Program and Abstracts

Pacific Northwest Chapter

Society of Environmental Toxicology and Chemistry (PNW-SETAC)

27th Annual Conference

Contaminants of Concern: Responding to a 21st Century Challenge

OSU CH2M Hill Alumni Center

March 8 - 10, 2018

Hilton Garden Inn
2500 SW Western Boulevard, Corvallis, OR 97333

OSU CH2M Hill Alumni Center
725 SW 26th Street, Corvallis, OR 97331

Hilton Garden Inn

2500 SW Western Boulevard, Corvallis, OR 97333
Phone: 1-541-752-5000, FAX: 541-752-5001

Inn Events:
- Pre-Registration/Check-in (Thursday)
- Thursday short courses
- Thursday evening Welcome Reception
- Vans (am and pm) for the morning U.S. EPA ORD National Health and Environmental Effect Research Laboratory Tour and the afternoon Lewisburg Saddle Old Growth Forest Hike

For Guests:
- Check-in time: 3:00 PM, check-out time: 12:00 PM
- Free Wi-Fi
- Free self-parking (for hotel guests only). Conference attendees please see page 3.

Directions to Hotel (See Map 1):

From the North on I-5
- Take **exit 228**
- Turn **right** on OR-34 W/Corvallis-Lebanon Hwy 210
- Continue on OR-34 (9.6 mi)
- Turn **left** onto OR-34 Bypass W (1.1 mi)
- Continue onto US-20 W (0.6 mi)
- Turn **right** onto SW 26th St (0.2 mi)
- Turn **right** onto SW Western Blvd, hotel is on the **right** (282 ft)

From the South on I-5:
- Take **exit 228**
- Turn **left** on OR-34 W/Corvallis-Lebanon Hwy 210
- Follow rest of instructions for from the North on I-5
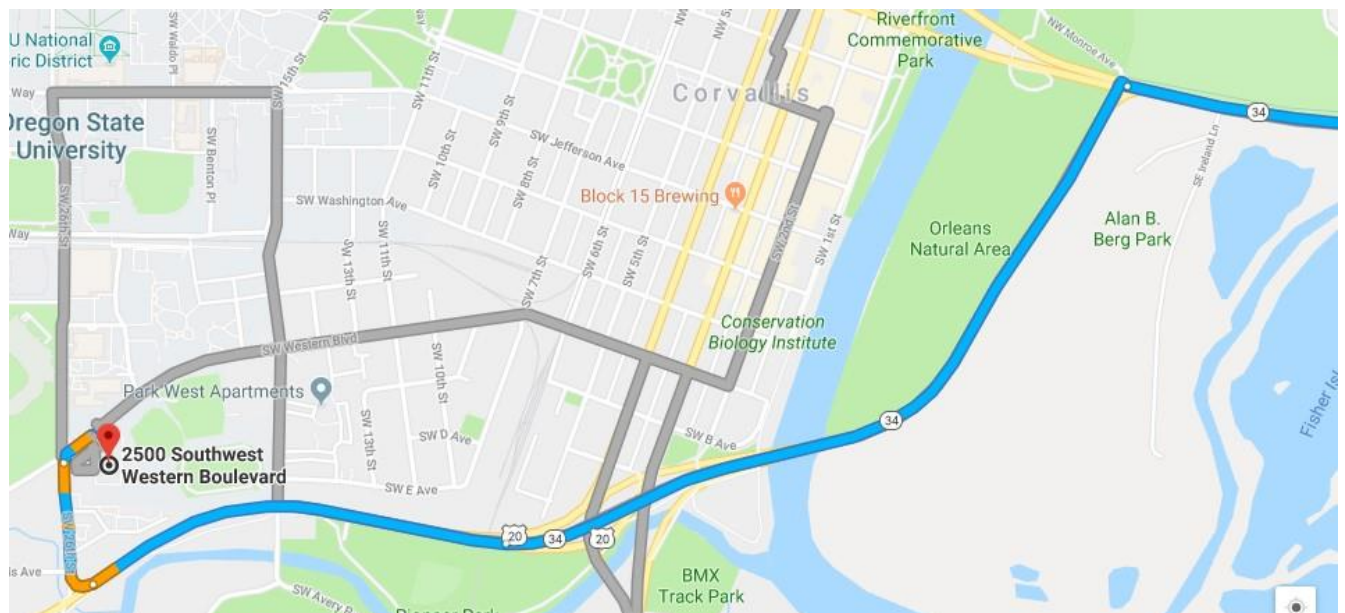
CH2M Hill Alumni Center
725 SW 26th Street, Corvallis, OR 97331

Center Events:
- Registration and Check-in
- Friday platform and poster presentations
- Friday evening dinner (optional, paid when registering)
- Saturday morning platform and poster presentations

Directions to Center (See Map 2):

From the Hilton Garden Inn (~0.2 miles distance)
- Exit hotel and turn left onto SW Western Blvd (115 ft)
- Turn **right** onto SW 26th Street (0.1 mi)
- Center is on the **right**.
- If driving, please park in B or C lots (See OSU Parking)

OSU Parking

A parking permit is required to park on the OSU campus Monday through Friday from 8:00 am to 5:00 pm. Cost is $10/day. Attendees can purchase a B or C zone permit ahead of time online **HERE** (limited number are available) or at kiosks. Pay stations are also available for hourly parking up to 4 hours. There are B zone lots to the east of the Alumni Center, and C zone south of the stadium lots across SW 26th St. Parking is also available in the parking structure (to the north) on the "no residence" levels. No permits are needed in the B or C zones on Saturday!

PNW-SETAC
Meeting Sponsors

Special thanks to all our Meeting Sponsors!

Student Travel Awards
Azimuth Consulting Group
Golder

Thursday Evening Welcome Reception
Compliance Services International
Windward Environmental

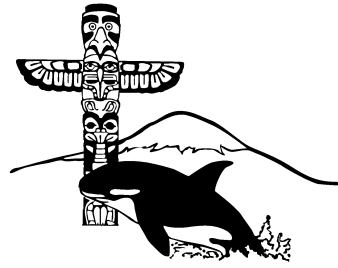### Friday Poster Social
Golder

Refreshment Breaks
Anchor QEA

SETAC Books
SETAC North America

PNW-SETAC
Corporate Members

Chinook Level

Please join us in thanking this year's Corporate Members!

Azimuth Consulting Group Partnership

Azimuth provides science-based assessments of the significance of environmental contamination. We created the Azimuth partnership to build a small, flexible team that is responsive to clients' needs. Our collective experience spans biology, ecology, toxicology, science policy and conflict resolution. These skill sets have been applied to a range of fields including risk assessment, environmental impact assessment, regulatory policy, permitting and monitoring. Among our senior staff we have two Contaminated Sites Approved Professionals Society (CSAP – risk assessors) and a Diplomate of the American Board of Toxicology (DABT).

Compliance Services International (CSI)

CSI specializes in global regulatory and scientific consulting services for product registration and risk assessment. Established in 1988, our diverse staff of experienced regulatory scientists develop strategies to meet specific needs for a global client base. Our services include USA & EU regulatory affairs, ecological risk assessment, endangered species analysis, endocrine disruptor evaluation, REACH chemical safety assessment, exposure modeling, study monitoring & data development, litigation support, information management systems, and task force management. Specialists in regulatory & scientific consulting - serving industry with dedication, expertise, and focus from offices in the USA and Europe.

Golder

Golder was founded in 1960 and is an employee-owned, global organization providing consulting, design, and construction services in the areas of mining, oil and gas, manufacturing, transportation, energy production, water resources, wastewater treatment, and environmental remediation. Currently, they employ over 6,500 people, operating from 165 offices worldwide, who provide technical expertise, innovative solutions and award-winning client service. Today, their clients represent the world's major industries and drivers of development: Oil and Gas, Mining, Manufacturing, Power, and Infrastructure.

PNW-SETAC
Corporate Members
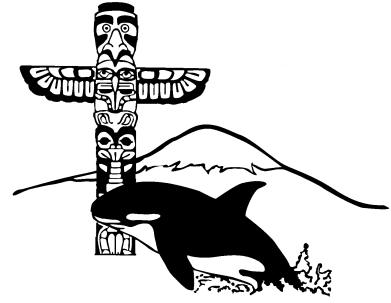
Heron Level

Anchor QEA

Anchor QEA provides a full range of science and engineering services to the public and private sectors, including planning and strategy development, scientific investigation, engineering design, and construction management. We enjoy working on some of the most challenging sites in the nation, and our completed projects are among the most successful in the industry. Our clients recognize that the strength Anchor QEA brings to every project reflects our core values of technological leadership, integrity, superior product quality, and client satisfaction.

It has offices across the United States and a team of more than 300 scientists, planners, and engineers working closely with their clients towards achieving common goals on water resources, surface and groundwater quality, coastal development, habitat restoration, and contaminated sediment management projects.

Windward Environmental

Windward Environmental is a Seattle-based consulting firm founded in 2000 on the premise that environmental consultants can best serve clients' interests by providing high-quality, defensible data for use in decision making. Our technical approach is based on sound scientific principles, identifying and investigating environmental problems transparently and without bias. 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
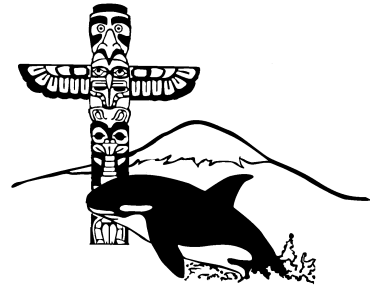
Many thanks to all of you who volunteered your time to make this meeting possible:

Conference Organization:
Jeff Wirtz, Compliance Services International
Julann Spromberg, NOAA Fisheries
Angie Perez, Center for Toxicology and Environmental
Health (CTEH), LLC

On-Site Coordinator:
Jeff Wirtz, Compliance Services International

Abstract Review:
Julann Spromberg, NOAA Fisheries
Diana Dishman, NOAA Fisheries/Ocean Associates Inc.
Kara Warner, Golder

Plenary Speakers:
Angie Perez, CTEH LLC
Jeff Wirtz, Compliance Services International

Meeting Program:
April Markiewicz, Western Washington University
Jennifer Lanksbury, WDFW

Meeting Registration:
April Markiewicz, Western Washington University
Angie Perez, CTEH LLC

Volunteer Coordinator:
Lauren Crandon, Oregon State University

Student Travel Awards:
Ed Kolodziej, University of Washington

Student Presentations Judging
Ed Kolodziej, University of Washington
Bryson Finch, WA Department of Ecology

Student Presentation Awards
Coreen Hamilton, AXYS Group
Jennifer Lanksbury, WDFW
Angie Perez, CTEH LLC

Fundraising:
Jeff Wirtz, Compliance Services International

27th PNW-SETAC ANNUAL CONFERENCE

Meeting Program

March 8 – 10, 2018

PNW-SETAC
Chapter Meeting Agenda

Thursday March 8th	***Hilton Garden Inn (2500 SW Western Blvd)***
7:30 AM – 9:00 AM	**Preconference/Registration Check-in** (Hilton Garden Inn)
8:00 AM – 12:30 PM	**Short Course** (Hilton - University Club Room): *Scientific Communication.* Instructor: **Ruth Sofield**, Western Washington University
9:45 AM – 11:00 AM	**Tour**: *US EPA ORD National Health and Environmental Effects Research Laboratory Tour*. Meet in Hilton lobby to board vans. **Vans leave at 9:45 am!** Latecomers walk! Tour Guide: **James Markwiese**, US EPA WED
11:30 – 1:30 AM	**Lunch** (optional box lunch paid for when you registered or on your own)
1:00 PM – 4:30 PM	**Hike**: *Lewisburg Saddle Old Growth Forest Hike*. Meet in Hilton lobby to board vans. **Vans leave at 1:00 pm!** Guide: **Jeff Wirtz**, CSI
1:30 PM – 3:30 PM	**Short Course** (Hilton - University Club Room): *Integrative Ecological and Human Well-being Risk Assessment.* Instructor: **Wayne Landis**, Western Washington University
5:30 PM – 7:00 PM	**Conference/Registration Check-in** (Hilton Garden Inn)
5:30 PM – 8:30 PM	**Welcome Reception with hors d'oeuvres** (Hilton - University Club)
Friday March 9th	***CH2M Hill Alumni Center, OSU Campus (725 SW 26th St.)***
7:00 AM – 7:45 AM	*PNW-SETAC Board Meeting* (Hilton Stadium Bar & Grill restaurant)
7:30 AM – 5:00 PM	**Conference/Registration Check-in** (Foyer)
7:30 AM – 8:00 AM	Poster setup (Cascade Ballroom 110B)
8:00 AM – 8:40 AM	Welcome Address, Chapter President **Angie Perez**, SETAC Update (Cascade Ballroom 110A)
8:40 AM – 10:00AM	Platform presentations (20 min each) (Cascade Ballroom 110A)
10:00 AM – 10:20 AM	**Refreshment break, poster session** (Cascade Ballroom 110B)
10:20 AM – Noon	Platform presentations (20 min each) (Cascade Ballroom 110A)
Noon – 1:30 PM	**Lunch (on your own!)**
12:45 PM – 1:30 PM	*PNW-SETAC Business Meeting* (Cascade Ballroom 110A)
1:30 PM – 2:00 PM	***Plenary Speaker Robert Tanguay, OSU (Cascade Ballroom 110A)***
2:00 PM – 3:00 PM	Platform presentations (20 min each) (Cascade Ballroom 110A)
3:00 PM – 3:20 PM	**Refreshment break, poster session** (Cascade Ballroom 110B)
3:20 PM – 5:00 PM	Platform presentations (20 min each) (Cascade Ballroom 110A)
5:00 PM – 6:00 PM	**Poster Social with refreshments** (Cascade Ballroom 110B)
6:00 PM – 8:30 PM	**Dinner** (optional, paid when registered) (Cascade Ballroom 110B)
Saturday March 10th	***CH2M Hill Alumni Center, OSU Campus (725 SW 26th St.)***
8:00 AM – 9:40AM	Platform presentations (20 min each) (Cascade Ballroom 110A)
9:40 AM – 10:10 AM	**Refreshment break, poster session** (Cascade Ballroom 110B)
10:10 AM – 11:30 AM	Platform presentations (20 min each) (Cascade Ballroom 110A)
11:30 AM – 12:00 PM	***Plenary Speaker – Susanne Brander OSU (Cascade Ballroom 110A)***
12:00	Closing ceremony with student awards (Cascade Ballroom 110A)

PNW-SETAC
Thursday AM Short Course
8:00 am – 12:30 pm

Scientific Communication Workshop

Instructor: Ruth Sofield, Western Washington University
Location: Hilton University Club Room

Overview:
With the expanse of social media as a primary communication tool, scientific communication now occurs through many different outlets. Scientists also have access to a wider range of people now and can directly communicate with the public. Although many scientists have perfected their peer-to-peer communication skills, there is still a need to improve how we communicate with non -technical audiences.

This workshop will introduce some of the research on what limits understanding of scientific communication, support why we need to broaden our communication, and lead participants through an exercise to develop a plan for communication to a targeted audience. Participants will be encouraged to share their successful experiences and lessons learned with the class.

Class Location and Time: Class starts at 8:00 am in the University Club room in the Hilton Garden Inn hotel and will last approximately 4.5 hours with time built in for a break.

Contact Info: Dr. Ruth Sofield, Western Washington University.
Any questions concerning the class, please contact Ruth at: ruth.sofield@wwu.edu

PNW-SETAC
Thursday Morning Tour
9:45 am – 11:00 am

U.S. EPA ORD National Health & Environmental Effects Research Laboratory Tour

Guide: **James Markwiese**, US EPA Western Ecology Division
**Location**: 200 SW 35th Street

Tour Description:
Tour guide(s) will provide an overview of studies in the EPA labs, including nanomaterial toxicity and use of stable isotopes in ecological research. They will also provide a tour of campus grounds to discuss work in field simulations (mesocosms), greenhouse studies to examine effects of pyrolized organic matter (biochar) in sequestering heavy metals in soils, and field studies, such as at their instrumented tree site and coast-to-crest network of field sites to assess forest vulnerability to climate change.

Transportation:
Vans will be available outside the Hilton at 9:30 am to transport people to the lab, as well as pick them up at 11:00 am to transport them back to the hotel. **The vans will depart from the hotel at 9:45 am, so please be on board by then**. Attendees can also walk the 7 blocks (1.3 miles) from the hotel to the U.S. EPA office at 200 SW 35th Street: Directions are as follows:
- From the Hilton head southwest on SW Western Blvd towards SW 26th St. (0.6 mi).
- Turn right onto SW 35th St. (0.6 mi).
- Turn left and proceed to destination (0.1 mi).
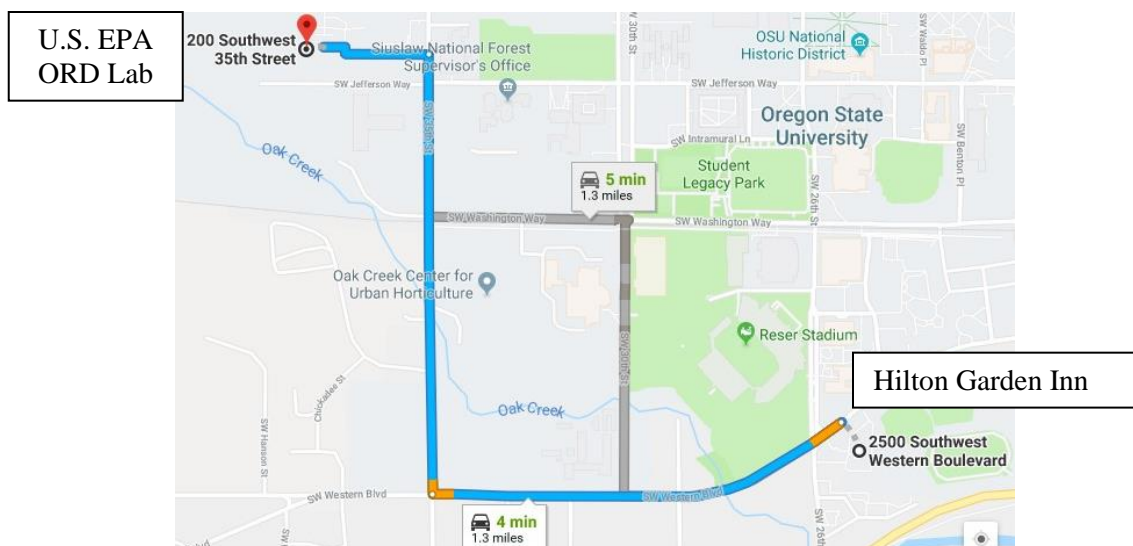
PNW-SETAC
Thursday PM Short Course
1:30 pm – 4:00 pm

Integrative Ecological and Human Well-being Risk Assessment

Instructor: Wayne Landis, Western Washington University
Location: Hilton University Club Room

Overview:
Risk assessments for ecological and human health and well-being endpoints are often seen as separate processes. New research has demonstrated that they are not. The terminology and the criteria used in each are different due to their separate routes of development. They share, however, the fundamentals of the exposure-response paradigm and having to deal with cumulative effects. In a number of recent scientific papers, it has been demonstrated that Bayesian network relative risk models (BN-RRM) can be built to describe ecological effects of Hg and other stressors in a major riverine system and can estimate the efficacy of mitigation tools such as bank stabilization and use of best management practices in the watershed. It is also possible to build adaptive management tools that assist in the planning of long-term management actions. In this class, attendees will use several examples that will demonstrate how ecological and human well-being risk assessment can be integrated. Attendees can bring their own case studies as well. The course will begin with a review of the basic principles of risk assessment and risk calculation methods. The second half will be spent in the exploration of other case studies, some of which will be provided, but the use of other examples supplied by students will be welcomed.

Class Location and Time: Class starts at 1:30 pm in the University Club room in the Hilton Garden Inn hotel and will last approximately 2 hours, with time built in for a break.

Instructor: Dr. Wayne G. Landis, Western Washington University. Any questions concerning the class, please contact Wayne at wayne.landis@wwu.edu.

Course notes: can be accessed **HERE**

PNW-SETAC
Thursday Afternoon Hike
1:00 pm – 4:30 pm

Lewisburg Saddle Old Growth Forest Hike

Guide: Jeff Wirtz, Compliance Services International
Location: McDonald State Forest, N.W. Sulphur Springs Rd

Hike Description:
The Lewisburg Saddle Trail Area includes the New and Old Growth Trails to the northeast of the parking area, and the Alpha and Ridge Trails to the southwest. The Old Growth and New Growth Trails are a short hike from the trailhead on the 580 Road, and allow visitors to experience and learn about two very different forest types as they traverse through an old growth stand and a younger, more intensively managed stand.

PNW-SETAC Past President Jeff Wirtz will lead the tour, however participants will have plenty of time to walk at their own pace, read the educational placards located along the trails, and enjoy the ambiance that only an old growth forest (and its denizens) can provide!

You can also find more information at the following links:
> https://www.oregonhikers.org/field_guide/Lewisburg_Saddle_Old_Growth_Hike
> http://therighttrail.org/trails/new-growth-trail
> http://therighttrail.org/trails/old-growth-trail

Transportation:
Vans will be available outside the Hilton Garden Hotel at 12:45 pm for boarding. **The vans will depart from the hotel at 1:00 pm, so please be on board by then**.

PNW-SETAC
Plenary Speaker

Friday March 9th at 1:30 PM
CH2M Hill Alumni Center Cascade Ballroom 110A

Robert Tanguay, Oregon State University, will be presenting:

Tackling the "Mixtures Problem" using Zebrafish

Robert Tanguay is a Distinguished Professor in the Department of Environmental and Molecular Toxicology at OSU, the Director of the Oregon State University Superfund Research Program, Director of the Sinnhuber Aquatic Research Laboratory, Director of the OSU Environmental Health Sciences Center, and Director of the NIEHS supported training program.

He received his BA in Biology from California State University-San Bernardino, his PhD in Biochemistry from the University of California-Riverside and postdoctoral training in Developmental Toxicology from the University of Wisconsin-Madison.

He serves on a number of academic, commercial and federal advisory boards and is on the editorial board for several scientific journals. He has authored more than 200 manuscripts and book chapters across numerous disciplines. Over the past several years, he has pioneered the use of zebrafish as a systems toxicology model and recently developed automated high throughput instrumentation and workflow to accelerate phenotype discovery in zebrafish.

A major focus of his is on identifying chemicals and mixtures that produce neurotoxicity. Phenotypic anchoring coupled with the inherent molecular and genetic advantages of zebrafish are used to define the mechanisms by which chemicals, drugs and nanoparticles interact with and adversely affect vertebrate development and function. These tools are also now routinely used to assist in the development of inherently safer chemicals and nanoparticles.

PNW-SETAC
Plenary Speaker

Saturday March 10th at 11:30 AM
CH2M Hill Alumni Center Cascade Ballroom 110A

Susanne M. Brander, Ph.D., Oregon State University, will be presenting:

From the Benchtop to the Beach:
Assessing Responses to Environmental Stress in
Marine and Estuarine Organisms

Susanne Brander is a new faculty member in the Department of Environmental Toxicology and Chemistry, having recently moved to OSU from the University of North Carolina, Wilmington.

The Brander lab's research encompasses the fields of toxicology, endocrinology, and ecology; integrating molecular approaches with measurements at the organism and population level.

In this talk, Susanne will discuss her current work examining the impact of endocrine disrupting compounds (EDCs) on molecular endpoints, sex ratio, and population dynamics. Recent work investigated fish responses to combined exposure to EDCs and increased temperatures associated with global climate change.

She and her research team are also examining the potential for transgenerational effects following early life exposure to pollutants, studying the trophic transfer of microplastics, and assessing the sensitivity of a deep-sea fish species to oil-associated toxicants.

PNW-SETAC
Friday Platform Presentations
Morning Session

Friday, March 9, 2018

8:00 AM Welcome and Opening

Session Chair: **Jennifer Lanksbury**, Washington Department of Fish & Wildlife

Stormwater Toxicity, Effects, & Treatments

8:40	Julann Spromberg	Roads to Ruin: The Threats of Urbanization to Conservation of a Sentinel Species
9:00	Edward Kolodziej	High Resolution Mass Spectrometry Screening of Urban Stormwater for Identification of Novel Contaminants and Their Sources
9:20	Jenifer McIntyre	Tire Leachate Recapitulates the Pathophysiology, Unique Sensitivity, and Mortality of Coho Salmon Acutely Exposed to Urban Road Runoff
9:40	Ben Leonard	Ability of Compost Amended Biofiltration Swales to Reduce Toxicity in Urban Highway Run-Off
10:00	**Break/Poster Viewing**	

Organic Contaminants

10:20	Christine Ghetu	Assessing Presence and Flux of PAHs Across Sediment-Water and Water-Air Phases at a Legacy Creosote Site in St. Helen's, Oregon
10:40	Raymmah García	Homologous Series to Find Hydrocarbon Surfactants in AFFFs and in AFFF-impacted Groundwater
11:00	Justin Rewerts	In-Vial Extraction and Large Volume Injection GC-MS for Semi-Volatile Polyfluorinated Alkyl Substances in Papers and Textiles
11:20	Courtney Roper	Implications of $PM_{2.5}$ Filter Extraction Methods on Chemical and Toxicological Analyses
11:40	Lane Tidwell	Air-water Exchange of PAHs and OPAHs at a Superfund Mega-site
12:00 to 1:30 PM		**Lunch (on your own!)**
12:45 to 1:30 PM		**PNW-SETAC Business Meeting**

PNW-SETAC
Friday Platform Presentations
Afternoon Session

Friday, March 9, 2018

Session Chair: **Angela Perez**, Center for Toxicology and Environmental Health LLC

1:30 PM   Plenary: Robert Tanguay   *Tackling the "Mixtures Problem" using Zebrafish*

Metal Toxicity & Methodologies

2:00	Claire Walli	Impacts of Major Freshwater Ions on the Acute Toxicity of Silver Nanoparticles to *Daphnia Magna*
2:20	Ian Moran	Bioavailability and Toxicity of Metal Mixtures Using the Tissue Residue Approach
2:40	Amanda Nahlik	Development of a Heavy Metal Index (HMI) for Indicating Anthropogenic Activities to Wetlands and the Examination of Lead (Pb) in US Wetland Soils
3:00	**Break/Poster Viewing**	

Non-target Exposures from Remediation Efforts

3:20	Jennifer Lanksbury	Effects of Polycyclic Aromatic Hydrocarbons (PAHs) on Pacific Herring (*Clupea Pallasii*) Embryos Exposed to Creosote-Treated Pilings Related to a Piling Removal Project in Quilcene Bay, Washington
3:40	L. Blair Paulik	Environmental and Individual PAH Exposures near Rural Natural Gas Extraction
4:00	Alix Robel	Pilot-Scale Application of Granular Activated Carbon for Removal of Per- and Polyfluoroalkyl Substances in Groundwater at a Military Site
4:20	Mark Johnson	Designing Biochars for *In Situ* Remediation of Metal Contaminated Mine Spoils
4:40	Paul Mayer	Environmental Trade-Offs of Stream Restoration Approaches for Managing Nutrients and Metals in Urban Ecosystems
5:00	**Poster Social**	**No-host bar and light refreshments provided!**
6:00	**Dinner**	**Dinner at the Alumni Center**

PNW-SETAC
Saturday Platform Presentations
Morning Session

Saturday, March 10, 2018

Session Chair: **Gerrad Jones**, Oregon State University

Risks and Population Effects

8:00	Wayne Landis	Using the Bayesian Network Relative Risk Model to Integrate Molecular Effects, Ecological Context and Ecosystems Services to Estimate Risk over Space and Time
8:20	Valerie Chu	Assessing the Effects of Chemical Mixtures using a Bayesian Network-Relative Risk Model (BN-RRM) Integrating Adverse Outcome Pathways (AOPs) in Four Watersheds
8:40	Gunnar Guddal	Energy Dispersive X-ray Spectroscopy Mapping of Particles as a Component of Lichen Biomonitoring in Seattle, Washington
9:00	Matthew Slattery	Encapsulated Pesticides: Analytical and Toxicological Nuances
9:20	John Stark	Differential Stage Susceptibility to Toxicants: Is this an Important Consideration for Populations Exposed to Stressors?
9:40	**Break/Poster Viewing**	
10:10	Jennifer Lanksbury	Assessing the Threat of Contaminants of Emerging Concern to Early Marine Survival of Chinook Salmon
10:30	Gerrad Jones	Global Environmental Variability Drives Trace Element Changes in Soils
10:50	Teresa Michelsen	Evaluating Emerging Chemicals of Concern and Non-Chemical Stressors in the 21st Century: A Multivariate Approach using Machine-Learning Algorithms
11:10	Chance Asher	Climate Change Impacts for Washington State Contaminated Sites: A Vulnerability Assessment and Adaptation Strategy to Increase the Resilience of Washington's Contaminated Sites
11:30	**Plenary: Susanne Brander**	*From the Benchtop to the Beach: Assessing Responses to Environmental Stress in Marine and Estuarine Organisms*
12:00	**Student Award Presentations Wrap Up/Adjourn**	

PNW-SETAC
Poster Presentations

Presenter(s)	Presentation
Christian Anderson	Transformation and Release of Micronized Cu Used as a Wood Preservative in Treated Wood in Wetland Soil
Stephanie Blair	Multi-component Analysis to Detect Stress-Induced Hemoglobin Derivatives in Coho Salmon (*Oncorhynchus kisutch*)
J. Renée Brooks	An Isotopic View of Water and Nitrate Transport through the Vadose Zone in Oregon's Southern Willamette Valley's Groundwater Management Area
Gary Chapman	The Acute Effects of Constant vs. Cycling Hypoxia on Rainbow Trout
Lauren Crandon	Calibration of Energy Input During the Preparation of Aqueous Nanoparticle Dispersions
David Hanson	Restoration Scaling of Cultural Service Injuries Using Structured Decision Support
Rachel Hennegan	Attenuation of Brominated Flame Retardants in Hepatic Microsomes Derived from Starry Flounder
Philip Janney	Probabilistic Methods to Evaluate the Relationship Between Chlorpyrifos Use at the Watershed Scale and Impacts on Aquatic Resources
Amber Kramer	Oxidation of Polycyclic Aromatic Hydrocarbons in Secondary Organic Aerosol Particles
Amber Kramer	Using Polycyclic Aromatic Hydrocarbons to Track Air Pollution Sources

PNW-SETAC
Poster Presentations

Presenter(s)	Presentation
Jeremy Larson	Systematically Defining the Bioactivity of a Diverse Suite of Precision-Engineered Nanomaterials Using a High-Throughput Zebrafish Screening Paradigm
Eric Lawrence	Integrating Global Climate Change Stressors and Human Health and Well-Being Endpoints into A Bayesian Network Relative Risk Model of the Skagit River
Mary Leonard	Analysis of Polycyclic Aromatic Hydrocarbon Transformation Products by High-Resolution Mass Spectrometry Coupled to High-Performance Liquid Chromatography
Joelle Lo	Histological Study of the Transgenerational Impact of 17α-ethinylestradiol on Gametogenesis in F4 *Oryzias melastigma*
James Markwiese	Environmental Toxicology and Chemistry at EPA's Western Ecology Division
Jared Miller, Allie Johnson	Bioaccumulation of Copper and Zinc in the Fruticose Lichen *Ramalina Farinacea* Analyzed By Sequential Extraction and SEM
David Olszyk	Biochar Improves Performance of Plants for Mine Soil Revegetation
Kaitlyn Spellman	Assessing the Risk of Microplastics in Marine Nearshore Environments and Biota Using the Bayesian Network-Relative Risk Model
Julann Spromberg	Modeling Potential Population-level Impacts of Oil Spills on Puget Sound Pacific Herring Stocks
Zhanghuan Xia	Residual Level, Dietary Exposure and Health Risk of DDTs and HCHs in a Typical Northern City in China

Pacific Northwest Chapter

Society of Environmental Toxicology and Chemistry
(PNW-SETAC)

27th Annual Meeting

Platform Presentation Abstracts
(In order of presentation)

Roads to Ruin: The Threats of Urbanization to Conservation of a Sentinel Species

Feist, B.E.[1], Buhle, E.R.,[1] Baldwin, D.H.[1], Spromberg, J.A.[1*], Damm, S.E.[2], Davis, J.W.[2], Scholz, N.L.[1] [1]National Marine Fisheries Service, NOAA, Northwest Fisheries Science Center, Seattle, WA, [2]U.S. Fish and Wildlife Service, Lacey, WA.

Since the late 1990s, coho salmon adults returning to their natal urban streams in Puget Sound experience high rates (e.g., 40-90% of run) of spawner mortality syndrome. Evidence suggests that urban stormwater runoff is the likely causative agent and that this high mortality may threaten wild coho populations, particularly in urbanizing basins. The ability to identify basins currently at risk for this syndrome is critical to conservation efforts. We looked at the relationship between the mortality syndrome (time series of coho spawner survey data from 51 streams distributed across an urban gradient in the Puget Lowlands) and basin scale habitat conditions (time series of nationally available geospatial data, including seasonal precipitation) to better understand the landscape characteristics most associated with the syndrome and to generate predictive maps of mortality rates in unmonitored basins. Structural equation modeling revealed a latent urbanization gradient that was associated with road density and traffic intensity, among other variables, and positively related to mortality, which is consistent with other studies that suggest motor vehicles are the likely source of a chemical mixture that washes off urban landscapes into coho spawning streams. Across years within sites, mortality increased with summer and fall precipitation, but the effect of rainfall was strongest in the least developed areas and was essentially neutral in the most urbanized streams. We used the best-supported structural equation model to generate a predictive mortality risk map for the Puget Sound Basin. The predictive mortality map identified likely hotspots for coho spawner die-offs in unmonitored basins across the gradient of urbanization in Puget Sound. Our analyses improve our understanding of the interplay between urbanization and climatic drivers of the mortality syndrome, are easily transferable to other regions, and can be used for siting green stormwater infrastructure in the current built environment and in future development scenarios.

Contact Author: Julann Spromberg, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112, T: 206-302-2426, julann.spromberg@noaa.gov.

High Resolution Mass Spectrometry Screening of Urban Stormwater for Identification of Novel Contaminants and Their Sources

Kolodziej, E.[1,2], Peter, K.[1], Du, B.[1], Lofton, J.[1], McIntyre, J.[3]. [1]Center for Urban Waters, University of Washington Tacoma, Tacoma, WA, [2]University of Washington, Seattle, WA, [3]Washington State University Puyallup Research Extension, Puyallup, WA.

Untreated urban runoff transports many chemical contaminants, toxicants, and other bioactive chemicals, thus contributing to poor water quality in receiving waters. The identity and key sources of many of these contaminants are unknown or poorly defined, thus impairing our ability to effectively protect ecosystem and human health. However, the identification of contaminants in complex mixtures such as urban runoff is a challenging analytical task. Additionally, it can be difficult to determine key sources of contaminants to receiving waters, especially when multiple sources are contributing similar contaminants to receiving waters. Here, we present the use of high-resolution quadrupole time-of-flight mass spectrometry to characterize the occurrence and fate of known and novel trace organic contaminants in stormwater runoff. Key transformation products and structurally related compounds are presented for a variety of sources, highlighting the importance of reactive processes to contaminant fate in stormwater. In addition, we linked the occurrence of several of the dominant runoff-derived contaminants to their primary sources by creating a variety of synthetic solutions, leachates or extracts from key chemical sources in urban stormwater. These sources included tire and plastic leachates, antifreeze, motor oil, and other automotive fluids. We then developed non-target "chemical fingerprints" or "signatures" for subsets of feature detections in these samples types, and used dilution series of these fingerprints to estimate the contributions of these sources to highway runoff. In particular, leachates of used motor oil and tires were especially rich in uncharacterized features, including highly abundant features that often dominated feature detections in urban waters, pointing to the importance of these specific sources to polluted waters.

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Tire leachate recapitulates the pathophysiology, unique sensitivity, and mortality of coho salmon acutely exposed to urban road runoff

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Coho salmon (*Oncorhynchus kisutch*) spawners returning to spawn in streams receiving urban road runoff suffer high rates of pre-spawning mortality. Direct exposure of spawners to road runoff causes a significant loss of blood ions, drop in pH, and increase in hematocrit, followed by death within hours of exposure. Neither the pathophysiology nor the mortality is seen in concurrently exposed chum salmon (*O. keta*). Contaminants in road runoff are dominated by vehicles sources including fluid leaks, and particulates from exhaust emissions, brake friction materials, and tire wear. Chemicals that leach from tires or tire particles can be acutely toxic to aquatic animals including fish. We tested whether particles from tires could leach sufficient toxic chemicals into water to be acutely lethal to coho salmon. Fine tire particles were generated and placed in a 100-μm mesh filter sock, inserted into an HDPE filter housing, and continuously leached with a fixed volume of clean well water for 22 h. The resulting filtrate (leachate) was essentially clear and devoid of visible particles. Adult coho salmon returning from Puget Sound were placed in well water or a dilution of well water and tire leachate. The lowest concentration that killed all coho spawners within 5 h (0.32 g/L) was used for subsequent testing. At this concentration, all coho exposed to the tire leachate died within 24 h whereas none of the exposed chum spawners died. Finally, blood sampled from coho exposed for 3 h to 0.32 g/L tire leachate showed significant loss of plasma Na and Cl, drop in pH, and increase in hematocrit whereas the blood of chum concurrently exposed did not show these changes. Tire particles may be an important source of the unknown chemicals contributing to pre-spawning mortality in coho salmon exposed to urban road runoff.

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Ability of Compost Amended Biofiltration Swales to Reduce Toxicity in Urban Highway Run-off

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Biofiltration swales, or bioswales, use vegetated soil substrates to filter contaminants from stormwater, decrease sediment load, and reduce erosion. Following a storm, runoff moves slowly through the swale at a shallow depth. While stormwater is retained in the bioswales, pollutants are removed by the combined effects of filtration, infiltration, settling, and biotransformation. The system currently being evaluated at the Washington State University (WSU) Puyallup Research and Extension Center (PREC) uses compost to further enhance the ability of bioswales to remove toxicants. WSDOT has created guidelines for constructing compost amended biofiltration swales (CABS) and implemented a field site for CABS along Washington State Route (SR) 518 in 2009. As part of an ongoing study, influent and effluent samples are currently being collected at the field site during storm events and tested for metals, PAHs, pesticides, phthalates, and unknowns (LC-QTOF). Toxicity is also measured using 48-hour zebrafish (*Danio rerio*) bioassays to suggest how CABS may affect aquatic organisms. Along with researchers from University of Washington (UW) we created a laboratory model for CABS at the WSU PREC to verify field test results in a controlled setting and identify ways that the WSDOT design could be improved. This system is exposed to highway runoff from a previously studied high volume source off SR 520 and tested at different flow rates, swale lengths, and slope gradients. Filtered and unfiltered stormwater from the laboratory CABS is subjected to the same set of analyses as the field CABS. By comparing results from these two systems we demonstrate the ability of CABS to protect urban waterways from toxic highway stormwater run-off.

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Assessing Presence and Flux of PAHs across Sediment-Water and Water-Air Phases at a Legacy Creosote Site in St. Helen's, Oregon

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In conjunction with the Port of St Helens, Oregon Department of Environmental Quality, and Cascadia Associates LLC, this study focused on the deployment of Oregon State University-developed passive samplers (PSDs) at a legacy creosote site located in St. Helen's Oregon. These passive samplers were co-deployed at the sediment–water and water–air interface within and outside the former creosote site. In addition, trial advective flux seepage meters were co-deployed with sediment passive samplers for measurement of bulk water flow through the site. Using gas chromatography mass spectrometry, PSDs extracts were quantitatively analyzed. Analysis included four separate instrumental methods that encompass the following analyte classes; 63 parent and alkylated polycyclic aromatic hydrocarbons (PAHs), parent and alkylated PAH compounds specific to forensic source determination of environmental mixtures, 22 oxygenated PAHs, and 12 hopanes/cholestanes. Analysis of data, and investigation of advective flow at this site is ongoing as we work with Oregon Department of Environmental Quality, and Cascadia Associates LLC. Further data analysis will inform the direction and magnitude of diffusive PAH movement between the sediment, aqueous, and atmospheric phases at this heavily contaminated site. Understanding contaminant movement across environmental phases at contaminated sites will help to inform and provide better data for managers and regulatory agencies responsible for the maintenance and future decontamination of these and other similar locations.

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Homologous Series to Find Hydrocarbon Surfactants in AFFFs and in AFFF-impacted Groundwater

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Hydrocarbon and (per- and perfluoroalkyl substances) PFASs are used together in proprietary mixtures of Aqueous Film Forming Foams (AFFFs), which are used to extinguish hydrocarbon-based fuel fires. Although hydrocarbon surfactants are more abundant (5-10% w/w), more is known about the identity of PFASs that comprise only 0.9-1.5% w/w in AFFFs. Hydrocarbon surfactants in AFFFs and AFFF-contaminated groundwater have not yet been investigated. However, in this study, 34 AFFFs and eight AFFF-contaminated groundwater samples were analyzed for hydrocarbon surfactants by liquid chromatography quadrupole time-of-flight mass spectrometry. A hydrocarbon surfactant suspect screening list and a modified homologous series detection computational tool, enviMass were used for the identification of hydrocarbon surfactants in AFFFs and AFFF-contaminated groundwater. It was found that of the 34 AFFFs analyzed, 29% of AFFFs contain polyethylene glycols, 18% contain alcohol ethoxylates, 12% contain betaines, 9% AFFFs contained nonylphenol polyethylene glycol and 6% of AFFFs contain alkyl ethoxysulfates. It is known that alkylphenol ethoxylates degrade into products including octylphenol or nonylphenol, which are known to be an endocrine disruptors that produce weakly estrogenic effects in aquatic life. Nonylphenol polyethylene glycol was found in 50% of AFFF-contaminated groundwater. AFFF-contaminated groundwater discharges into surface waters where hydrocarbon surfactants, which are likely persistent under anaerobic aquifer conditions, can begin to biodegrade under aerobic conditions.

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In-Vial Extraction and Large Volume Injection GC-MS for Semi-Volatile Polyfluorinated Alkyl Substances in Papers and Textiles

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Volatile polyfluorinated alkyl substances (PFASs) are found in consumer goods such as papers and textiles. Volatile PFASs are known precursors to the ionic, non-volatile perfluorinated carboxylates (PFCAs) and sulfonates (PFSAs) in humans and the environment. At the end of their use, consumer products are sent to landfills and thus landfills are a major source of PFASs to the environment. The potential release of volatile PFASs from consumer products informs estimates on the discharge of PFASs into the environment, as well as human exposure. To understand the proliferation of PFASs in the environment, analytical methods specifically for volatile PFASs are needed to understand the total analytical input of PFCAs and PFSAs. The method presented is a rapid, quantitative and selective method for volatile PFASs with sensitivity comparable to other methods. A 1.5 x 1.5 cm piece of material is placed into an autosampler vial with solvent and stable isotope mass-labeled internal standards. The autosampler vial is sonicated in a water bath for 30 minutes before it is placed directly onto the GC autosampler for analysis, with no prior clean up or removal of material within the autosampler vial. A large volume injection (20 µL) GC-MS injection technique is carried out utilizing a standard split/splitless injector. Using the presented method coupled with suspect screening and QTOF-MS, we present for the first time additional homologues of the ECF-derived Me-FASE and Et-FASE, both of which have homologues C_3-C_7 and C_2-C_7 (respectively) in addition to their known C_8 homologue. The additional ECF-derived Me- and Et-FASE homologues account for upwards of 12% of the total volatile PFAS signature on select commercially available textiles, thus indicating that volatile PFASs contributions to total environmental inputs of PFCAs and PFSAs are currently underestimated and that additional volatile PFASs should be considered in other methods.

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Implications of $PM_{2.5}$ Filter Extraction Methods on Chemical and Toxicological Analyses

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Understanding of the global public health burden of fine particulate matter ($PM_{2.5}$) exposures requires toxicological experiments however, research groups use varying filter extraction methods to prepare $PM_{2.5}$ creating a potential toxicity bias. To determine the impact of filter extraction methods on chemical constituent recovery and toxicity outcomes we took equal portions of a single hi-volume $PM_{2.5}$ filter sample from Riverside, CA. Each filter portion underwent a different extraction method (n=6) and recovered $PM_{2.5}$ was then prepared for developmental toxicity testing by collecting the soluble fraction from DMSO extraction. Zebrafish (n=32/treatment) were treated with controls (DMSO, blank filter portions) and treatments ($PM_{2.5}$ filter portions undergoing filter extraction) starting at 6 hours post fertilization. Aliquots of these $PM_{2.5}$ solutions were used for chemical constituent analysis of polycyclic aromatic hydrocarbons (PAHs, n=120) and elements (n=20). Significant increases in mortality were observed for $PM_{2.5}$ from 5 of the 6 filter extraction methods when compared to both the DMSO and blank filter controls. Combined mortality and morphological changes were significantly increased following $PM_{2.5}$ treatment in all extraction methods compared to DMSO controls. Importantly, two of the methods showed significant mortality and morphological changes with blank filters when compared to DMSO controls. Chemical analysis is underway and differences in $PM_{2.5}$ solutions between extraction methods will be investigated. Correlations between chemical components and developmental toxicity outcomes will identify components that are driving toxicity and potentially altered during specific extraction procedures. This research highlights the toxicity bias due to $PM_{2.5}$ filter extraction methods that must be considered when conducting research with complex ambient mixtures. Ultimately, this work identifies extraction procedures for use in this cost-effective surrogate to compare the inherent toxicity differences of $PM_{2.5}$, and provides a path that will ultimately promote improved understanding of $PM_{2.5}$-associated health effects.

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Air-water Exchange of PAHs and OPAHs at a Superfund Mega-site

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Chemical fate is a concern at environmentally contaminated sites, but characterizing that fate can be difficult. Identifying and quantifying the movement of chemicals at the air-water interface are important steps in characterizing chemical fate. Superfund sites are often suspected sources of air pollution due to legacy sediment and water contamination. A quantitative assessment of polycyclic aromatic hydrocarbons (PAHs) and oxygenated PAH (OPAHs) diffusive flux in a river system that contains a Superfund Mega-site, and passes through residential, urban and agricultural land, has not been reported before. Here, passive sampling devices (PSDs) were used to measure 60 polycyclic aromatic hydrocarbons (PAHs) and 22 oxygenated PAH (OPAHs) in air and water. From these concentrations the magnitude and direction of contaminant flux between these two compartments was calculated. The magnitude of PAH flux was greater at sites near or within the Superfund Mega-site than outside of the Superfund Mega-site. The largest net individual PAH deposition at a single site was naphthalene at a rate of -14,200 ($\pm$5780) (ng/m^2)/day. The estimated one-year total flux of phenanthrene was -7.9 $\times 10^5$ (ng/m^2)/year. Human health risk associated with inhalation of vapor phase PAHs and dermal exposure to PAHs in water were assessed by calculating benzo(a)pyrene equivalent concentrations. Excess lifetime cancer risk estimates show potential increased risk associated with exposure to PAHs at sites within and in close proximity to the Superfund Mega-site. Specifically, estimated excess lifetime cancer risk associated with dermal exposure and inhalation of PAHs was above 1 in 1 million within the Superfund Mega-site. The predominate depositional flux profile observed in this study suggests that the river water in this Superfund site is largely a sink for airborne PAHs, rather than a source.

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Impacts of Major Freshwater Ions on the Acute Toxicity of Silver Nanoparticles to *Daphnia magna*

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Silver nanoparticles (AgNPs) are increasing in presence in commercial and medical products due to their bactericidal properties. Aqueous silver (Ag$^+$) toxicity to freshwater organisms has been well studied using the Biotic Ligand Model (BLM), a model that predicts metal toxicity at reactive biological surfaces of freshwater organisms in relation to their surrounding water chemistry. Although dissolved Ag$^+$ from the AgNP surface is the main toxic mechanism of action of AgNPs, toxicity via ionic dissolution is not accurately predicted by the BLM when ingestion is a possible route of exposure, suggesting the existence of other chemical or biological reactions in effect. The purpose of this research is to observe the effects of the major freshwater ions Ca^{2+}, Na$^+$, Cl$^-$, and NO$_3^-$ on the toxicity of AgNPs to the freshwater daphnid, *Daphnia magna*. These ions have been proven to change the kinetic behavior of the AgNPs by increasing freshwater concentrations of Ag$^+$ via ionic dissolution of the particles or, contrarily, reducing the reactive surface area of the particles as they aggregate and sediment out of a water column. This study used eight acute toxicity tests performed in ASTM moderately hard synthetic freshwater that had varying additions of Ca^{2+}, Na$^+$, Cl$^-$, and NO$_3^-$. These tests have shown that both the mechanisms included in the BLM for Ag$^+$, and nanoparticle kinetics influence toxicity. There were significant differences between AgNP LC50s in experimental freshwaters with higher concentrations of higher valency ions. Multivariate analysis is used to compare AgNP toxicity to the BLM predictions for Ag$^+$ toxicity as well as different particle behaviors, measured using single particle ICP-MS and UV-Vis spectrophotometry. This research aims to further inform the debate about the toxic mechanism of action for AgNPs, as well as understand the impact of specific major ions in freshwater ecosystems on the environmental toxicity of AgNPs.

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Bioavailability and Toxicity of Metal Mixtures Using the Tissue Residue Approach

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Many toxicants are found in the environment as mixtures but because toxicants are routinely tested individually, mixture effects are poorly understood. Therefore, understanding the biological effects of realistic exposures, like mixtures, is essential to managing environmental contamination. In this study we explored how the presence of one metal affects the bioavailability and toxicity of a second metal when present in tandem. In addition to toxicity testing, we are measuring accumulated concentrations of metals in exposed seedlings. This data will be used within the tissue-residue approach (TRA) for toxicity assessment, which uses internal tissue concentrations as a dose metric rather than ambient aqueous concentrations. This approach removes exposure variability and allows for more accurate prediction of toxicity under realistic conditions. For this experiment we conducted acute toxicity tests with lettuce seedlings exposed to binary metal mixtures and used growth inhibition as the effect endpoint. The first step was to determine the tissue accumulation and toxicity of single metals (Al, Cu, Cd, Fe, Zn) to establish a baseline for bioavailability and toxicity. Next, we exposed seedlings to all combinations of binary mixtures and measured growth inhibition and bioaccumulation of metals. Using toxic units and the Isobole approach allowed us to classify the mixture effects as additive, synergistic or antagonistic, indicating whether the metals are more or less toxic when present together in a mixture. The nominal toxicity results have shown antagonistic interactions for all mixtures tested, except Fe and Cu. The tissue concentration data collection is on-going and results will be presented. Primarily applied to organic mixtures, experimental studies that utilize the TRA approach to describe metal mixture toxicity are rare. This work improves our understanding of mixture effects and bioavailability and is critical to predicting toxicity of metals in the environment under realistic conditions.

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Development of a Heavy Metal Index (HMI) for Indicating Anthropogenic Activities to Wetlands and the Examination of Lead (Pb) in US Wetland Soils

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There are few available, large-scale, chemical indicators that can be used to rapidly detect the potential for anthropogenic impacts to wetlands. Soil concentrations of 12 heavy metals that have been linked to various anthropogenic activities were measured in samples collected from the uppermost horizon in approximately 1000 wetlands across the conterminous US as part of the 2011 National Wetland Condition Assessment (NWCA). These data were used to develop a Heavy Metal Index (HMI) to report on areal extent of wetlands with human-mediated additions of heavy metals to the soils that may ultimately affect wetland biological condition. Additionally, these data were used to report baseline wetland soil heavy metal concentrations on national and sub-regional scales. Our data show that wetlands of the conterminous US typically have low levels of heavy metals in the soil, and that most of the elements included in this analysis occur nationally in levels below concentrations that relate to anthropogenic activities. However, concentrations above expected background (i.e., > 35 ppm) of soil lead occur nationally in 11.3% of the wetland area. Regionally, the greatest extent of wetland area with elevated soil lead concentrations was located in the Eastern Mountains & Upper Midwest followed by the West (23.9 and 18.4% of the wetland population, respectively). Our data show positive relationships between soil lead concentration and four individual disturbances: road density, percent impervious surface, housing unit density, and population density in a 1-km radius buffer area surrounding the site. Because lead can be strongly bound to wetland soils in particular, maintenance of the good condition of our nation's wetlands is likely to minimize risk of lead mobilization.

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Effects of Polycyclic Aromatic Hydrocarbons (PAHs) on Pacific Herring (*Clupea pallasii*) Embryos Exposed to Creosote-Treated Pilings Related to a Piling Removal Project in Quilcene Bay, Washington

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Fish embryos spawned in Puget Sound nearshore marine habitats face a risk of exposure to a wide variety of toxic chemical pollutants during their incubation. Of particular concern are polycyclic aromatic hydrocarbons (PAHs), chemicals originating from oil spills, combusted fossil fuels, and creosote-treated pilings (CTPs). Removal of CTPs and prohibiting their use in marine waters are two recovery practices aimed at reducing PAHs and other creosote-related chemicals in marine waters. We used manually spawned and field-deployed Pacific herring embryos as a sensitive indicator of PAH exposure from CTPs, to test the efficacy of a CTP removal project in Quilcene Bay Washington. Embryos were deployed near CTPs in a 100-year-old derelict CTP field (1) before the CTPs were removed, (2) just after the removal process, to evaluate whether PAHs were released during removal, and (3) one year later, to evaluate whether PAHs lingered after CTP removal. Embryos incubated in the undisturbed CTP field prior to CTP removal exhibited PAH body burdens approximately five times higher than at reference areas, though total PAHs in the CTP-field embryos were below health effects thresholds. The CTP removal project was not fully completed during this study; CTP debris remained in the piling field and many CTPs were cut at the seafloor, resulting in freshly exposed CTP surfaces after the removal project ended. PAH concentrations in embryos sampled during and after CTP removal were 25x to 83x higher than reference embryos, and many exceeded health effects thresholds. PAH concentrations in embryos after CTP removal correlated with distance from former CTP locations. In addition, expression of *cyp1a*, a gene involved in PAH-detoxification, was correlated with PAH body burden. These results link embryo health with toxic contaminants associated with CTPs and illustrate the importance of fastidious adherence to appropriate CTP-removal protocols to avoid contaminant risks to biota.

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Environmental and Individual PAH Exposures near Rural Natural Gas Extraction

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Natural gas extraction (NGE) has expanded rapidly in the United States in recent years. Despite concerns, there is little information about the effects of NGE on air quality or personal exposures of people living or working nearby. Recent research suggests NGE emits polycyclic aromatic hydrocarbons (PAHs) into air. This study used low-density polyethylene passive samplers to measure concentrations of PAHs in air near active (n=3) and proposed (n=2) NGE sites. At each site, two concentric rings of air samplers were placed around the active or proposed well pad location. Silicone wristbands were used to assess personal PAH exposures of participants (n=19) living or working near the sampling sites. All samples were analyzed for 62 PAHs using GC-MS/MS, and point sources were estimated using the fluoranthene/pyrene isomer ratio. ΣPAH was significantly higher in air at active NGE sites (Wilcoxon rank sum test, p < 0.01). PAHs in air were also more petrogenic (petroleum-derived) at active NGE sites. This suggests that PAH mixtures at active NGE sites may have been affected by direct emissions from petroleum sources at these sites. ΣPAH was also significantly higher in wristbands from participants who had active NGE wells on their properties than from participants who did not (Wilcoxon rank sum test, p < 0.005). There was a significant positive correlation between ΣPAH in participants' wristbands and ΣPAH in air measured closest to participants' homes or workplaces (simple linear regression, p < 0.0001). These findings suggest that living or working near an active NGE well may increase personal PAH exposure. This work also supports the utility of the silicone wristband to assess personal PAH exposure.

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Pilot-Scale Application of Granular Activated Carbon for Removal of Per- and Polyfluoroalkyl Substances in Groundwater at a Military Site

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Aqueous film-forming foams (AFFFs) have historically been applied to hydrocarbon-based fuel fires because of their unique, proprietary chemistries and, as a result, are used for both emergency response and fire-fighter training purposes. Repeated use of AFFFs at fire-fighter training areas resulted in contamination of soils, aquifer sediments, and groundwater with PFASs including perfluoroalkyl carboxylates (PFCAs, e.g., PFOA) and sulfonates (PFSAs, e.g., PFOS) at concentrations above current health advisory levels. Granular activated carbon (GAC) is one remediation technology used to remove PFASs from groundwater. At present, there are few data at pilot and full scale that describe the removal of PFASs by GAC. With the focus primarily on the removal of PFOA and PFOS, there are few data that describe the removal of other PFASs by GAC, including precursors. A pilot-scale system consisting of flow-through lead and lag vessels, each containing 91kg DSR-GAC, and was operated at a flow rate of approximately 9.5 liters per minute. Weekly samples of influent and the effluents from the lead and lag vessel were analyzed for 16 individual PFASs including C4-C8 PFCAs, C4-C8 PFSAs, 4:2-8:2 fluorotelomer sulfonates, C6 and C8 perfluoroalkyl sulfonamides, and a cationic precursor. Samples were also analyzed by the total oxidizable precursor (TOP) assay and by particle induced gamma ray emission (PIGE) spectrometry for total fluorine. Individual PFASs that are oxidizable accounted for the production of PFCAs upon oxidation, thus closing the mass balance on PFASs in the influent groundwater. Breakthrough curves were constructed to determine the efficacy for removal of the individual PFASs. In addition, the relationship between the order of individual PFAS elution on analytical columns used in LC-MS/MS analysis was determined to be the same as the order of breakthrough on GAC. The relationship between elution and breakthrough could be used for predicting breakthrough of other precursors. Breakthrough curves were also generated from TOP assay and PIGE data. Discussion will include the advantages and limitations of relying on TOP assay and PIGE data for total fluorine as an alternative or in addition to individual PFAS analysis by LC-MS/MS.

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Designing Biochars for *In Situ* Remediation of Metal Contaminated Mine Spoils

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Biochar in conjunction with other soil amendments can be used for *in situ* remediation of metal-contaminated mine spoils for improved site phytostabilization. For successful phytostabilization to occur, biochar must improve mine spoil health with respect to plant rooting plus uptake of water and nutrients. An inappropriate biochar may negatively impact plant growth conditions resulting in poor plant establishment and growth. Matching the appropriate biochar for each mine site requires reconnaissance of spoil chemical and physical conditions and then identification of properties which need to be rectified to promote plant growth. A rectification hierarchy needs to be established with the primary limiting factor being addressed first, followed by successive limitations addressed individually or simultaneously. We hypothesize that spoils at each site will have a unique chemical, physical, and biological signature that will affect plant growth. Quantifying these and other conditions beforehand allows for the production of a designer biochar with specific characteristics tailored for specific plant growth deficiencies within each spoil. Additionally, we recommend the use of proximally located, undisturbed soils to establish spoil remediation targets. In our work, we have developed a decision-tree flow-chart that identifies salient chemical, physical and microbial characteristics needed for plant growth. Combined with our knowledge of site conditions, we can then design a biochar best suited for site-specific remediation. We also propose a framework for monitoring changes in soil conditions and health, and to plot their progress and gauge their improvement after phytostablilization begins.

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Environmental Trade-Offs of Stream Restoration Approaches for Managing Nutrients and Metals in Urban Ecosystems

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Hydrologic modifications in urban ecosystems impact water quality via soil compaction, impervious surface cover, drainage, and channelization. Urban stream restoration strategies that are designed to regain lost ecosystem function such as nutrient uptake may have unintended consequences and environmental trade-offs. Regenerative Stormwater Conveyance (RSC) is a restoration approach based on engineering stream channels to incorporate shallow pools, riffles, and grade controls to increase storm water retention and control erosion, and adding a carbon layer (e.g. wood chips) to the stream bed to enhance microbial processes like denitrification. We examined RSC effects on nutrients (P and N) and trace metals (Fe and Mn) at two sites 5 and 7 years post-construction, using combined field and laboratory measurements. Field measurements showed that RSCs usually had lower dissolved oxygen (DO) and pH relative to nearby untreated stream reaches, but did not have consistently different P, N, Fe, Mn, or dissolved organic carbon (DOC) suggesting that engineering ecosystem function like nutrient uptake is affected and ultimately limited by watershed variability. In lab simulation experiments, we observed removal of N and P when sediment was amended with wood chips and leaf litter, and that these DOC sources had significantly different effects on nutrient and metals release suggesting that organic matter additions to streams drive nutrient transformation and that trade-offs exist between P and N management in restored streams depending on quantity and quality of DOC source and anoxic conditions in the hyporheic zone. An additional trade-off occurs in some RSCs where elevated groundwater levels expand the zone of anoxia but, in turn, drown and kill riparian zone trees, potentially reducing DOC inputs. Consideration of trade-offs and unintended consequences are critical for choosing and implementing BMPs in urban ecosystems that will be most effective at removing nutrients and metals.

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Using the Bayesian Network Relative Risk Model to Integrate Molecular Effects, Ecological Context and Ecosystems Services to Estimate Risk over Space and Time

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An ongoing dilemma in risk assessment is the perceived difficulty in successfully integrating scales that range from the molecular to ecological, timeframes from days to decades, and endpoints that can be species specific to a host of ecosystem services. Starting In the late 2000s to now there has been an interest in defining ecosystem services and in the calculation of risk to these properties. Human well-being has become part of the lexicon to included endpoints such as a sense of place, education, employment, public safety and traditional activities. In a recent publication (Harris et al. 2017) it was demonstrated that it is possible to estimate risk in a contaminated site to ecological endpoints, human health and ecosystem services using a clearly defined causal pathways and Bayesian networks. Now we are extending the integration of ecological endpoints, ecosystem services and human well-being from the scale of a contaminated site to that of the Salish Sea. Vancouver, Seattle, Tacoma, major ports, numerous refineries, paper mills, and high tech industries. The same area is also noted for intense agricultural use, outdoor recreation and the harvest of marine resources. Time frames will be from current conditions to 2070 and will include climate change projections for water temperature and precipitation. We will demonstrate the application of the Bayesian-network relative risk model to integrate pesticide effects at the molecular level and the alteration of watersheds to calculate risk to the ecological endpoint Chinook Salmon, the specific economic ecosystem services provide by the endpoint and the watersheds, and finally demonstrate the risks to human well-being as defined from a variety of cultural perspectives.

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Assessing the Effects of Chemical Mixtures using a Bayesian Network-Relative Risk Model (BN-RRM) Integrating Adverse Outcome Pathways (AOPs) in Four Watersheds

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Chemical mixtures are difficult to assess at the individual level, and are more challenging at the population level. We have conducted a regional-scale ecological risk assessment by evaluating the effects chemical mixtures to populations with a Bayesian Network- Relative Risk Model (BN-RRM) in four Washington state watersheds (Lower Skagit, Nooksack, Cedar and Lower Yakima). Organophosphate pesticides (diazinon, malathion, and chlorpyrifos) were chosen as the chemical stressors and the Middle Columbia and Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*) Evolutionary Significant Units were chosen as the population endpoints. Laetz et al. (2009, 2013) found that organophosphate pesticide mixtures act synergistically and impair acetylcholinesterase activity leading to a change in swimming behavior and mortality. Exposure-response equations have been generated for single chemicals, binary and ternary mixtures and integrated into the BN-RRM framework to predict risk to populations. Ecological stressors such as dissolved oxygen and temperature were also included in our risk analysis. Risk was defined as the differences between the population size probability distribution in the no stressor model compared to the model with chemical and ecological stressors. Our risk calculations indicate that synergism at measured concentrations did not increase risk compared to single chemical exposures. Malathion, the synergist, was not found in concentrations that induced a greater than additive response. However, at malathion concentrations of 3-15 µg/L, synergism with the other OPs does occur and does increases risk. Our research demonstrates that mixture toxicity can be incorporated into a probabilistic model that estimates the risk of mixtures to populations.

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Energy Dispersive X-ray Spectroscopy Mapping of Particles as a Component of Lichen Biomonitoring in Seattle, Washington

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Lichen are an increasingly popular medium for air quality monitoring due to their sensitivity to SOx and NOx, as well as their bioaccumulation of airborne material. This study incorporates characterization of particulate matter (PM) on the surface of lichen *Ramalina farinacia* to map exposure to air pollution in three industrial clusters in Seattle, Washington. The PM was characterized using scanning electron microscopy with energy-dispersive X-ray spectroscopy mapping to determine PM size and composition. We also measured bioaccumulation of metals and the biomarkers glutathione, chlorophyll degradation, malondialdehyde, and usnic acid in the lichen. Principal components analysis has identified which geographic locations and particle types correlate the strongest with increased metal accumulation and physiological response in the lichen.

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Encapsulated Pesticides: Analytical and Toxicological Nuances

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More than 1.1 billion pounds of pesticide active ingredients (AIs) are applied in the United States each year. Pesticide regulation is reliant upon the properties of these AI, such as hydrophobicity, as it is an important determinant of AI fate and transport. The adoption of encapsulated pesticide technologies may present an emerging gap in pesticide regulation; encapsulated pesticides have demonstrated delayed release, slower degradation, and improved efficacy when compared to their conventional counterparts. Despite the presence of micro- and nano-sized encapsulated formulas on the commercial market, the analytical and toxicological implications of encapsulation are uncertain. To explore this issue quantitatively, we fractionated the capsules of a commercially available encapsulated insecticide (AI = gamma-cyhalothrin) into two size ranges: micro-capsules (>1000 nm) and nano-capsules (<1000 nm). These were compared against the free AI (no capsule). When free AI is extracted from an aqueous solution with hexane, the hydrophobic AI immediately partitions into the hexane. However, the micro-capsules and nano-capsules inhibited the hydrophobic partitioning for up to 48 hours, quantitatively demonstrating the capacity for encapsulated pesticides to influence the analytical behavior of the AI. To assess any capsule effects on AI toxicity, we conducted an acute immobilization test with a freshwater macroinvertebrate (*Ceriodaphnia dubia*), normalizing treatments according to their AI content. The nano-capsules were significantly more toxic than both the micro-capsules treatment and the free AI treatment (EC$_{50}$ = 0.18 µg/L, 0.57 µg/L, and 0.65 µg/L respectively), while the toxicity of the micro-capsules remained similar to the free AI. Together, these findings highlight that encapsulation of AI inhibits hydrophobic partitioning and influences toxicity in a size-dependent manner. Recognizing these analytical and toxicological nuances may lead to more effective regulatory practices and improved design of pesticide formulations.

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Differential Stage Susceptibility to Toxicants: Is this an Important Consideration for Populations Exposed to Stressors?

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Certain life stages of an organism may be more susceptible to toxicants than others. If differential susceptibility among life stages occurs, what does this mean to population viability of the population being exposed? This question was addressed using an aphid parasitoid, *Diaeretiella rapae*, and a ladybeetle, *Coccinella septempuncata* exposed to pesticides. Both species exhibited differential stage susceptibility to the pesticides used in this study. Data from toxicity studies were incorporated into population models to evaluate long-term impacts on populations of these two species. Results of this study will be discussed in terms of protecting threatened and endangered species.

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Assessing the threat of Contaminants of Emerging Concern to Early Marine Survival of Chinook Salmon

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Pharmaceuticals and personal care products (PPCPs), and a number of industrial compounds, such as alkylphenols, bisphenol A, phthalates, perfluorinated compounds (PFCs), and current-use pesticides, are all contaminants of emerging concern (CECs) in aquatic habitats, regionally and globally. CECs enter our rivers, estuaries, and marine habitats from various sources, including discharges from wastewater treatment plants, aquaculture operations, industrial outfalls and stormwater outfalls, as well as surface stormwater runoff from impervious surfaces, landfills, agricultural lands, and lands where biosolids were applied. However, the environmental fate and toxicity of CECs to biota are not well understood. To provide an initial assessment of CECs in juvenile Chinook salmon in Puget Sound, we measured concentrations of CECs in 15 whole body samples of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) out-migrating through river, estuary, and nearshore marine habitats from five Puget Sound river systems in 2013. Collectively, 48 of 194 chemicals were detected, with more CECs detected in salmon that had migrated through urban than non-urban areas. Overall, antibiotics were detected most frequently, followed by alkylphenols, PFCs, and antidepressants. Fifteen different antibiotics were detected; at least one antibiotic was detected in all samples, however the mean number of antibiotics detected at each river system ranged from two to five. Five different types of antidepressants were detected, however, they were not detected in salmon from all river systems. Based on predicted fish plasma concentrations of PPCPs, which were compared to effective pharmaceutical doses for human plasma, we concluded that several of the CECs detected in juvenile Chinook salmon were high enough to potentially impair health of salmon residing temporarily in estuarine and nearshore habitats of Puget Sound, possibly reducing their marine survival.

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Global Environmental Variability Drives Trace Element Changes in Soils

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Human health is intimately linked to concentrations of both beneficial and harmful elements present in soils. Plants take up essential micronutrients (e.g., Cu, S, and Se) that are critical for maintaining homeostasis as well as harmful elements (e.g., As, Hg, Pb) that are carcinogenic, neurotoxic, and have other adverse impacts. Although the factors affecting plant uptake of essential/toxic elements are becoming increasingly well studied, the mechanisms controlling their broad-scale distributions and concentrations in soils are poorly understood. To identify these mechanisms, we modeled concentrations of 8 elements (As, Cu, Hg, Ni, Pb, S, Se, and Zn) using advanced machine learning algorithms as a function of 11 environmental variables describing climate, soil physical and chemical properties, geology, anthropogenic emissions, irrigation, and vegetation. Potential mechanisms were determined using model sensitivity analyses, which evaluate the independent effects of each predictor variable. In general, soil physical properties (e.g., clay content), organic carbon content, and emissions were the most important drivers of all element concentrations. Model sensitivity analyses suggest that these variables are controlling current soil distributions by increasing sorption and deposition. Using climate, organic carbon, and emission data from optimistic (RCP 4.5/B1) and extreme (RCP 8.5/A1F) climate change scenarios, most soil element concentrations were predicted to decrease over the 21st century, resulting from decreasing emissions and changes in precipitation, both likely affecting deposition. Geology variables were of low importance for all elements and are unlikely to substantially affect the cycling of these elements, although we recognize that changes in weathering rates of parent material could affect local concentrations. This work demonstrates how environmental change may cause widespread changes in soil element concentrations in the future, which could have both positive and negative effects on human health.

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Evaluating Emerging Chemicals of Concern and Non-Chemical Stressors in the 21st Century:
A Multivariate Approach using Machine-Learning Algorithms

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It has been estimated that over 200,000 chemicals are in active use in the world today. In China alone, as many as 250 new chemicals are released into the environment each year. Worldwide, less than 300 of these chemicals are regulated or routinely monitored in the environment. Current regulatory programs are focused on evaluating toxicity and setting environmental standards on a chemical-by-chemical basis, through a laborious and costly process that often involves both laboratory studies and field data. As a result, very few criteria have been developed for new chemicals in the last 20 years, although considerable concern has been expressed regarding chemical classes such as pharmaceuticals, personal care products, PCB analogues, other chlorinated, brominated, and fluorinated compounds, nanoparticles. Currently, the environmental effects of most of these chemicals are unknown. It is uncertain which of these chemicals are of concern, particularly relative to non-chemical environmental stressors. We present a conceptual model for development of a multivariate approach to identifying and regulating chemical and non-chemical stressors, making use of 21st century methods that have one common feature – they are able to address hundreds of factors at once. Through these methods, we hope to rapidly identify uncharacterized chemicals in the environment, evaluate which are most likely to have adverse effects, compare the magnitude of these effects to those of non-chemical stressors, identify regulatory thresholds, and perform cost-effectiveness analyses. The approach combines: 1) Analytical methods such as comprehensive two-dimensional gas chromatography/time-of-flight mass spectrometry, capable of efficiently analyzing and identifying hundreds of chemicals at once. 2) Inclusion of non-chemical stressors such as temperature, oxygen, pH, nutrients, salinity, and habitat quality. 3) Toxicity tests. 4) Pharmaceutical-type assays for higher trophic level and human adverse effects (e.g., carcinogenesis, teratogenesis, endocrine disruption). 5) Machine learning techniques for evaluating the data sets and exploring answers to a variety of questions.

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Climate Change Impacts for Washington State Contaminated Sites
A Vulnerability Assessment and Adaptation Strategy to Increase the Resilience of Washington's Contaminated Sites

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This presentation will include the results of a vulnerability analysis and resulting adaptation strategy developed to increase the resilience of the state's contaminated sites to the impacts of climate change. Our ability to improve the resilience of cleanup remedies and respond to the impacts associated with climate change is important to: 1) Protect human health and the environment, 2) Ensure long-term effectiveness of cleaned up sites, and 3) Protect the significant financial and resource investment in cleanup. Ecology conducted a vulnerabilities analysis of the state's ~11,000 contaminated sites to understand the effects of climate change impacts. We used the results to develop an adaptation strategy to increase the resilience of cleanup remedies that includes: 1) Technical guidance for Ecology site managers, state and federal agencies, and other stakeholders to implement during each phase of the cleanup process. 2) A web-based GIS application to locate vulnerable sites and understand potential risks. The best available climate science from the Intergovernmental Panel on Climate Change, NOAA, EPA, and University of Washington Climate Impacts Group was used to identify the climate change impacts that can impact contaminated sites. They include: 1) Sea level rise, 2) Flooding, 3) Landslide, 4) Wildfire. This information was used to conduct the vulnerabilities analysis and resulting adaptation strategy. Specifically we: 1) Developed a GIS analytical tool and risk scenarios to determine which climate change impacts posed the highest threat to compromise contaminated sites, 2) Identified what sites and cleanup remedies were vulnerable, and 3) Determined scientific and technical criteria to increase resilience of contaminated sites at different phases of the cleanup process. Final technical guidance was published in November 2017 (Publication No. 17-09-052). Among the cleanup sites that had the greatest vulnerability to these impacts, sea level rise poses the greatest threat to sediment sites and upland cleanup sites near marine and tidally influenced waterbodies.

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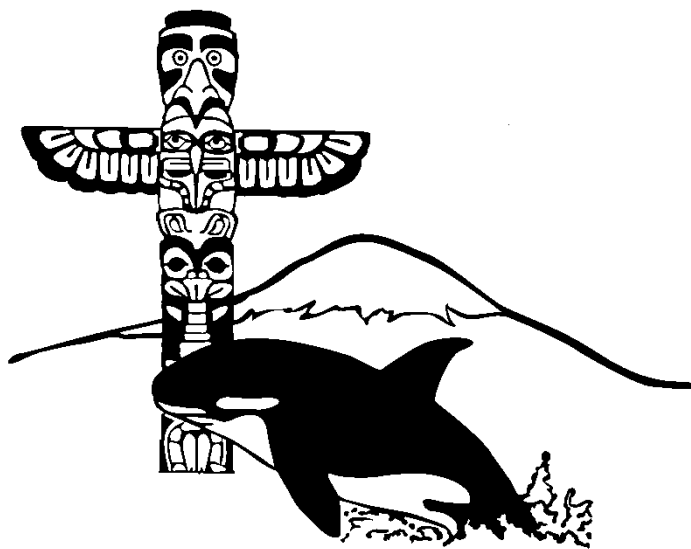
Poster Abstracts
(in alphabetical order)

Transformation and Release of Micronized Cu Used as a Wood Preservative in Treated Wood in Wetland Soil

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Micronized Cu (μ-Cu) is used as a wood preservative, replacing toxic Chromated Copper Arsenates. Micronized Cu is Malachite [$Cu_2CO_3(OH)_2$] that has been milled to micron/submicron particles, many with diameters less than 100 nm, and then mixed with quat or azol biocides. In addition to concerns about the fate of the Cu from μ-Cu, there is interest in the fate of the nano-Cu (n-Cu) constituents as μ-Cu treated wood frequently contacts the ground. We examined movement of μ-Cu from treated wood after placing treated wood stakes into model wetland ecosystems. Release of Cu into surface water and deep soil leachate was monitored. After 5 months, Cu in thin-sections of treated wood and adjacent soil was localized and characterized with X-Ray Absorption Spectroscopy (XAS). Surface water Cu reached maximum levels 3 days after stake installation and remained elevated. Sequential filtering indicated that some of the Cu in solution was associating with soluble organics, but there was no evidence for n-Cu in solution. Deep leachate Cu levels were 10% of surface water levels at day 3 and increased gradually thereafter. Localization and speciation of Cu in the wood and adjacent soil using XAS, clearly indicated that Cu concentrations in the treated wood decreased, and increased in the adjacent soil. However, n-Cu from the treated wood was not found in the adjacent soil. These results indicate that Cu in the μ-Cu treated wood dissolves and leaches into adjacent wetland soil and waters primarily in ionic form (e.g., Cu^{2+}) and not as nano-sized Cu particles.

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Multi-component Analysis to Detect Stress-Induced Hemoglobin Derivatives in Coho Salmon (*Oncorhynchus kisutch*)

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Urban runoff contains a complex mixture of anthropogenically-sourced contaminants that threaten the conservation of culturally and economically significant species, such as coho salmon (*Oncorhynchus kisutch*). Coho exhibit symptoms of cardio-respiratory distress and acute mortality linked to rainfall events, which can also be elicited through exposure to highway runoff. Vehicle-related pollutants could contribute significant levels of oxidative stress in road runoff due to their high content of organic and inorganic chemicals with prooxidative potential. Hemoglobin, the blood protein responsible for oxygen transport, may be an important recipient of oxidative damage, leading to oxygen transport impairment in coho salmon. However, due to observed precipitation upon the addition of oxidizing reagents used in standard fish methemoglobin analysis techniques, we currently lack the methodology to accurately quantify coho hemoglobin oxidative degradation products. As such, we adapted a multi-component analysis (MCA) method that was originally developed for use in humans to characterize the hemoglobin oxidative degradation products in coho. MCA methods are sensitive to between-species differences in the spectral absorbance patterns of hemoglobin derivatives and must be verified prior to their application. Absorptivities of three coho hemoglobin derivatives (carboxyhemoglobin, methemoglobin and hemichrome) were found in visible wavelength regions to be significantly different from values previously reported for humans, while oxyhemoglobin and deoxyhemoglobin did not show significant differences from human absorptivity values. Furthermore, 42% ± 5% of coho hemoglobin rapidly formed hemichrome following heme oxidation. Hemichrome formation leads to irreversible loss of oxygen transport ability due to structural changes of the molecule, leading to precipitation. As such, hemoglobin MCA can be applied to ongoing studies to investigate the potential linkages between pollutants present in highway runoff and the lethal and sublethal effects of hemoglobin oxidative degradation in this important sentinel species.

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An Isotopic View of Water and Nitrate Transport through the Vadose Zone in Oregon's Southern Willamette Valley's Groundwater Management Area

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Groundwater nitrate contamination affects thousands of households in Oregon's southern Willamette Valley and many more across the USA. The southern Willamette Valley Groundwater Management Area (GWMA) was established in 2004 due to nitrate levels in the groundwater exceeding the human health standard of 10 mg nitrate-N L^{-1}. Much of the nitrogen (N) inputs to the GWMA comes from agricultural fertilizers, and thus efforts to reduce N inputs to groundwater are focused upon improving N management. However, the effectiveness of these improvements on groundwater quality is unclear because of the complexity of nutrient transport through the vadose zone and long groundwater residence times. Our objective was to focus on vadose zone transport and understand the dynamics and timing of N and water movement below the rooting zone in relation to N management and water inputs. Stable isotopes of water are a powerful tool for tracking water movement, and transit times. We established lysimeters at multiple depths and groundwater wells in a corn field in the GWMA, and have monitored nitrate and water isotopes biweekly for over a year. Our results indicate that vadose zone transport is highly complex, and the residence time of water collected in lysimeters was much longer than expected. During the fall wetup period, high nitrate concentrations were found in old irrigation water, and not precipitation at 0.75m depth. Water isotopes at 3 m depth also matched that of irrigation water but was low in nitrate concentrations. In March-April after 1m of precipitation fell, water isotopes at 0.75 depth finally match that of cumulative precipitation inputs, and had low nitrate concentrations. However, precipitation water in March-April carried high nitrate concentrations to 3m depth. We are exploring how these vadose zone complexities can be incorporated into practical understanding of the impacts of N management on groundwater inputs.

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The Acute Effects of Constant vs. Cycling Hypoxia on Rainbow Trout

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Twenty-four (24) hr acute tolerance tests were conducted at 12 and 16 ºC with rainbow trout acclimated to 4 mg/L dissolved oxygen (D.O.) and then exposed to various hypoxic oxygen regimes. Constant D.O. exposures were conducted at levels from 0.8 to 1.6 mg/L, while single cycling exposures, changing down and then back up at the rate of 1 mg/L/hr were conducted to minima at levels from 0.7 to 1.2 mg/L. Total mortality occurred at 1.1 and 1.2 mg/L at 12 and 16 ºC, respectively in constant exposure, and at 0.67 and 0.85 mg/L at 12 and 16 ºC, respectively in cycling exposures. No mortality occurred with cycle minima of 1.0 and 1.3 mg/L at 12 and 16 ºC, respectively, or at 1.4 and 1.6 mg/L in constant exposure at 12 and 16 ºC, respectively. LC50s for the constant and cycling exposures were l.29 and 0.88 mg/L, respectively at 12 ºC, and 1.44 and 1.08 mg/L, respectively, at 16 ºC. In an ancillary study, holding trout at constant D.O. and increasing the water temperature by 1ºC per day resulted in lower lethal temperatures at 2 and 3 mg/L, but not at 4 and 5 mg/L, compared to 8 mg/L.

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Calibration of Energy Input during the Preparation of Aqueous Nanoparticle Dispersions

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When evaluating the fate and toxicity of nanoparticles, it is recognized that the size of NP agglomerates significantly affects the dose to organisms and observed effects. To achieve stable NP dispersions, ultrasonic waves are used to break apart large agglomerates, and several standard ultrasonication protocols have been proposed to improve the reproducibility of data and uniformity of NP dispersions. However, we reviewed recent nanotoxicology studies which revealed that sonication procedures vary greatly in the type of ultrasonicator used, total energy input, and reporting of associated metadata. In this study, we demonstrate a method to deliver equivalent energy to NP dispersions using two different ultrasonicator systems: a bath and a cup horn ultrasonicator. The power input was varied while maintaining an equivalent energy input of 8400 J. Our sonication protocol was applied to CeO_2 and TiO_2 NPs of similar primary particle size dispersed in MQ water, 0.1 mM KCl, and simulated fish water. The hydrodynamic diameter (HDD) was measured using dynamic light scattering (DLS) to assess agglomeration. We found that HDD was not significantly different between ultrasonication systems or power inputs for a given material and dispersion medium. The delivered sonication energy was then altered (4200-16800 J) for NP dispersions in 0.1 mM KCl. CeO_2 NPs exhibited a decrease in HDD with increasing energy, but TiO_2 NPs did not display energy dependent agglomeration behavior, emphasizing that optimal energy input for stable NP dispersions is material specific. This study presents a method to deliver equivalent sonication energy using different ultrasonication systems and power settings. We recommend that future studies implement these calibration methods and report sonication energy, dispersion medium, NP material, and DLS data to better inform NP exposure in relevant testing conditions.

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Restoration Scaling of Cultural Service Injuries Using Structured Decision Support

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Various environmental regulations require the protection from, mitigation of, and/or restoration of cultural services impacted by proposed development projects and releases of environmental contaminants. NRDA regulations require restoration and compensation of lost use of ecosystem services, including both direct-use and non-use of cultural services. Direct-use cultural service values are considered those that can be measured using traditional economic methods (e.g., tourism and recreation) and are often included in NRDA claims. Non-use values (sometimes referred to as non-market or passive values) include existence and bequest cultural values and can be described as cultural services associated with natural resources from which the public derives value independent of direct use (e.g., existence, spiritual, sense of place, educational, and other values). Non-market cultural services are especially important to Native American peoples and are generally considered nonmaterial, non-consumptive, and non-measurable using traditional economic methods. The inclusion of requirements to restore injured cultural services and compensate for their lost use associated with natural resource injuries under NRDA regulations for CERCLA, OPA, and CWA presents a dilemma for non-market services if we don't know how to measure them in an objective, acceptable manner. Based on methods developed assisting First Nations and Aboriginal peoples in Canada using multi-criteria attribute, structured decision support, and negotiation theories, this presentation presents a method for scaling threatened or lost passive cultural services associated with natural resource injuries from environmental contaminants. Our presentation includes a brief review of the regulatory requirements for acceptable assessment methodologies under NRDA and describes how the proposed method complies with these requirements.

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Attenuation of Brominated Flame Retardants in Hepatic Microsomes Derived from Starry Flounder

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Polybrominated diphenylethers (PBDEs) have been widely used as flame retardants in furniture, computer circuit boards and other consumer goods. These brominated flame retardants (BFRs) have now become globally distributed as they leach from their substrates and often undergo long range transport and end up in isolated environments. Studies of PBDEs have shown that though somewhat unreactive in an abiotic environment, they undergo biotransformation in biotic systems. This project utilized microsomes extracted from Starry Flounder hepatic tissue to investigate their part in the debromination of BDE 99 to BDE 47, two PBDE congeners that are commonly found in environmental matrices. Flounder liver tissue was homogenized and microsomes were extracted via fractionation, characterized for protein content and enzyme activity and then used in assays with BDE 99. The disappearance of BDE 99 and appearance of BDE 47 and any lesser bromininated BDEs was analyzed using gas chromatography-mass spectrometry. The data was compared to that from previous studies of BDE 99 debromination by hepatic microsomes isolated from staghorn sculpin. Both starry flounder and staghorn sculpin are forage fish common to near-shore environments of the Pacific Ocean and their interaction with PBDEs may be tied to not only environmental levels of these contaminants but may also indicate health threats to Pacific fisheries. The structural similarity of BDE 99 to the thyroid hormone, thyroxine allows it to disrupt normal thyroid function and its ensuing debromination to BDE 47, a known neurotoxin, adds to the problems posed by these contaminants. Since PBDEs are persistent in natural environments, they pose a long-term threat to ecological and human health. The results presented in this poster shed light on the mechanisms by which BFRs are broken down in biological systems and helps explain the various levels of BDE 99 and BDE 47 in the two fish species studied.

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Probabilistic Methods to Evaluate the Relationship between Chlorpyrifos Use at the Watershed Scale and Impacts on Aquatic Resources

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Pacific Northwest freshwater resources are key elements in the life history and ecology of Pacific salmon and steelhead (*Oncorhynchus sp.*). In addition to overfishing, critical habit degradation and loss has been identified as contributing to population decline, resulting in 26 evolutionarily significant units listed as threatened or endangered under the Endangered Species Act. Characterizing risks to Pacific salmonids and their food web requires complex spatial and temporal information on life history and ecology, as well as pesticide use patterns and environmental fate. The Zollner Creek watershed, located in the Willamette River Basin in Oregon, contains designated critical habitat for two ESA listed Pacific salmonid species and has been intensively monitored since the early 1990s. The Soil and Water Assessment Tool (SWAT), a watershed scale ecohydrologic model, was used to estimate continuous daily pesticide surface water loading for 2010 and 2011. Probabilistic methods were used to characterize chlorpyrifos spatial and temporal use patterns to derive daily estimates of chlorpyrifos surface water loading; estimates are compared to surface water monitoring data to evaluate model performance. The 2 year pattern of chlorpyrifos exposure was used to evaluate acute and chronic impacts on aquatic macroinvertebrate species associated with the salmonid food web.

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Oxidation of Polycyclic Aromatic Hydrocarbons in Secondary Organic Aerosol Particles

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Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous environmental pollutants which are transported globally on fine particulate matter (PM 2.5). Secondary organic aerosols (SOA) are naturally formed through atmospheric reactions of biogenic volatile organic compounds, making up a large fraction of PM 2.5, and have been shown to trap and transport PAHs. SOA particles have been shown to consist of highly oxidized organic compounds (HOCs), which have the potential to react with other organic components such as PAHs. The chemical speciation of PAHs within individual particles needs to be explored to improve atmospheric transport modeling and human risk assessment. In controlled laboratory experiments, SOA will be grown with gas phase a model PAH, phenanthrene present. Particles will be monitored for physical characteristics over time, and filters of SOA particles will be collected and analyzed for PHE and PHE transformation products. The chemical changes in PHE over time will provide information that modelers can use to help predict PAH transport in PM 2.5 and will be screened for changes in toxicity. Preliminary experiments have shown that PHE reacts within SOA to form mono-hydroxy PHE, and poly-hydroxy PHE, and the ratios of compounds continues to change over aging of the particles.

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Using Polycyclic Aromatic Hydrocarbons to Track Air Pollution Sources

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Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous atmospheric contaminants which are transported around the globe on fine particulate matter (PM 2.5). Oil refinery emissions regulations do not currently include PAHs in regulatory advisories. In an attempt to track oil refinery emissions, two high-volume air samplers have been deployed to collect PM 2.5 near an oil refinery complex. Paired filters are being analyzed with local and global air mass tracking applications to determine if PAH emissions coming from the refineries can be determined. The two samplers are 7 kilometers apart, with one placed 1 km from the fenceline of the refinery property, and the other in the center of a nearby village. Using advanced GC/MS methodology, I am looking at PAH concentrations, as well as PAH transformation products concentrations to establish chemical profiles during different weather patterns all year long. Profiles will be used to discern emissions coming from the refineries when weather conditions are directly affecting the samplers.

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Systematically Defining the Bioactivity of a Diverse Suite of Precision-Engineered Nanomaterials Using a High-Throughput Zebrafish Screening Paradigm

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The bioactivity of engineered nanomaterials (ENMs) is influenced by physicochemical characteristics such as core material, size and surface chemistry. Systems level investigation of nano-bio interactions *in vivo* can uncover relationships between ENM characteristics and higher order biological outcomes (e.g., behavior) that would be missed *in vitro*. Our approach was a systems level study to evaluate the bioactivity of well-characterized, precision-engineered metal oxide, silica oxide, and silver silica nanomaterials. Our objective is to generate an ENM bioactivity data set that might be broadly applicable to vertebrate developmental hazard potential. ENMs were synthesized and characterized by the HSPH-NIEHS Nanosafety Center at Harvard University and stably dispersed in ultra-pure water using a rigorous and standardized sonication protocol, which included monitoring hydrodynamic diameter and zeta potential over time. Zebrafish were dechorionated and statically exposed to each ENM (0, 2.32, 5, 10.7, 23.2, or 50 µg/ml; n=32/conc) from 6-120 hours post fertilization (hpf). Two behavioral assays, one at 24 hpf, a second at 120 hpf, and 22 developmental morphological endpoints were evaluated. Silver silica nanocomposites (4% or 16% [w/w]) were associated with significant mortality at 24 and 120 hpf. Aluminum oxide, cerium oxide, silica oxide, and iron oxide nanomaterials were associated with abnormal behavior (hyper- or hypoactivity) at 24 and 120 hpf. Collectively, these results enhance our understanding of complex structure-activity relationships at the nanoscale and could contribute toward the rational design of safer nanomaterials and better hazard prediction. Future studies will investigate the role of oxidative stress and cell death in the acute toxicity of the silver silica nanocomposites and persistence of neurodevelopmental deficits into adulthood. These studies were supported by U01 ES027294.

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Integrating Global Climate Change Stressors and Human Health and Well-Being Endpoints into a Bayesian Network Relative Risk Model of the Skagit River

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Global climate change (GCC) is expected to have widespread impacts on future ecosystem services in the Salish Sea. In this research, we focused on the question of how stressors generated by GCC affect contaminant toxicity to marine species in the Skagit River, WA. Specifically we assessed how those combined effects potentially influence risks to the ecosystem services that, in turn, impact human health and well-being. To answer this question, we are conducting an ecological risk assessment using the Bayesian network Relative Risk Model (BN-RRM). It is a quantitative, probability-based approach that calculates complex relationships between ecological variables to provide estimates of risk to valued receptors (endpoints). The Skagit River study area contains important habitats for native salmon species and bald eagles (*Haliaeetus leucocephalus*). These species provide numerous ecological, economic, cultural, and spiritual benefits to humans. Its floodplains also provide fertile, highly productive croplands, making it an important agricultural center in the region. Pesticide use on croplands in the watershed may pose risks to these non-target species that may increase in severity with GCC. Increasing water temperature, decreasing dissolved oxygen, and changes in seawater pH are of particular interest, as are changing river and stream flows, increasing storm event frequency and intensity, and sea level rise. These stressors have potential to impact human health and well-being endpoints such as human health, water quality, salmon fisheries, tribal cultural and community health indicators, recreation areas, tourism, agriculture, boating, fishing, and shellfishing. The risk assessment will enable us to calculate the risks posed by pesticides on these select endpoints in the Skagit River watershed due to climate change. Once constructed the risk assessment framework can also serve as a useful tool for resource managers and decision-makers to direct future research in the watershed, as well as in other watersheds in the Salish Sea region.

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Analysis of Polycyclic Aromatic Hydrocarbon Transformation Products by High-Resolution Mass Spectrometry Coupled to High-Performance Liquid Chromatography

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Polycyclic aromatic hydrocarbons (PAHs) are environmental contaminants generated by the incomplete combustion of organic compounds. Several PAHs have been classified as toxins, mutagens and/or carcinogens, which has led the United States Environmental Protection Agency (US EPA) to list 16 PAHs as priority pollutants. Gas chromatography coupled to mass spectrometry (GC-MS) is commonly used to screen for PAHs in complex environmental matrices. PAHs can be metabolized by mammals and some microbes to form hydroxylated PAHs (OHPAHs) and a variety of other transformation products (TPs). PAH-TPs are more polar than their parent compounds and consequently have the potential to be more toxic and mobile in the environment. A high-performance liquid chromatography (HPLC) method was developed to separate a mixture of ten OHPAHs. Detection was performed with a high-resolution time-of-flight mass spectrometer (HR-TOF-MS) equipped with an electrospray ionization source operated in negative ion mode. Baseline resolution of the OHPAHs, including three hydroxyphenanthrene isomers, was achieved with a C_{18} column and a run time of 25 minutes. HR-TOF-MS provided high mass accuracy and resolution, allowing accurate determination of each OHPAH molecular formula. Other PAH-TPs will be analyzed with this method, which will enable separation of complex mixtures without the derivatization step required for GC-MS analysis. This will reduce sample preparation time and make the identification and quantification of target compounds more efficient. The workflow will also be used to identify unknown transformation products that contribute to toxicity, a process called non-targeted analysis.

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Histological Study of the Transgenerational Impact of 17α-ethinylestradiol on Gametogenesis in F4 *Oryzias melastigma*

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Endocrine Disrupting Compounds (EDCs) are known to interfere with endocrine function in humans and wildlife by affecting the biological systems responsible for an organism's growth, metabolism, reproduction and immune function. Estrogenic EDCs (EEDCs) have the potential to impact an organism's estrogen pathways by mimicking natural estrogen or binding to its receptors. 17α-ethinylestradiol (EE2) is of particular interest as a synthetic estrogen and a persistent compound in aquatic ecosystems. EE2 is known to impair an organism's reproductive fitness and potentially the sustainability of the population. Studies on EEDCs and EE2 on reproduction have largely involved the F0 and F1 generations during direct exposure. There is a need to investigate the transgenerational impacts in the F3 generation and beyond. These studies target modifications that could result in downstream impacts from EE2 exposure on the development of offspring. The marine medaka (*Oryzias melastigma*) was used as a fish model to study the effect of EE2 on reproductive fitness using gonadal histology on the F4 generation. Developmental abnormalities were detected in oocytes alongside a decrease in more mature spermatocytes across the high concentration exposures for long term parental exposure group. Although this trend was established, additional work is needed to address transgenerational impacts particularly the underlying molecular, biochemical and physiological changes that occur that impede an organism's ability to reproduce.

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Environmental Toxicology and Chemistry at EPA's Western Ecology Division

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The US Environmental Protection Agency's Western Ecology Division (WED) has been involved in environmental toxicology and chemistry research since its inception in 1961 when it was established as the Pacific Northwest Water Laboratory. Currently, WED is one of four ecological effects divisions of the National Health and Environmental Effects Research Laboratory, distributed bio-geographically on the coasts. Our mission is: 1) to provide EPA with national scientific leadership for terrestrial and regional-scale ecology; and, 2) to develop the scientific basis for assessing the condition of aquatic resources and their response to natural and anthropogenic stresses. Key scientific disciplines at WED include: terrestrial and aquatic ecology, landscape ecology, wildlife biology, plant physiology, biotechnology, toxicology, biogeochemistry, oceanography, geography, geospatial statistics, economics, ecological risk assessment and systems modeling. The Division seeks to advance scientific understanding through experiments, field studies, modeling, and analysis of large-scale environmental and ecological data sets. Scientists at WED provide technical support to EPA's national Offices, Regions, States and Tribes. Our ultimate objective is to provide the best available research information and analytical tools are available to the EPA as it implements the Agency's mission to protect human and environmental health. We will describe selected WED research on heavy metals in wetland soils, using stable isotopes to understand fate and transport of nutrients than can lead to eutrophication, how pyrolized organic matter (biochar) can help attenuate heavy metal contamination in soil and facilitate land remediation, how engineered nanomaterials move and are transformed in the environment and their effect on plant genomics and how the built environment affects the fate and transport of heavy metals and nutrients in urban areas.

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Bioaccumulation of Copper and Zinc in the Fruticose Lichen *Ramalina Farinacea* Analyzed By Sequential Extraction and SEM

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To evaluate the heterogeneity of metal accumulation in lichens, sequential metal extraction and scanning electron microscope imaging will be performed on *Ramalina farinacea* exposed to varying concentrations of copper and zinc in the laboratory. First, in a 72 hour toxicity test, *R. farinacea* lichens were dosed with a range of copper and zinc concentrations at 0, 24, and 48 hours. To analyze the cellular location of metals, EDTA will be used as a chelating agent in sequential extraction of the water-soluble non-bound metals, extracellular metals, and intracellular metals. Lichen samples will then be digested and analyzed to quantify particulate metals. Scanning electron microscope imaging will also be used to determine accumulating particles of copper and zinc on exterior and interior thalli by using a microtome to cross section the lichen. Results collected to date will be presented. We hypothesize that the highest metal concentrations will be observed for the extracellular metals due to the short-term lab exposure to copper and zinc allowing little time for intracellular accumulation.

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Biochar Improves Performance of Plants for Mine Soil Revegetation

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Biochar (the solid by-product of pyrolysis of biomass), has the potential to improve plant performance for revegetation of mine soils by improving soil chemistry, fertility, moisture holding capacity and by binding heavy metals. We investigated the effect of gasified conifer softwood waste biochar to improve the growth of wild blue rye (*Elymus glaucus*) and Douglas fir (*Pseudotsuga menziesii*) seedlings growing in a low pH mine spoil soil with a variety of amendments. Preliminary results indicate that addition of 1% lime (by weight) was required to raise the pH of the soil enough to allow for plant growth, with biochar causing a slight additional increase in pH. Biosolids (2% by weight) were added to supply nutrients, but resulted in phytotoxicity due to excess N. Biochar (1, 2.5 or 5% by weight) in addition to lime and biosolids, enhanced plant growth, especially for wild blue rye, with increased growth as biochar amendments increased. Biochar likely reduced the concentration of plant nutrients to below plant phytotoxic levels. The interaction of soil inoculation with Locally Effective Microbes (LEM) and rate of biochar amendment also was evaluated for Douglas fir. Overall the study suggested that addition of biochar in combination with other appropriate soil amendments will enhance plant growth for revegetation purposes low pH metal-contaminated mine soils.

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Assessing the Risk of Microplastics in Marine Nearshore Environments and Biota Using the Bayesian Network-Relative Risk Model

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Microplastics are emerging as a contaminant of interest in marine environments. Microplastics can cause physical damage to organisms via ingestion or respiration, can interact with other chemicals in the environment, and can act as a mode of transport for less mobile microorganisms and toxicants. The toxicological effects have been documented in the recent literature, but the exposure of microplastics to key endpoints are relatively unknown. The aim of this project is to sample multiple locations of the Salish Sea region for the presence, location, size, and area cover of microplastics. This data will be input into the Bayesian Network-Relative Risk Model (BN-RRM) to illustrate the exposure-effect pathway of microplastics to specific, key endpoints in the nearshore environment. The model will also include other ecological and physical stressors in the region that could potentially affect the endpoints. We will integrate Bayesian networks to calculate the relative risk for each endpoint, which will be displayed as a probability. The goal of this project will be to develop a model that can be updated periodically as more data emerges regarding the exposure and effects of microplastics on marine nearshore environments.

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Modeling Potential Population-level Impacts of Oil Spills on Puget Sound Pacific Herring Stocks

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Localized oil spills that contaminate nearshore spawning areas pose a threat to developing Pacific herring embryos. Fish embryos are particularly susceptible to the developmental toxicity of oil derived PAHs, which can be acutely lethal or, at lower exposure doses, lead to permanent changes in heart structure, craniofacial morphology, and metabolic processes that cause delayed mortality, or more subtle delayed impacts that may be associated with premature subadult mortality. A variety of localized oil spill scenarios simulating direct and delayed mortality to young of the year were used to examine the potential response of Puget Sound stocks. The healthy stocks remaining in Puget Sound could withstand short term impacts, but the growing number of depressed and unhealthy stocks are vulnerable to an increased risk of localized extinction. Model output predicted that for short term, low level impacts the stock abundance did not exceed the natural variability observed in the population demographic data. This indicates a limited ability to observe in the field any predictions made by the model. High mortality in a single year or impacts across multiple year classes may cause stock abundance changes that exceed natural variability. Despite this, the model does indicate the magnitude of impact on the intrinsic growth rate that could reduce productivity of affected stocks. Additional toxic endpoints and effects thresholds are currently being investigated, including sublethal impacts on cardiac function, immune function, and lipid metabolism that may all lead to delayed mortality. Characterizing these adverse outcome pathways may alter predicted impacts of oil spills on herring stocks.

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Residual Level, Dietary Exposure and Health Risk of DDTs and HCHs in a Typical Northern City in China

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In a market basket study made in Linfen, a typical northern city in China, eleven categories of foods were sampled in January 2015. Concentrations of DDTs and HCHs in foods were determined by GC-MS. The residual amounts of DDTs and HCHs in foods were $1.63 \sim 21.28$ ng·g^{-1} and $0.52 \sim 4.62$ ng·g^{-1}, respectively. The highest residual of $\sum_{10}$OCPs was 19.04 ng·g^{-1} in fish whereas the lowest was 2.75 ng·g^{-1} in flour. With respect to food categories, the consumption of vegetables generated the highest dietary exposure, accounting for $25.13\% \sim 32.13\%$ of the total dietary exposure. Non-cancer risk induced by DDTs and HCHs exposures was found negligible for local residents, whereas cancer risk was estimated to be within $10^{-6} \sim 10^{-4}$, which was higher than the acceptable risk level. Among residents of different gender and age, females showed higher risk than males in all age groups, and children were the most vulnerable age group to health risk.

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