Program and Abstracts

Pacific Northwest Chapter

Society of Environmental Toxicology and Chemistry

(PNW-SETAC)

24th Annual Meeting

April 30-May 2, 2015

Courtyard Marriott Downtown/Convention Center
Portland, OR

Hotel Information

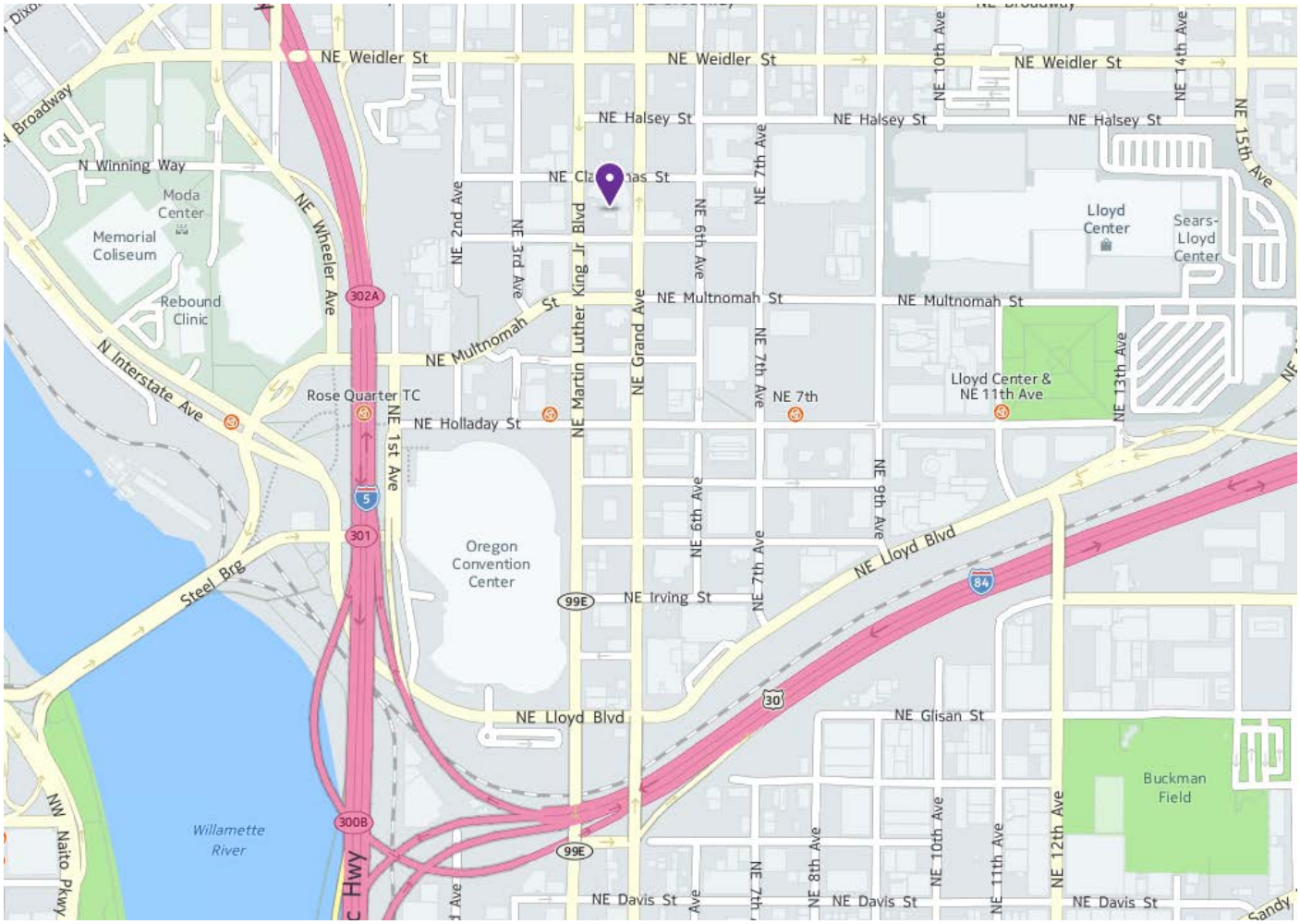
Courtyard Marriott Downtown/Convention Center
435 NE Wasco Street
Portland, OR 97232
P: (503) 234-3200

For guests:

- Check-in time: 3:00 PM , check-out time: 12:00 PM, late checkout available
- Free wired and wireless internet service
- Mini-fridge in rooms
- Full room service available as well as onsite restaurant and bar
- Parking $24/day valet (or see below for transit info)

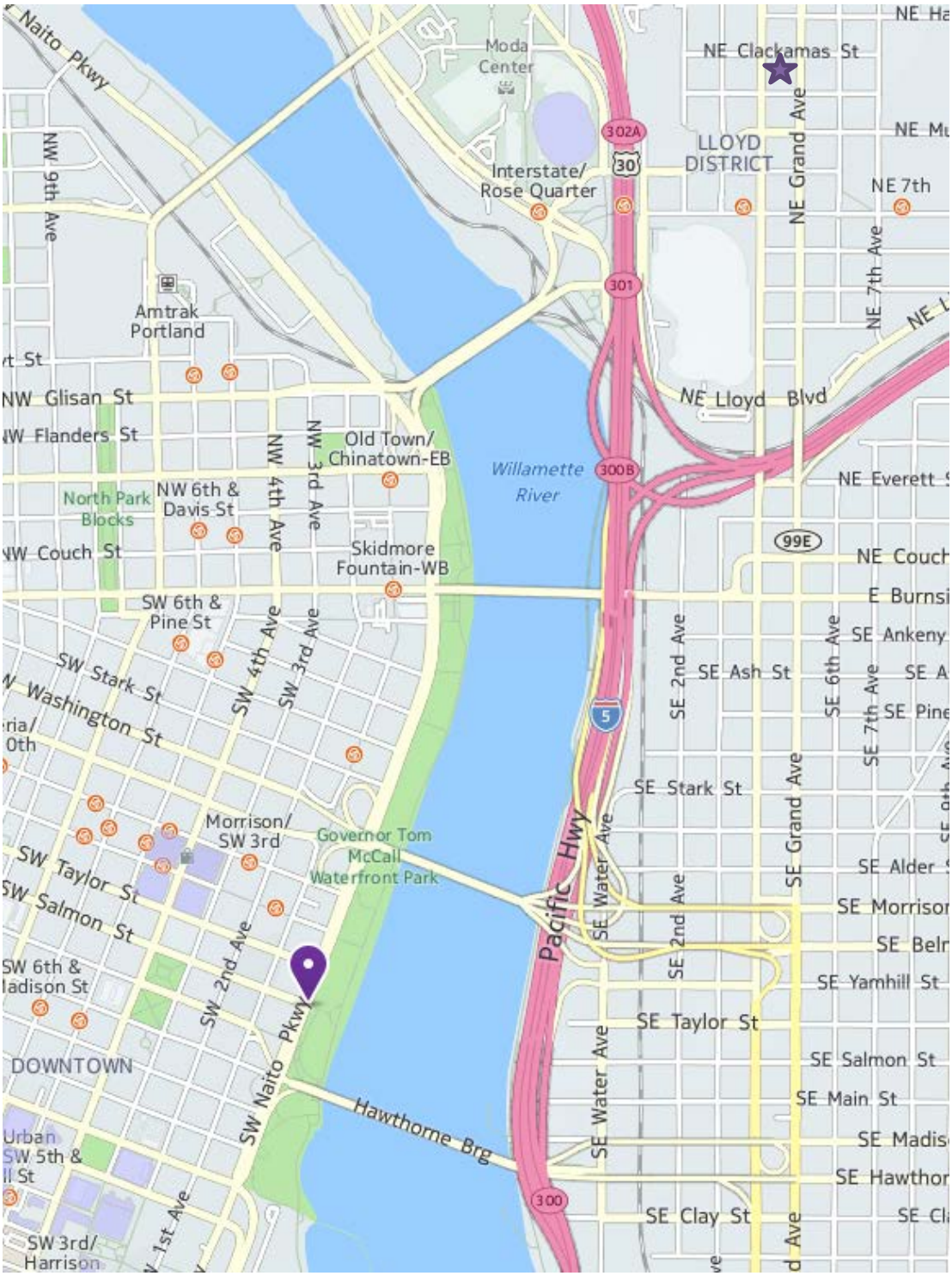
For conference attendees:

- Wireless internet available in lobby and conference rooms, 24-hr business center
- Complimentary coffee in the lobby
- Valet parking $15/day; limited on-street metered parking, 3 hr. max
- Convention Center light rail stop 2 blocks away; take the red line from the Portland Airport
- Friday breakfast provided with sign-up
- Morning and afternoon coffee break and refreshments provided on Friday
- Additional snacks and refreshments available for purchase in the lobby



Directions to the Portland Spirit Salmon Street Springs Dock and information for the Boat Tours

503-224-3900



BOAT TOUR INFORMATION

Boarding is at SW Naito Parkway and SW Salmon Street in the Tom McCall Waterfront Park, near the Salmon Springs Fountain. Please plan to be at least 15 minutes early for check-in and boarding to allow an on-time departure. There is a restroom, but no food or water on the boat, so bring snacks and water if you want them. Be prepared for unpredictable spring weather with warm clothes and layering – the boat has a roof and open sides, which can be covered with clear plastic if inclement. A picture and some additional instructions for the boat are attached. Please check in with a conference volunteer when you arrive.

DRIVING FROM THE EAST SIDE: Cross Morrison Bridge westbound to SW Front Ave/Naito Pkwy. At the stop light turn right. Follow to SW Salmon Street (between Hawthorne & Morrison bridges). SW Front Ave/Naito Pkwy runs North/South along the Willamette River.

There is no parking at the dock. However, there is paid parking in the area around (see below for suggestions). We strongly suggest carpooling if you plan to drive. For those who want to drive/ride, please gather in the lobby at 8:00 am for the morning tour and 12:30 pm for the afternoon tour to arrange carpools. Alternatively, you may take light rail (directions below).

Parking Options

1. **UNDER THE HAWTHORNE BRIDGE**
Enter from SW Front Ave/Naito Pkwy northbound
(coins or credit card payment only)
2. **UNDER THE MORRISON BRIDGE**
Enter from SW Front Ave/Naito Pkwy southbound
(coins or credit card payment only)
3. **SW FRONT AVE/NAITO PKWY, JUST SOUTH OF SW SALMON ST**
Enter from SW Front Ave/Naito Pkwy southbound.
(This lot is across the street from McCall's Waterfront Cafe)
(Coins or credit card payment only)
4. **SECOND AVE AND SW SALMON ST**
Enter from Second Ave Northbound, or from Salmon St eastbound
5. **SMART PARK LOTS**
SW First and Jefferson - Enter from Jefferson Westbound, mid-block right
SW Fourth and Taylor - Enter on SW Fourth Northbound, mid-block right
6. **ON-STREET METERED PARKING**

MAX Light Rail

FROM THE EAST SIDE: Walk 3 blocks south to the Convention Center light rail stop. Take the Red Line or the Blue Line 5 stations to the Stop at SW Third & Morrison Street, by the Rock Bottom Brewery. Walk toward the river to the Tom McCall Waterfront Park and south to the dock.

This 40-foot vessel carries up to 35 passengers and can travel up to 45 miles per hour. Equipped with a canopy top with zip down windows, on-board restroom, and bench seating with custom cushions.

Please Note: For safety and comfort, guests should be in good health and free from heart, back, knee or neck problems, motion sickness or other conditions that could be aggravated. Expectant mothers should not ride. Children must be accompanied by an adult. Guests may need to negotiate a steep series of steps when boarding and disembarking the vessel. The Explorer is not wheelchair accessible.

How to Ride MAX

Step-by-step directions for using TriMet's MAX Light Rail

TriMet's MAX (Metropolitan Area Express) Light Rail connects downtown Portland with Beaverton, Clackamas, Gresham, Hillsboro, North/Northeast Portland and the Portland International Airport. Hours of operation vary, but all MAX lines run about every 15 minutes or better most of the day, every day. See the map on the next page – ours is the circled stop labeled “Convention Center.”

1. You must have a valid ticket or pass *before* boarding MAX. Ticket machines and validators are located at the station. Remember to activate your mobile ticket before boarding.

2. Signs at the station indicate where to wait and when the next train is due. Signs on the front of each train identify the line (Blue, Green, Red or Yellow) and destination.

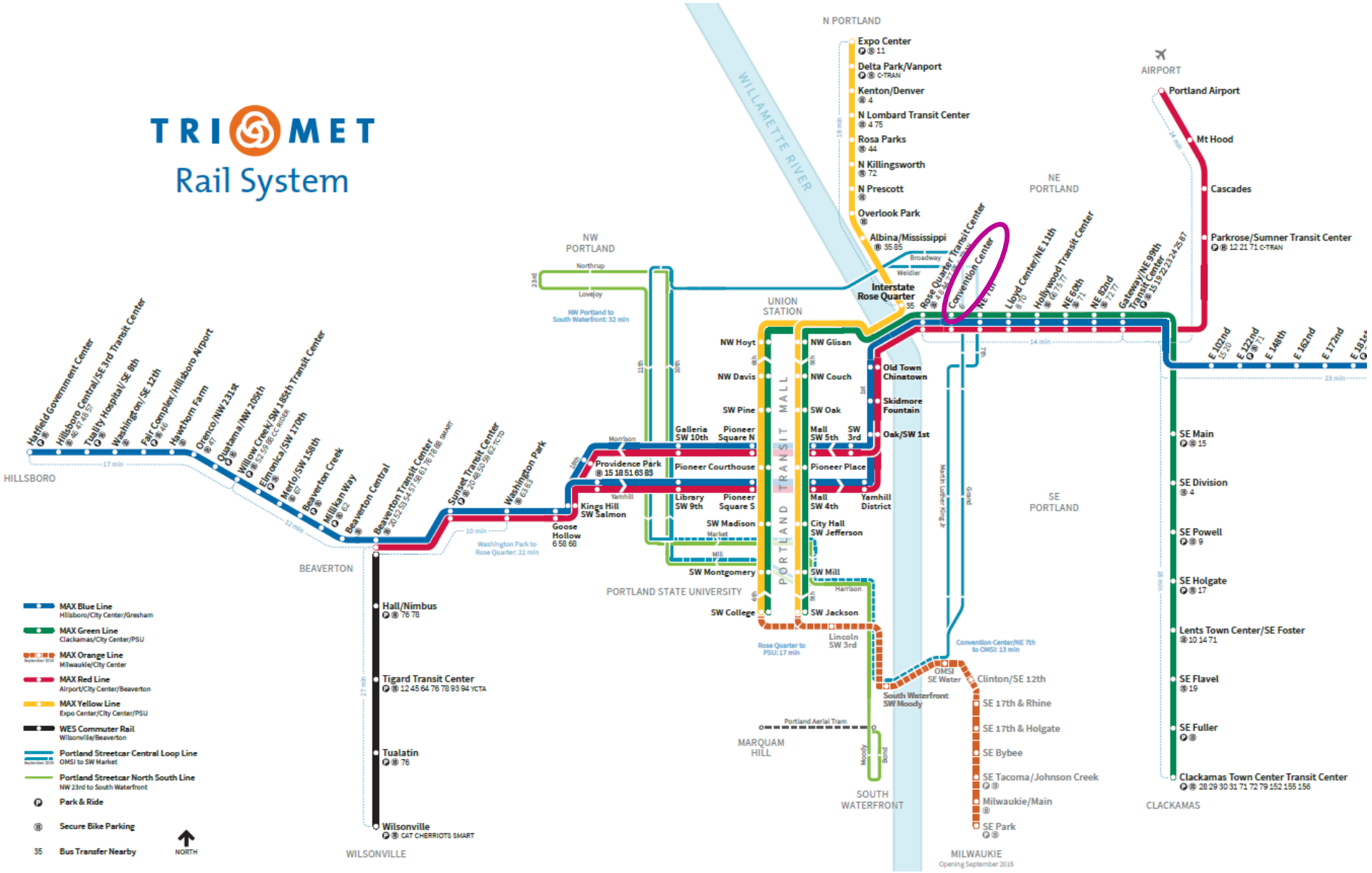
3. As MAX approaches, stay well behind the white bumpy tiles and wait for the train to come to a complete stop.

4. The doors will open automatically and you can board the train. If you're standing, move back so others can board.

5. MAX stops at every station, so you don't need to signal the operator to get on or off. The station name is announced before each stop and appears on a reader board overhead.

6. Gather all your personal items and exit the train.

TRIMET Rail System



PNW-SETAC

2015 Board of Directors

These are the people that make it all happen!

President: Roger Thomas

Vice-President: Julann Spromberg

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Agency At-Large: Art Buchan

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Student At-Large: Meagan Harris

Conference Coordinator: Teresa Michelsen

Webmistress & Registered Agent: April Markiewicz

If you would like to get involved, we will be looking to fill several positions for 2016, including Vice President, Industry At-Large, Student At-Large, and Conference Coordinator (in training).

Please let any of us know if you are interested in any of these positions! You can find out more about them on our website, at http://www.pnw-setac.org/about.html.

PNW-SETAC

Meeting Sponsors

Special thanks to all our 2015 Meeting Sponsors!!

Program Production and Printing
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Thursday Boat Tours
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Thursday Short Courses
Maxxam Analytical

Thursday Evening Welcome Reception
Nautilus Environmental

Friday Lunch Buffet
Windward Environmental

Friday Refreshments
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Scientific Notations

Student Presentation Awards
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Student Travel Funds
Northwestern Aquatic Sciences

PNW-SETAC Corporate Sponsors

Please join us in thanking our 2015 Corporate Sponsors!!

Nautilus Environmental

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

Our team of environmental scientists has expertise in the fields of environmental toxicology, chemistry, biology, and ecology, which ensures that studies conducted by our company are designed, implemented and interpreted in a manner that maximizes the value of the data. Nautilus has developed a renowned program that applies both standardized and innovative methodologies to address a range of toxicological concerns. At the core of the business are our accredited environmental toxicology laboratories in Vancouver, B.C. and San Diego, CA, each offering a wide range of toxicity testing services. Please explore our site or contact us to learn more about how we can assist you.

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

Northwestern Aquatic Sciences

Northwestern Aquatic Sciences (NAS) specializes in providing aquatic toxicology testing and consulting services to industries, municipalities, environmental consultants, ports, and other private and governmental entities. NAS provides aquatic toxicity tests required for whole effluent (WET) biomonitoring, bioaccumulation, TIE/TRE evaluations, dredged sediment disposal, sediment characterization and remediation, hazardous waste testing, and industrial chemical evaluation. NAS, established in 1978, is a small business with core professional staff members who have worked together for more than 20 years. The direct involvement of its professional staff in project management enables NAS to provide a very high level of quality research and testing results for its clients. NAS operates a modern aquatic toxicology laboratory facility located in Newport, OR, which includes over 5000 ft^2 of offices, wet and dry biological laboratories, refrigerated and frozen storage and an analytical support laboratory located on a 1.2-acre site adjacent to Yaquina Bay. NAS has been a Washington State accredited aquatic toxicology laboratory since 1991 and is certified for over thirty marine and freshwater sediment and effluent testing protocols. Please visit our website at http://www.nwaquatic.com to learn more and let us know how we can assist you.

Maul Foster & Alongi, Inc. is a locally based, 80-person firm of environmental scientists, engineers, planners, landscape architects, Geographic Information Systems analysts, and sustainability professionals. MFA has developed respected, trust-based, and results-oriented relationships with clients and regulators, and MFA's multidisciplinary capabilities facilitate expeditious and implementable solutions for complex and multi-phased projects. Our professionals develop sound solutions to environmental and engineering challenges for our clients.

Germano & Associates, Inc. (G&A) is the world's foremost provider of SPI technology; even though sediment profile cameras are available on the commercial market for purchase by anyone, no one approaches the expertise of our scientists in this area. Since our start in 2001, we have performed SPI surveys on the east, west, and Gulf coasts of the United States as well as surveys in international waters (off the coasts of Hong Kong, mainland China, west Africa, Italy, United Kingdom, Mexico, Brazil, and in the Caspian Sea). Our vision and goal with our in-house capabilities and experience is to make science understandable to our clients and the public.

Windward Environmental was founded in 2000 on the premise that environmental consultants best serve clients' interests by providing high-quality, defensible data and insightful analyses for use in decision-making. Because our technical approach is based on sound scientific principles, we identify and investigate environmental problems transparently and without bias. As a consequence, our work is given serious consideration by all parties, even in contested situations. Windward has a reputation for providing clients with superior service and results that make a difference, regardless of the size or complexity of the project. Windward prides itself on being a great place for young environmental scientists and engineers to develop their careers, and for leaders in the field to pursue their practices. Please visit our website (www.windwardenv.com) or contact us at info@windwardenv.com to learn more about Windward.

PNW-SETAC
Acknowledgments

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

Abstract Review:	Julann Spromberg, Meagan Harris, John Stark
Meeting Program:	Teresa Michelsen, Taku Fuji
Meeting Registration:	April Markiewicz, Teresa Michelsen
Volunteer Coordinator:	Meagan Harris
Volunteers:	Ed Bain, Alan Bergmann, Nicolas Boye, Juan Cervantes, Alicia Clendandiel, Connor Coatney, Lindsay Denluck, Ryan Dewitt, Bryson Finch, Lara Gaasland-Tatro, Scarlett Graham, Christopher Kasanke, Gerald Kitsis, Marianna Lane, Sidney Love, Madi Novak, Melanie Pylatuk, Maria Redig, Michelle Redmond, Fauve Strachan, Colleen Trostle, Fabiola Ukah, Lindsay Wallis, Fan Wu
Student Awards and Judging:	Ruth Sofield, Alan Bergmann, Art Buchan, Diana Dishman, Maggie Dutch, Bryson Finch, Lara Gaasland-Tatro, Stacey Harper, Josh Hopp, Feng Lin, Shannon Mitchell, Maria Redig, Irv Schultz, Fran Solomon, Fabiola Ukah, Lindsay Wallis, Jeff Wirtz
Fundraising:	PNW-SETAC Board
Boat Tour Coordination:	Diana Dishman, Keith Johnson
Session Chairs:	Madi Novak, Dawn Sanders, Stacey Harper, Chance Asher
Student Travel Awards:	Ruth Sofield, Heather Henson-Ramsey
Conference Coordinator:	Teresa Michelsen

PNW-SETAC ANNUAL MEETING

April 30 to May 2, 2015

Meeting Program

PNW-SETAC

Chapter Meeting Agenda

Thursday, April 30, 2015

9:00 AM – 12:00 PM	Short Course: Passive Sampling – Hawthorne Room
9:00 AM – 11:30 AM	Boat Tour: Portland Downtown Reach – Salmon Springs Dock, Portland
12:00 PM	**Boxed lunches available** – Lobby
1:30 PM – 4:30 PM	Short Course: Risk Communication – Hawthorne Room
1:30 PM – 4:30 PM	Boat Tour: Portland Harbor – Salmon Springs Dock, Portland
3:00 PM on	**Hotel Check-in Time**
5:30 PM – 8:00 PM	**Conference/Registration Check-in** – Lobby
6:00 PM – 8:00 PM	Welcome Reception – Charley's on Grand
8:00 PM – 9:00 PM	Board Meeting – Belmont Boardroom

Friday, May 1, 2015

7:30 AM – 5:30 PM	**Conference/Registration Check-in** – Lobby
7:30 AM – 8:30 AM	Poster setup – Hawthorne and Broadway Rooms
7:30 AM – 8:30 AM	Buffet breakfast – Bar area
8:30 AM – 8:45 AM	Welcome address, Chapter President Roger Thomas
8:45 AM – 9:00 AM	SETAC NA Updates, John Toll
9:00 AM – 12:00 PM	Platform presentations, 20 min break for refreshments and poster viewing
12:00 PM – 2:00 PM	**Lunch Break**
12:15 PM – 1:15 PM	**Lunch Buffet – Charley's on Grand**
1:00 PM – 1:50 PM	Chapter Business Meeting – Charley's on Grand – ALL WELCOME!
2:00 PM – 5:00 PM	Platform presentations, 20 min break for refreshments and poster viewing
5:00 PM – 5:30 PM	Interactive Poster Session & no-host bar – Hawthorne and Broadway Rooms
5:30 PM – 6:30 PM	Poster Social – Hawthorne and Broadway Rooms

Saturday, May 2, 2015

9:00 AM – 12:00 AM	Platform sessions with 20 min break for poster viewing
12:00 PM – 12:30 PM	Student Award Presentations
12:30 PM	**Adjourn**

1st Annual Scavenger Hunt!

Your Name: _____ Are you a student? (yes/no) _____

Instructions:

The goal of the scavenger hunt is to support networking opportunities during the meeting. **Anyone can participate.** Simply print a copy of this paper and mark all of the scavenger hunt items you achieve during the meeting (including during scheduled events and outside of the scheduled events). There will be some prizes for participants with the most check marks. Turn in your marked scavenger hunt sheet by Saturday at 10 am at the registration desk. Have fun!

- ☐ Eat a meal with someone you don't know
- ☐ Find out someone's favorite environmental toxicology or chemistry concept (and why)
- ☐ Get a business card or contact information of someone you don't know
- ☐ Find out what first inspired someone to study or work in the environmental sciences
- ☐ (For students) meet someone from as many of the other schools as possible (Butler University, The College of Idaho, Evergreen, Indiana, University of Pennsylvania, Oregon State University, Simon Fraser University, University of Alaska Fairbanks, Western Washington University, and others!) List how many unique schools you met someone from _____.
- ☐ Learn a new acronym
- ☐ Use the new acronym in conversation
- ☐ Make someone laugh in a conversation
- ☐ Get professional advice from someone
- ☐ Find someone who shares a hobby with you
- ☐ Shake someone's hand
- ☐ Reconnect with someone you haven't talked to in at least the last year (non students) or in at least the last month (students)
- ☐ Find a poster that interests you and ask the presenter a question
- ☐ Ask a question following an oral presentation (during the question period)
- ☐ Talk to someone who lives or works in a different city than you
- ☐ Go somewhere new in Portland
- ☐ (For students) talk to a student from another school/program about their plans after graduation
- ☐ Ask someone what was the best career advice they've received in the past, and why
- ☐ Do something with another attendee that is unique to or emblematic of Portland

PNW-SETAC
Thursday AM Short Course
9:00-12:00 AM, Thursday, April 30, 2015

Passive Sampling for Marine and Freshwater Environments

Instructor: Heather L. Lord, PhD, Maxxam Analytics, Mississauga, ON, Canada
T: 905-817-5711, F: 905-817-5777, hlord@maxxam.ca

Passive sampling for aqueous environments (surface water and groundwater) is gaining interest in North America. Commercially available passive sampling devices are available for several classes of pollutants, including volatiles, semivolatiles and metals. In this short course you will learn what the available devices are for each of these chemical classes and how to use them, the benefits passive samplers can potentially add to a project, and a comparison of the merits of passive sampling with the more traditional grab sampling. We will also cover passive sampling theory, practical tips on how to use passive samplers in the field, recommended field and lab QA practices, what the laboratory processes are and how these differ from conventional sampling, as well as how to interpret the laboratory reports. Finally, a number of case studies will be presented for a range of passive sampling technologies and field conditions.

Although the technology has not yet matured to the point that regulatory authorities will accept passive sampling results on their own, there is increasing interest in including passive sampling programs to supplement compliance monitoring, to more fully delineate the temporal and spatial nature of impacts on a site, prior to or in parallel with compliance monitoring, or to provide evidence to support conclusions on the nature of site concerns and approaches to addressing them. Passive sampling is a valuable addition to monitoring programs for sites that are difficult to access, have frequent and significant swings in contaminant concentrations, or have high sediment load where sediments are known to interfere with data integrity.

The workshop will be of interest to environmental professionals involved in risk assessment or site management who are facing some of the challenges mentioned, as well as those seeking a better understanding of the role this new technology is likely to play in the field of environmental management in the future.

PNW-SETAC
Thursday PM Short Course
1:30-4:30 PM, Thursday, April 30, 2015

Risk Communication

Instructors:
Julie Wilson, HartCrowser, julie.wilson@hartcrowser.com
Mandy Putney, Enviroissues, mputney@enviroissues.com

The need for effective risk communication has become increasingly paramount because of several factors:

- Our lives and the real and perceived threats we face have become more complex in the last 30 years;
- Traditional channels of communication, such as newspapers and television news, vie with many other communication methods and are not as popular with younger generations; and
- We are faced with more difficult decisions and trade-offs in a society with growing population demands and fewer financial resources available to address these issues.

Many government agencies have put out their own versions of training and manuals to address this need. In this class, we will address risk communication in a global manner, identifying how to correctly identify the target audience(s), articulate the risk in a manner that can be understood, and effectively deliver the message. This will include use of traditional means of communication as well as use of social media for message delivery. We will discuss different methods of risk communication that are used depending on the speed in which the message must be delivered, and describe how government agencies such as the Food and Drug Administration, FEMA, the CDC, and others are tailoring these techniques to best fit their needs.

PNW-SETAC
Thursday AM Boat Tour
9:00-11:30 AM, Thursday, April 30, 2015

State Cleanups, Redevelopment, and Restoration in the Portland Downtown Reach

Tour Leaders: Keith Johnson, Oregon Department of Environmental Quality
Madi Novak, Maul Foster & Alongi
Chris Bozzini, Portland General Electric
Allison Rouse, Portland Parks & Recreation

Join us for this interesting boat tour of the downtown area of the waterfront, highlighting several different sites and projects:

- **Zidell site cleanup** - Historic activities at Zidell site included ship building, dismantling, repairing, and salvaging. Zidell purchased the site in 1946 and became the largest ship breaking operation in the United States by 1960. These operations included onsite disposal and discharge of a variety of toxic metals, asbestos, PAHs, and PCB contaminants to the property and adjacent sediments. Removal of high concentrations of metal contaminated soil was conducted in 2010 followed by capping the entire upland portion of the site in 2013. A 16-acre bankline and sediment cap was completed in 2011 to physically isolate contaminated sediments and shoreline contaminants. The cap was designed in a manner to allow Zidell to continue its barge construction operations. A long term monitoring plan has been completed, to include monitoring for natural recovery, to ensure the in-water remedy remains protective over time.

- **Portland General Electric Station L -** This site is on the east side of the river, across from the Zidell site. Contaminants included PCBs, heavy metals, BTEX, and PAHs. Dredging and capping of sediments at the site occurred in 1991, and long-term monitoring with 5-year reviews show that the cap is stable. Recent surface sediment samples adjacent to the cap boundary do not show significant contaminant levels, indicating that the cap footprint was adequate and contaminants were stabilized. In addition, there are two adjacent areas being considered for additional capping to address separate historic releases.

- **Tillicum Crossing Bridge -** This newly constructed bridge crossed the river at the location of the above two sites, and serves public transportation, bicycle, and foot traffic. Challenges of permitting and construction at this location will be discussed.

- **Central District Greenways Property -** This project is immediately upriver from the Zidell site. The goal was to redevelop the old bankline to create habitat features as part of the City's greenway plan. The project (completed in 2014) included a remedial action for in-water and upland soil/sediment to address contamination by PCBs, metals, and PAHs. The remedial action included removal of contaminated soil and sediment above hot spot levels and installation of a protective cover (cap) of various thicknesses. The in-water cap consists of up to three layers of reactive core mat/organo clay mat, filter gravel, and habitat rock. The bankline cap consists of filter blanket, riprap, and hardscape (planter boxes). The upland cap consists of cap of clean-fill soil and hardscape. The in-water remedial action was completed as part of mitigation credits for the Tri-met Tillicum Crossing bridge construction**.**

PNW-SETAC
Thursday PM Boat Tour
1:30-4:30 PM, Thursday, April 30, 2015

Portland Harbor Superfund Site

Tour Leaders:
Bob Wyatt, NW Natural, Chair of the Lower Willamette Group, rjw@nwnatural.com
Jim McKenna, Verdant Solutions, Senior Project Manager for the Lower Willamette Group, jim.mckenna@verdantllc.com
Gene Revelas, Integral Consulting
Julie Mentzer, Director of Environmental Operations, Wildlands PNW, jmentzer@wildlandsinc.com

Portland Harbor is a Superfund site that was listed in 2000, and comprises an approximately 10-mile stretch of the Willamette River from RM2 to RM11. This area has been heavily industrialized with a wide variety of different industries and also receives urban stormwater inputs. The Remedial Investigation and Feasibility Study for Portland Harbor were completed in 2012, and the Human Health and Ecological Risk Assessments in 2013. EPA will use these documents to develop a Proposed Plan for cleanup. In addition, the Oregon DEQ has conducted extensive source control efforts throughout the watershed to support the ultimate cleanup. Meanwhile, many interesting and challenging early cleanups have been conducted of sites along this stretch of the river, such as the McCormick & Baxter Creosoting Company, Arkema, Gasco, Terminal 4, Triangle Park, and US Moorings. We will visit many of these sites on our way down the river and discuss some of the assessment and cleanup challenges encountered in working on the project to date, and what the future holds.

We will also visit the Alder Creek Restoration Project site at the southern tip of Sauvie Island. The Alder Creek Restoration Project is an aquatic, riparian, and upland forest restoration and enhancement project developed in coordination with the Portland Harbor Natural Resource Trustee Council. The Alder Creek Restoration Plan, signed by the Trustees in 2014, allows the habitat values provided by the Project to be used to offset Natural Resource Damages (NRD) resulting from past industrial use along the Willamette River in Portland, Oregon. The Project is located on a 52.3-acre property, former site of the Alder Creek Lumber Mill, on the southern tip of Sauvie Island, at the divergence of the Willamette River and Multnomah Channel, approximately 10 miles north of downtown Portland, and within the northern extent of the Portland Harbor Superfund Site Study Area.

PNW-SETAC
Friday Platform Presentations
Morning Session - May 1, 2015

Session Chair: Madi Novak, Maul, Foster & Alongi and Dawn Sanders, City of Portland BES

Portland Harbor Remediation

9:00	Benjamin Johnson Anchor QEA	Natural Recovery of MGP-Impacted Sediments in the Willamette River in Downtown Portland, Oregon
9:20	Madi Novak Maul Foster & Alongi, Inc.	Using Multiple Lines of Evidence to Define the Boundary of a Remedial Action
9:40	Erik Bakkom Maul Foster & Alongi, Inc.	Integration of Multiple Design Elements for a Multi-Component Sediment Cap
10:00	Connor Lamb Maul Foster & Alongi, Inc.	Precision Dredging in Design, Permitting, and Application
10:20	Erin Carroll Hughes GSI Water Solutions, Inc.	Potential Impacts on Site Management Decisions: Matrix Interferences Associated with the Analysis of Organochlorine Pesticides
10:40	**Break/Poster Viewing**	

Stormwater Impacts & Green Stormwater Infrastructure

11:00	Maria Redig The Evergreen State College	An Examination of the Toxicological Effects of Leachate from Rain Garden Substrates on Zebrafish, *Danio rerio*
11:20	Jenifer McIntyre Washington State University	Bioavailability of Neurotoxic Metals In Highway Stormwater Runoff
11:40	Julann A. Spromberg NOAA NWFSC	Coho Salmon Spawner Mortality in Pacific Northwest Urban Watersheds: Lethal Stormwater Impacts are Prevented by Soil Bioinfiltration
12:00	**to 2:00 PM**	**Lunch Break**
12:15	**to 1:15 PM**	**Lunch Buffet (Charlie's on Grand)**
1:00	**to 1:50 PM**	**PNW-SETAC Business Meeting (Charlie's on Grand)**

PNW-SETAC
Friday Platform Presentations
Afternoon Session - May 1, 2015

Session Chair: Stacey Harper, Oregon State University

Quantitative Tools for ERA

2:00	Christina Mott Frans EcoChem, Inc.	Five Step Process to Ensure Data Usability for RI/FS Decision Making
2:20	Simphiwe Laura Stewart USEPA Region 10	The Community Focused Exposure and Risk Screening Tool (C-FERST) Supporting Communities using EPA Science Tools
2:40	Wayne G. Landis Western Washington University	The Application of the Bayesian Network Relative Risk Model for Regional Risk Assessment into an Adaptive Management Scheme
3:00	Meagan J. Harris Western Washington University	Application of the Relative Risk Model to an Integrated Human Health and Ecological Risk Assessment for the South River, Virginia
3:20	Heather Lord Maxxam Analytics	Evaluation of Alkylated PAH Patterns for Site Characterization using LDPE Passive Samplers

3:40 **Break/Poster Viewing**

Aquatic Toxicology with Real-World Applications

4:00	Sydney Love Simon Fraser University	The sublethal effects of copper exposure on the swimming performance and osmoregulation in juvenile rainbow trout (Oncorhynchus mykiss).
4:20	Bryson Finch Oregon State University	Photo-enhanced Toxicity of Fresh and Weathered Macondo Crude Oils to Marine Organisms under Natural and Artificial Sunlight
4:40	Alicea Clendaniel Oregon State University	The Influence of Size on the Toxicity of Pesticide Encapsulations: a Comparison Between Micron and Nano Sized Capsules
5:00	**Interactive Poster Session**	Presents outreach projects designed to communicate technical information about contaminated site cleanups in Washington State and current projects being conducted by Western Washington University students. The interactive session will include 3 presentations related to posters on display.
5:30	**Poster Social**	With no-host bar

PNW-SETAC
Saturday Platform Presentations
Morning Session - May 2, 2015

Session Chair: Chance Asher, Washington Department of Ecology

Complex Site Remediation

9:00	Christopher Kasanke University of Alaska Fairbanks	Stimulating Sulfolane Biodegradation in Contaminated Subarctic Aquifer Substrate: A Rate Limiting Step in Remediation
9:20	Jose L. Gomez-Eyles Integral Consulting Inc.	Sorptive Biochars can Match Activated Carbon Performance in Sediments with High Native Bioavailabilities
9:40	Shannon Mitchell Washington State University	Biochar Sorbs Antibiotic Residues, Ammonia, and Organic Nitrogen in Calf Pens, but does not Affect Populations of Antibiotic Resistant Escherichia coli
10:00	Josh Hopp Kennedy/Jenks Consultants	Vapor Mitigation of Chlorinated Hydrocarbons at a Day Care Center Coupling Soil Vapor Extraction - Sub-Slab Depressurization and Enhanced Bioremediation
10:20	Bumhan Bae Gachon University, Korea	Pilot-Scale Phytoremediation of Explosive Compounds in Soil by *Miscanthus sacchariflorus* at a Live-Fire Military Training Range in Korea
10:40	**Break/Poster Viewing**	

Estimating Ecological Risk

11:00	Siobhan Sloan-Evans Windward Environmental	Development of Surface Water TRVs for the Lower Passaic River Study Area RI/FS Ecological Risk Assessment: A Case Study in Using Species-Sensitivity Distributions to Identify Ecologically Relevant TRVs for Risk Assessment
11:20	Brian Church Windward Environmental	Updated Species Sensitivity Distribution Evaluations for Acute and Chronic Lead Toxicity to Saltwater Aquatic Life
11:40	Diana Dishman Integral Consulting	Linking Pesticide Application at Local Scales to Population-Level Assessment Endpoints: a Case Study of an Endangered Songbird Population in the Willamette Valley, OR
12:00	**Student Award Presentation**	

PNW-SETAC
Poster Presentations

Presenter(s)	Presentation
Interactive Poster Session	
Macon Abernathy Western Washington University	Phytoremediation of Arsenic and Petroleum-Hydrocarbon Contaminated Soils using Mustard Plants: An Examination of Remediation Potential in the Presence of Annelids
Bryson Bellefeuille Western Washington University	An Assessment of the Long-term Efficacy of Activated Carbon When Ingested By Marine Worms
Ruth Sofield Western Washington University	Communicating Details of Complex Site Remediation in Washington State to Non-technical and Technical Audiences
General Poster Session	
Shannon Ashurst Integral Consulting Inc.	Strategies for Meeting Temperature Standards in an Urbanized River: A Weight of Evidence Approach
Hannah G. Bulovsky Oregon State University	The Effect of Stabilizers on Zero Valent Iron Nanoparticle Stability, Toxicity, and Reactivity
Kayla Campasino Compliance Services International	Sea Turtle Organotypic Culture: Viability and Suitability for Toxicity Testing
Juan Cervantes The College of Idaho	Characterization of Metallothionein in Signal Crayfish (*Pacifastacus Leniusculus*)
Connor Coatney Battelle PNNL Marine Sciences Lab	AOPs and Reverse Toxicokinetics: Estimating Tamoxifen Internal Dose Metrics from Environmental Exposures
Ryan J. DeWitt Western Washington University	Spatial and temporal effects of Train-Sourced Air Pollution on Lichen (*Ramalina farinacea*) as Measured by Numerous Biomarker Responses and Community-Structure
Lara Gaasland-Tatro Western Washington University	Integrating Climate Change and Toxicology in Ecological Risk Assessment for the Mercury Contaminated South River, Virginia

PNW-SETAC
Poster Presentations

Presenter(s)	Presentation
Kendall Gillies PNNL	A Computational Model of the Rainbow Trout Hypothalamus-Pituitary-Ovarian-Liver Axis
Scarlett Graham Western Washington University	Using Benthic Community Environmental DNA in an Ecological Risk Assessment for Southeast Queensland Estuaries
Tor Gunnar Guddal and Nicolas Boyé Western Washington University	Toxicity of copper and zinc to multiple generations of *Daphnia magna*
Gerald Kitsis Western Washington University	Trophic Response to Multiple Stressors Using Species Sensitivity (SSD) Distribution Models
MariAnna Lane Western Washington University	Hydraulic Fracturing: A Case Study in Science-Policy Interaction and Bending Science
Ryan Lebek Simon Fraser University	Characterization of the *in vivo* energetic and transcript expression response in rainbow trout (*Oncorhynchus mykiss*) to a proposed model P-gp inducer
Shannon Mitchell Washington State University	Pinewood Biochar Adsorbs Hydrophilic Antibiotic Compounds
Nick Osman Integral Consulting	The 10th Criterion: Inter-comparison of Net Ecosystem Services as a Means to Evaluate Superfund Remedial Alternatives
Melanie Pylatuk Simon Fraser University	Metagenomics Analysis at a Potential Northern Mine Site: Towards Natural Copper Bioremediation
Jino Son Oregon State University	Toxicity of different size fractions of encapsulated lambda-cyhalothrin to the crustacean *Daphnia magna*
Colleen Trostle Battelle PNNL Marine Sciences Lab	AOPs and Reverse Toxicokinetics: Estimating Prochloraz Internal Dose Metrics from Environmental Exposures
Fabiola Ukah Simon Fraser University	Use of Biomonitoring Tools in Ecological Risk Assessment in Howe Sound British Columbia

Presenter(s)	Presentation
Claire Walli, Bryson Bellefeuille Western Washington University	A comparison of the sub-lethal effects of the photomodified and unmodified PAH Benzo[a]pyrene on Daphnia magna
Michael Willis University of Alaska Fairbanks	Comparison of Groundwater and Alluvial Sediment Microbial Communities In A Sulfolane-Contaminated Sub-Arctic Aquifer
Fan Wu Oregon State University	The Effect of UV-A and Titanium Dioxide Nanoparticles on Triclosan Toxicity to *Escherichia coli*

Pacific Northwest Chapter

Society of Environmental Toxicology and Chemistry

(PNW-SETAC)

24th Annual Meeting

Platform Presentation Abstracts

(in order of presentation)

Natural Recovery of MGP-Impacted Sediments in the Willamette River in Downtown Portland, Oregon

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The former Portland Gas Manufacturing Site (PGM Site) operated between 1860 and 1913 near River Mile 12.2 on the west bank of the Willamette River, producing gas from coal, carbureted water, and crude oil. Polycyclic aromatic hydrocarbons and other contaminants have been found above regulatory criteria in sediments offshore of the Site. A sediment remedial investigation and upland source control evaluation were completed under the Oregon Department of Environmental Quality, and a Feasibility Study is currently underway to evaluate remedial alternatives for addressing site contamination. Under appropriate conditions, monitored natural recovery (MNR) can be part of a sustainable, implementable, and cost-effective remedial approach for reducing site risk. The objectives of the MNR evaluation at the PGM Site include characterizing and quantifying natural recovery processes and rates, delineating areas where MNR is a viable remedial option, and estimating time frames for sediment recovery in various in-water areas. Upland sources have been sufficiently controlled to allow in-water remediation to proceed; a limited upland groundwater issue will be addressed through in-water remedy selection. Multiple lines of evidence are being used to assess MNR, including: (1) analysis of sedimentation rates based on bathymetric survey comparisons and dredging records; (2) analysis of contaminant recovery profiles in sediment cores; (3) application of mass balance/mixing models to predict changes in surface sediment quality over time; (4) application of a one-dimensional groundwater contaminant transport model, supported by site-specific seepage measurements and porewater analyses, to assess the effects of contaminated groundwater discharges; (5) sediment stability analysis; and (6) literature compilation of sediment biodegradation rates. Results from these analyses are being used to determine the role of MNR in remedial alternatives at the PGM Site. By identifying areas likely to recover naturally, cleanup alternatives can be developed that incorporate MNR, thus limiting disruption of the site and controlling project costs.

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Using Multiple Lines of Evidence to Define the Boundary of a Remedial Action

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Multiple lines of evidence were examined to define the boundary of a sediment cap at a former ship-dismantling facility in downtown Portland, Oregon, on the Willamette River. A sediment cap is required to isolate contaminants of concern (COCs) in the sediment. The Record of Decision (ROD) for the site required additional sediment characterization to determine the location of the sediment cap boundary. A variety of factors complicated the cap boundary determination, including cleanup levels for polychlorinated biphenyls (PCBs) below ambient levels in the Willamette River and substantial heterogeneity in concentrations. Several possible cap boundaries were evaluated to determine the optimal size and configuration of the cap in terms of risk reduction. A primary line of evidence involved reducing area-weighted average PCB concentrations through placement of the cap while simultaneously considering ambient PCB concentrations upstream of the site. Additional COCs at concentrations above

cleanup levels were addressed, as well as sediment where toxicity bioassays indicated adverse effects to benthic invertebrates. Engineering constraints presented by steep slopes in a section of the reach and the desire to preserve shallow-water habitat in another section of the reach were also considered in the cap delineation.

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Integration of Multiple Design Elements for a Multi-Component Sediment Cap

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A sediment cap was required to address sediment contamination at a former ship-breaking and salvage facility on the Lower Willamette River in Portland, Oregon. A traditional approach of a sand cap (to isolate contaminants) and riprap armoring, combined with bank grading to address slope stability, was originally recommended in the Feasibility Study to address PCBs, PAHs, and metals contamination in sediment and bank soil. Following the Record of Decision for the site, an iterative process began with the Oregon Department of Environmental Quality to develop the sediment and bank line cap design. The project manager encouraged the design group to develop concepts that would reduce ecological impacts associated with the remedy and its implementation, improving the chances of success during the Endangered Species Act consultation for listed fish (salmon and steelhead). During the design process, the team evaluated contaminant distribution, contaminant isolation, bathymetry, fluvial dynamics, bank stability, armoring against erosion, site operational considerations (vessel launching), hydraulics (impacts to flood elevation), ecological impacts, and infrastructure (e.g., municipal stormwater discharges, existing and proposed bridges). Investigation of these elements has provided the design team a higher level of understanding of the site needs, resulting in a significantly modified and more complex remedy concept that integrates the bank and sediment cap components. This complex multi-component cap design was permitted and constructed in 2011.

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Precision Dredging in Design, Permitting, and Application

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Sediment in a river adjacent to a former wood treating facility in southwest Washington was dredged to remove dioxin contamination. The remedy included extensive predesign sampling, surveying for and clearing the remedy area of structures and debris, dredging, enhanced natural recovery, and stabilization of the bank. To accomplish the removal portion of the remedy, precision dredging—the primary best management practice (BMP) for the project—was selected as an appropriate method given the shallow contamination and to limit residuals generation. The shallow water levels, limited depth of contamination in the sediment, tidally-influenced river level fluctuations, and water quality

requirements fit the selection of precision dredging. The precision dredge method was selected during design to remove the contaminated sediment while achieving the project performance criteria. The use of specialty equipment was prescribed in the design and included GPS-guided, fixed-arm excavation equipment with a fully-enclosed double arced rehandling bucket to achieve the control and precision intended. A detailed removal grid was developed in AutoCAD Civil 3D that allowed for a high degree of control and tracking during removal. To reduce generated residuals the design also included a multiple pass approach requiring bulk removal followed by a cleanup pass. The precision dredge method was selected to limit sediment resuspension and associated potential adverse water quality effects without cumbersome and sometimes less effective engineered controls such as work area isolation methods. Oversight observations, bathymetric surveys, and turbidity measurements all indicated that the precision dredging approach substantially limited resuspension, residuals, recontamination, and overall risk (4 R's) on this environmental dredging project. Further, the approach was readily recognized by regulators and permitting agencies as a BMP, reducing transaction time and cost during permitting.

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Potential Impacts on Site Management Decisions: Matrix Interferences Associated with the Analysis of Organochlorine Pesticides

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Analysis of contaminated sediment for organochlorine pesticides using the conventional gas chromatography/electron capture detection (GC/ECD) method (EPA 8081A) is subject to interferences when compounds such as polychlorinated biphenyls (PCBs) and other non-target compounds are present. These interferences can result in reported pesticide concentrations that are biased high. Sediment samples collected as part of the Remedial Investigation (RI) for the Portland Harbor Superfund Site (Portland Harbor) were analyzed by the GC/ECD method and these results were used in the human health and ecological baseline risk assessments. Biased results could have significant impact on risk estimates that would influence site management and remedial action decisions. The DDx Group of pesticides was identified as a harbor-wide risk driver and remedial action levels (RALs) are being established by EPA to define areas where active remediation may be required. To assess the degree of interferences in the conventional organochlorine pesticide results, a subset of archived sediment samples from a subarea of Portland Harbor containing both elevated PCBs and elevated GC/ECD pesticides, were re-analyzed using a high resolution gas chromatography/tandem mass spectrometry (GC/MS/MS) method (EPA 1699M). Innovative mapping and graphing techniques were used to evaluate and illustrate the bias of the organochlorine pesticide results obtained using both methods. The results of this evaluation indicate that most of the previously reported elevated pesticide concentrations in sediment measured using the GC/ECD method from the subarea were biased high. After reanalysis using the high resolution GC/MS/MS method, all of the DDx compounds were below the most conservative RAL for this compound in this subarea. The results of this comparison shows that the high resolution GC/MS/MS method more accurately predicts risk, delineates remedial action areas, and more effectively guides source control efforts to prevent recontamination.

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An Examination of the Toxicological Effects of Leachate from Rain Garden Substrates on Zebrafish, *Danio rerio*

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Rain gardens are a Low Impact Development (LID) approach which is used to combat the problem of stormwater pollution. They are meant to be a way to control not only the amount of water, but the pollution as well, by becoming a means of contaminant removal from the stormwater before it enters larger bodies of water. Recent data has suggested that compost and soils may leach heavy metals. This relationship is not clear, as soil and compost also have been shown to bind to and remove metals by adsorption. This study addressed this concern by testing the leachate from a soil mixture as well as a gravel drainage layer which would be used in rain garden construction. The soil leachate displayed an increase in arsenic, chromium, copper, lead, nickel, and zinc. The effects to zebrafish embryos from this leachate were general cardiac dysfunction. For the second part of the study, collected stormwater was tested. The concern is that rain gardens may be successfully removing PAHs and other organic contaminants from the stormwater but adding heavy metals. This will ultimately set up a comparison of the pollutant removal potential of rain gardens versus the pollution generating capability of the soils.

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Bioavailability of Neurotoxic Metals In Highway Stormwater Runoff

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Urban road runoff contains elevated concentrations of dissolved metals and other contaminants that are acutely toxic to aquatic animals. Dissolved copper is particularly neurotoxic to aquatic animals, including fish, impacting peripheral sensory systems following minutes to hours of exposure. Runoff was collected from an urban highway in Seattle, WA, USA during distinct storm events. Neurotoxicity was tested using larval zebrafish (*Danio rerio*) and juvenile coho salmon (*Oncorhynchus kisutch*). Zebrafish (3-4 days old) were exposed to laboratory control water, highway runoff, or highway runoff spiked with dissolved copper for 3 h followed by 5-min immersion in DASPEI dye. Neurotoxicity was noted by decreased fluorescence of sensory neurons at the O2 neuromast relative to zebrafish exposed to clean laboratory water. The olfactory system of juvenile coho (4 months) were exposed to hatchery water for 30 min, followed by 30-min of highway runoff, and then another 30-min of hatchery water. An odorant, L-serine, was pulsed into the background water every 5 min. Neurotoxicity was noted as a

decrease in the electrical olfactogram response to L-serine compared to initial responses in hatchery water. Exposure to highway runoff did not result in neurotoxicity, whereas runoff spiked with dissolved copper was neurotoxic at sufficiently high concentration. We found that metals in highway runoff were not bioavailable to the sensory systems of zebrafish or juvenile coho salmon, likely due to the presence of organic matter.

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Coho Salmon Spawner Mortality in Pacific Northwest Urban Watersheds: Lethal Stormwater Impacts are Prevented by Soil Bioinfiltration

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Adult coho salmon (*Oncorhynchus kisutch*) return each fall to freshwater spawning habitats throughout western North America. The migration coincides with increasing seasonal rainfall, which in turn increases stormwater runoff, particularly in watersheds with urban and suburban land cover characteristics (e.g., impervious surfaces). For more than a decade, field assessments in urban streams have shown that adult coho are dying prematurely, often at rates exceeding 50% of the entire fall run. The syndrome is characterized by a loss of orientation and equilibrium, leading to death on a time scale of a few hours. Such high levels of mortality are a significant concern for the long-term conservation and recovery of wild coho, particularly those distinct population segments vulnerable to ongoing and future development pressures in the Pacific Northwest. Although indirect evidence from forensic investigations and geospatial land use analyses has implicated toxic runoff as causing the mortality syndrome, this has not been directly demonstrated. In the present study we exposed otherwise healthy coho spawners to undiluted stormwater collected from a high traffic volume urban arterial (i.e., highway runoff) and highway runoff that was first pre-treated via bioinfiltration through experimental soil columns to remove pollutants. We found that untreated highway runoff collected during nine distinct storm events was universally lethal to adult coho relative to unexposed controls. The mortality syndrome was prevented when highway runoff was pretreated by soil infiltration. Our findings show that exposure to urban stormwater is sufficient to cause the adult coho mortality syndrome. Moreover, although the causal chemical stressor(s) have not yet been identified, conventional green stormwater infrastructure can effectively protect adult spawners from the acutely toxic effects of highway runoff. Integration of these types of infrastructure may protect salmonid habitat in urban watersheds.

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Five Step Process to Ensure Data Usability for RI/FS Decision Making

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On complex investigation and remediation projects, important, and potentially costly, decisions are made on the basis of data collected during the Remedial Investigation and Feasibility Study (RI/FS). Therefore, it is essential that the data collected be of the quality needed to support those decisions. Data quality issues are to blame for expanded investigations, budget overruns, incomplete risk evaluations, and many other problems that occur at complex sites. To collect valid and usable data for site evaluations and remedial decision making, each stage of the project, from planning to execution, needs to be reviewed. A systematic approach should be used to plan, collect, analyze, validate, and evaluate the RI/FS data. When data quality issues arise, the project team is forced to respond and adapt, often making do with less than ideal results. Data errors and inconsistencies increase project timelines and budgets and reflect poorly on the project team. By understanding the project objectives and clearly defining the problems at a given site, realistic data quality objectives can be developed that will generate reliable and defensible data throughout the life of the RI/FS project. Using a data quality framework will assist in keeping a project on budget and in meeting the project goals. This collaboration between EcoChem and Kennedy/Jenks Consultants will provide a practical and efficient five step process for building high quality, defensible, usable data sets for complex site investigations and remedial decision making. The presentation will highlight the key steps in the RI/FS process where it's important to engage data quality professionals (laboratory chemists and project managers, data validators, database managers, GIS users, and others) and will present some of the tools to facilitate the process. We will discuss the key to keeping RI/FS projects on track: "prioritization" as well as tips to stay focused on data quality solutions.

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The Community Focused Exposure and Risk Screening Tool (C-FERST): Supporting Communities using EPA Science Tools

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The Community Focused Exposure and Risk Screening Tool (C-FERST) is a web-based environmental information and mapping tool that is currently under development by the U.S. Environmental Protection Agency (EPA) Office of Research and Development (ORD) in collaboration with various agency arms and community partners. The beta version of C-FERST is being trialed and vetted in phases. In EPA Region 10, C-FERST is being developed as part of the Regional Sustainability and Environmental Sciences (RESES) research program with communities in Portland, OR and Tacoma, WA. This presentation focuses on the research using C-FERST to assess community, human and environmental health issues in the Portland Harbor area with local partners. Groundwork Portland, a local nonprofit that participates in the Portland Harbor Community Coalition, is one partner in the project. Groundwork is using the tool as a resource in a community-based assessment and citizen science project on Brownfields and the Portland Harbor Superfund Site. Local academic and government partners have also used the tool to assess air issues as

well as transit and demographic indicators in the Portland Harbor area. This community-based participatory research is generating feedback on the tool including technical capacity, data, user-interface and prospects for community involvement. In the Portland Harbor area, C-FERST is supporting communities with environmental justice concerns through the best available science and peer- reviewed data while giving the ORD an opportunity to assess C-FERST in concert with intended end users at the local level.

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The Application of the Bayesian Network Relative Risk Model for Regional Risk Assessment into an Adaptive Management Scheme

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Adaptive management (AM) is often hailed as the process for the management of landscapes. The landscapes can be contaminated, are subjected to a number of others stressors, and are managed for the extraction of natural resources and ecosystem services.. Unfortunately the analytical tools necessary to implement an adaptive management approach have not developed to match the scale of the need. One of the assumptions of AM is that testable predictions are made that then can be tested by before and after management implementation (BACI) design. BACI designs have a number of assumptions and limitations, one of which is that natural factors are in a natural equilibrium be it static or dynamic. At a regional scale this assumption will be violated given climate change, non-indigenous species, population growth and technological innovation. Ecological risk assessment offers an alternate means of making predictions that embraces change, the associated uncertainty, and fits into an adaptive management framework. Incorporating Bayesian networks into the relative risk model (BN-RRM) allows probabilistic predictions to be made regarding risks due to specific stressors. Management options can be evaluated and the magnitude of change in risk to endpoints evaluated. Sensitivity analysis points to the variables most important to monitor and with what degree of accuracy and precision. The models are updateable as new information is obtained from field monitoring or related research. The output can then be placed into a multiple criteria decision analysis framework to evaluate the trade-offs of various options.

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Application of the Relative Risk Model to an Integrated Human Health and Ecological Risk Assessment for the South River, Virginia

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Regional scale risk assessments can be used to determine the likelihood of effects from multiple stressors on multiple human or ecological endpoints at multiple scales. The Relative Risk Model (RRM) is an effective tool by which to calculate and assess risk to human health, ecological endpoints, and ecosystem services in an integrated approach to risk assessment. In this research, we applied the RRM to an integrated assessment of human health and ecological risk from mercury contamination and environmental stressors in the South River, Virginia. The Bayesian network (BN) software Netica™ was used to calculate relative risk and uncertainty (Norsys Corp). The BN-RRM approach allows for the calculation of relative risk to human and ecological endpoints and the quantitative assessment of risk to ecosystem services of the South River. Risk was assessed for four human health and wellbeing endpoints: Human Health, Water Quality, Recreation, and the South River Fishery. Relative risk to Human health was low for users of the South River. Risk to Recreation in the South River was moderate with little spatial variation between risk regions. The endpoints at highest risk in the South River were Water Quality and the South River Fishery. The sensitivity and uncertainty analysis of the BNs identified the parameters that contributed the most risk for each endpoint in each risk region. Mercury concentrations in floodplain soils and river water influenced human health risk. River temperature and E. coli bacteria were the main contributors of risk to water quality and recreational river uses. Lack of Public Access contributed risk to recreation and ecosystem services endpoints. Integrating human health and ecological risk assessment improves the decision-making process especially in looking at trade-offs and avoiding unintended consequences.

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Evaluation of Alkylated PAH Patterns for Site Characterizing Using LDPE Passive Samplers

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Passive sampling has been used extensively for characterizing the types and levels of parent polycyclic aromatic hydrocarbons (PAH) in aquatic systems, primarily through the use of SPMD and LDPE passive samplers. The technology has been used less often for determination of alkylated PAH, possibly due to a lack of reliable data for partition coefficients between water and the passive sampler materials. Most reports have provided only the masses of alkylated PAH taken up by the samplers. The recent publication of a comprehensive set of empirically determined LDPE partition coefficients for alkylated PAHs (1) has allowed for improved estimation of water concentration for many of these compounds. In this project, we investigated whether we could obtain reliable estimations of water concentrations for a suite of alkylated PAHs for source determination at a site that had historically had sporadic positive grab sample results for parent PAHs in surface waters. Previous results had been at levels close to reporting limits, which confounded attempts at source determination. LDPE films in different thicknesses were

pre-loaded with performance reference compounds (PRC) and deployed in sets at seven locations around the site. All sites were surface water locations with varying degrees of water movement. The deployments lasted approximately 30 days and were repeated for three consecutive months. The results showed clear patterns of seasonal and spatial changes in parent PAH concentrations at water concentration detection limits well below those for grab sampling. The water concentrations calculated for alkylPAH homologous series were consistent with the parent PAH data and provided strong evidence of a petrogenic rather than pyrogenic source. Patterns of weathering in the alkylated PAH signatures further aided in identifying the likely source.

1. Choi, Y. et al. 2013. Environ. Sci. Technol. 47, 6943.

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The sublethal effects of copper exposure on the swimming performance and osmoregulation in juvenile rainbow trout (*Oncorhynchus mykiss*).

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Copper (Cu) is an abundant metal and widely occurring contaminant in aquatic systems. It 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 study the sublethal effects of Cu on juvenile rainbow trout (*Oncorhynchus mykiss*) swimming performance and osmoregulatory ability. Fish were exposed to Cu (control, 16 and 50% LC50) for 4, 8 and 16 d in either soft (10 mg/L $CaCO_3$) or artificially hardened 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. There was an increase in swimming speed, irrespective of concentration in soft water compared to hardened water. A seawater challenge was conducted to assess osmoregulatory impairment following 4 and 16 d of exposure to Cu (control, 16 and 50% LC50) in soft and hard water. Fish were placed in seawater (29 ppt) for 24 h following Cu exposure. No mortalities occurred during the challenge in any treatment group. Biochemical indicators of stress and impaired osmoregulatory function (plasma $[Na^+]$, $[Cl^-]$, osmolality, hematocrit and gill Na^+,K^+-ATPase activity) were also assessed. Cu had no effect on any endpoints, while duration and water hardness significantly reduced plasma $[Na^+]$, $[Cl^-]$, osmolality and gill Na^+,K^+-ATPase activity. Hematocrit was unaffected by any treatment. The results indicate there may be a narrow threshold between acutely toxic concentrations and the manifestation of sublethal effects of Cu exposure. It is possible that compensatory mechanisms are allowing for several physiological systems to temporarily offset major physiological disturbances until Cu concentrations reach levels where mortality occurs.

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Photo-enhanced Toxicity of Fresh and Weathered Macondo Crude Oils to Marine Organisms under Natural and Artificial Sunlight

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Crude oils contain a mixture of hydrocarbons including phototoxic polycyclic aromatic hydrocarbons (PAHs) that are novel in their ability to absorb and respond to ultraviolet (UV) light. PAH absorption of UV light can substantially increase toxicity to marine organisms. The objective of the current study was to examine the potential for photo-enhanced toxicity of fresh and naturally weathered Macondo (MC-252) crude oils collected from the Deepwater Horizon incident to mysid shrimp (*Americamysis bahia*), inland silverside (*Menidia beryllina*), sheepshead minnow (*Cyprinodon variegatus*), and Gulf killifish (*Fundulus grandis*). Acute toxicity tests were conducted using combinations of natural or artificial sunlight and low energy water-accommodated fractions (LEWAFs) of fresh and weathered MC-252 crude oils. LEWAFs were prepared with crude oil alone as well as in combination with the dispersant Corexit 9500. Validation studies were conducted to compare toxicity observed over one diurnal period under artificial and natural UV light conditions. Comparisons between different crude oils and species sensitivity were made using median lethal LEWAF concentrations (LC50s). Data demonstrated MC-252 fresh crude oil was slightly more toxic than weathered crude oils, both in the presence and absence of UV light. The addition of Corexit 9500 to crude oil increased toxicity compared to tests with crude oil alone, by increasing phototoxic PAH concentrations in LEWAFs.

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The Influence of Size on the Toxicity of Pesticide Encapsulations: A Comparison Between Micron and Nano Sized Capsules

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Pesticide products that are classified as suspension concentrate (SC) or capsule suspension (CS) formulations incorporate encapsulation technology to entrap the pesticide's chemical active ingredient (AI) in a hollow polymeric shell. The polymeric carriers allow for easier and safer handling of the pesticides by farmworkers and for more uniform applications of hydrophobic chemicals. Although pesticide microencapsulation has been utilized for many years, the size evolution of these formulations has partially entered the nanoscale (1-1000nm). *In lieu* of the data needed to assess the risks of complete formulation, understanding how carrier size influences toxicity is important to understanding if current pesticide risk assessments are sufficient to protect against products that incorporate nanoencapsualation technology. Here, a commercial pyrethroid SC pesticide with lambda cyhalothrin as the active ingredient was partitioned into two suspensions [a fraction consisting of nano-sized capsules (~230nm) and a fraction of micron-sized capsules (~2300nm)] in order to investigate the influence of capsule size on toxicity to embryonic zebrafish, *Danio rerio*. Toxicity was measured by the presence of pyrethroid-specific tremors after 24 hours of exposure to concentrations ranging from 0.64-2 µg/L AI. Tremors were quantified for both duration and frequency. Exposure to the complete formulation, micro fraction and nano fraction resulted in similar tremor activity starting at 80 µg/L AI and no significant

differences were observed for mortality or sublethal effects.

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Stimulating Sulfolane Biodegradation in Contaminated Subarctic Aquifer Substrate: A Rate Limiting Step in Remediation

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Sulfolane, an industrial solvent used to de-acidify natural gas and selectively remove lighter aromatics from petroleum, has a high affinity for water and is found in the aquifers surrounding sites where it has been improperly handled. To date sulfolane degradation in aquifer substrate has only been studied in three contaminated sites: Western Canada; Brisbane, Australia; and Lathrop, California. Recently, a sulfolane plume located in North Pole, Alaska, was identified as being the largest groundwater contaminant plume in the state and spans roughly a 5.5 by 3.2 km area. Due to the size of the contaminant plume, we questioned if there was any potential for sulfolane biodegradation to occur in subarctic aquifer substrate, and if so, what factors limit biodegradation *in situ*. To address these questions, aerobic and anaerobic microcosm studies were performed at 4 - 8°C using substrate from the contaminated North Pole aquifer. Sediment/groundwater slurries and groundwater-only microcosms were established under aerobic conditions. Aerobic sediment slurries contained different sulfolane concentrations with and without nutrient addition. Since portions of the plume also contain hydrocarbon contamination, we assessed the effect of hydrocarbon co-contamination on sulfolane degradation. Anaerobic sediment slurries were established under nitrate and sulfate reducing conditions. Sulfolane was found to degrade only in the presence of an aerated microbial community, with no detectable degradation occurring in sterile controls or in anaerobic incubations. The addition of a mineral nutrient solution significantly stimulated biodegradation at high sulfolane concentrations, but had no effect at low sulfolane concentrations. Hydrocarbon co-contamination retarded the rate of sulfolane biodegradation. In microcosms using groundwater as the sole inoculum, the addition of a nutrient solution was crucial to initiate sulfolane biodegradation. This research suggests that the key to remediating sulfolane is to modify environmental conditions to biostimulate the metabolic capabilities of indigenous microorganisms present in aquifer substrate.

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Sorptive Biochars can Match Activated Carbon Performance in Sediments with High Native Bioavailabilities

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A bench scale treatability study was conducted to evaluate the effectiveness of *in situ* amendments to reduce the bioavailability of contaminants in sediments from a site impacted with polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and cadmium. The amendments tested included powdered activated carbon (PAC), granular activated carbon (GAC), biochar, organoclay, and coke dosed at 5% of sediment dry weight. Amendment performance was evaluated by measuring reductions in freely dissolved sediment porewater concentrations of PCBs, PAHs and cadmium, and by conducting bioaccumulation studies to assess reductions in biological uptake of PCBs in a freshwater oligochaete. Strong reductions in total PCB porewater concentrations were observed in sediments amended with the biochar (99.6-99.8%) and PAC (94.9-99.5%). More modest reductions were observed for GAC (67.0-81.6%), organoclay (36.6-58.2%) and coke (36.3-40.3%). Strong reductions in porewater PCB concentrations were reflected in reductions in total PCB bioaccumulation in fresh water oligochaetes (*Lumbriculus variegatus*) for both the biochar (96.1-96.3%) and the PAC (91.9-96.0%). Total PAH porewater concentrations were also greatly reduced by the biochar (>97.8%) and PAC (>96.1%) treatments. Biochar matched or slightly outperformed the PAC throughout the study, despite sorption data indicating a much stronger affinity of PCBs for the PAC. Modeling biochar and PAC effectiveness on other sediments confirmed the high effectiveness of the biochar was due to the high native bioavailability of PCBs in the study sediments. Sorptive biochars can therefore provide a suitable alternative to AC in sediments impacted with hydrophobic organic contaminants that are not strongly sorbed within the sediment matrix. However, neither the biochar of the PAC amendments were able to significantly reduce cadmium bioavailability.

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Biochar Sorbs Antibiotic Residues, Ammonia, and Organic Nitrogen in Calf Pens, but does not Affect Populations of Antibiotic Resistant *Escherichia coli*

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We tested the hypothesis that adding biochar to the soil of calf pens can sequester excreted antibiotics and thereby limit establishment of antimicrobial resistant (AMR) bacterial populations following therapeutic antibiotic treatments. Dairy calf pens were cleaned and fresh bedding material was added: wood-shavings only, or biochar and wood-shavings. Two different antibiotics were tested, florfenicol and ceftiofur, both of which are mostly excreted in urine. Bedding-soil and feces samples were collected for 10 days. Samples were analyzed for *E. coli* abundance, antibiotic concentration, ammonia, and total nitrogen. Ceftiofur residues were moderately labile and/or adsorbed to the bedding-soil solids because ceftiofur was not detected in any sample. Approx. 90 mg/kg florfenicol was found in the control bedding-soil after 5 days, and <10 mg/kg florfenicol was found in the biochar bedding-soil. Approx. 50 mg/kg florfenicol was detected in the feces after 1 day. Because both the control and biochar treatment

had essentially the same abundance of AMR *E. coli*, we clearly rejected our hypothesis given the conditions used in this study. It is possible that fecal loading of AMR *E. coli* is more important for this system than selection from environmental residues, but it is also possible that the antibiotic residues were not immediately adsorbed by the biochar or the wood-shavings may have allowed antibiotic-microbe interactions. We also observed that the biochar treatment retained more ammonia and organic nitrogen compared to the control, which may reduce nitrogen leaching or ammonia emissions.

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Vapor Mitigation of Chlorinated Hydrocarbons at a Day Care Center Coupling Soil Vapor Extraction - Sub-Slab Depressurization and Enhanced Bioremediation

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The Frank Wear Cleaners Site, located in a commercial area of Yakima Washington, is a former dry cleaning facility with a daycare facility currently in an adjacent building. Initial indoor air sampling indicated tetrachlorethene (PCE) concentrations exceeding the Washington State Department of Ecology Model Toxics Control Act (MTCA) Method B indoor air cleanup levels prompting implementation of an interim remedial action. A soil vapor extraction (SVE) system was constructed with the primary objective of mitigating vapor intrusion of PCE and other chemicals of concerns (COCs) by inducing vacuum beneath the concrete slab (i.e., sub-slab depressurization). The SVE system was also designed with operational flexibility to remove contaminant mass in the unsaturated zone (including accommodating for seasonal groundwater fluctuation) and with the ability to capture and treat PCE and associated degradation products off-gassing from groundwater during treatment in the saturated zone via enhanced bioremediation. Remediation of the saturated and smear zone is being completed using groundwater recirculation sequentially applied to both the source area and diffuse plume zones within the estimated 400-foot by 200-foot treatment area. The groundwater remedy relies on a combination of reductive dechlorination within the direct treatment areas, as well as anaerobic and aerobic oxidation, abiotic mechanisms, and co-metabolism of dechlorination products outside of immediate recirculation influence. The approach seeks to minimize biomass accumulation and long-lasting reductive influence by strategically recirculating complex electron donors, co-solvents, surfactants, and very dilute emulsified oil. This approach has led to rapid reduction in contaminant mass (up to 68,000 micrograms per liter of PCE) and has stimulated complete dechlorination (up to 400 micrograms per liter ethene within 9 months) without bioaugmentation. Overall, the SVE system has been effective at suppressing vapor intrusion and coupled with enhanced bioremediation, continues to reduce contaminant mass in the subsurface.

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Pilot-Scale Phytoremediation of Explosive Compounds in Soil by *Miscanthus sacchariflorus* at a Live-Fire Military Training Range in Korea

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A two-year pilot-scale phytoremediation study was conducted at Darakdae range which is the one of the oldest and largest military shooting range in Korea to reduce transport of 2,4,6-trinitrotoluene(TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) to nearby streams and groundwater for the protection of ecosystem and human health. An indigenous perennial plant, Amur silver-grass (*Miscanthus sacchariflorus*), was selected after a series of site vegetation survey, hydroponic culture, and pot & soil column experiments. Seedlings of 20 cm in height were transplanted to test plots at the range on May, 2013. Surface soil, shoot, and root were sampled periodically and analyzed for explosives concentration along with measurement of plant longitudinal growth and photosynthetic activity. At the end of the study, above-ground biomass was harvested followed by stratified subsurface soil and root sampling by excavation. Amur silver-grass proliferated on the site without any special care. Analysis of plant explosives concentration showed that RDX in shoot increased up to 25.7ug/g-DW from spring to summer and then decreased to less than 3.1ug/g-DW in autumn suggesting possible degradation in the leaf. Explosives in the subsurface soil decreased significantly in the planted zone. The average concentration in the planted subsurface soil (n=50) was 0.26±0.97 mg-TNT/kg and 2.31±2.04 mg-RDX/kg, whereas those in the unplanted subsurface soil (n=45) of 0.49±2.35 mg-TNT/kg and 29.43±18.39 mg-RDX/kg. The development of thick hairy root and rhizome were noticed as deep as 1 m below ground. The results of field study demonstrated the effectiveness of Amur silver-grass for in-situ explosives phytoremediation. The results of pilot-scale field study and greenhouse plant-column study using the same soil will be presented and discussed.

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Risk Assessment: A Case Study in Using Species-Sensitivity Distributions to Identify Ecologically Relevant TRVs for Risk Assessment

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Baseline ecological risk assessments (BERAs) estimate site-specific risks to support remedial clean up decisions. As such, toxicity thresholds for BERAs should be established using the most current toxicological literature relevant to the site, rather than generic thresholds or thresholds based on toxicity data that are no longer current. Using a species sensitivity distribution (SSD) approach to derive toxicity reference values (TRVs) assessment allows for the integration of the most up-to-date toxicity data available to derive a concentration protective of a predetermined percentage of a group of relevant species. This presentation will explore the use of SSDs in the context of current USEPA guidance for risk assessment, using the BERA for the Lower Passaic River Study Area (LPRSA), a large urban river located in New Jersey, as a case study.

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Updated Species Sensitivity Distribution Evaluations for Acute and Chronic Lead Toxicity to Saltwater Aquatic Life

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The United States Environmental Protection Agency's (USEPA's) current ambient water quality criteria (AWQC) for lead (Pb) in salt water were developed in 1984. The acute and chronic criteria, as dissolved Pb, are 210 and 8.1 µg/L, respectively. Because chronic toxicity data were limited, the chronic criterion was derived using an acute-chronic ratio (ACR). Since 1984, several studies on the toxicity of Pb to saltwater species have been conducted, and there are now sufficient data such that an ACR is no longer necessary to derive a chronic criterion. This has prompted this proposed update of the USEPA's acute and chronic criteria for Pb in saltwater. The proposed updated acute and chronic saltwater Pb criteria, derived using the species sensitivity distribution (SSD) approach, are 100 and 8.7 µg/L, respectively. For comparison, these proposed criteria are well above ambient dissolved lead concentrations from estuarine and coastal marine waters of North America, which are generally < 0.05 µg/L. Toxicity studies on how factors such as dissolved organic carbon (DOC) influence Pb bioavailability to saltwater organisms are still limited and should be considered a priority in future studies.

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Linking Pesticide Application at Local Scales to Population-Level Assessment Endpoints: a Case Study of an Endangered Songbird Population in the Willamette Valley, OR

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Threatened and endangered species are increasingly impacted by agricultural pesticides. Interest in developing regulatory approaches that address pesticide impacts on populations is creating a need for risk assessment tools that capture interactions between life histories and spatially-distributed stressors at landscape scales. Such applications can also inform risk management decisions at contaminated sites that span large spatial areas. Here, we illustrate how a spatially-explicit IBM (individual-based model) can help researchers and regulators link the application of pesticides at local scales to the range-wide population dynamics of an endangered bird. We patterned our simulation model after an endangered subpopulation of streaked horned larks (*Eremophila alpestris strigata*), whose range falls within Oregon's Willamette Valley -- an area dominated by agriculture that also includes a network of natural areas and wildlife refuges. We use our model to evaluate the consequences for horned larks of alterations to the extent and pattern of pesticide applications, and we illustrate how the results can be used to characterize population response to stressors at large spatial scales. These evaluations have led to insights into the potential of a network of habitat refuges to mitigate the impacts of pesticides on

horned larks. Lessons that we have learned from this work have application in remedy selection where the spatial configuration of various potential remedies provides differing extents and patterns of refugia. Spatially explicit population modeling can be used to optimize protectiveness at the population level when selecting a final remedy.

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Poster Abstracts

(in alphabetical order by first author)

Phytoremediation of Arsenic and Petroleum-Hydrocarbon Contaminated Soils using Mustard Plants: An Examination of Remediation Potential in the Presence of Annelids

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Arsenic from agricultural application and geologic weathering is a contaminant of concern for many regions of Washington State. Recent studies have demonstrated that organic matter in the form of petroleum compounds is capable of affecting the speciation and mobility of As in the subsurface. The proposed mechanism for this focuses on the degradation of the petroleum by microorganisms present in the soil through the reduction of Fe in FeOOH, which results in the de-sorption and release of As. In this study we will assess the toxicity and phytoremediation potential in locally collected soils. Four soil treatments will be tested: untreated soil, soil treated with petroleum, soil treated with As, and soil treated with petroleum and As. Toxicity of the soils on annelids will be assessed after four weeks of exposure. Leachate will be collected from each treatment and analyzed for As and total petroleum hydrocarbons. As accumulation in the *Brassica sp*. will be measured, along with total biomass production after four weeks. This work will be conducted as part of the Spring 2015 Science and Management of Contaminated Sites class at Western Washington University.

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Strategies for Meeting Temperature Standards in an Urbanized River: A Weight of Evidence Approach

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A segment of an urbanized river in north-central Colorado is classified as Warm Water Tier I, indicating more thermally sensitive warm-water fish (Johnny darter, *Etheostoma nigrum*) occur within a community largely consisting of less sensitive warm-water species. The segment receives tributary flows and stormwater, as well as municipal water treatment and power plant effluents. Hydrology is controlled by releases from an upstream reservoir, adding to the challenge of meeting regulatory temperature standards, which are set for the summer (March through November) and winter (December through February) seasons. Parties with warm-water effluents can seek site-specific standards after demonstrating no negative impacts on survival, growth, and reproduction of expected fish species. We used available data from several monitoring studies to develop lines of evidence that demonstrate negligible risk of negative impacts to fish from a local waste water treatment plant (WWTP) effluent in pursuit of a site-specific temperature standard. Empirical water temperature data from a monitoring station downstream of the WWTP show periodic exceedances of the standard during seasonal transition months (December and February). These exceedances occur within the normal river temperature cycle and can be attributed in part to the abrupt change between the winter and summer standards. Johnny darters are consistently present throughout the segment. They also occur in other Colorado streams with similar winter temperature fluctuations, including occasional warm periods above the standard. Condition (K) of individual Johnny darter immediately downstream of the WWTP was not significantly different (p<0.05) from the condition of those immediately upstream of the WWTP

or of those at the upstream end of the reach above the influence of municipal effluents. Weekly average water temperatures at the monitoring station downstream of the WWTP exhibit temperature conditions consistent with the timing and magnitude of water temperatures in which Johnny darters spawn as reported in the literature.

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The Effect of Stabilizers on Zero Valent Iron Nanoparticle Stability, Toxicity, and Reactivity

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Zero valent iron nanoparticles effectively remediate groundwater contaminants due to their catalytic properties and enhanced surface area. However, these properties also contribute to particle agglomeration and decrease their effectiveness for remedial applications. Stabilizing compounds can be added during particle synthesis to overcome the attractive forces between particles. In this study, we examined the effect of two stabilizing agents (gum arabic (GA) and sodium carboxymethyl cellulose (CMC)) on particle stability, reactivity, and toxicity. Particle stability was assessed by measuring particle hydrodynamic diameter using dynamic light scattering. The hydrodynamic diameter of the unstabilized particles was over 1000 nm, while the CMC and GA stabilized particles were around 100 nm. Particle degradation of trichloroethylene (TCE) was assessed using gas chromatography following a 24 hour incubation as a measure of particle reactivity and efficacy for remediation applications. The concentration of TCE incubated with the GA and CMC stabilized particles decreased significantly, while the unstabilized particles did not reduce the TCE concentration at all. Embryonic zebrafish were used to investigate the sublethal toxicity and mortality resulting from 10-60% particle solution exposure over 5 days of development. The CMC alone, the CMC stabilized particles, and the unstabilized particles caused significant mortality at lower concentrations, while the GA alone and lower concentrations of GA stabilized particles only caused a significant delay in hatching. The small size of the particles synthesized with stabilizers indicated these compounds effectively stabilized the particles and provided more reactive sites per particle, leading to increased TCE degradation. GA stabilized particles had the smallest hydrodynamic diameter, led to the greatest decrease in TCE, and were assessed to be the least toxic in this study. Integrating research on the efficacy and potential toxicity of nanomaterials used in environmental remediation can support sustainability goals and ultimately protect the environment from unforeseen impacts.

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Sea Turtle Organotypic Culture: Viability and Suitability for Toxicity Testing

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Organotypic culture refers to the *ex vivo* method where organ explants are cultured. Organotypic culture is well established in mammalian toxicology but has not yet been validated in reptilian species. The purpose of this study was to (1) demonstrate viability of reptilian skin explants in a laboratory setting and (2) determine whether skin explant methodology can be used to detect changes in sea turtle physiology upon toxicant exposure. Here we report on the viability of loggerhead sea turtle (*Caretta caretta*) skin explants up to 96h, and the detection of cytochrome P450 1A5 (CYP1A5) in explants exposed to benzo(a)pyrene (B(a)P). Mammalian studies indicate that culture time and media components are key variables that can affect the viability of organotypic cultures and their suitability for toxicology studies. We tested viability of the skin explants after 24 – 96h of culture in media with and without fetal bovine serum (FBS) via the ability to grow cell cultures from the explants. CYP induction has been studied extensively in mammalian laboratory animals *in vivo* and *ex vivo* to evaluate PAH-mediated carcinogenesis, and in wildlife as a biomarker of exposure to environmental contaminants. To assess applicability CYP1A5 as a biomarker of exposure in sea turtle skin explants, induction of CYP1A5 in explants exposed to B(a)P was investigated. Skin explants were cultured with 0.01– 100µM B(a)P for 72h, followed by qPCR analysis of CYP1A5 mRNA expression. Fibroblast cultures were successfully grown from all organotypic tissues, demonstrating viability after 24 – 96h in culture. CYP1A5 mRNA was detected in all explants, however further optimization of methods is needed before quantitative analyses can be completed. Our lab is the first to document CYP1A5 in sea turtle skin explants. This research indicates that organotypic culture provides a viable non-lethal alternative to traditional toxicity testing in species where *in vivo* studies are prohibited.

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Characterization of Metallothionein in Signal Crayfish (*Pacifastacus Leniusculus*)

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Pollution in aquatic ecosystems has implications for both widespread dispersion, exposure to organisms inhabiting impacted areas and potentially having adverse biological effects. In this study, we characterized the expression of metallothionein (MT), a protein involved in binding and sequestering metals within the cell, in signal crayfish (*Pacifastacus Leniusculus*). Wild crayfish were captured, allowed to acclimate in a laboratory setting and exposed to varying concentrations of zinc chloride, dimethoate or mercury chloride via direct abdominal injection. Tissues were harvested 72 hours after exposure and MT was measured in gill tissue using an MT absorbance assay. No MT induction was observed in animals treated with zinc chloride (P=0.467) or dimethoate (P=0.078). Significant MT induction was observed in animals treated with 0.3 ug/kg (P=0.018) and 0.6 ug/kg (P=0.006) doses of mercury chloride. Further study found that a significant MT increase occurred within 24 hours of exposure to 0.6 ug/kg mercury

chloride injection (P= 0.047). MT concentrations were also monitored in lab acclimated crayfish over a 28 day period to determine whether concentrations decreased over time in a stable laboratory environment. MT concentrations fluctuated over the four week time period with no significant decrease. We were able to conclude that MT in the gill tissue of signal crayfish was sensitive to exposure to trace amounts of mercury chloride within 24 hours of exposure and that concentrations measured in laboratory acclimated crayfish remained stable over a 28 day period.

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AOPs and Reverse Toxicokinetics: Estimating Tamoxifen Internal Dose Metrics from Environmental Exposures

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Tamoxifen is a selective estrogen receptor modulator exhibiting both weak agonistic and antagonistic behavior. In previous unpublished studies in rainbow trout, tamoxifen was observed to have an overall antagonistic effect towards estrogen signaling. We are currently using tamoxifen as one of a suite of model compounds to evaluate in vitro testing for predicting whole fish effects of contaminants. These studies are part of larger effort seeking the best approaches for implementing the adverse outcome pathway (AOP) concept in toxicity testing. The full development of an AOP model requires knowledge of chemical dosimetry in addition to estimation of target organ toxicity and associated dose-response relationships. The term reverse toxicokinetics has been used to describe the process of estimating hypothetical environmental exposures necessary to achieve a specific target organ concentration of adverse concern. For many contaminants that lack animal test data, toxicokinetic analysis will need to rely on QSAR and/or in vitro based approaches to estimate target organ dosimetry. In the present study, we characterized the toxicokinetics and disposition of tamoxifen in sexually mature female trout. Tamoxifen was added to 70-90 L exposure tanks at an initial concentration of 50 µg/L. Water was sampled before and at various times after the addition of trout. At completion of the 72 hour exposure, trout were euthanized and various tissues removed for tamoxifen analysis. Estimates of tamoxifen uptake, tissue distribution and clearance due to biotransformation or non-metabolic pathways were obtained using a two compartment toxicokinetic model. These values will be compared to those derived from QSAR or in vitro based approaches to evaluate the accuracy of these methods. Supported by EPA-STAR grant # R835167

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Spatial and temporal effects of Train-Sourced Air Pollution on Lichen (*Ramalina farinacea*) as Measured by Numerous Biomarker Responses and Community-Structure.

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The overall goal of this project is to examine the effect of train-specific air pollutants on lichens, (*Ramalina farinacea*) along the railway corridor near Bellingham, WA. Currently, there is little research on the effect of train-specific pollutants on lichens. This gap in knowledge of air quality impacts on biological systems is important to recognize, however, because of the forecasted increase in rail traffic in Washington State. This study uses lichens as low cost air quality monitors. *Ramalina farinacea* were collected from an area of minimal air pollution and transported to two locations: an experimental site directly adjacent to the Chuckanut rail corridor, and a control site located one mile west of the tracks. The experimental and control sites are similar in slope, aspect, canopy cover, exposure to marine influence, and other abiotic factors. At each site a gradient approach was utilized. In January 2015, lichen samples were placed in mesh bags and deployed in three transects parallel to, and at increasing distances away from the rail corridor and the marine environment. Each mesh bag contained five individual samples. Each month one sample will be collected from each bag, allowing for the examination of both spatial and temporal trends. Each collected sample will be evaluated for elemental content, cellular membrane integrity, chlorophyll α / phaeophytin α ratio, concentration of malondialdehyde, superoxide dismutase, and glutathione. These responses will be correlated with air pollution and rail traffic. In addition, community structure analysis will be performed at both sites with increasing distance from the corridor. The results of these analyses allow for the temporal quantification of train-sourced air pollution on lichen, and give insight into the character of the spatial gradient of that pollution. Results from the first two months of exposure and the community structure results will be presented.

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Integrating Climate Change and Toxicology in Ecological Risk Assessment for the Mercury Contaminated South River, Virginia

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The changing climate will have far reaching ecological effects that may be particularly important in the long-term management of contaminated sites. Our study incorporates climate predictions and the Relative Risk Model to calculate the likelihood of effects to biological endpoints with multiple stressors in a complex ecological system. We selected an ensemble of seven global circulation models downscaled to predict region specific temperature and precipitation for the 2050s and 2080s under two International Panel on Climate Change scenarios. We integrated the climate predictions into Bayesian networks to calculate relative risk and estimate uncertainty for two birds and two fish endpoints in the mercury contaminated South River watershed. Our results can provide managers with a quantitative method for assessing climate change effects to avoid unintended consequences in long-term site management. The versatility of Bayesian networks allows this framework to be adapted for incorporating site-specific climate predictions for other endpoints and ecological systems.

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A Computational Model of the Rainbow Trout Hypothalamus-Pituitary-Ovarian-Liver Axis

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The development of adverse outcome pathway (AOP) models requires knowledge of dose-dependent perturbations across varying biological scales (cells→organs→systems→ organism→populations). In vitro, cell-based assays are expected to provide the bulk of experimental data for future AOP models while computational or quantitative physiological models are used to extrapolate across biological scales. We are developing a mathematical model of the trout hypothalamus-pituitary-ovary-liver (HPOL) axis to assist in extrapolation of in vitro results to estimates of reproductive success. The model incorporates features of biologically based mammalian and indirect response models to mathematically describe the critical endocrine components of the female trout reproductive axis. Estimates of select model parameters can be obtained from the in vitro assays using either quantitative (direct estimation of rate constants) or qualitative (relative change from control values) approaches. This permits evaluation of practical aspects of incorporating in vitro results into the model. An overall benefit of the approach is the ability to integrate effects at multiple target tissues by incorporation of in vitro data from multiple assay systems. The combination of in vitro testing with HPOL modeling provides estimates of target tissue levels that would be considered adverse (e.g. LOEC, AC50 or other internal dose metric). The corresponding environmental exposure levels needed to achieve adverse tissue concentrations is estimated using a two-compartment clearance-volume toxicokinetic model. Parameter estimates for the toxicokinetic modeling are primarily obtained from QSAR methods and published physiological data for trout. This poster will provide an overview of the process illustrated with recently collected data from testing of tamoxifen and prochloraz. Supported by EPA-STAR grant R835167.

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Using Benthic Community Environmental DNA in an Ecological Risk Assessment for Southeast Queensland Estuaries

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Sequencing of environmental DNA (eDNA), also known as DNA metabarcoding, is a methodology to rapidly and accurately collect community composition data of microorganisms present in environmental media such as sediments, surface water, and soils. These microorganisms form the base of food webs,

provide key functions for ecosystems, and are sensitive to changes in the environment. The application of eDNA to risk assessment has the potential to further understanding of the effects of stressors on microorganisms. In addition, the eDNA provides the taxonomic clarity and statistical power for multivariate analyses of community structure. For this research, we are using eDNA of estuarine surface sediments to better estimate risk to ecological endpoints in the Southeast Queensland estuaries surrounding Brisbane, Australia using the Relative Risk Model with Bayesian networks (BN-RRM). Similar to other estuaries across the world, sediment and nutrient loading from anthropogenic development are major stressors in Southeast Queensland. The BN-RRM is well suited to incorporate eDNA in a risk assessment coupled with data from long-term water quality monitoring, land use statistics, and habitat information. I will be presenting a Bayesian network influence diagram linking cause-effect pathways between catchment land use, stressors, eDNA, and assessment endpoints including commercially important fish, crabs and prawns and water quality objectives for the region. Ultimately this risk assessment framework can be used to 1) understand the utility of collecting eDNA data to monitor estuaries and 2) make management decisions to achieve conservation objectives for estuarine systems.

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An Assessment of the Long-term Efficacy of Activated Carbon When Ingested By Marine Worms

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Addition of activated carbon (AC) to contaminated sediment is used as a remedial technology to reduce the bioavailability of contaminants such as PCBs. However, the bioturbation and consumption of applied AC by marine worms has been proposed as a pathway that may reintroduce contamination into the marine environment. This proposed experiment will use a biomimetic approach to assess the effect of marine worm digestive fluid on the desorption of PCBs from AC. Experimental sediment containing AC and PCBs will be exposed to an artificial digestive fluid designed to mimic the digestive fluids of marine worms. Artificial benthic worm digestive fluid will be prepared according to the procedures of previous work using commercially available analytical chemicals representing surfactants and buffers. PCB concentrations in the artificial digestive fluid will be compared to a control (without artificial digestive fluids) to determine whether digestive conditions have affected desorption. If benthic organisms have an impact on sorption of PCBs to AC, then the long-term efficacy of AC for interrupting the exposure pathway between marine sediments and organisms may be compromised. If digestive fluids have no impact on the sorption of PCBs to AC, then AC should be upheld as an effective method for protecting marine life from PCBs. This work will be conducted as part of the Spring 2015 Science and Management of Contaminated Sites class at Western Washington University.

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Toxicity of copper and zinc to multiple generations of *Daphnia magna*

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Toxicants are often drivers of natural selection by the inhibition of reproductive success in more vulnerable phenotypes. This leads to overall population resistance to the initial stressor as more resistant genotypes proliferate. This study used a multi-generational approach to investigate whether short-term resistance to copper and zinc is induced in *Daphnia magna* populations that have been previously exposed to these metals. A first generation of neonates was chronically exposed to different concentrations of copper and zinc, and their mortality and fecundity were recorded. The second generation was exposed to no toxicants, and the third generation was exposed to a similar gradient of copper and zinc as the first generation. Pollution induced resistance to these metals was evaluated by percent mortality in the different lineages of *D magna* corresponding to initial exposure in the first generation. Variation in resistance to metals corresponding with exposure in previous generations may reflect the ability of populations of *D magna* to survive high concentrations of metals that can occur during events such as storms. If previous background exposure to higher concentrations of copper and zinc result in offspring that are more resistant to high concentrations of these metals, then this could indicate genetically inherited resistance that can be assessed in future studies using biomarkers of genetic change.

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Trophic Response to Multiple Stressors Using Species Sensitivity (SSD) Distribution Models

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For three decades, the species sensitivity distribution (SSD) has been the primary ecotoxicological tool to assess the effects of toxicants on species biodiversity. Despite prolific use by international environmental protection organizations and application in a wide range of ecosystems, there are several problems. 1) The hazardous concentration to protect 95% of a taxonomic group (HC5) is rejecting a portion of species that may have significant ecological roles. 2) Confidence intervals are entirely based on the number of species available with toxicological data and infer a large range of what is considered a “safe” concentration. 3) The minimum sample size to produce an SSD produces broad confidence intervals. 4) The parameters for data inputs to produce SSDs are not universal. 5) The trophic structure for an endpoint or location is not considered. In this research we use four taxonomic groups were used to represent a riparian food web; phytoplankton, zooplankton, macroinvertebrates, and predators. Individual and community SSDs were generated using zinc and copper with at least 10 species from each taxonomic group. Our findings suggest that the phytoplankton HC5 is less than zooplankton, macroinvertebrates, and predators. Furthermore, the range defined by confidence intervals for phytoplankton is from 0.06 ug/L to 33.23 ug/L indicating a high degree of uncertainty for a safe regulatory concentration to protect multiple trophic levels. Since copper is an algaecide, the HC5 toxicity is greater than

zinc for a community SSD. Future studies of SSDs must incorporate trophic response to phytoplankton toxicants, and trophic levels in toxicant regulation.

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Hydraulic Fracturing: A Case Study in Science-Policy Interaction and Bending Science

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The issues of normative and bent science have become well established the realm of science-policy interaction. As hydraulic fracturing has increased in recent years, debate has arisen as to whether its purported benefits outweigh the associated risks. In this study, I analyzed the recent peer reviewed and non-peer reviewed literature involving the environmental effects of hydraulic fracturing for signs of bending and conducted a search for risk assessments. The results indicate that while bending was not widespread in the literature, signs of it were visible from every funding category, on every side of the debate, and by every bending strategy looked for. The search for risk assessments revealed that while there is much discussion of the need for risk assessments, only three have been done.

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Characterization of the *in vivo* energetic and transcript expression response in rainbow trout (*Oncorhynchus mykiss*) to a proposed model P-gp inducer

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P-glycoprotein (P-gp) is widely recognized as playing a significant role in cellular defense against toxic insult from xenobiotics in both mammalian and aquatic organisms. P-gp is a member of the ATP-binding cassette (ABC) family of proteins (encoded by the abcb1 gene in *O. mykiss*), whose expression confers the multi-xenobiotic resistant (MXR) phenotype in the cell/organism. Three experiments have been proposed to characterize this system; 1) to identify a model P-gp inducer, 2) to characterize the energetic costs of P-gp activity, and 3) to quantify P-gp transcript levels under baseline and induced conditions. Identification of a model inducer for P-gp was achieved through a rhodamine 123 (R123) activity assay in isolated hepatocytes following intraperitoneal injection of several chemicals. Clotrimazole was found to illicit the highest levels of induction. The energetic costs of expression/induction were assessed *in vitro* using isolated hepatocyte O_2 consumption and *in vivo* through measurements of O_2 consumption and growth under several conditions (basal, clotrimazole exposure, substrate exposure, clotrimazole + substrate). *In vitro* O_2 consumption increased during exposure to clotrimazole alone and in combination with a P-gp substrate. *In vivo* O_2 consumption increased by exposure to clotrimazole and a P-gp substrate. Growth endpoints suggest a tradeoff between P-gp expression/activity and other physiological functions. In the 3rd experiment (in progress),

quantitative real-time PCR (qPCR) is being used to assess the absolute abcb1 transcript levels in seven tissues under basal and induced conditions to characterize the tissue-specific expression and induction response of two abcb1 isoforms. Preliminary data suggests a more ubiquitous expression of abcb1a as compared to a refined expression of abcb1b. A planned extension of this work will be to characterize P-gp localized expression and induction response in the blood-brain barrier (BBB).

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Pinewood Biochar Adsorbs Hydrophilic Antibiotic Compounds

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The goal of this project was to determine if biochar can be used to sequester antibiotic residues in the environment. Slurries of different biochars (n = 27) and water were evaluated for their capacity to adsorb two relatively hydrophilic veterinary antibiotics, florfenicol and ceftiofur. Freely available antibiotic was quantified using HPLC-UV and a bioassay. Biochars prepared at higher pyrolysis temperatures (>500°C) adsorbed the antibiotics with greater efficiency compared with lower preparation temperatures (P<0.005). Florfenicol was adsorbed (>99.8%) by six different biochars while ceftiofur was adsorbed (>99.98%) by these and ten additional biochars. Florfenicol was sorbed by 4 biochars (>99.94%) in the presence of soil; however, the sorption performance decreased for two biochars when calf urine and feces were added with the soil. The effect of the biochar proportions on florfenicol sorption in soil-urine-feces slurries were tested with two distinct pinewood biochars, yielding Freundlich sorption coefficients of 2,160 and 312 L kg^{-1}. Pinewood biochar and potentially other types of biochar are excellent candidates for sequestering antibiotic residues in soil-urine-feces environments.

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The 10th Criterion: Inter-comparison of Net Ecosystem Services as a Means to Evaluate Superfund Remedial Alternatives

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Incorporating the value of natural capital into resource management decisions is gaining popularity worldwide. Spatially explicit models are being applied to quantify and compare the goods and services differing ecosystems provide to human economies, informing management strategies. To test the utility of this concept for risk management decision-making at Superfund sites, we performed a comparative study of relative gains in ecosystem services among cleanup alternatives for a hypothetical Superfund site contaminated with PAHs in Puget Sound. Superfund site feasibility studies include a comparison of the alternatives using nine Superfund Remedy Selection Criteria, which include consideration of each

alternative's protection of natural resources and its cost. Explicit accounting for gains and losses in ecosystem services of each alternative complements the nine existing criteria and improves the environmental relevance of the final cleanup decision.

To explore the potential use of the ecosystem services concept in selecting remedial alternatives, we prepared a hypothetical evaluation of net service gains resulting from the combination, spatial extent, and spatial distribution of remedial actions for cleanup alternatives patterned off those found in publically available EPA documents for other Puget Sound Superfund sites. Ecosystem services addressed include benthic macroinvertebrate biodiversity, biomass, and habitat structural heterogeneity. Our model considers potential differences among the alternatives in structural and functional aspects of the ecosystem (e.g., connectivity, time to full service restoration) associated with each remedial alternative. Results for each alternative were compared to an estimated cost of the cleanup alternative itself. The results indicate that consideration of ecosystem services can significantly impact remedial cost estimates and that metrics currently used for Ecological Risk Assessments and Remedial Investigations are inadequate for robust calculations of ecosystem services.

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Metagenomics Analysis at a Potential Northern Mine Site: Towards Natural Copper Bioremediation

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In the environment, copper (Cu) is persistent, bioaccumulative, and toxic to aquatic organisms. Minimizing the impacts of Cu containing effluents on receiving waters is the focus of bioremediation efforts and are particularly crucial for the protection of aquatic environments. At a potential mine site in the Yukon, Canada, headwaters containing a naturally high Cu concentration and low pH are reduced to low concentrations at downstream sites. Physicochemical properties do not appear to be the cause of the Cu reductions and it has been proposed that microbial communities and biofilms may be responsible through Cu transformational processes. Biofilms were collected in triplicate from 5 sites along the watercourse: upstream at a reference site, at the site of copper introduction, a few meters downstream, and 2 km and 7 km further downstream. Biofilm genetic DNA was extracted and taxa identification and profiling were performed with 16S amplicon sequencing. A relationship between Cu concentrations (and pH) and taxonomic profiles was clear: as Cu is introduced to the waterway, one taxa occurs in high abundance within the microbial community and its abundance decreases downstream. The site of high Cu concentration is currently being shotgun sequenced and compared to the upstream reference site for a comparative gene profile of the microbial communities. Comparisons with known Cu metabolising genes will describe molecular roles that these biofilms could perform in the community. This initial study will build fundamental knowledge of microbial communities under copper-rich and acidic conditions, aiding future development of natural bioremediation processes for metal contaminated sites.

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Communicating Details of Complex Site Remediation in Washington State to Non-technical and Technical Audiences

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The goals of the Science and Management of Contaminated Sites (SMoCS) classes at Western Washington University are to teach students to navigate cleanups with consideration of the regulatory, social, and technical aspects. Knowledge of these details are only the beginning; communicating that information in ways that maintain technical accuracy, but are accessible to non-technical and technical audiences is an important focus. Students have worked on self-designed projects related to cleanups guided by the Model Toxics Control Act in Washington State since 2010. The projects include laboratory based work on remedial technologies, documentaries that provide examples of cleanup sites and emerging technologies, and comic books that focus on public participation and source control. Examples of the completed documentaries and comic books will be presented along with posters of on-going laboratory work.

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Toxicity of different size fractions of encapsulated lambda-cyhalothrin to the crustacean *Daphnia magna*

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Encapsulation of pesticides in polymers is common practice to control the release of active ingredients and to enable the application of poorly water-soluble active ingredients in agricultural environments. Although these encapsulated pesticides sometimes range in size from several hundred nanometers to several microns, our current understanding of how and to what extent each of the different size fractions may affect aquatic organisms is still limited. In a previous study, we developed predictive models to identify the behavior of encapsulated -cyhalothrin as a function of pH and ionic strength (IS). Effects on *Daphnia magna* were closely related to the behavior of encapsulated -cyhalothrin in the overlying water with toxicity being greatest when the capsules were stable and small in the overlying water. In this study, *D. magna* was exposed to either the nano-fraction, fractionated by centrifugation, or the complete formulation of -cyhalothrin for 48 hours to compare the toxicity of each fraction to *D. magna*. *D. magna* was also exposed to nano-fraction under four different exposure conditions to investigate to what extent different exposure scenarios influence the toxicity of nano-fraction of -

cyhalothrin to *D*. *magna*. The four exposure conditions, in terms of pH and IS, at which either hydrodynamic diameter or stability of encapsulated λ-cyhalothrin was maximized or minimized in the overlying water were simulated based on our previous study. The nano-fraction was significantly more toxic than the complete formulation to the immobilization and mortality of *D*. *magna*. Moreover, the highest toxicity of nano-fraction to *D*. *magna* was observed when the capsules were stable and small in the overlying water. These results indicate the importance of understanding the impacts of size on the behavior of encapsulated pesticides and highlight its importance when assessing potential risks to the aquatic environment.

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AOPs and Reverse Toxicokinetics: Estimating Prochloraz Internal Dose Metrics from Environmental Exposures

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Prochloraz is an imidazole fungicide widely used in agriculture. Prochloraz is considered an endocrine disruptor in fish causing effects on steroidogenesis and changes in circulating estrogen or androgen levels. We are using prochloraz as one of a suite of model compounds to evaluate in vitro testing for predicting whole fish effects of contaminants. These studies are part of larger effort seeking the best approaches for implementing the adverse outcome pathway (AOP) concept in toxicity testing. The full development of an AOP model requires knowledge of chemical dosimetry in addition to estimation of target organ toxicity and associated dose-response relationships. The term reverse toxicokinetics has been used to describe the process of estimating hypothetical environmental exposures necessary to achieve a specific target organ concentration of adverse concern. For many contaminants that lack animal test data, toxicokinetic analysis will need to rely on QSAR and/or in vitro based approaches to estimate target organ dosimetry. In the present study, we characterized the toxicokinetics and disposition of prochloraz in sexually mature female trout. Prochloraz was added to 90 L exposure tanks at an initial concentration of 50 µg/L. Water was sampled before and at various times after addition of the trout. At completion of the 96 hour exposure, trout were euthanized and various tissues removed for prochloraz analysis. Estimates of prochloraz uptake clearance, tissue distribution and clearance due to biotransformation or non-metabolic pathways were obtained using a two compartment toxicokinetic model. These values will be compared to those derived from QSAR or in vitro based approaches to evaluate the accuracy of these methods. Supported by EPA-STAR grant # R835167

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Use of Biomonitoring Tools in Ecological Risk Assessment in Howe Sound British Columbia

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Howe Sound is a fjord located north of Vancouver (BC, Canada) that has been impacted by industrial activities including two pulp and paper mills, copper mine and log storage facility. Over the past 20 years, one of the pulp mills was closed and a number of remediation projects completed. Despite a decrease in contaminant load, Howe Sound biological community has experienced minimal recovery as evidenced by the intertidal community diversity and abundance. The minimal recovery of intertidal community at several sites in Howe Sound suggests the presence of impeding factors. This study was designed to understand the factors inhibiting recovery in the intertidal community using biomointoring tools. We characterized intertidal communities at seven sites located along Howe Sound shores in terms of the quality of intertidal habitat, as well as abundance and diversity of species present. We also analyzed the effects of metals and organic contaminants in bivalves (mussels) using two biomarkers: Metallothionein (MT) and ethoxyresorufin-O-deethylase (EROD) activity. MT was used to measure bioavailable metals present in the environment that may be capable of causing toxicity. EROD activity used to assess exposure to organic contaminants in the environment. We also used a 48-h giant kelp germination and tube growth toxicity assay for assessing the overall effect of dissolved contaminants present in the water column. Conducting an ecological assessment with the use of biomarkers estimates the type and magnitude of effects caused by these contaminants at these different sites. Specifically, this study will show the effect of historical contaminant present and historical contamination in Howe Sound and their role in shaping intertidal communities and recovery.

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A comparison of the sub-lethal effects of the photomodified and unmodified PAH Benzo[a]pyrene on *Daphnia magna*

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Polycyclic aromatic hydrocarbons (PAHs) are a class of widespread persistent organic pollutants that are the result of the incomplete combustion of hydrocarbons. These organic and hydrophobic chemicals are of concern due to their known genotoxic, mutagenic, and carcinogenic properties, and increased toxicity in the presence of solar radiation as their conjugated benzene rings absorb ultraviolet A (UVA) and ultraviolet B (UVB) radiation and facilitate the production of reactive oxygen species (ROS). In this 21-day chronic daphnia toxicity test, various concentrations of benzo[a]pyrene (BaP), a common PAH and known carcinogen, were exposed to UVA radiation, with a duplicate set exposed to ambient light. Toxicological effects on the survival, growth, and reproduction in *Daphnia magna* were measured over the 21-day test period. Second generation daphnia from the two experiments were collected and similarly exposed to determine whether their response would be less, equal to, or greater than the first generation's. Preliminary results indicate that UVA radiation did not increase toxicological effects in the first generation daphnia. Moreover, mortality was similar and reproduction was similar between the two tests. Second generation daphnia displayed different responses from the first generation. The

results of this study indicate that UVA does not affect survivorship and reproduction in first generation daphnia, as well as in second generation daphnia.

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Comparison of Groundwater and Alluvial Sediment Microbial Communities In A Sulfolane-Contaminated Sub-Arctic Aquifer

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In May of 2001, an industrial solvent called sulfolane (2, 3, 4, 5-Tetrahydrothiophene-1, 1-dioxide) used to refine acidic natural gas was found to be released into the aquifer of North Pole, AK. It is now known to be the largest groundwater contaminant plume in the state of Alaska, affecting a large proportion of the residential drinking water supply. The viability of natural attenuation of sulfolane as a remediation strategy for the plume is currently being assessed at the University of Alaska Fairbanks. Microcosm studies indicate that aerobic degradation of sulfolane is possible by the indigenous aquifer microbial community. It was also found that sulfolane degradation rates were demonstrably higher in studies containing nutrients. A plume-wide geo-microbial assessment is ongoing to link environmental variables to microbial sulfolane degraders using groundwater from existing monitoring wells. However, using groundwater samples may not be an effective representation of the true aquifer microbial community. This prompted the collection of adjacent groundwater and alluvial sediment samples on site using a Geoprobe®. Microbial DNA extraction, quantitative PCR, and sequencing will expose apparent differences in microbial community composition between groundwater and alluvial sediments at the same location. Our hypothesis is that monitoring groundwater for sulfolane-degrading microbes underestimates the biodegradation potential in an intact aquifer. This analysis effectively challenges the conventional approach to monitoring natural attenuation processes in contaminated aquifers. If groundwater microbial communities are less active as predicted, new management and treatment considerations must be made to satisfy environmental quality standards.

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The Effect of UV-A and Titanium Dioxide Nanoparticles on Triclosan Toxicity to *Escherichia coli*

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Triclosan is an anti-bacterial chemical prevalent in numerous personal care products. Existing data raise valid concerns about the environmental effects of repetitive daily release of triclosan. Titanium dioxide (TiO_2) nanoparticles (NPs) as the second most-produced nanomaterial worldwide, is likely to be encountered in aquatic environments alongside triclosan. Co-exposure to these common contaminants

could result in altered toxicity and understanding these interactions will inform risk assessments for these common pollutants. In addition, environmental factors (such as sunlight) can confound risk assessments, especially when mixtures are present. UV radiation can enhance the production of free radicals from TiO_2 NPs which could potentially degrade triclosan into more or less toxic compounds. Based on these concerns, this study aimed to build knowledge on the toxicity of degradation products, along with a triclosan and TiO_2 NP mixtures. *Escherichia coli* were selected as a model organism to investigate the toxic effects of the single and mixed chemicals, and the impacts of UV-A treatment. *E.coli* was exposed to TiO_2 NPs (10 mg/L) and/or triclosan (0.008 to 2 mg/L) either a) alone, b) as a mixture or c) as a mixture with removal of TiO_2 NPs by centrifugation. Studies were conducted for each scenario with and without UV-A radiation. The presence of TiO_2 NP significantly decreased the toxicity of triclosan to *E.coli* with the lowest toxicity occurring in the mixed exposure that included the removal of the TiO2 NPs prior to toxicity testing, suggesting that triclosan could be absorbed onto TiO_2 NPs. The UV-A treatment enhanced the toxicity of triclosan alone, did not affect the toxicity of TiO_2 and triclosan mixture, and reduced the toxicity of the centrifuged mixture at the highest exposure concentrations. Overall, this study indicates that TiO_2 NPs can mitigate the toxicity of triclosan, and environmental factors (like sunlight) can influence toxicity.

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