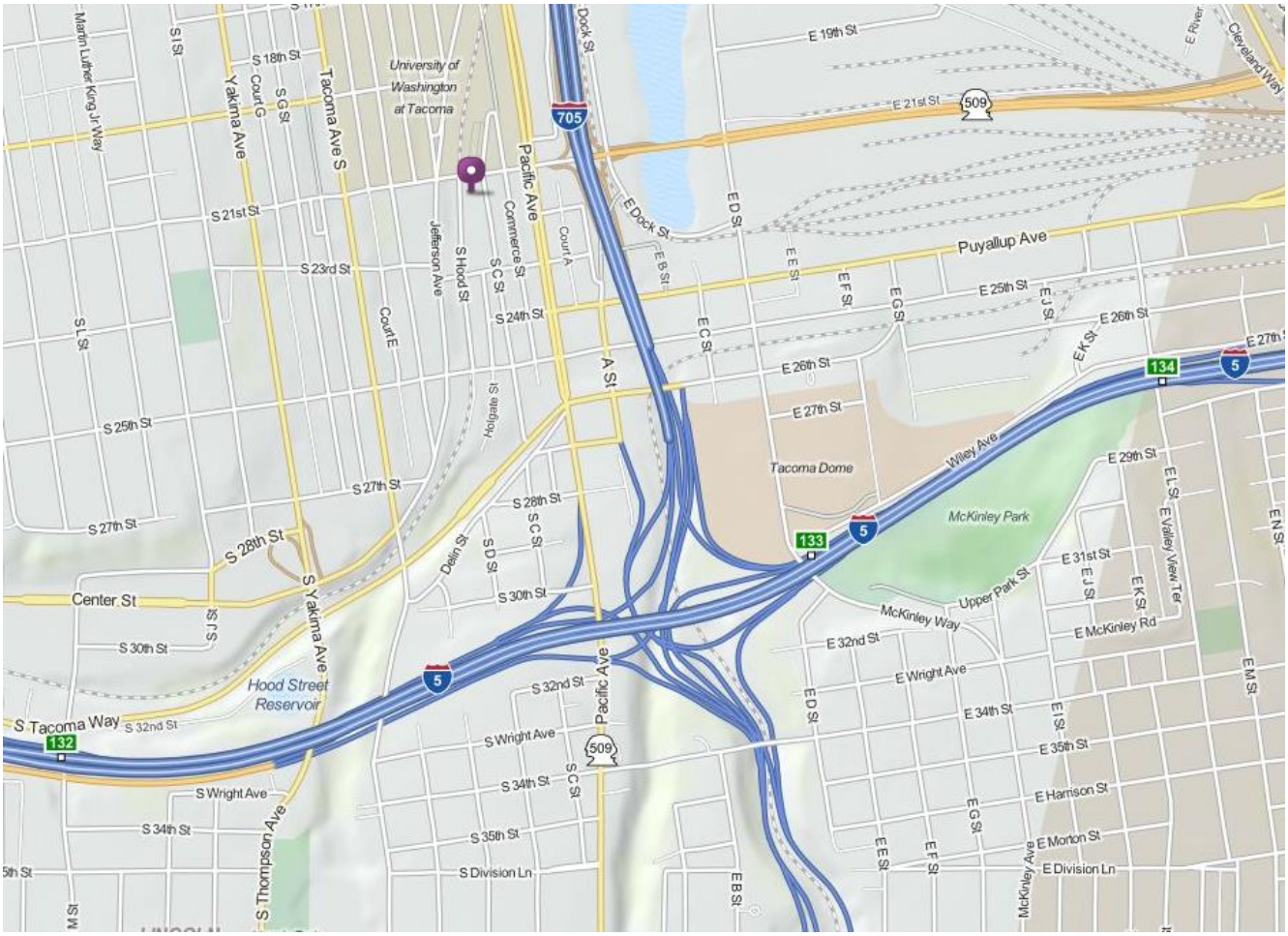
Holiday Inn and Suites – Tacoma Downtown
Hotel Information
2102 South C Street, Tacoma, WA 98402
Hotel Front Desk: 1-253-272-2434 Hotel Fax: 1-253-272-2764

For guests:

- Check-in time: 3:00 PM , check-out time: 12:00 PM, late checkout available
- Free wired and wireless internet service
- Complimentary breakfast
- Complimentary parking in above ground parking garage

For conference attendees:

- Wireless internet available in lobby and conference room, wired internet in business center
- Morning and afternoon coffee break and refreshments provided on Friday
- Additional snacks and refreshments available for purchase in the lobby
- Complimentary parking in above ground parking garage
  ~ Please obtain a keycard from one of our student volunteers to open the parking garage gates~



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

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Maxxam is proud to support this year's PNW-SETAC meeting in Tacoma, and invites you to attend the SETAC North America conference occurring in Vancouver, BC in November 2014. This will be a great opportunity to meet with you, so let us know if you would like to visit our Burnaby laboratory (contact Jerome Laroulandie at jlaroulandie@maxxam.ca).

PNW-SETAC
Acknowledgments

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

Conference Organization and Catering:	Teresa Michelsen, Avocet Consulting
Workshop Organization and Facilities:	John Stark, WSU-Puyallup Joel Baker, UW-Tacoma Center for Urban Waters
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Volunteer Coordinator:	Mandy McDougall, Simon Fraser University
Student Awards and Judging Coordinator:	Ruth Sofield, Western Washington University
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Session Chairs:	Teresa Michelsen, Avocet Consulting Maggie Dutch, WA Dept. of Ecology Heather Henson-Ramsey, Lewis-Clark State College
Student Travel Awards:	Ruth Sofield, Western Washington University Ryan Loveridge, CH2M Hill Patrick Moran, USGS

PNW-SETAC ANNUAL MEETING

April 24 to 26, 2014

Meeting Program

PNW-SETAC
Chapter Meeting Agenda

Thursday, April 24, 2014

1:00 PM – 4:00 PM	Workshops at WSU-Puyallup and Center for Urban Waters, Tacoma *Please see maps in the workshop section of the program* **Workshop 1**: *Clarks Creek: Science, Restoration, and Education,* WSU-Puyallup **Workshop 2**: *Stormwater Low-Impact Development Projects Tour,* City of Puyallup (meet at WSU) **Workshop 3**: *Stormwater, Soil, Plants, and Fish Research,* WSU-Puyallup **Workshop 4**: *New Analytical Tools for Environmental Toxicology & Chemistry,* Center for Urban Waters, Tacoma
3:00 PM on	**Hotel Check-in**, Holiday Inn Express and Suites, Tacoma
5:30 PM – 8:00 PM	**Conference/Registration Check-in** (Holiday Inn lobby)
6:00 PM – 8:00 PM	Welcome Reception/Refreshments (Holiday Inn lobby & conference room)
7:00 PM – 8:00 PM	PNW-SETAC Board Meeting

Friday, April 25, 2014 **Holiday Inn Express Conference Room**

7:30 AM – 5:30 PM	**Conference/Registration Check-in** (Holiday Inn Lobby)
7:30 AM – 8:30 AM	Poster setup
8:40 AM – 9:00 AM	Welcome address, Chapter President John Stark
9:00 AM – 9:15 AM	SETAC update, Executive Director Greg Schiefer
9:20 AM – 12:00 PM	Platform presentations, 20 min break for refreshments and poster viewing
12:00 PM – 2:00 PM	**Lunch, on your own**
1:00 PM – 1:50 PM	Chapter Business Meeting, **All Welcome to Attend!!**
2:00 PM – 5:00 PM	Platform presentations, 20 min break for refreshments and poster viewing
5:00 PM – 6:00 PM	Poster Social
6:00 PM – 8:30 PM	Baja Buffet Dinner

Saturday, April 26, 2014 **Holiday Inn Express Conference Room**

9:00 AM – 11:00 AM	Platform sessions with 40 min break for refreshments and poster viewing
11:00 AM	Student Award Presentations
11:30 AM	**Adjourn**
1:30 PM – 3:30 PM	Post-Meeting Restoration/Service Project – WSU-Puyallup

PNW-SETAC
Thursday Workshop 1

1:00 PM, Thursday, April 24, 2014

Clarks Creek: Science, Restoration, and Education

Instructors: **TanyaLee Erwin**, Research Assoc. and Manager, Washington Stormwater Center
Laurie Larson, Program Specialist, Washington Stormwater Center
Rita Hummel, Associate Professor/Extension Horticulturist, WSU-Puyallup
Chris Beale, Associate Planner, ISA Certified Arborist, City of Puyallup

Workshop Overview
The renewed emphasis on restoring Puget Sound has brought focus to the issue of nonpoint source pollution. Recognizing that nonpoint source pollution is strongly linked to local land uses and the actions of individuals, WSU has combined science with education and demonstration strategies to reduce fecal coliform and sediments in Clarks Creek, a designated 303(d) water body in Puyallup. We will tour and discuss projects that are part of an integrated Water Quality Implementation Plan for Clarks Creek carried out by WSU in partnership with the City of Puyallup, Pierce County, the Puyallup Tribe, and Friends of Clarks Creek, and funded in part by the Washington Department of Ecology. Projects include:

- **Pathogen control at DeCoursey Pond** – We will hear an overview of an upcoming lecture for a national conference explaining installed pilot-scale biofiltration cells to treat pond outflow prior to entering Clarks Creek.
- **Tour a "living classroom"-** We will walk to DeCoursey Pond, the new "living classroom" for the Puyallup School District and learn about field strategies for lowering waterfowl density at pond, including engagement of the public and changing behaviors.
- **Best management practice implementation across the watershed** – We will discuss additional best management practices designed to provide reductions in fecal coliform loads and improve water quality in the Clarks Creek Watershed and how these were implemented.
- **Water quality monitoring and sediment assessment**– We will learn how Clarks Creek and tributaries were and are monitored to establish baseline conditions as well as characterizing spatial and temporal changes.
- **Riparian buffer restoration** – We will visit demonstration plantings designed to familiarize property owners with attractive streambank landscapes that are also beneficial for stream health. A recent survey of property owners' attitudes toward the attractiveness of various riparian landscapes will be discussed.
- **Woodland Creek daylighting** – We will visit this urban restoration site designed to daylight a culvert running through the WSU property and restore stream and riparian habitat. This project is a good example of one that had both benefits and unexpected challenges.
- **Citizen science and engagement, restoration and education** – Throughout the tour we will talk about educational programs WSU has with the community that develop interest and results in restoration, suitable riparian habitats, and the value of clean water.

PNW-SETAC
Thursday Workshop 2

1:00 PM, Thursday, April 24, 2014

Puyallup LID Tour

Instructors: **Mark Palmer**, City of Puyallup, City Engineer
Joy Rodriquez, City of Puyallup, Associate Stormwater Engineer

Workshop Overview
The tour will cover 3-4 major LID installations in the City. The first stop will be at the 8th Ave NW LID Retrofit site, which was the first of many neighborhood rain garden cluster installations (two more are immediately adjacent to this site) which spawned the complete reconstruction of 8th Ave NW between 9th and 11th Streets to a completely pervious right-of-way. Learn how a group of motivated citizens, receptive government officials and staff, and grant funding transformed (and continues to transform) this neighborhood. Examples within this two block area include rain gardens, both on private and public property, 8th Avenue's curvilinear and narrow LID retrofit as well as Wilson Loop's direct replacement of dense graded HMA with porous asphalt pavement to address drainage and failing pavement concerns. Innovations include use of porous gravel shoulders in strategic locations to improve drainage, and lessons learned from that experience.

The second stop will be at the Clarks Creek Park Porous Maintenance Road and Riparian Habitat project, which demonstrates use of permeable Gravelpave® for a maintenance access road in combination with soil amendment and riparian plantings for a habitat/water quality project related to Clarks Creek. Another neighbor cluster of rain gardens is in this vicinity, which also has our first permeable paver driveway. Lastly, another pervious asphalt pavement road application on 6th Ave SW demonstrates an LID solution to a localized drainage issue. This street repeatedly flooded during moderate rain events in the past, but those events are now a thing of the past.

The third stop will be at the Riverwalk Trail Phase IV project, which will hopefully be under construction at this time. This project is the connection between the Riverwalk Trail and Pierce County's Foothills trail. Porous asphalt has become a preferred alternative when constructing trails.

PNW-SETAC
Thursday Workshop 3

1:00 PM, Thursday, April 24, 2014

Stormwater, Soil, Plants, and Fish

Instructors: **John Stark**, Director, WSU-Puyallup
Rita Hummel, Associate Professor/Extension Horticulturist, WSU-Puyallup
T.J. Knappenberger, Soil Scientist, WSU-Puyallup
Jenifer McIntyre, Postdoctoral Research Associate, WSU-Puyallup

Workshop Overview

Introduction: We'll start with an overview of all of the interrelated research at WSU focused on stormwater, its history, purpose, and construction of major test plots and facilities. This research is conducted as part of the new Stormwater Center at WSU and to support low-impact develop efforts and requirements for local municipalities.

Part I – Engineering, Soil, and Plants: We will proceed on an outdoor tour of the replicated testing area (also an employee parking lot) for pervious asphalt and concrete, constructed with stormwater collection infrastructure underneath and the capability of simulating stormwater events. The collected stormwater is used in a variety of studies at different scales of the capabilities of various types of soil and plants to filter out contaminants and bacteria and retain the stormwater. The latest data on the effectiveness of these approaches will be discussed.

Part II – Aquatic Life: Performance metrics for the effectiveness of green storm water infrastructure for treating runoff are typically related to flow and concentrations of pollutants. While important, these metrics do not address whether treated runoff is safe for fish and wildlife in receiving waters. Using a variety of toxicological tests, we have been investigating the biological effectiveness of green storm water infrastructure. We will discuss recent research into the biological performance of bioretention systems for treating urban highway runoff and tour the greenhouse soil and plant columns and fish laboratory facilities where this research is conducted.

PNW-SETAC
Thursday Workshop 4

1:00 PM, Thursday, April 24, 2014

New Analytical Tools

Instructors: **Joel E. Baker**, Science Director, Center for Urban Waters at UW-Tacoma
Justin P. Miller-Schulze, Postdoctoral Researcher, Baker Laboratory
Stuart Magoon, Assist. Div. Manager, City of Tacoma Environ. Services Lab.
Greg Perez, Scientist, City of Tacoma Environmental Services Laboratory

Workshop Overview
This workshop covers new analytical tools for environmental chemistry and toxicology.

Objective: To give attendees an idea of new tools that can be used to approach current issues in environmental chemistry and toxicology, i.e., quantification of trace levels of environmental pollutants, identification of new pollutants of interest, implication of pollution sources based on source tracing techniques, etc. Presentations and discussion will detail the theory and background behind the analytical capability of the instrumentation at the Center for Urban Waters in Tacoma, WA, as well as some examples of their application to current and ongoing projects.

1:00-2:15 Conference Room
Introduction to the Center for Urban Waters facilities. Brief description of building, tenants, and laboratory capabilities/instrumentation:

- City of Tacoma: GCMS, GCMSMS, automated sample prep/workbench, EPA methods
- UW-Tacoma: GCMS, LCMSMS(QQQ), LCMSMS(QTOF), clean rooms

More in depth discussion and comparison of instrumentation/techniques:

- City of Tacoma: GCMS (single quad) vs. GCMS (triple quad)
- UW-Tacoma: LCMSMS (triple quad) vs. LCMSMS (quadrupole time of flight)

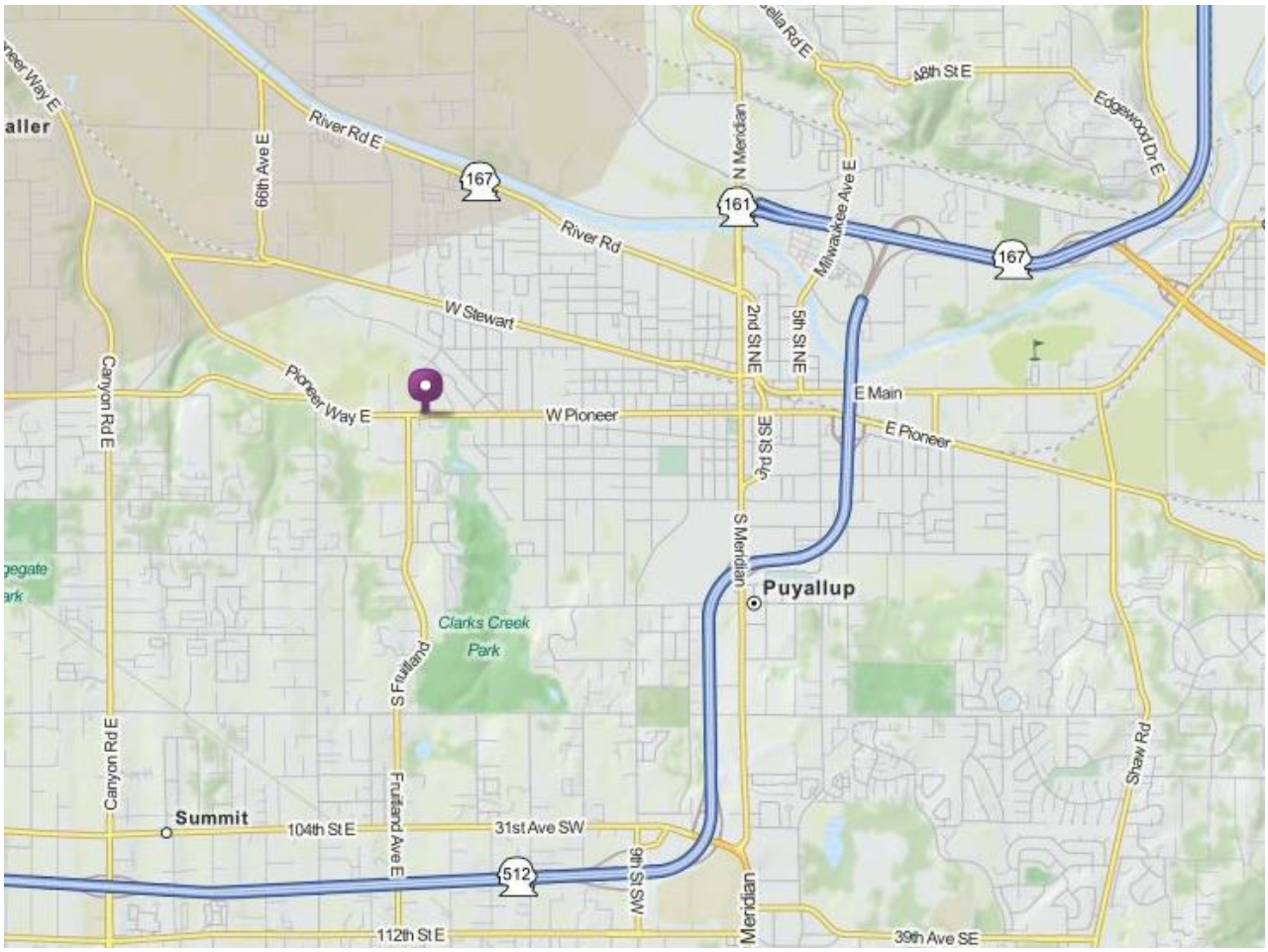
Followed by a Q&A session and discussion of new analytical techniques and future directions (independently or as a collaborative endeavor).

2:20-2:45 Laboratory Tour
Focusing on new instruments, City of Tacoma Labs and UW-Tacoma Lab.

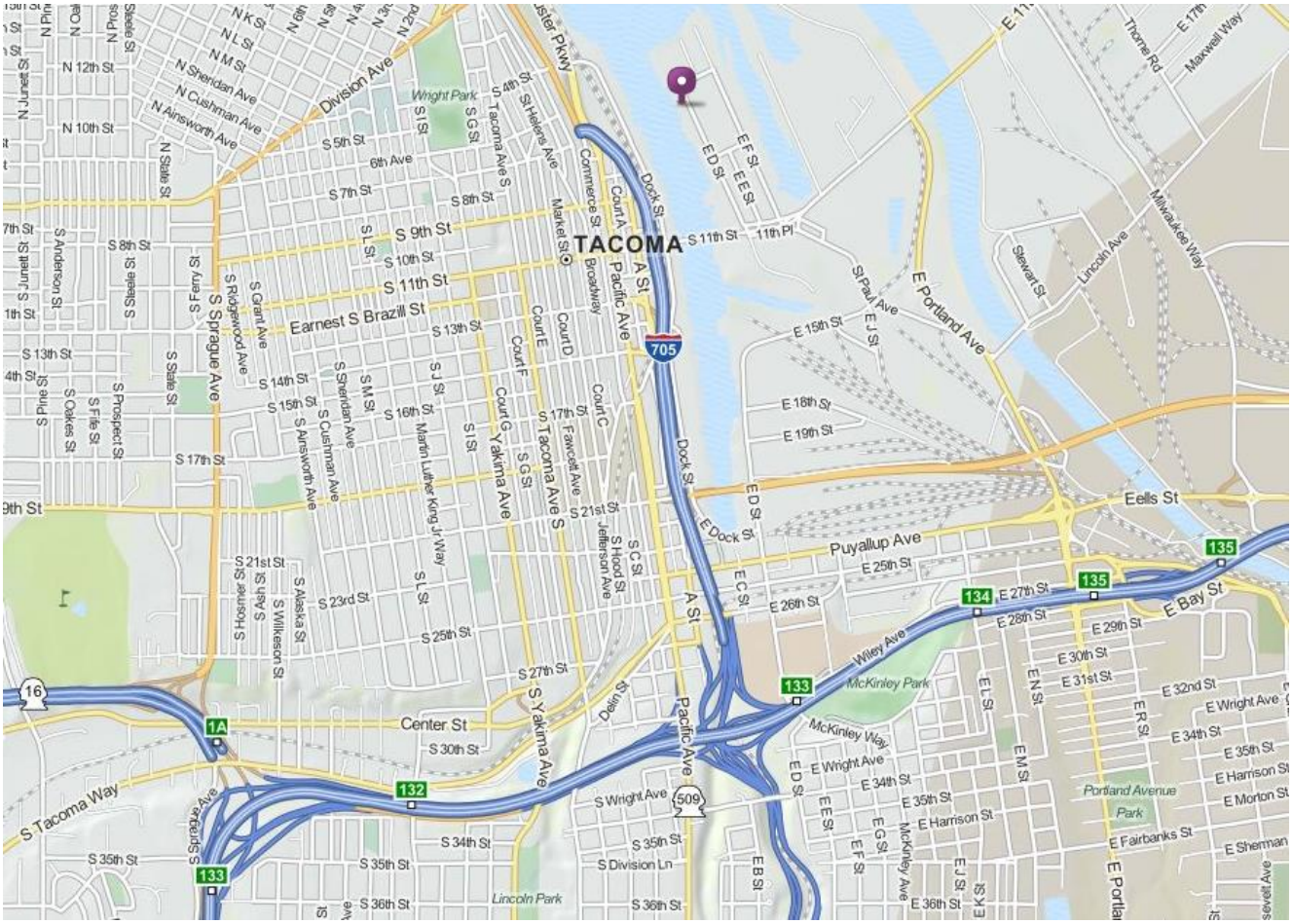
2:50-3:50 Conference Room
Discussion of QC/QA protocols and challenges (with a focus on the capabilities that we have that help ameliorate some of these challenges). Description of current and past projects and data that highlight novel capabilities and approaches.

3:50-4:00 Wrap up

Map to WSU-Puyallup - 2606 West Pioneer, Puyallup WA 98371
Meet up in the Allmendinger Center for Workshops 1-3 (please arrive early!)
http://puyallup.wsu.edu/cmap.html (Building marked 5)



Map to UW Tacoma Center for Urban Waters – 326 E D St, Tacoma, WA 98421
Meet up in the Conference Room for Workshop 4 (please arrive early!)
http://puyallup.wsu.edu/cmap.html



PNW-SETAC
Friday Platform Presentations
Morning Session

Friday, April 25, 2014

8:40 Welcome & Opening Remarks **Chapter President John Stark**

9:00 SETAC Update **Executive Director Greg Schiefer**

Session Chair: Teresa Michelsen, Avocet Consulting

Muddy Waters – Urban Stormwater Run-off

9:20	Scott Tobiason	Assessing the Amount, Environmental Impact, and Treatability of Copper Released from Copper Roofs in Stormwater Runoff
9:40	Jenifer McIntyre	Does Green Stormwater Infrastructure Prevent Toxicity in Aquatic Animals Exposed to Urban Runoff?
10:00	Julann Spromberg	Coho Salmon Pre-Spawn Mortality is Caused by Urban Runoff and Reduced by Bioremediation
10:20	**Break/Poster Viewing**	
10:40	P. Bruce Duncan	Introduction to EPA's Stormwater Calculator – Incorporating Low Impact Development and Climate Science Tools
11:00	P. Bruce Duncan	USEPA Stormwater Calculator Demonstration
11:10	LID/Stormwater Panel Discussion	
12:00	**to 2:00 PM**	**Lunch**
1:00	**to 1:50 PM**	**PNW-SETAC Business Meeting – all welcome!**

PNW-SETAC
Friday Platform Presentations
Afternoon Session

Friday, April 25, 2014

Session Chair: Maggie Dutch, WA Department of Ecology

Alphabet Soup – POPs, CECs, and Metals

2:00	Scott Tobiason	Assessment of Saltwater Copper Concentrations in Marinas: Comparisons to Aquatic Life Criteria Based on the Biotic Ligand Model and Current State Copper Criteria
2:20	Callie Mathieu	Metals, Phthalates, and Bisphenol A in Children's Products Purchased from Washington State Retailers
2:40	Kathryn Kuivila	Occurrence and Fate of Fungicides Used on Various Crops in the Western USA
3:00	Whitney Temple	Reconnaissance of Emerging and Legacy Contaminants in the Habitat and Tissues of the Pacific Lamprey (*Entosphenus tridentatus*) in the Columbia River Basin
3:20	**Break/Poster Viewing**	

Bayesian Modeling

3:40	John Stark	Influence of Population Vital Rates on the Impact of Toxicants: Implications for Ecological Risk Assessment of Pesticides
4:00	Annie Johns	Calculating Mercury Risk and Evaluating Remediation Actions Using Bayesian Networks for the South River, Virginia, USA
4:20	Wayne Landis	Transforming the Weight of Evidence Estimation to A Bayesian Network Calculation
4:40	Carlie Herring	Evaluating Non-Indigenous Species Eradication Options in a Bayesian Network Derived Adaptive Management Framework
5:00	**Poster Social**	
6:00	**Dinner**	

PNW-SETAC
Saturday Platform Presentations
Morning Session

Saturday, April 26, 2014

Session Chair: Heather Henson-Ramsey, Lewis-Clark State College

Monitoring our Estuaries

9:00	Carly Greyell	Bulk Air Deposition in the Green/Duwamish River Watershed
9:20	Jessica Lundin	Persistent Organic Pollutants (POPs) in the Puget Sound Ecosystem: An Evaluation of POPs in Fecal Samples of Southern Resident Killer Whales
9:40	**Break/Poster Viewing**	
10:20	Bryson Finch	Photo-enhanced Toxicity of Gulf of Mexico Marine Organisms at Early Life Stages and Two Ultraviolet Light Intensities
10:40	Maggie Dutch	Quantification of Pharmaceuticals, Personal Care Products, and Perfluoroalkyl Substances in the Sediments of Elliott Bay, Puget Sound, Washington
11:00	**Student Award Presentations**	
11:30	**Wrap Up/Adjourn**	

1:30 – 3:30 Post-meeting Restoration/Service Project – WSU-Puyallup
(see map in Workshop section)

Clarks Creek Riparian Planting. This field workshop offers participants the opportunity to improve a 35' riparian and habitat buffer along 150' of Clarks Creek stream bank at WSU in Puyallup. The participants will plant native trees, shrubs and herbaceous plants, install tree protection and mulch the new plantings.

PNW-SETAC
Poster Presentations

Presenter(s)	Presentation
Julie Alaimo	Cyanotoxins in Samples at Routine Swimming Beach Sites and During Bloom Events in Four King County Lakes from 2009 to 2013
Fiona Brinkman	Use of Metagenomic DNA Sequencing Technologies to Identify Markers of Water Quality
Arthur Buchan	Dioxins, Furans, and PCBs: Laboratory Analysis and Non-Detected Values
Arthur Buchan	Dioxins, Furans, and PCBs: Calculation Methodology for Ecological Risk
Collin Clovis Alicia Latta	Biomarker Expression and Mercury Concentrations in Signal Crayfish (*Pacifastacus leniusculus*) Inhabiting the Boise River, Idaho
Honalee Elkan	Reductive Biotransformation of PBDE-99 in Staghorn Sculpin and Starry Flounder Derived Hepatic Microsomes
Meagan Harris	Integrating Ecological and Human Health Risk for the South River, Virginia
Brent Hepner	Validation Studies of Time- Integrative Solid Phase Extractive Sampler to Passive and Discrete Sampling Methods Conducted by Federal and State Agencies
Jeremy Jackson	Modulating P-Glycoprotein Gene Expression and Functional Activity in *Danio rerio* (Zebrafish)
Jordan Johnson Amberose Kelly	Lichens as Air Quality Biomonitors Along the Pacific Northwest Rail Corridor in Bellingham, Washington
Sidney Love	The Effects of Copper Exposure on the Swimming Performance and Osmoregulatory Ability of Juvenile Rainbow Trout (*Oncorhynchus mykiss*)

PNW-SETAC
Poster Presentations

Presenter(s)	Presentation
Jaipreet Mattu Sanjit Makkar	Anthropogenic Impacts on Water Quality in the Lower Fraser Valley of British Columbia
Mandy McDougall	Comparing Trophic Magnification of Select Perfluoroalkyl Acids (PFAAs) in Aquatic and Terrestrial Food Webs
Christopher San Courtney Fung	Investigation of Silver Nanoparticle Toxicity at Different Temperatures
Laura Tupper-Ring	Back to the Future: Using an Activity-Fugacity Approach for Cumulative Environmental Risk Assessment of Phthalates

Pacific Northwest Chapter

Society of Environmental Toxicology and Chemistry
(PNW-SETAC)

23rd Annual Meeting

Platform Presentation Abstracts

(in order of presentation)

Assessing the Amount, Environmental Impact, and Treatability of Copper Released from Copper Roofs in Stormwater Runoff

LaBarre, W.[1]; Lev, S.M.[1]; Ownby, D.R.[1]; Rader, K.J.[2]*; Tobiason, S.[3]; and Casey, R.E.[1]
[1] Towson University, Towson, MD 21252 USA; [2] Mutch Associates, LLC, Ramsey, NJ 07446 USA; [3] Windward Environmental, LLC, Seattle, WA 98119

Within the last 20 years, local, state and federal regulators have been increasingly addressing potential water pollutants in stormwater discharges. In some areas, concerns over the impact of roof runoff have resulted in bans or other restrictions on the installation of certain types of metal roofing materials including copper roofs and gutters, asphalt shingles with copper granules and galvanized steel roofing and gutters (for example in Palo Alto, California and in King County, Washington). Appropriate regulations for roofing and other construction materials require a comprehensive scientific examination of not only chemical concentration, but also toxicity potential, transport/fate and treatability. Although stormwater best management practices (BMPs) based on the Low Impact Development (LID) approach are becoming increasingly available and used in industrial and urban settings, little is known about treating elevated copper levels found in direct runoff from copper roofing. Therefore, a study was initiated in 2012 at Towson University in Maryland to provide information on the treatability of copper roof runoff. This study investigates the potential for two relatively simple, easy to construct, LID-type BMPs to decrease the amount of copper in copper roof runoff. A 10 x 20 ft structure with a copper roof was built along with two biofiltration swales and two bioretention planters. The roof was sectioned into quarters; each drains into one of the BMPs. Runoff flow and concentration data were collected from 17 storms to date. The data collected indicate that on average, the BMPs removed approximately 94% or more of copper and changed the chemistry of the runoff in a way that limits the potential for toxicity. These data provide strong evidence that runoff from copper roofs can be managed effectively, and close to the source while providing an aesthetically appealing approach.

Contact Author: Kevin J. Rader, Mutch Associates, LLC
360 Darlington Avenue
T: 201-669-4171, krader@mutchassociates.com

Presenting Author: Scott Tobiason, Windward Environmental, LLC
ScottT@windwardenv.com

Does Green Stormwater Infrastructure Prevent Toxicity in Aquatic Animals Exposed to Urban Runoff?

McIntyre, J.K.*, Hinman, C., Macneale, K. Davis, J., Scholz, N., Stark, J.

Stormwater runoff contains a complex mixture of contaminants that can affect the resiliency of aquatic ecosystems. In the Pacific Northwest, urban stormwater runoff impacts both the development and adult survival of coho salmon (*Oncorhynchus kisutch*). Green stormwater infrastructure (GSI) approaches such as soil bioretention can greatly improve the quality of runoff from urban surfaces, however very little is known about whether these improvements prevent toxic harm to animals in receiving waters. We used a variety of animal models to determine the baseline toxicity of highway runoff to aquatic animals and to test the biological effectiveness of soil bioretention – a non-proprietary GSI technique. Highway runoff was collected during 6 storms between October 2011 and September 2012. Some events were acutely lethal to aquatic invertebrates (*Ceriodaphnia dubia*) and developing fish (*Danio rerio*). Sublethal effects included reproductive impairment in *C. dubia* and cardiovascular toxicity in *D. rerio*. Runoff from the final storm event was treated with soil bioretention. Untreated runoff was acutely lethal to juvenile *O.*

kisutch, *C. dubia*, and *Baetis spp* (wild mayflies) and caused cardiovascular toxicity in *D. rerio*. Treatment with bioretention prevented acute lethal and sublethal effects in all four species.

Contact Author: Jenifer McIntyre, Washington State University
Puyallup Research & Extension Center
2606 W Pioneer Ave
Puyallup, WA 98371
Jenifer.mcintrye@noaa.gov

Coho Salmon Pre-Spawn Mortality is Caused by Urban Runoff and Reduced by Bioremediation

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

Urban streams in the greater Seattle area have been the focus of habitat restoration projects since the 1990s. Post-project effectiveness monitoring surveys revealed anomalous behaviors among adult coho salmon returning to spawn in these restored streams. Behaviors included erratic surface swimming, gaping, fin splaying, and loss of orientation and equilibrium. Affected fish died within hours, and female carcasses showed high rates (> 90%) of egg retention. This phenomenon was termed coho pre-spawn mortality (PSM). From 2002-2012, rates of coho PSM ranged from ~30-90% in monitored urban streams. The severity of PSM was closely associated with both the timing and amount of fall rains. Affected coho exhibited evidence of exposure to metals and petroleum hydrocarbons, both of which commonly originate from motor vehicles. The weight of evidence suggests that an as-yet unidentified toxic contaminant or contaminant mixture in urban stormwater runoff is killing coho spawners. Geospatial analyses point to urban land uses, impervious surfaces and specifically road density as being directly related to the levels of PSM across watersheds. During the autumns of 2012 and 2013 we exposed adult coho recently returned to freshwater to collected urban road runoff. Across multiple rainfall events, untreated stormwater produced the familiar PSM symptomology or mortality in all fish within 4 hours. These acute effects were eliminated when the runoff was filtered through a mix of sand and compost (60:40). These protective effects of simple bioremediation were also evident in coho exposed to treated runoff for longer durations (24 h). Our findings show that exposure to urban stormwater is sufficient to cause coho PSM. Moreover, although the causal chemical agent(s) have not yet been identified, conventional green stormwater infrastructure can effectively protect adult spawners from the acutely toxic effects of runoff.

Contact Author: Julann A. Spromberg, NOAA
Northwest Fisheries Science Center
2725 Montlake Blvd. E
Seattle, WA 98112
T: 206-302-2426 F: 206-860-3335; julann.spromberg@noaa.gov

Introduction to EPA's Stormwater Calculator – Incorporating Low Impact Development and Climate Science Tools

Duncan, P.B.[1], L. Rossman[2]
[1]EPA Region 10, Seattle, WA 98101 USA, [2]EPA Region 5, NRMRL, Cincinnati, OH

The EPA Office of Research and Development released its National Stormwater Calculator (SWC) which is available at: http://www.epa.gov/nrmrl/wswrd/wq/models/swc/ (contact: SWC@EPA.gov). It is a desktop application that estimates the annual amount of rainwater and frequency of runoff from a specific site anywhere in the United States. Estimates are based on local soil conditions, land cover, and historic rainfall records. The Calculator accesses several national databases that provide soil, topography, rainfall, and evaporation information for the chosen site. Who is it for? It is designed to be used by anyone interested in reducing runoff from a property, including site developers, landscape architects, urban planners, and homeowners. Users are encouraged to develop a range of SWC results with various assumptions about model inputs such as percent of impervious surface, soil type, sizing of green infrastructure, as well as historical weather and future climate change scenarios. Users are encouraged to check with local authorities about whether and how use of these tools may support local stormwater management goals and requirements. Low Impact Development. The user supplies information about the site's land cover and selects the types of low impact development (LID) controls they would like to use. The LID controls that the user can choose are the following seven green infrastructure practices: Disconnection; Rain harvesting; Rain gardens; Green roofs; Street planters; Infiltration basins; Porous pavement. Green infrastructure promotes the natural movement of water, instead of allowing it to wash into streets and down storm drains. Green infrastructure also has the added benefit of beautifying neighborhoods and increasing property values. Future Climate. Users can consider how runoff may vary based on historical weather and potential future climate. This presentation highlights the ease of use, and investigatory capabilities. The intent is to have the SWC available during meeting breaks for those interested in its use.

Presenter: Bruce Duncan, USEPA Region 10
1200 Sixth St, OEA-095
Seattle, WA 98101
T: 206-553-0218, F: 206-553-0119, duncan.bruce@epa.gov

Contact Author: Lewis Rossman, USEPA Region 5
National Risk Management Research Laboratory
26 W. Martin Luther King Drive
Cincinnati, OH 45268
T: 513-569-7603, F: 513-569-7658, rossman.lewis@epa.gov

Assessment of Saltwater Copper Concentrations in Marinas: Comparisons to Aquatic Life Criteria Based on the Biotic Ligand Model and Current State Copper Criteria

Tobiason, Scott A*; DeForest, David K.
Windward Environmental, LLC Seattle, WA

The two 303(d) listings for copper in Washington State salt waters are for two marinas in the Anacortes area. These copper listings are based on data from samples collected in 2006-2007 by the Washington State Department of Ecology, who found dissolved copper concentrations exceeded the State's numeric saltwater chronic copper criterion of 3.1 µg/L and sometimes the acute criterion of 4.8 µg/L. The study

also influenced Ecology's conclusion that nearshore copper is a Priority 1 chemical of concern in Puget Sound and it appears to be related to rationale for the phase-out of copper-based anti-fouling bottom paints on recreational boats in Washington. The current EPA and Washington saltwater copper criteria are fixed values, but it is now understood that aquatic toxicity of copper in fresh and salt waters varies with water chemistry, which strongly influences metal bioavailability. In 2007 the EPA recommended updated freshwater criteria for copper based on the biotic ligand model (BLM), which predicts copper toxicity as a function of water chemistry, and BLM-based copper criteria for saltwater are forthcoming. Water samples were collected at each of the two Anacortes area marinas and were analyzed for copper and saltwater BLM parameters (dissolved organic carbon, salinity, pH) and tested for toxicity to blue mussel (*Mytilus galloprovincialis*) embryo-larval development (the basis for current saltwater copper criteria). Copper concentrations in inner marina waters exceeded current acute and chronic fixed criteria, yet only one sample exceeded BLM-based criteria, which were on average 2.5-fold greater than the fixed criteria. No toxicity was identified in the one sample where BLM-based criteria were exceeded. These results are similar to the more intensive 2011 Shelter Island Yacht Basin studies conducted by the US Navy in San Diego and indicate that actual saltwater copper toxicity concerns in marinas are unsubstantiated and that anticipated TMDLs may be unnecessary.

Contact Author: Scott Tobiason, Windward Environmental LLC
200 West Mercer St, Suite 401
Seattle, WA 98119
T: 206-812-5424, F: 206-973-3048; scottt@windwardenv.com

Metals, Phthalates, and Bisphenol A in Children's Products Purchased from Washington State Retailers

Mathieu, C.A.*, Bookter, A.
Washington State Department of Ecology, Olympia, WA

In 2008, Washington State passed the Children's Safe Products Act (CSPA) to address the risk of toxic chemicals in children's products. This law limited the permissible amount of lead, cadmium, and phthalates in children's products sold in Washington State and required manufacturers to report to the Washington State Department of Ecology (Ecology) if chemicals of high concern are present in their children's products. Another law was passed in 2011 that prohibited the sale of baby bottles and toddler cups containing bisphenol A (BPA). Ecology's Environmental Assessment Program conducted independent testing of metals, phthalates, and BPA in children's products from 2012–2013 to assess compliance with state laws. Three hundred products were purchased from 15 in-store and on-line Washington State retailers. Samples were pre-screened for metals using X-ray fluorescence to aid in selection of samples sent for laboratory analysis. Metals concentrations exceeded the threshold for reporting to Ecology in fourteen out of thirty five samples and five of those samples exceeded the state cadmium and lead standards. Twenty seven percent (11 out of 40) of samples analyzed for phthalates contained one or more of the following restricted phthalates above the legal limit of 1,000 ppm: di-n-octyl phthalate, di-2-ethylhexyl phthalate, diisononyl phthalate, and diisodecyl phthalate. One out of 85 samples contained BPA above the compliance threshold of 20 ppm. All samples that exceeded state limits were referred to Ecology's enforcement officer to assess compliance with state and federal laws. This presentation will address the challenges of product testing and discuss our current understanding of chemicals of concern in children's products in Washington State.

Contact Author: Callie Mathieu, Washington State Department of Ecology
PO Box 47600
Olympia, WA 98504-7600
T: 360-407-6965, callie.mathieu@ecy.wa.gov

Occurrence and Fate of Fungicides Used on Various Crops in the Western USA

Kuivila, K.M.*[1]; Smalling, K.L.[2]; and Hladik, M.L.[2]
[1]US Geological Survey, Portland, OR, [2]US Geological Survey, Sacramento, CA

Fungicides are pesticides designed to control fungal diseases, and tend to be understudied or even ignored during routine monitoring of contaminants in aquatic environments. Used on a wide variety of crops, fungicides are typically applied repetitively throughout the growing season. Chlorothalonil, a broad spectrum fungicide, has been applied for over 50 years, but recently the use of other new classes of fungicides has been increasing. Fungicides are moderately hydrophobic (log Kow 3-4) and are considered to be relatively persistent in water and sediments. To better understand the environmental occurrence of fungicides, methods were developed to analyze 34 currently-used fungicides by using gas chromatography/mass spectrometry. Crops in the western USA with high fungicide use include lettuce, onions, orchard crops, potatoes, and strawberries. Water, sediments, and biota from these land-use settings are being analyzed for current-use fungicides. Overall, twelve fungicides were detected in water and sediments. In water, boscalid was detected most frequently (88% of samples) and at the highest concentration (3600 ng/L). In sediment, chlorothalonil was detected frequently (69%) and at the highest concentration (62 ug/kg). Three other fungicides (azoxystrobin, myclobutanil, and pyraclostrobin) were detected frequently in both water and sediment. Mixtures were common, with more than half of the water and sediment samples containing three or more fungicides. Preliminary results from select locations indicate that fungicides are also present at measurable concentrations in fish and crab tissue. Currently, there are limited environmental data available for many of these compounds and the aquatic toxicity of the newer fungicides, especially in sediment, is unknown. Future studies will include collaborative efforts between chemists, toxicologists and ecologists to link observed tissue pesticide concentrations to aquatic ecosystem health.

Contact Author: Kathryn Kuivila, US Geological Survey
2130 SW 5th Ave. Portland, OR 97201
T: 503-251-3257. F: 503-251-3470, kkuivila@usgs.gov

Reconnaissance of Emerging and Legacy Contaminants in the Habitat and Tissues of the Pacific Lamprey (*Entosphenus tridentatus*) in the Columbia River Basin

Nilsen, E.B. and Temple, W.B.*
U.S. Geological Survey, Portland, OR

After surviving several hundred million years, the Pacific lamprey (*Entosphenus tridentatus*) population has declined in the Columbia River Basin in recent decades to the point where regional extinction is feared. Tribal people have relied on Pacific lamprey for food and medicine for generations. There are many gaps in our understanding of this species. Studies have primarily focused on abundance and distribution, dam passage, and habitat improvement. Work is also needed to understand the role of contaminants as a potential threat to the survival of the species, and to Tribal health. The developmental effects of contaminant body burden in the pre-adult life stages are not fully understood, but it has been shown that elevated contaminant levels in adults can cause a host of sublethal effects at the cellular and organism level and in some cases direct mortality. In 2011 and 2012 thirty paired larval lamprey and sediment samples were collected from the Columbia River Basin and analyzed. Virtually all areas sampled have measurable concentrations of anthropogenic waste indicator (AWI) compounds and halogenated contaminants in bed sediments where larval lamprey were collected. Halogenated pesticides were widespread in both the sediments and larval lamprey tissues at the sites sampled. Concentrations of halogenated compounds in lamprey tissues were much higher than in sediments, reflecting

bioaccumulation. Most sites had a combination of flame retardants and pesticides detected, with pesticides at higher concentrations. The concentration patterns were somewhat different in tissues as compared to sediments. The most prevalent contaminants in larval lamprey tissues were organochlorine pesticides and their degradates and several polybrominated diphenyl ether (PBDE) flame retardants. In sediments, the most prevalent contaminants were PAHs, sterols, fragrances, and a chemical solvent. Final results will contribute to better understanding the role of contaminants as a potential threat to the survival of the species, and to human health.

Contact Author: Whitney Temple, U.S. Geological Survey
Oregon Water Science Center
2130 SW 5th Ave, Portland, OR 97201
T: 503-251-3459, F: 503-251-3470, wbtemple@usgs.gov

Influence of Population Vital Rates on the Impact of Toxicants: Implications for Ecological Risk Assessment of Pesticides

Stark, J.D.
Washington State University, Puyallup Research and Extension Center

This study was conducted to determine the extent to which differences in life history traits can influence population-level susceptibility to pesticides. Four species that interact in agricultural ecosystems were used as model organisms to address this issue. Deterministic matrix population models were developed for two closely related pest Tephritid fruit fly species, Diptera: Tephritidae, the Mediterranean Fruit Fly, *Ceratitis capitata*, and the Oriental Fruit Fly, *Bactrocera dorsalis* and for two parasitic wasp species, Hymenoptera: Braconidae, *Diachasmimorpha longicaudata* and *D. tryoni*, that parasitize Tephritids. Acute toxicity data for pesticides were used to parameterize the models. These pesticides chosen because acute toxicity data showed that at LC50 there were no significant differences in susceptibility between the two fruit fly species to diazinon and there were no significant differences in susceptibility between the two parasitoid species to permethrin. However, *C. capitata* and *B. dorsalis* exhibited differences in life history traits as did the two parasitoid species; weekly population growth rates (λ) for *C. capitata* and *B. dorsalis* were 1.60 and 2.74, respectively and 2.60 and 1.71 for *D. longicaudata* and *D. tryoni*, respectively. Results of this study will be discussed in the context of ecological risk assessment of pesticides.

Contact Author: John D. Stark, Washington State University,
Puyallup Research and Extension Center
Puyallup, Washington 98371
T: 253-445-4568 F: 253-445-4571 starkj@wsu.edu

Calculating Mercury Risk and Evaluating Remediation Actions Using Bayesian Networks for the South River, Virginia, USA

Johns, AF[1]*; Ayre, KK[1]; Stinson, J.[1]; Summers, HM[2]; and Landis, WG[1].
[1]Western Washington University, Bellingham, WA 98225 USA; [2]Integral Consulting Inc, Annapolis, MD, 21401 USA

Ecological managers are required to implement one or more management options to reduce risk to ecosystem services without the integration of risk assessment and the evaluation of management

alternatives. This paper introduces a method to provide that integration. In this study, I use Bayesian networks in a relative risk assessment model framework (BN-RRM) to integrate two remedial options into existing risk assessment models for four biotic endpoints and four water quality endpoints for the mercury contaminated site, South River, VA. Bayesian networks explicitly describe the effects of mercury toxicity on these endpoints, as well as the interaction between mercury and other stressors. I analyzed two of the management options for the site: bank stabilization and agricultural best management practices. The management goals for the South River reach beyond simple mercury remediation. The primary goal expressed by managers is "no regrets." In other words, the managers do not want to make the site worse in any way, such as reducing mercury levels at the detriment of habitat, loss of other species, degradation of water quality or other environmental parameters. The BNs are able to represent the expected effects of a management option and potentially unintended consequences. Agricultural BMPs reduce risk by less than 5% to all endpoints because nutrient levels are not the primary risk drivers for any endpoint. Bank stabilization decreases risk 5-35% to the fish species and fishing recreation endpoint in areas with the highest fish fillet mercury concentrations. For other endpoints, bank stabilization increases risk 1-13%, though the Belted Kingfisher will be eliminated from a region if bank stabilization is implemented without consideration of their nests. Management for the South River is a long term process. The BN-RRM models can be updated with new monitoring data as a part of the long-term adaptive management for this site.

Contact Author: Annie Johns, Western Washington University
Institute of Environmental Toxicology, Huxley College of the Environment
516 East College Way, Bellingham, WA 98225
T: 360-650-613, F: N/A, johnsa7@students.wwu.edu

Transforming the Weight of Evidence Estimation to A Bayesian Network Calculation

Landis W.G.
Western Washington University

In contrast to conventional weight of evidence evaluations Bayesian networks are effective means of incorporating disparate type of evidence for estimating risk and assigning causality in order to establish management programs. Lines of evidence are expressed as combinations of casual pathways from source to stressor to habitat to effect and impact. The interactions between a stressor, the environment and the receptor are expressed in conditional probability tables (CPT). Uncertainty due to a lack of site specific data, extrapolation between species or other factors can be documented and expressed in the distributions represented in the CPT and the distributions of the parent nodes. A specific advantage of this approach is that the mathematics of Bayesian networks is clearly established, in contrast to current formulations to combine various lines of evidence. Information for mechanistic data, population modeling and expert elicitation can be integrated using the framework. Risk can be calculated. Inversely, current conditions can be put into a parameterized Bayesian network and the likely causes estimated with a concurrent sensitivity and uncertainty analysis. Examples will be presented ranging from contaminated sites, the decline of Cherry Point herring, prespawn mortality and non-indigenous species.

Contact Author: Wayne Landis, Western Washington University
Institute of Environmental Toxicology, Huxley College
MS 9180, 518 High Street, Bellingham WA 98225-9180
T: 360-650-6136, wayne.landis@wwu.edu

Evaluating Non-Indigenous Species Eradication Options in a Bayesian Network Derived Adaptive Management Framework

Herring, C.E.*; Stinson, J.; Landis, W.G.
Western Washington University, Bellingham, WA 98225 USA

Many coastal regions are facing problems with the introduction and spread of non-indigenous species (NIS). Common efforts addressing this issue include eradicating these species, which can occur at different stages of NIS invasions, such as the elimination of species before being introduced to the habitat, or removal of species after settlement. Eradication methods can either target multiple species (such as with ballast water treatments) or single species eradications, with chemical and/or mechanical treatment options. Little information is available as to the consequences of some of these eradication practices in terms of ecological and toxicological impacts to the surrounding habitat. A regional risk assessment using a Bayesian Network Model was conducted in Padilla Bay, Washington, a National Estuarine Research Reserve. The objectives of this study were to 1) determine the vectors of introduction associated with higher risks of NIS invasions and 2) analyze various management options that will reduce the risk of NIS introductions, while being least disruptive to the marine community. The Bayesian Network Model is advantageous because it allows us to analyze various adaptive management options for controlling NIS, comparing and contrasting methods such as chemical and mechanical eradication, as well as various treatments of ballast water before it is discharged into coastal waters. Preliminary results indicate that risk is greatest in Region 3 and the Dungeness crab is the endpoint at greatest risk, followed by changes to community composition and eelgrass (all regions). Results for adaptive management options have not yet been configured. Once calculated, we can evaluate the likelihood of NIS risk reduction for each management option in respect to the four regions and endpoints within each region. The framework from the risk assessment and adaptive management is adaptable for other regions in the Salish Sea interested in the eradication of NIS organisms.

Contact Author: Carlie Herring, Western Washington University
Institute of Environmental Toxicology, Huxley College of the Environment
516 East College Way, Bellingham, WA 98225
T: 360-650-3000, F: N/A, herrinc4@students.wwu.edu

Bulk Air Deposition in the Green/Duwamish River Watershed

Colton, J. A., Greyell, C. A.* and Jack, R.A.
King County, Seattle, WA 98104 USA

King County conducted a bulk air deposition study in 2011/2012 to examine how contaminant deposition varies with land use and to understand the relative contributions of atmospheric deposition within the Green/Duwamish River Watershed. Six stations were passively sampled over approximately a year period for metals, PAHs, PCB congeners and dioxin/furans. When possible, sampling stations were selected at Puget Sound Clean Air Agency monitoring stations. Stations included two in the Lower Duwamish River Valley (Duwamish and South Park), one at

Beacon Hill, two in Kent and one in Enumclaw. These stations varied with different mixes of land use (industrial, commercial, residential) and development (urban, suburban and rural). Daily deposition rates were calculated for each sample and compared over space and time. Multivariate analysis was used to test for significance of environmental factors in affecting deposition rates. Results showed metals and total PCB deposition rates were often higher at the Lower Duwamish River Valley stations than the others.

Contact Author: Carly Greyell, King County Department of Natural Resources and Parks
Water and Land Resources Division
Science and Technical Support Section
King Street Center, KSC-NR-0600,
201 South Jackson Street, Suite 600
Seattle, WA 98104
T: 206-477-4703, F: 206-296-0192, carly.greyell@kingcounty.gov

Persistent Organic Pollutants (POPs) in the Puget Sound Ecosystem: An Evaluation of POPs in Fecal Samples of Southern Resident Killer Whales

Lundin, J.[1*], R.K. Booth[1], B. Anulacion[2], J. Hempelmann[2] , K.A. Parsons [2,3], G.M. Ylitalo,[2], S.K. Wasser[1].
[1] Center for Conservation Biology, University of Washington, Seattle, WA USA, [2] NOAA, Northwest Fisheries Science Center, Seattle, WA USA, [3] NOAA, National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA USA

The Puget Sound ecosystem of Washington State has been riddled with human impacts. Exposure to anthropogenic persistent organic pollutants (POPs) is listed as a primary risk factor for the endangered Southern Resident killer whale (SRKWs, *Orcinus orca*) population that resides in these waters. The objective of this study is to obtain real-time measures of POP (PBDEs, PCBs, and DDTs) levels in SRKW scat (fecal) samples to quantify variations in toxicant levels by pod, age, sex, reproductive status, and birth order, as well as prey availability and year. Samples were collected using detection dogs that ride on the bow of a boat and use scent to locate fresh scat on the water's surface. Using this non-invasive method we collected 267 samples over 4 years (2010-2013) across our 5-month study period. In our validation study using samples from 14 individual whales, gas chromatography/mass spectrometry was used to quantify contaminant levels, reproductive and thyroid hormones measurements were measured by radioimmunoassay, and species/individual was confirmed by DNA analysis. Significant correlations were apparent between toxicant measurements in scat and previously analyzed blubber-biopsy samples from the same whale (n=7 unique pairs; ∑PCBs, r=0.75, p=0.05; ∑PBDEs, r=0.76, p=0.05; ∑DDTs, r=0.92, p<0.01). Consistent with blubber biopsy measurements, the toxicant profiles in scat samples demonstrate significantly higher ∑DDT/∑PCB ratios in K and L pods, known to forage off the California coast, compared to J pod (p=0.02 and 0.02, respectively), and significantly lower (p<0.05) levels of ∑PCB, ∑PBDE, and ∑DDT were detected in reproductive age females compared to males and post-reproductive females, adjusted for pod. These validated measures will be applied to all samples to investigate temporal patterns and variations in toxicant levels relative to population demographics, hormones measures, and environmental factors. Results are forthcoming and will be presented at the conference.

Contact author: Jessica Lundin, University of Washington
Center for Conservation Biology
232 Johnson Hall, Box 351800, Seattle, WA 98195
T: 206-552-3698, F: 206-616-2011, jlundin2@uw.edu

Photo-enhanced Toxicity of Gulf of Mexico Marine Organisms at Early Life Stages and Two Ultraviolet Light Intensities

Finch BE*, Edgington AJ, Stubblefield WA
Oregon State University, Corvallis, Oregon

Polycyclic aromatic hydrocarbons (PAHs) are ubiquitously distributed throughout the environment from natural and anthropogenic sources. PAHs are novel in their ability to absorb ultraviolet radiation (UVR) as a result of their structure and can result in the production of reactive oxygen species within an organism. Significant increases in toxicity have been observed as a result of PAH absorption of UVR in aquatic organisms, i.e., photo-enhanced toxicity. Early life stage aquatic organisms are predicted to be more susceptible to photo-enhanced toxicity as a result of their translucence and habitat in shallow surface waters. The current study examined the photo-enhanced toxicity of a known phototoxic PAH, fluoranthene, on different larval life stages of the mysid shrimp (*Americamysis bahia*), inland silverside, (*Menidia beryllina*), sheepshead minnow (*Cyprinodon variegatus*), and Gulf killifish (*Fundulus grandis*). Organisms were exposed to fluoranthene and UVR at different life stages and were compared using lethal concentrations that resulted in 50% mortality (LC50s) and lethal times to death (LT50s). Additionally, studies were conducted to discern differences in toxicity based on the intensity of UVR. A high UVR intensity, short duration study (4 h) was conducted at ~24 W/m^2 of ultraviolet radiation A (UVA) and compared with a low intensity, long duration (12 h) study at ~8 W/m^2 of UVA. LC50s exceeded all fluoranthene concentrations measured nearshore during the Deepwater Horizon event. Results indicated decreased toxicity with age for all larval organisms but the Gulf killifish, which was uniformly insensitive. Differences in toxicity were observed between the high intensity short duration and low intensity long duration treatments. Data suggests toxicity is dependent on life stage and intensity of UVR.

Contact Author: Bryson Finch, Oregon State University
Dept. of Environmental and Molecular Toxicology
1007 Agriculture & Life Sciences Building; Corvallis, OR 97331
541-926-3171, finchb@onid.orst.edu

Quantification of Pharmaceuticals, Personal Care Products, and Perfluoroalkyl Substances in the Sediments of Elliott Bay, Puget Sound, Washington

Dutch, M.E.*, Partridge, V.A., Weakland, S., Welch, K.I.
Washington State Department of Ecology, Olympia, WA

Pharmaceuticals and Personal Care Products (PPCPs) and Perfluoroalkyl Substances (PFASs) are identified as Chemicals of Emerging Concern (CECs) in Puget Sound due to their potential to cause adverse toxicological, biological, and ecological effects when unintentionally discharged to the environment. Characterization of sources, transport patterns, and the fate of CECs in the environment has been prioritized as part of the toxics monitoring strategy for Puget Sound. To this end, concentrations of PPCPs and PFASs have recently been measured and detected in influent, effluent, and biosolids from municipal wastewater treatment plants in Puget Sound, WA. They were also measured and detected in sediments from ten long-term monitoring stations located throughout Puget Sound and thirty stations in Bellingham Bay in 2010. In June, 2013, sediments were collected at thirty randomly-selected stations in Elliott Bay using a probabilistic sampling design developed for the Washington State Department of Ecology's Urban Waters Initiative. Sediments were tested for the presence of 119 PPCPs and 13 PFASs. Analyses were conducted by AXYS Analytical Services Ltd., Sidney, BC, Canada, using AXYS Method MLA-075. This method uses liquid chromatography with tandem mass spectrometry (LC/MS/MS). Acid

and base fractions were extracted, followed by five instrumental analyses in positive and negative electrospray ionization (ESI) modes. Results of these analyses are summarized and presented graphically to indicate the concentration and distribution of PPCPs and PFASs in Elliott Bay sediments, with comparisons made to concentrations measured in Bellingham Bay sediments.

Contact Author: Margaret Dutch, Washington State Department of Ecology
PO Box 47600
Olympia, WA 98504-7600
T 360-407-6021, F 360-407-6884**,** margaret.dutch@ecy.wa.gov

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Poster Abstracts

(in alphabetical order)

Cyanotoxins in Samples at Routine Swimming Beach Sites and During Bloom Events in Four King County Lakes from 2009 to 2013

Alaimo, J.*; Yoshida, G; Hannach, G.; Frame, E. and Revelle, R.
King County, Seattle, WA.

As part of a routine King County monitoring program for toxic cyanobacteria in county swimming beaches, microcystin and anatoxin are measured at 20 swimming beaches in four recreational lakes (Washington, Union, Green and Sammamish). In addition, algae toxins are tested in response to algae blooms as part of the Washington State Department of Ecology Algae Control Program, whether at routine swimming beach stations, shoreline accumulations or mid-lake. If cyanotoxins are measured at levels above recreational guidance levels, swimming beaches will be posted. In a central Seattle recreational lake (Green Lake), routine monitoring indicated microcystin guidance levels at all swimming beach sites were less than guidance levels from 2009 to 2013. For algae blooms from 2011 to 2013, anatoxin levels were less than the action level of 1 µg/L in all instances. Microcystin levels at various locations (along shoreline, adjacent to boat launches, in coves or at Duck Island) exceeded the guidance level of 6 µg/L twice in 2011, eight times in 2012 and thirteen times in 2013. At six of the sites, no visible scum was present. Between 2011 and 2013, 28 to 45 percent of bloom samples from Green Lake contained microcystin at levels known to be harmful to humans, pets and wildlife. The majority of bloom incidents occurred in fall, primarily from September to October. Information is used to advise recreational water use during toxic algae blooms and action necessary to reduce their occurrence.

Contact Author: Julie Alaimo, King County Department of Natural Resources and Parks
Water and Land Resources Division, Environmental Laboratory Section
322 West Ewing Street, Seattle, WA 98119
T: 206-684-2319, F: 206-684-2395, Julie.alaimo@kingcounty.gov

Use of Metagenomic DNA Sequencing Technologies to Identify Markers of Water Quality

Van Rossum, T.[1]; Peabody, M.A.[1]; Uyaguari Diaz, M.I.[2]; Croxen, M.A.[2]; Cronin, K.[2], Laird, M.R.[1]; Lo, R.[1]; Tian, X.[2], Hsiao, W.W.L.[2,3]; Suttle, C.A.[2]; Prystajecky, N.A.[2,3]; Issac-Renton, J.L.[2,3]; Tang, P.K.C.[2,3]; Brinkman, F.S.L[1]*
[1]Simon Fraser University, Burnaby, BC, Canada [2] University of British Columbia, Vancouver, BC, Canada [3] British Columbia Center for Disease Control, Vancouver, BC, Canada

Abundance levels of culturable E. coli have been used as a biological marker of fecal contamination for decades. This test is well established and demonstrates the principle of using a microbial indicator for environmental assessment. However, these culture-based methods are slow, can be inaccurate, and lack the specificity to identify sources of contamination. We are working to identify a set of genetic features that could be used as more specific biomarkers, not just for fecal contamination, but also for chemical contamination (e.g. phosphorus, ammonia, etc). We have collected a year of monthly samples from seven sites in protected, urban, and agricultural river systems around the southwestern coast of British Columbia. For each sample, we have recorded physical and chemical data and have taken a snapshot of the microbial communities (protists, bacteria and viruses). By sequencing both phylogenetic marker genes and metagenomic DNA, we surveyed the taxa and genes present in each sample, compiling biological feature profiles. We are analyzing these profiles in the context of the environmental physiochemical data, looking for relationships between biological features and specific environmental variables and identifying features that correlate with indexes of agricultural or urban contamination. From these relationships, we will describe sets of biological features that are predictive of contamination and use them to develop qPCR-based tests for potentially rapid and cost-effective environmental assessment. Because these new

tests will measure the abundances of multiple biological features, and involve molecular sequence data, they not only have the potential to more accurately measure contamination levels, but may also identify the likely sources of contamination. This work demonstrates how new community-level microbiome sequencing can be leveraged to improve existing use-cases of biomarkers for environmental monitoring, and potentially extend to new uses in monitoring urban and agricultural chemical contaminants.

Contact Author: Fiona Brinkman, Simon Fraser University
Department of Molecular Biology and Biochemistry
8888 University Drive, Burnaby, BC, Canada, V5A 1S6
T: 778-782-5646, F: 778-782-5583, brinkman@sfu.ca

Dioxins, Furans, and PCBs: Laboratory Analysis and Non-Detected Values

Buchan, A.
Washington State Department of Ecology, Lacey, WA 98503 USA

This poster presentation includes recommended procedures for evaluating laboratory detection limits for complex mixtures of dioxins (chlorinated dibenzo-p-dioxins [PCDDs], chlorinated dibenzofurans [PCDFs], and dioxin-like polychlorinated biphenyls [PCBs]). This includes both the censorship of data and congener-specific laboratory quantitation limits. These procedures should allow for a consistent approach for both site managers and consultants to calculate site contaminant levels that would be used to characterize a site for comparison to screening and cleanup levels under the Model Toxics Control Act.

Contact Author: Arthur Buchan, Washington State Department of Ecology
Toxics Cleanup Program
PO Box 47600, 300 Desmond Drive, Olympia, WA 98504
T: 360-407-7146, F: 360-407-7154, arthur.buchan@ecy.wa.gov

Dioxins, Furans, and PCBs: Calculation Methodology for Ecological Risk

Buchan, A.
Washington State Department of Ecology, Lacey, WA 98503 USA

There are many complex mixtures present at hazardous waste sites. This poster presentation includes the toxicological effects and recommended procedures that should be used to evaluate risk for complex mixtures of dioxins (chlorinated dibenzo-p-dioxins [PCDDs], chlorinated dibenzofurans [PCDFs], and dioxin-like polychlorinated biphenyls [PCBs]). These procedures should allow for a consistent approach for both site managers and consultants to calculate site contaminant levels that would be used to characterize a site for comparison to the Model Toxics Control Act, Terrestrial Ecological Assessment Screening Levels (Table 749-2 and 749-3) for both characterization and cleanup purposes. This presentation is specific as it pertains to Ecological Risk Assessment and the Terrestrial Ecological Evaluation procedures under the Model Toxics Control Act (WAC 173-340-7490 through 7494).

Contact Author: Arthur Buchan, Washington State Department of Ecology
Toxics Cleanup Program
PO Box 47600, 300 Desmond Drive, Olympia, WA 98504
T: 360-407-7146, F: 360-407-7154, arthur.buchan@ecy.wa.gov

Biomarker Expression and Mercury Concentrations in Signal Crayfish (*Pacifastacus leniusculus*) Inhabiting the Boise River, Idaho

Clovis, C.H., A.M. Latta, J.C. Cervantes Reyes, L.L. Holden, C. Lineberger, P. Erstad, B. Nguyen, and M.P. Gunderson
The College of Idaho, Department of Biology, 2112 Cleveland Blvd., Caldwell ID

Human activities associated with mining, development, and agricultural activities can increase pollution in aquatic ecosystems from heavy metals, contaminants associated with sewage waste effluent and storm drain runoff, and chemicals used on golf courses, yards and farms. It is therefore important to not only monitor chemical pollutants but also determine whether chemicals and mixtures of chemicals illicit biological responses in organisms inhabiting impacted ecosystems. The goals of this study were to measure mercury concentrations in signal crayfish (*Pacifastacus leniusculus*) inhabiting the Boise River (Idaho) as well as determine whether physiological markers that are sensitive to contaminant exposure change in response to environmentally relevant concentrations of contaminants as well as vary among sites with different types of land use practices taking place in the surrounding areas. Acetylcholine esterase (ACHE), metallothionein (MT), phase I and II detoxification enzymes, catalase, and superoxide dismutase were all detectable in signal crayfish. ACHE activity in tail muscle and MT concentrations in gill tissue were measured in crayfish treated with $ZnCl_2$ or the organophosphate pesticide dimethoate as well as in crayfish collected from different sites along the Boise River. ACHE was inhibited at all concentrations of dimethoate tested (0.3, 0.6, 0.9 mg/kg) relative to a saline control however neither ACHE nor MT changed in response to $ZnCl_2$ (0.6, 0.9, 1.2 mg/kg). Both ACHE and MT varied in animals collected downstream of urban and agricultural areas. Further work is needed to examine the responses of the biomarkers detected in this study to environmentally relevant chemicals to determine whether these endpoints serve as sensitive indictors of contaminant exposure in this species.

Contact Author: Mark P. Gunderson, The College of Idaho
Department of Biology
2112 Cleveland Blvd., Caldwell ID. 83605
T: 208-459-5657 F: 208-459-5044, mgunderson@collegeofidaho.edu

Reductive Biotransformation of PBDE-99 in Staghorn Sculpin and Starry Flounder Derived Hepatic Microsomes

Elkan, H. H., Hoferkamp, L. A.
University of Alaska Southeast, Juneau, AK

The reductive capacity of hepatic enzymes derived from southeastern Alaska forage fish toward brominated flame retardants was investigated as a possible contributor to elevated levels of lower brominated analogues found in tissue surveys. This debromination process may potentially disrupt thyroid hormone homeostasis in affected fish and the product lower brominated analogues are associated with neurotoxicity. Hepatic microsomal fractions derived from fish liver tissue were characterized and used in assays designed to measure debromination of the pentabrominated polybrominated diphenyl ether (PBDE-99). PBDE-99 is commonly found in tissue surveys of marine species alongside its tetrabrominated analogue, PBDE-47. The relative concentrations of PBDE-47 to PBDE-99 were compared to the 47/99 ratios found in concurrent tissue surveys of the species under investigation. While the majority of PBDE production and use in the US and Europe has been either banned or severely restricted since 2004, their environmental persistence is made apparent by the surveys reported here and

throughout the literature showing detectable levels in biotic and abiotic matrices. Moreover, the distributions of PBDEs with varying degrees of bromination (i.e. congeners) that are most common to flame retardant formulations are infrequently mirrored in environmental congener distributions, particularly those of biological origin. Reports of PBDE levels in fish species show larger proportions of lower brominated congeners suggesting reductive biotransformation is a significant attenuation pathway. PBDE levels were measured in tissue from staghorn sculpin (*Leptocottus armatus*) and starry flounder (*Platichthys stellatus*) collected from an urban estuary in Juenau, AK and exhibit a disproportionate amount of the lesser brominated congeners. Liver tissue was harvested from the same species collected from a pristine site in Juneau, AK, microsomal fractions isolated, characterized and used in assays with the PBDE99. Survey, microsomal assay results and evidence linking biotransformation of PBDE99 to PBDE47 in fish species to the deiodinase enzyme is presented.

Contact Author: L. Hoferkamp, University of Alaska Southeast
Dept. Natural Science
11120 Glacier Hwy
Juneau, AK 99801
(907) 796 6538

Integrating Ecological and Human Health Risk for the South River, Virginia

Harris, Meagan J * and Landis, Wayne G
Western Washington University, Bellingham, WA.

Regional scale risk assessments can be used to determine the likelihood of effects from multiple stressors on multiple ecological or human endpoints at multiple scales. The Relative Risk Model (RRM) is an effective tool by which to calculate and assess risk to both ecological and human endpoints in an integrated approach to risk assessment. We will apply the RRM to an integrated assessment of ecological and human health risk from mercury contamination and environmental stressors in the South River, Virginia. Bayesian networks will be used with the relative risk model (BN-RRM) to calculate relative risk and uncertainty. Initial risk assessments for the South River by the Landis group have calculated risk and associated uncertainty to four water quality and four biotic endpoints. Two additional conceptual models for human health and human wellbeing will be incorporated into the BN-RRM to create an integrated framework for calculating risk and estimating uncertainty. While integration of human and ecological risk assessment is a salient goal in the field of risk assessment, it is nearly absent from the published literature. Integrating the two aspects of risk assessment will improve the decision-making process especially in looking at trade-offs and avoiding unintended consequences.

Contact Author: Meagan Harris, Western Washington University
Institute of Environmental Toxicology
516 High St., MS 9180
Bellingham, WA 98225
T: (360) 650- 6136; F: (360) 650- 6556, harris61@students.wwu.edu

Validation Studies of Time- Integrative Solid Phase Extractive Sampler to Passive and Discrete Sampling Methods Conducted by Federal and State Agencies

Hepner, B.A
Aqualytical Services Inc. Maple Valley, WA, 98038 USA

The need to sample natural waters for a diverse array of trace organic compounds (TOCs) is rapidly intensifying. Recent advances in sampling technologies now can provide rapid, low level, time- integrative options for identifying TOCs in water. A newly developed continuous solid phase extractive (SPE) in situ sampling method was compared to a passive sampling method, and a standard discrete sampling method. The continuous low-level aquatic monitoring (C.L.A.M.) sampler is a submersible, SPE, time-integrative, active extractive sampler. C.L.A.M. samplers were deployed at two stream field sites in conjunction with the deployment of polar organic chemical integrative samplers (POCIS) and the collection of standard discrete 1-L water samples. All samples were analyzed for a suite of 69 organic waste-indicator TOCs. The C.L.A.M. and POCIS samples represent time-integrated samples that accumulate the TOC present in the water over the deployment period (19-23 hours for C.L.A.M. and 29 days for POCIS); the discrete samples represent only the TOCs present in the water at the moment of sampling. This work was supported by the U.S. Geological Survey Water Science Field Team, and the U.S. Geological Survey National Water Quality Laboratory. A concurrent validation comparison study of the C.L.A.M. in situ time integrative extractive event, to the discrete grab sample, was supported by the Washington State Department of Ecology. This study utilized HRMS methods detecting ultra-low levels of PCB's, PBDE's, and Dioxins in the Spokane River.

The device, extraction disks and technology was supplied to both agencies by Aqualytical Services Inc. a division of C.I.Agent Storm-Water Solutions. This presentation will introduce the new C.L.A.M. technology, summarize the findings of both studies, and compare qualitative, and quantitative capabilities, and contrast bias, and recovery.

Contact Author: Brent Hepner, Aqualytical Services Inc.
Div. C.I.Agent Storm-Water Solutions
Research and Development
23010 S.E. 222nd St.
Maple Valley, WA 98038
T 253-732-5319, brent@ciagent.com

Modulating P-Glycoprotein Gene Expression and Functional Activity in *Danio Rerio* (Zebrafish)

Jackson, J. and C. Kennedy
Simon Fraser University, Burnaby, BC, Canada

Fish living in polluted waters rely on cellular mechanisms of defense to reduce the toxic effects associated with exposure to environmental contaminants. One such mechanism (known as multidrug resistance, MDR) involves the ATP-binding cassette (ABC) transporter, P-glycoprotein (P-gp), a transmembrane efflux pump which prevents the accumulation of toxicants in vulnerable tissues such as the liver, gills, and brain. Several mammalian studies have shown that gene expression of P-gp and CYP3A (a cytochrome P450 monoxidase), is controlled by the pregnane X receptor (PXR). PXR is a promiscuous nuclear receptor directly activated by a diverse range of ligands including many structurally unrelated environmental toxicants. To examine the potential role of PXR in regulating fish P-gp gene expression and activity *in vivo*, *Danio rerio* (zebrafish) were intraperitoneally (i.p.) administered the PXR activator pregnenolone 16α-carbonitril (PCN) and an equimolar dose of PCN and the PXR inhibitor, ketoconazole (KTC). At 48 h post i.p. injections, P-gp activity was compared between control, PCN, and PCN + KTC-treated fish by spiking tank water with 5μM of the P-gp substrate rhodamine 123 (R123) and measuring liver R123 accumulation 0, 1.5, and 3 h. Area under the [R123] *v*. time curve showed a significant decrease in overall liver R123 accumulation in fish treated with PCN relative to both control and PCN + KTC-treated fish, suggesting that PCN induces P-gp activity in zebrafish while KTC has an inhibitory effect. Interestingly, qPCR analysis showed that PCN-treated fish had significantly lower *abcb4* (P-gp) and *cyp3a65* (CYP3A) mRNA levels compared to control and PCN + KTC fish at 48 h post i.p. injections, suggesting that complex post-transcriptional regulation and negative feedback mechanisms may be involved with controlling P-gp gene expression and functional activity *in vivo.*

Contact Author: Chris Kennedy, Simon Fraser University
Department of Biological Sciences
8888 University Drive, Burnaby, BC, V5A-1S6
778-782-5640, ckennedy@sfu.ca

Lichens as Air Quality Biomonitors Along the Pacific Northwest Rail Corridor in Bellingham, Washington

Johnson, J.L.*; Kelley, A.; and Sofield, R.M.
Western Washington University, Bellingham, WA 98225 USA.

Epiphytic lichens are useful biomonitors of air quality because they have a high surface area and acquire nutrients only through direct exposure to the atmosphere. While the impacts of train air pollution are a current topic of interest, there are few studies that exploit biomonitors to investigate air pollution from railroad point sources. In this study the lichen *Ramalina farinacea* was harvested from a site without known sources of air pollution in Bellingham, Washington and transplanted onto trees directly adjacent to the railroad at three locations in the Chuckanut region of the Pacific Northwest Rail Corridor (PNWRC) for a three-month period. Transplants were arranged into distinct height groups to survey the impact of train exhaust plumes and particulate matter on oxidative stress, chlorophyll degradation, membrane stability and heavy metal accumulation. Results were compared to reference lichens deployed at the collection site. No significant differences compared to the reference lichens were observed for oxidative stress and chlorophyll degradation. Membrane stability and heavy metal accumulation analyses are ongoing and will be presented. Qualitative effects, such as visible damage to thalli and color changes were evident in lichens deployed along the PNWRC. Lichen community structure in forested areas bordering the railroad was surveyed and suggests that resident lichens exhibit reduced size.

Contact Author: Jordan Johnson and Amberose Kelly, Western Washington University
Huxley College of the Environment, WWU
T: 208-869-8652, johnson.jordi@gmail.com, amberosekelley@gmail.com

The Effects of Copper Exposure on the Swimming Performance and Osmoregulatory Ability of Juvenile Rainbow Trout (*Oncorhynchus Mykiss*)

Love, S.A.S.[1]*; Skirrow, R.C.[2]; van Aggelen, G.C.[2]; Kennedy, C.J.[1]
[1] Simon Fraser University, Burnaby, BC, [2] Pacific Environmental Science Center (PESC), Environment Canada, North Vancouver, BC.

Copper (Cu) is a widely occurring metal contaminant in aquatic systems and is known to be acutely toxic to fish as well as affecting several physiological systems of fish at sublethal concentrations. Three experiments were conducted to determine the sublethal effects of Cu on juvenile rainbow trout (*Oncorhynchus mykiss*) swimming performance and osmoregulatory ability. Fish were exposed to Cu (0, 20 or 60 µg/L) for 4, 8 and 16 d in hard water (100 mg/L $CaCO_3$) and assessed for burst swimming performance (U_{burst}). Cu exposure did not affect mean swimming speeds at any concentration, at any time point. A seawater challenge was conducted to assess osmoregulatory impairment; following 4 d of exposure to Cu at 0, 20 or 60 µg/L, fish were placed in seawater (29 ppt) for 24 h. No mortalities occurred during the challenge for any treatments. Biochemical indicators of stress and impaired osmoregulatory function (plasma cortisol, plasma sodium, plasma chloride, plasma osmolality, hematocrit and gill Na^+,K^+ -ATPase) were also assessed. A concurrent study is being conducted to examine these same endpoints, with Cu exposures in soft water (10 mg/L $CaCO_3$) to determine the modulation factor of water hardness in Cu toxicity.

Contact Author: Sydney Love, Simon Fraser University
Department of Biological Sciences
8888 University Dr, Burnaby, BC, V5A 1S6
T: 778-782-4475, F: 778.782.3496, sal7@sfu.ca

Anthropogenic Impacts on Water Quality in the Lower Fraser Valley of British Columbia

Makkar, S., S.*, Mattu, J.*, Marlatt, V.L., Gillies, S.L.
University of the Fraser Valley, Abbotsford, BC

Several anthropogenic activities and associated pollutants impact water quality, and many studies have reported their adverse effects on aquatic wildlife. This is of particular concern in the Lower Fraser Valley where effluent from wastewater treatment plants, individual septic systems and agricultural lands discharged into freshwater bodies may introduce a variety of contaminants (i.e. nutrients, personal care products, pharmaceuticals and hormones). In this study, the levels of 17β-estradiol (E_2), total nitrogen (N) and total phosphorus (P) were measured in single, near shore, grab sample collected from a pristine lake (Chilliwack Lake) and an anthropogenically-impacted lake (Hatzic Lake) that receives sewage effluent and agricultural run-off. The N and P levels were found to be higher in Hatzic Lake (0.0019 µg/ml [N] and 0.00023 µg/ml [P]) compared to the presumed pristine, Chilliwack Lake (0.00035 µg/ml [N] and 0.0001 µg/ml [P]). Using an Enzyme-Linked Immunosorbent Assay (Abraxis) E_2 was detected in both lakes. Surprisingly, E_2 was approximately 2 fold higher in the presumed pristine lake (Chilliwack Lake) compared to Hatzic lake with known anthropogenic impacts. Undoubtedly, future studies including additional sampling and analytical techniques are required to confirm these preliminary findings at Hatzic and Chilliwack Lake. Nonetheless, these results demonstrate that further investigations surrounding sewage treatment and agricultural waste practices in the Lower Fraser Valley are warranted to determine the pervasiveness of these anthropogenic pollutants in surface waters, and to assess their risks on aquatic wildlife.

Contact Author: Jaipreet Mattu, University of the Fraser Valley
2105 Ridgeway St. Abbotsford, B.C. V2T3H1
T: 778-240-9606, Jaipreet.mattu@student.ufv.ca

Comparing Trophic Magnification of Select Perfluoroalkyl Acids (PFAAs) in Aquatic and Terrestrial Food Webs

McDougall, M. R. R.*, and Gobas, F.A.P.C.
Simon Fraser University, Burnaby, BC.

Predictive bioaccumulation models are tools developed to assist with chemical categorization and risk assessment for substances of bioaccumulative concern. These models, however, have been largely developed to account for neutral (i.e. non-ionic) substances. This creates challenges when using predictive models to estimate the bioaccumulative behaviour of ionizable substances in both aquatic and terrestrial food webs. Here, we modify existing bioaccumulation models to predict the bioaccumulative behaviour of various perfluoroalkyl acids (PFAAs), a class of environmentally ubiquitous commercial chemicals used predominantly as surfactants. To modify these models, we account for several relevant factors, including: i) the relatively high affinity of PFAAs for protein and polar lipids compared to neutral lipids, ii) different physiologies between water- and air-breathing organisms, and iii) the pH-dependent ionizable nature of PFAAs. Modified model outputs are compared to observed bioaccumulation data using trophic magnification factors (TMFs) to test the hypothesis that existing bioaccumulation models fail to account for the ionizable nature of PFAAs in aquatic and terrestrial food webs do not adequately evaluate the bioaccumulative behaviour of PFAAs. Ultimately, these modified models may be used to re-evaluate existing bioaccumulation risk assessment strategies (particularly for air-breathing organisms, including humans) and contribute to the modification of regulations surrounding PFAAs and similar chemicals as necessary.

Contact Author: Mandy McDougall, Simon Fraser University
School of Resource and Environmental Management
TASC 1 Rm 8404, 8888 University Drive
Burnaby, BC V5A 1S6
T: 778-782-4659, F: 778-782-4968, mmcdouga@sfu.ca

Investigation of Silver Nanoparticle Toxicity at Different Temperatures

San, C.S.*, Fung, C.Y.*, Sofield, R.M.
Western Washington University, Bellingham, WA, 98225 USA

Rapid advancements in nanotechnology have occurred over the past few years as the demand for nanomaterials in consumer goods continues to rise. Relatively little is known about the toxicity of these materials to organisms in the environment, specifically silver nanoparticles. The purpose of this study was to determine the effects of nano-silver on *Raphidocelis subcapitata (*formerly known as *Selenastrum capricornutum)*, a green alga found commonly in most fresh waters. Algae toxicity tests were performed at 24°C and 28°C, over a 96 hour period and silver nanoparticle cultured solutions were subsequently characterized. Silver nanoparticles are being characterized by Transmission Electron Microscopy (TEM), Zeta Potentiometer, Ultra-centrifugation, Ultraviolet-Visible Spectroscopy and Ion Selective Electrode to determine ionic and nanoparticle silver concentrations as well as chemical and physical characteristics.

Contact Authors: Christopher San and Courtney Fung, Western Washington University
Huxley College of the Environment
516 High Street, Bellingham, WA 98225
T: 253-576-0562, sanc@students.wwu.edu;
T: 360-584-5139, cfung715@gmail.com

Back to the Future: Using an Activity-Fugacity Approach for Cumulative Environmental Risk Assessment of Phthalates

Tupper-Ring, L.; Otton, V.; and Gobas, F.,
Simon Fraser University, School of Resource Environmental Management, Burnaby, B.C.

Phthalates are heavily used as plasticizers and are now ubiquitous in the environment. They are a family of chemicals with varying chemical and physical properties. While risk assessments for individual phthalates such as DEHP do not indicate significant environmental risks, the cumulative risks of phthalate esters remains unknown. The goal of this research is to identify the cumulative environmental risk of phthalates using an activity and fugacity approach. An activity and fugacity based approach makes it possible to include exposure and toxicologically significant concentrations in multiple environmental media in a single risk analysis, hence providing a greater weight of evidence. This approach will not only eliminate environmental exposure concentrations above their solubility limit, but it also presents all the exposure concentrations into one common unit, regardless of the medium.

Contact Author: Laura Tupper-Ring, Simon Fraser University
School of Resource Environmental Management
8888 University Drive, Burnaby, B.C. V5A 1S6
T: (778) 782-4659, F: (778) 782-4968, reminfo@sfu.ca