

# *Program and Abstracts*



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

## **28<sup>th</sup> Annual Conference**



*Bell tower across from the Vancouver (WA) Hilton.*

**April 4-6, 2019**

**Hilton Vancouver Washington  
301 W. 6<sup>th</sup> Street  
Vancouver, WA 98660**

**Hilton Vancouver Washington**  
301 W 6<sup>th</sup> Street, Vancouver, WA 98660  
Phone: 1-360-993-4500, FAX: 360-993-4484

**For Hotel Guests:**

- Reservations through [Booking Link](#) or call and use booking code PWN. **Deadline: March 14<sup>th</sup>!**
- Check-in time: 4:00 PM, check-out time: 12:00 PM
- Free Wi-Fi
- Guest Self-parking is \$18/day, valet parking is \$23/day. Overnight guests have access to the underground garage located on the east side of the hotel (at Columbia between 5<sup>th</sup> & 6<sup>th</sup>) after they have check in at the hotel.

**Conference Attendees (non-hotel guests) Parking**

- Is available at the "Park and Go" lot located at the N.E. corner of 6th and Columbia. Fees are \$1.25/hour and the receipt must be attached to the driver's side window. Pay Stations accept coins, VISA and MasterCard payment options.

**Directions to Hotel (See Map 1):**

- From I-5S take Exit 1C and stay in right lane
- Turn right on onto WA-510/E 15th St./Mill Plain Blvd (City Center signs)
- Turn left onto Columbia St.
- Turn right onto W. 6th St
- At the traffic circle take the 4th exit and stay on W. 6th St heading east.
- The hotel is on the right.

**Directions from South**

- From I-5N take Exit 1B toward City Center/Convention Center and stay left
- Turn slight left onto E. 6th St.
- At the traffic circle take the 4th exit and stay on W. 6th St heading east.
- The hotel is on the right.

**From the Portland International Airport (PDX)** Take I-205 North over Glen Jackson Bridge into Washington

- Take the first exit onto Hwy. 14 W towards Vancouver
- Stay on Hwy. 14 approx. 7 mi., follow signs into City Center
- Go left and follow signs to 6th St.
- Hotel is on the corner of 6th and Columbia.
- Distance from Hotel: 12 mi.
- Drive Time: 20 min.

Transportation to and from PDX Airport:

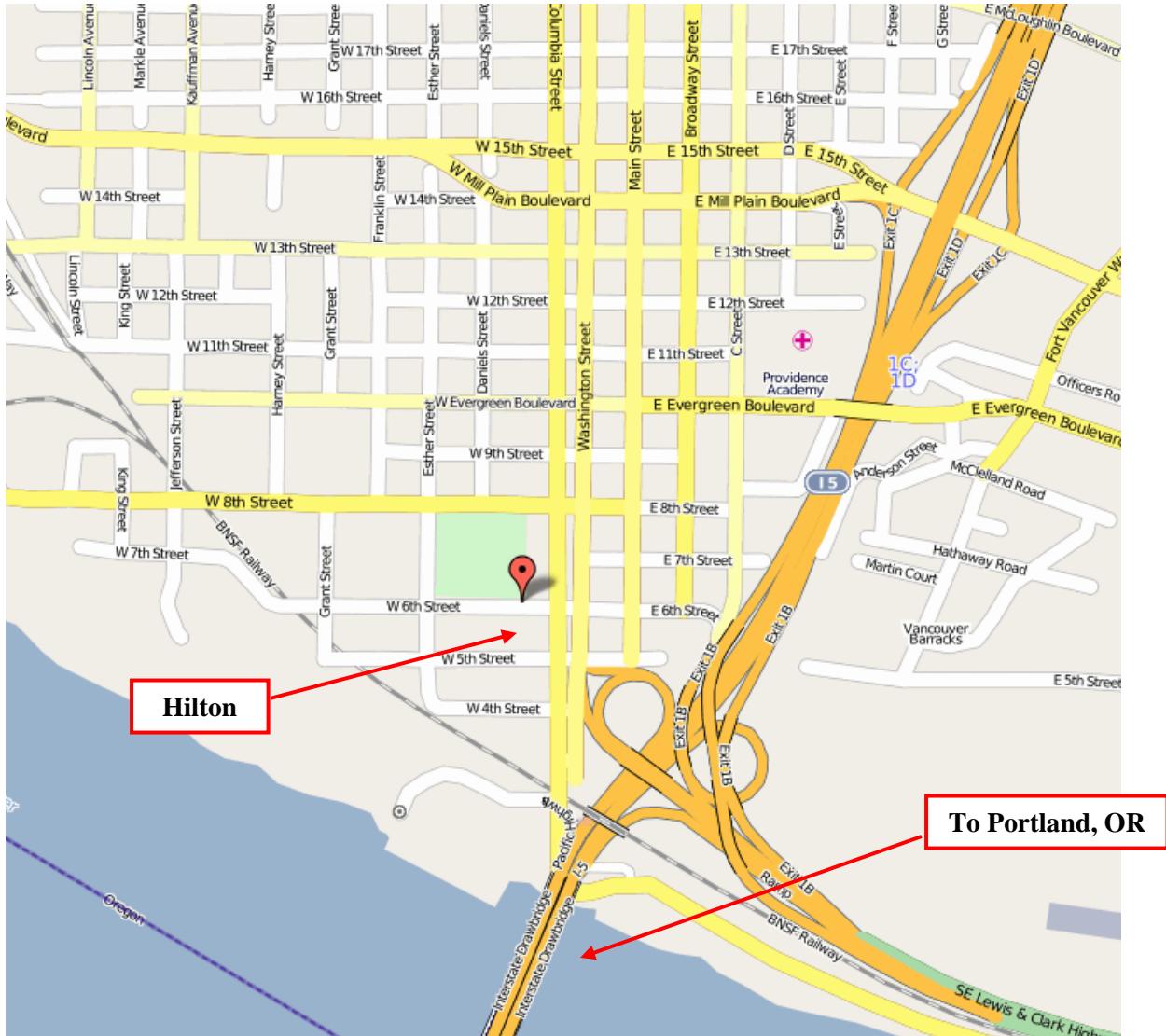
Type	Typical Minimum Charge
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Rental Car	75.00 USD
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Taxi	40.00 USD
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Various other	30.00 USD
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## Vancouver Hilton Location and Vicinity Map



**Map Inset**



# **PNW-SETAC**

## ***Acknowledgments***



**Many thanks to all of you who volunteered your time to make this meeting possible:**

<b>Plenary Speaker:</b>	Jenifer McIntyre, Washington State University
<b>Session Chairs:</b>	Dorothy Horn, Portland State University Ruth Sofield, Western Washington University Erik Naylor, Maul Foster & Alongi, Inc.
<b>Special Session:</b>	Dorothy Horn, Portland State University
<b>On-Site Coordinator:</b>	Kara Warner, Golder Associates Inc.
<b>Abstract Review:</b>	Julann Spromberg, NOAA Fisheries Kara Warner, Golder Associates Inc.
<b>Meeting Program:</b>	April Markiewicz, Western Washington University Kaley Major, Oregon State University
<b>Fun Run:</b>	Erik Naylor, Maul Foster & Alongi, Inc.
<b>Student Social:</b>	Stephanie Krail, Oregon State University
<b>Meeting Registration:</b>	April Markiewicz, Western Washington University
<b>Volunteer Coordinator:</b>	Stephanie Krail, Oregon State University
<b>Student Travel Awards:</b>	Ed Kolodziej, University of Washington
<b>Student Presentation Awards:</b>	Erik Naylor, Maul Foster & Alongi, Inc. Ed Kolodziej, University of Washington Bryson Finch, WA Department of Ecology
<b>Fundraising</b>	Jeff Wirtz, Compliance Services International

**PNW-SETAC**  
***Meeting Sponsors***



**Special Thanks to all our Meeting Sponsors!!**

**Student Travel Funds**

Azimuth Consulting Group  
Anchor QEA

**Student Best Presentation Awards**

Windward Environmental  
Golder Associates Inc.

**Thursday Welcome Reception**

Compliance Services International

**Refreshment Breaks**

Maul Foster & Alongi, Inc.

**SETAC Books**

SETAC North America

# PNW-SETAC

## *Corporate Members*

### Orca Level



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

#### 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.



**Maul Foster & Alongi, Inc. (MFA)** ([www.maulfoster.com](http://www.maulfoster.com)) is an integrated, multidisciplinary professional services organization consulting in the areas of environmental science, risk assessment, engineering, planning, health and safety, public involvement, and geographic information systems. MFA assists clients in successfully managing the risks and opportunities associated with their projects.

With more than 100 employees in eight Pacific Northwest offices, MFA offers creative and award-winning professional services to clients representing diverse industry and municipal sectors.



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# **PNW-SETAC**

## ***Corporate Members***

### **Chinook 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.

#### **Golder Associates Inc**

**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.



**GOLDER**

# **PNW-SETAC**

## ***Corporate Members***

### **Heron Level**



#### **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).



#### **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](http://www.windwardenv.com)) or contact us at [info@windwardenv.com](mailto:info@windwardenv.com) to learn more about Windward.



# **28<sup>th</sup> PNW-SETAC ANNUAL CONFERENCE**



## **Meeting Program**

**April 4 - 6, 2019**

# PNW-SETAC

## *Conference Agenda*



### **Thursday, April 4, 2019**

11:30 AM – 1:00 PM	<b>Conference Check-in/Registration</b> (2 <sup>nd</sup> Floor Pre-Function)
11:30 AM – 1:30 PM	<b>Sack Lunch Pick-up</b> (for those who prepaid during registration) (2 <sup>nd</sup> Floor Pre-Function)
12:00 PM – 1:00 PM	PNW-SETAC Board meeting (Cedar Room)
1:00 PM – 4:00 PM	<b>Short Course:</b> <i>Bayesian Networks and Risk Assessment Applied to Adaptive Management for Ecological and Human Well-Being Endpoints.</i> Instructor: <b>Dr. Wayne Landis</b> , WWU (Birch Room)
<b>4:15 PM – 5:15 PM</b>	<b>Fun Run!</b> (~5K) From hotel to along the Columbia River waterfront and back. Event Coordinator: <b>Erik Naylor</b> , Maul Foster & Alongi, Inc. (Meet in hotel lobby)
5:00 PM - 7:00 PM	<b>Conference Check-in/Registration</b> (2 <sup>nd</sup> Floor Pre-Function)
6:30 PM – 8:00 PM	<b>Poster setup</b> (Pine/Spruce)
5:30 PM - 8:00 PM	Welcome Reception with Refreshments (Hemlock/Oak)

### **Friday, April 5, 2019**

7:30AM – 5:00 PM	<b>Conference Check-in/Registration</b> (2 <sup>nd</sup> Floor Pre-Function)
7:30AM – 9:00 AM	<b>Poster setup</b> (Pine/Spruce)
8:20 AM - 9:00 AM	Welcome address, Chapter President <b>Kara Warner</b> (Hemlock/Oak) Report from SETAC NA, SETAC NA Board member <b>John Toll</b>
9:00 AM - 5:00 PM	Poster viewing (Pine/Spruce)
9:00 AM - 11:50 AM	Platform sessions (+break for refreshments and poster viewing) (Hemlock/Oak)
<b>12:00 PM – 1:30 PM</b>	<b>Lunch</b> (for those who prepaid during registration) (Cedar)
1:30 PM – 1:55 PM	Chapter Business Meeting, <b>All Welcome to Attend!!</b> (Cedar)
2:00 PM – 4:40 PM	Platform sessions (+break for refreshments and poster viewing) (Hemlock/Oak)
5:00 PM – 6:00 PM	Poster Social (Pine/Spruce)
<b>8:00 PM</b>	<b>Student Social at Main Event Sports Grill</b> (800 Main St) - See <a href="#">Stephanie Krali</a>

### **Saturday, April 6, 2019**

8:00 AM – 9:00 AM	<b>Conference check-in/Registration</b> (2 <sup>nd</sup> Floor Pre-Function)
9:00 AM - 11:35 AM	Platform sessions (+break for refreshments and poster viewing) (Hemlock/Oak)
9:00 AM - 10:40 AM	Poster viewing (Pine/Spruce)
11:35 AM	Student Award Presentations (Hemlock/Oak)
12:00 PM	Adjourn

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

**28<sup>th</sup> Annual Meeting**



**Schedule of Events and Presentations**

**PNW-SETAC**  
***Thursday Short Course***



**1:00 PM, Thursday, April 4, 2019**

**Hilton Birch Room**

*Bayesian Networks and Risk Assessment Applied to Adaptive Management for Ecological and Human Well-Being Endpoints*

**Instructor:** **Dr. Wayne Landis**, Western Washington University

**Overview:**

The application of Bayesian networks to risk assessment and adaptive management assessments was clearly demonstrated in an all morning session at the 2018 SETAC North America annual meeting in Sacramento. Risk assessments for ecological and human well-being endpoints are often seen as separate processes. New research has demonstrated that they are not. In the past the methods have been seen as different due to different terminology and regulatory goals. However they share the fundamentals of the exposure-response paradigm and deal with cumulative effects and heterogeneous endpoints. Now it has been demonstrated that Bayesian network relative risk models (BN-RRM) can be built to describe risk to ecological endpoints and human well-being. It is also possible to build adaptive management tools that assist in the planning of long-term management actions. In this class, attendees will learn some of the basics of the application of Bayesian networks to risk assessment, learn how societal values are an integral part of the process, and how adaptive management is critical to assessment, restoration and protection. 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.

**Please Note:** Attendees should **bring a laptop** to the short course. Handouts and class materials will be available for download from the PNW-SETAC website at <http://www.pnw-setac.org/meetings.html> prior to the class.

**Contact Info:** Wayne G. Landis, Western Washington University.  
Any questions concerning the class, please contact Wayne at: [Wayne.Landis@wwu.edu](mailto:Wayne.Landis@wwu.edu)

# PNW-SETAC

## Thursday 5K Fun Run/Walk



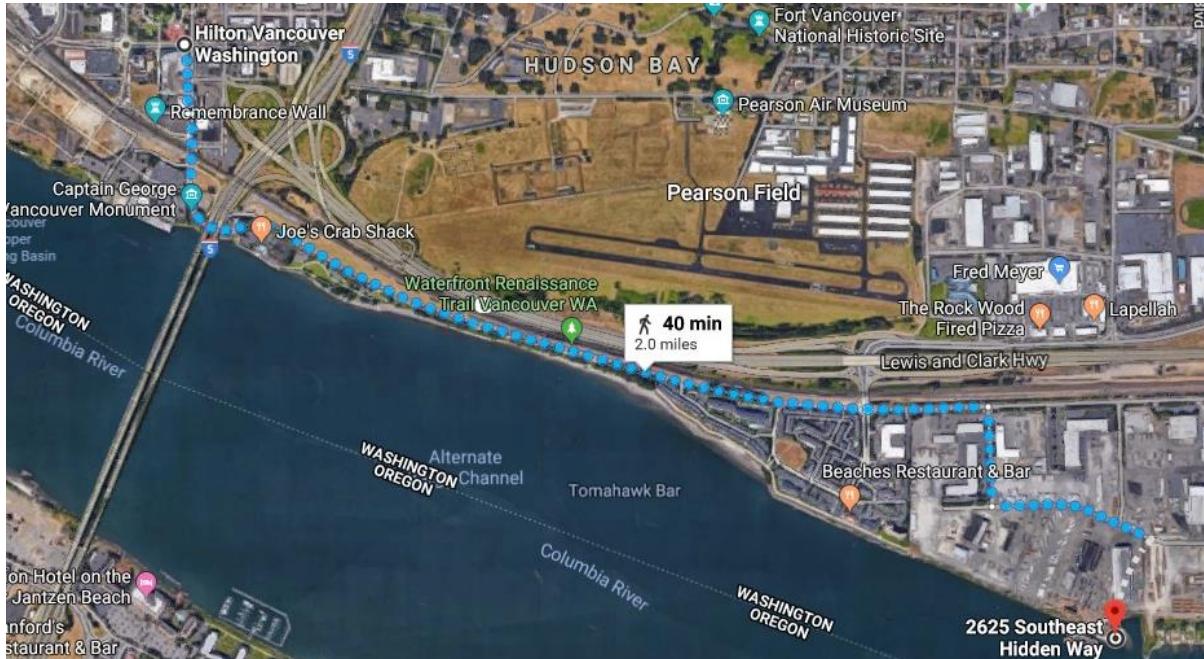
### Columbia River Waterfront Renaissance Trail

4:15 PM, Thursday April 4, 2019



The [Waterfront Renaissance Trail](#) along the north shoreline of the Columbia River provides an accessible, scenic escape for outdoor fans of all levels. The trail is five miles in length and offers paved pathways and interpretive trails that connect downtown Vancouver with the shops, restaurants, and historical attractions of the Columbia River waterfront. Stops include the World War II-era Kaiser shipyards, the Ilchee Statue and Plaza, and the stainless steel Wendy Rose sculpture.

**Erik Naylor**, PNW-SETAC At-Large (Industry) Representative, will lead participants on a roundtrip ~5K run from the hotel, east along the trail, and back to the hotel. Walkers are welcome to join as well and explore the trail's offerings at your own pace. The event is free and participants need to meet in the Hilton Lobby. If you want to explore the trail during the conference – head east on W 6<sup>th</sup> St., turn right onto Columbia St and follow it south and merge onto the trail to the left (east).



# PNW-SETAC

## *Friday Student Social!*



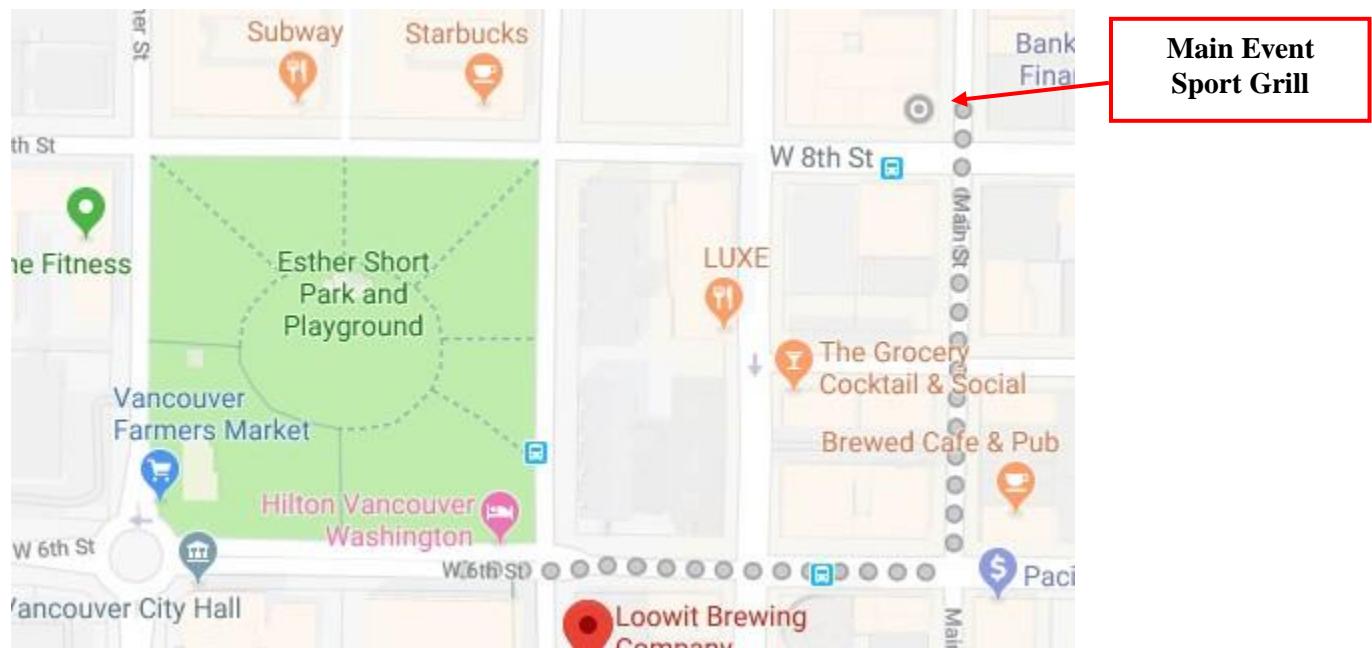
### Main Event Sports Grill

8:00 PM, Friday April 5, 2019



After a long day of platform sessions and the Poster Social, student conference attendees can raise a glass of their preferred beverage on us at the [Main Event Sports Grill](#). Located at 800 Main Street, it is about a 6 minute walk from the Hilton. Just head east on W. 6<sup>th</sup> St. two blocks to Main St., turn left, go two blocks, cross W. 8<sup>th</sup> St. and the grill will be on the left.

**Stephanie Krail**, PNW-SETAC At-Large (Student) Representative, will meet up with students at the Main Event Sports Grill at 8:00 pm. A portion of the bar will be set aside for our PNW-SETAC student conference attendees (sorry non-students have to find their own entertainment!). PNW-SETAC will buy the first round to kick-start the socializing!



**PNW-SETAC**  
***Friday Platform Presentations***  
***Morning Session***



**Hemlock/Oak Room**

**Session Chair:** Dorothy Horn, Portland State University

**New Approaches in Modelling and Monitoring**

9:00	Philip Steenstra	Natural Tungsten in Washington's Surface Waters: Controls and Modeling
9:20	Eric Lawrence	Integrating Climate Change Stressors and Human Health and Well-Being Endpoints into a Bayesian Network Relative Risk Model of the Skagit River Watershed
9:40	Ethan Brown	Conceptual Risk Framework for the Introduction of Transgenic <i>Mus musculus</i> into the Farallones
10:00	<b>Break/Poster Viewing</b>	

**Microplastics in Freshwater and Marine Ecosystems**

10:20	Elise Granek	Research Needs and Future Directions for the Study of Occurrence and Effects of Finfish and Shellfish in North America
10:40	Dorothy Horn	Impacts of Environmentally-Relevant Concentrations of Polypropylene Rope on Pacific Mole Crab ( <i>Emerita analoga</i> ) Development and Lifespan
11:00	Britta Baechler	Microplastic Concentrations in Two Oregon Bivalves: Spatial, Temporal, and Species Variability

**Plenary Speaker**

11:20	Jenifer McIntyre	State of the Science on Stormwater and Coho Urban Mortality
12:00	to 1:30 PM	<b>Lunch (for those who paid at registration)</b>
1:30	to 1:55 PM	<b>PNW-SETAC Business Meeting – all are invited!</b>

**PNW-SETAC**  
***Friday Platform Presentations***  
***Afternoon Session***



**Hemlock/Oak**

**Session Chair:** Ruth Sofield, Western Washington University

**Contaminants of Concern**

2:00	Matthew Slattery	CeO <sub>2</sub> Nanoparticles Alter the Growth of Soybeans and their Root-Associated Microbiome in a Non-Monotonic, Age-Dependent Manner
2:20	Elizabeth Ruberg	Effects of Diluted Bitumen on Survival and Physiology of the Zebra Finch ( <i>Taeniopygia guttata</i> )
2:40	Mason King	Embryonic Exposure to Mercury in a Marine Bird, the Rhinoceros Auklet, and Investigations into Associated Hepatotoxicity
3:00	Amy Ehrhart	Pharmaceuticals and Alkylphenols in Transplanted Pacific Oysters in Oregon and Washington
3:20	<b>Break/Poster Viewing</b>	
3:40	Jenna Keen	The Acute Effects of Anti-sea Lice Pesticides to Brachyuran and Porcelain Crab Zoea
4:00	Daniel King	The Sublethal Effects of the Anti-Sea Lice Pesticides Ivermectin and SLICE® on the Swim Performance, Camouflage and Avoidance Behaviour of the Starry Flounder
4:20	Lindsay Woof	Avoidance Behaviour of a Pacific Marine Amphipod to Aquaculture Chemotherapeutic-Contaminated Sediment
5:00	<b>Poster Social!</b>	Pine/Spruce

**PNW-SETAC**  
***Saturday Platform Presentations***  
***Morning Session***



**Hemlock/Oak Room**

**Session Chair:** Erik Naylor, Maul Foster & Alongi, Inc.

**Monitoring Contaminant Fate and Transport**

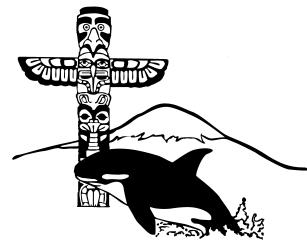
9:00	Lillian Smith	Analysis of Additive Migration from Bio-Based Plastic During Simulated Food Contact
9:20	Robert Johnston	Achieving Water Quality Goals for Coastal and Estuarine Ecosystems: Case Study of Ambient Monitoring in Sinclair and Dyes Inlets in the Puget Sound, WA, USA
9:40	Jonathan Strivens	Acute and Chronic Toxicity Monitoring by Grab Sampling and Diffusive Gradients in Thin-Films of Marine Waters Impacted by Copper

**Environmental Chemistry Tools in the Lab and in the Field**

10:00	Emmanuel Dávila-Santiago	Developing a Powerful and Novel Chemical Forensic Tool for Source-Tracking Pollutants
<b>10:20 Break/Poster Viewing</b>		
10:40	Manuel Montaño	Resolving the Natural Nano-Environment on an Individual Particles Basis Using spICP-TOF-MS
11:00	Erik Naylor	Ground Water Tracer Study, Bunker Hill Superfund Site, East Fork Ninemile Basin
11:20	Nicholas Hayman	Using Integrative Passive Sampling Devices to Obtain More Meaningful and Cost-Effective Data on Metal-Associated Impacts from Stormwater Runoff
11:40	<b>Student Award Presentations</b>	
12:00	<b>Adjourn</b>	

# **PNW-SETAC**

## ***Poster Presentations***



### **Pine/Spruce Room**

#### **Presenter(s)**

#### **Presentation**

Katie Benoit

The Presence of Metals on Algae Cells from the North Cascade Mountains

Stephanie I. Blair

Investigation of Oxidative Stress in Juvenile Coho Salmon (*Oncorhynchus kisutch*) Exposed to Highway Runoff

Julien Bonnard

Measuring Different Metal Valencies in Hard Water via Stabilized Liquid Membrane Devices

Vince Cataldi

Nano-Scale Components of a Commercial Fungicide Formulation Alter Pesticide Risk in a Size-Dependent Manner

Jordan M. Couture

Rotenone Attenuation in High Latitude Lakes and Laboratory Assessment of Photolytic Vs. Microbial Degradation

Bethany M. DeCourten

Exposure to EDCs Influences Development, Reproduction and Gene Expression across Generations in an Estuarine Fish, with Notes on Co-Exposure to Elevated Temperature

Claire N. Eberle

Copper Accumulation of Stabilized Liquid Membrane Devices in Varying Water Hardness

Steven R. Eikenbary

Addressing the Need for Risk Assessment of Gene Drives

Arek M. Engstrom

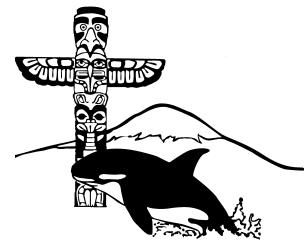
Hybrid Lipid-Coated Silver Nanoparticles with Long-Chain Hydrophobic Thiol Surface Coatings Show Decreased Toxicity Compared to Those Without Robust Surface Coatings

Abigail S. Ernst-Beck

Variability of Carbonate Chemistry in Association with Land Use in a Tillamook Bay Tributary: Tracing Acidification from the River to the Bay

# **PNW-SETAC**

## ***Poster Presentations***



### **Presenter(s)**

Ashley Heuchert  
Natalia Piestrup

William Jensen

Katherine S. Lasdin

Ben D. Leonard

Samantha H. Lundquist

Lane M. Maguire

Gouri Mahadwar

Kaley M. Major

Chelsea Mitchell

Jasmine J. Prat

### **Presentation**

Oxidative Stress Decreases the Efficiency of Photoreactivation in Chlamydomonas

Use of Stabilized Liquid Membrane Devices to Measure Trace Silver in Different Levels of Water Hardness

Quantifying Marine Microplastic Ingestion in Black Rockfish (*Sebastes melanops*) on the Oregon Coast

Quantitative Determination of Microhematocrit in Fish Blood with Computer Vision and K-Means Clustering

The Effects of Salmonid Aquaculture Anti-Sea Lice Chemotherapeutics on Non-Target Benthic Polychaete (*Nereis Virens*) Locomotion and Burrowing Behaviour

Longevity of Bioretention Depths for Preventing Acute Toxicity from Urban Stormwater Runoff

Degrading Contaminants of Emerging Concern Using In Situ Stream and Wastewater Microbiomes

The Potential of Early Life Exposure to Endocrine Disruptors to Cause Transgenerational Epigenetic Changes in a Fish Model

Testing Potential Bioretention Soil Media Amendments for Removal Potential of Polycyclic Aromatic Hydrocarbons and *Escherichia coli*

Assessing Coho Salmon (*Oncorhynchus kisutch*) Sensitivity to Stormwater Toxicity

**PNW-SETAC**  
***Poster Presentations***



**Presenter(s)**

Jenna Rheuben

Kaegan M. Scully-Englemeyer

Fran Solomon

Kristin Thomas

**Presentation**

Considerations for Creating a Simplified Food Web Model:  
An Application of the Arnot and Gobas Bioaccumulation  
Model

Exploring Biophysical Linkages between Forestry Practices  
and Oregon's Freshwater and Estuarine Shellfish

EDuCation about Endocrine Disruptor Chemicals: Bridging  
the Gap between Scientists and the General Public

Microclimate-Induced Variation in the Community  
Structure and Cell Morphology of Snow Algae in a Pacific  
Northwest Snow Algae Alpine Lake Ecosystem

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

**28<sup>th</sup> Annual Meeting**



**Platform Presentation Abstracts**  
(in order of presentation)

## Natural Tungsten in Washington's Surface Waters: Controls and Modeling

Steenstra, P.J.\*; Strigul, N.; Harrison, J.A. Washington State University, Vancouver, WA

Tungsten is a heavy metal which is present in various every-day items and was selected to replace lead in many applications due to its purported insolubility and environmental neutrality. A growing number of studies over the past two decades have begun to correlate tungsten with a variety of human ailments, including stroke, diabetes, childhood leukemia, and peripheral arterial disease. Its presence in the environment has been linked to aquatic toxicity, soil toxicity, and other environmental harm. All of this data together resulted in it being classified as an “emerging contaminant” by the US EPA in 2008 and a priority chemical for biomonitoring in California in 2014. A 2014 study by the Washington Environmental Biomonitoring Survey reported that Washington State resident concentration of tungsten in their urine was 150% the national average, indicating the necessity of further study. Most studies of tungsten focus on anthropogenic sources and the resulting toxicity while very few discuss the factors controlling the solubility and thereby mobility of tungsten from natural deposits into the environment. This study focuses on measuring naturally occurring tungsten concentrations in US Pacific Northwest (Washington State) surface waters, using statistical analysis to identify potential factors controlling tungsten mobility, and utilizing a modeling approach to predict tungsten concentration in unsampled areas using already available data sets. Modeling is crucial as most routine water analyses do not test for tungsten due to the specialized equipment required. This data gap can be temporarily filled using a predictive model and existing datasets until future sampling begins including tungsten in their normal testing suite. The data gathered during this study also allows for the calculation of a background level of tungsten for Washington State and to determine whether appreciable amounts of tungsten are leaching from natural deposits into surface waters.

**Contact Author:** Philip Steenstra, Washington State University  
School of the Environment  
14204 NE Salmon Creek Ave., Vancouver, WA 98686  
T: 734-476-6255, [philip.steenstra@wsu.edu](mailto:philip.steenstra@wsu.edu)

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

Lawrence, E.J.<sup>1\*</sup>; Lackey, L.R.P.<sup>2</sup>; Markiewicz, A.J.<sup>1</sup>; Landis, W.G.<sup>1</sup>. <sup>1</sup>Western Washington University, Bellingham, WA,  
<sup>2</sup>Whatcom Community College, Bellingham, WA

Climate change is expected to have widespread impacts on ecosystem services in the Salish Sea. In this research, we focused on the question of how stressors generated by climate change affect contaminant toxicity to species in the Skagit River watershed. Specifically we assessed how those combined effects potentially influence risks to the river’s ecosystem services that, in turn, impact human health and well-being. To answer this question, we conducted an ecological risk assessment using the Bayesian network relative risk model (BN-RRM). It is a quantitative, probability-based model that calculates complex relationships between ecological variables to provide estimates of risk to valued receptors (endpoints). We incorporated two main stressor pathways: first, water temperature and dissolved oxygen to represent physical parameters that are influenced by climate change and, second, organophosphate pesticides to represent chemical toxicity and to allow for potential interaction effects between climate and chemical stressors. We focused on Chinook salmon (*Oncorhynchus tshawytscha*) population as an ecosystem service to connect pathways from environmental stressors to human health and well-being endpoints such as economic well-being, water quality, food access, traditional resource practices, and commercial, recreational, and tribal fisheries. The BN-RRM enables us to calculate the risks posed by various stressors on these select endpoints in the Skagit River watershed due to climate change. The BN-RRM can also serve as a useful tool for resource managers and decision-makers as part of an adaptive management process and to direct future research efforts in the watershed, as well as in other watersheds in the Salish Sea region.

**Contact Author:** Eric J. Lawrence, Western Washington University  
Huxley College of the Environment, Institute of Environmental Toxicology  
516 High Street, Bellingham, WA 98225  
T: 206-291-7703, F: 360-650-6556, [lawrene2@wwu.edu](mailto:lawrene2@wwu.edu)

## **Conceptual Risk Framework for the Introduction of Transgenic *Mus musculus* into the Farallones**

Brown, E.B., Eikenbary, S.R., Landis, W.G. Western Washington University

To potentially reduce or eliminate the need for chemical rodenticides, the use of an engineered selfish genetic element, or “gene drive” has been proposed to eradicate mouse populations from island systems. The intended effect of this construct is to spread from male mice to their female offspring at an above-Mendelian rate of inheritance, causing female sterility and, hypothetically, an eradication of the island mouse population. However, a quantitative and probabilistic risk assessment has yet to be conducted concerning the release of “gene-drive-modified” house mice into the environment. To begin tackling this issue, we have developed a conceptual risk framework for the theoretical release of transgenic house mice (*Mus musculus*) into the Farallon Islands using the Bayesian Network – Relative Risk Model, which can incorporate toxicological, ecological, and “gene drive” stressors at multiple spatial and temporal scales. Endpoints include abundance of select species in the Farallones, a national wildlife refuge west of the Golden Gate, and potential change in the necessity of chemical rodenticide application on the islands.

**Contact Author:** Ethan Brown, Western Washington University  
Huxley College of the Environment  
516 E College Way, Bellingham, WA, 98225  
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## **Research Needs and Future Directions for the Study of Occurrence and Effects of Microplastics in Commercially Harvested Finfish and Shellfish in North America**

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Commercial fisheries feed the planet, support cultural practices, and provide widespread employment around the globe. Many commercially-harvested species face a myriad of anthropogenic threats such as overharvesting, degraded habitats, changing climate, and pollution. Microplastics, which are 5mm or smaller in length, are an aquatic pollutant of increasing concern that are now ubiquitous and persistent in nearly every ecosystem on the planet. Marine and freshwater organisms, including commercial species, encounter, ingest, and respire microplastics and increasingly microfibers, which harbor pollutants added during manufacturing or adsorbed from surrounding waters. Recent studies have identified widespread occurrence of microplastics in marine organisms ingested as seafood globally, but there is a paucity of data from species caught and cultured in North America. Additional research is necessary to determine the prevalence and impacts of microplastics on organisms harvested for human consumption in the United States of America (U.S.), Canada, and Mexico, as well as the population-level implications for wild and farmed species in these countries. Furthermore, estimates of human ingestion based on seafood consumption and investigations into the possibility of human health impacts are greatly needed. As the human population continues to grow and environmental stressors are amplified, the importance of investigating potential additive or synergistic effects of stressors occurring concomitantly with microplastics grows daily. Opportunities for closing critical knowledge gaps relating to microplastics in commercially important species in North America are discussed herein.

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## **Impacts of Environmentally-Relevant Concentrations of Polypropylene Rope on Pacific Mole Crab (*Emerita analoga*) Development and Lifespan**

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Microplastic is an emerging pollutant in marine and coastal ecosystems. Millions of tons of plastics are added into these systems annually and are of particular concern due to their persistence in the environment, propensity to attract other pollutants, their toxicity and tendency to degrade into microplastics (particles or fibers <5mm) making them easily ingestible. Sandy beaches are consistently exposed to plastic debris accumulation from wave action, near shore currents as well as effluent from waste water treatment plants, exposing the infauna to persistent plastic pollution. Pacific mole crabs (*Emerita analoga*), found in the sandy beaches along the Pacific coast, are filter feeders that have been shown to ingest microplastic in previous studies. To assess the impact of polypropylene fibers on the reproductive development of Pacific mole crabs, adult females were exposed to environmentally relevant concentrations of polypropylene fibers (<1mm) for 2 months during a reproductive cycle. Effects were investigated on offspring development. Our study shows that the exposure and ingestion of polypropylene microplastic debris at environmentally relevant concentrations alters development in Pacific mole crabs and warrants further research.

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## **Microplastic Concentrations in Two Oregon Bivalves: Spatial, Temporal, and Species Variability**

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Microplastics are increasingly recognized as an ecological stressor with implications for ecosystems and humans when found in seafood. This study quantified microplastic types, concentrations, anatomical loadings and geographic distribution in Pacific oysters and Pacific razor clams collected from 15 Oregon coast sites during 2 seasons in 2017. Organisms were chemically digested and visually analyzed for the presence of microplastics. A subset of suspected microplastics were validated with FTIR. Microplastics were present in both species from all 15 sites sampled. Mean microplastic loadings were  $10.95 \pm 0.77$  for Pacific oysters (range= 0-42) and  $8.84 \pm 0.45$  for razor clams (range= 0-38). Over 99% of identified particles were fibers averaging 1.34 mm in length. Spring samples contained more anthropogenic debris than summer samples in oysters but not clams. Significant geographical variation was only found in 2 oyster site pairings ( $p<0.0001$ ) but was not detected in razor clams. This study provides valuable insights about microplastic prevalence in important commercially-harvested and can serve as a baseline from which future microplastic studies in the region can draw comparisons.

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## **State of the Science on Stormwater and the Coho Urban Mortality Syndrome**

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Untreated urban runoff poses significant water quality threats to aquatic organisms. In northwestern North America, ongoing development in coastal watersheds is increasing the transport of toxic chemical contaminants to river and stream networks that provide spawning and rearing habitats for several species of Pacific salmon. Coho salmon (*Oncorhynchus kisutch*) adults are particularly vulnerable to the stormwater-driven mortality syndrome. The phenomenon may prematurely kill more than half of the coho that return each fall to spawn in catchments with a high degree of imperviousness. We evaluated the coho mortality syndrome at the juvenile life stage. Freshwater-stage juveniles were exposed to stormwater collected from a high traffic volume urban arterial roadway. Symptoms characteristic of the mortality syndrome were evaluated using digital image analysis, and discrete stages of abnormal behavior were identified as the syndrome progressed. At a subset of these stages, blood was analyzed for ion homeostasis, hematocrit, pH, glucose, and lactate. Several of these blood chemistry parameters were significantly dysregulated in symptomatic juvenile coho. Affected fish did not recover when transferred to clean water, suggesting a single runoff event to stream habitats could be lethal if resident coho become overtly symptomatic. Our findings indicate the urban runoff mortality syndrome is not unique to adult spawners. Therefore, the consequences for wild coho populations in developing watersheds are likely to be greater than previously anticipated. Also, juvenile coho will provide a much more tractable experimental framework for identifying which chemical contaminant(s) – among thousands in roadway runoff – is causing the syndrome.

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## **Ce<sub>2</sub> Nanoparticles Alter the Growth of Soybeans and Their Root-Associated Microbiome in a Non-Monotonic, Age-Dependent Manner**

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The use of cerium oxide nanoparticles (CeNPs) in fuel additives and other industrial products may result in the accumulation of these nanoparticles in soils. The biological interaction between CeNPs, plants, and the root-associated microbiome is poorly understood. Complicating the issue, the use of pristine nanoparticles in toxicity tests may not be realistic because complex interactions with environmental media can alter the fundamental properties of a nanoparticle (e.g. surface area) over time. Here, soybeans were grown to maturity in a natural soil with either aged CeNPs (3 month incubation in soil) or pristine CeNPs (no incubation in soil) at relatively low (1 ppm) or high (100 ppm) soil concentrations, then compared to control soybeans grown with no CeNPs. Some CeNP exposures caused significant changes to the soybean nodule biomass, bean biomass, number of beans, stem biomass, and plant height, depending on the CeNP concentration and age. Non-monotonic responses were apparent for certain phenotypic endpoints, particularly among the pristine CeNPs. To identify associations between plant growth and the root-associated microbiome, root samples were processed for 16S rDNA amplicon sequencing. The root microbiome structure displayed dramatic shifts that were dependent on spatial proximity to the root surface and CeNP treatment. Pristine CeNPs increased community evenness while fundamentally altering the taxonomic structure, including significant increases in some nitrogen fixing bacteria. Surprisingly, the aged CeNPs did not display this strong deviation from the community baseline despite a significant loss of richness when compared to the control. Overall, impacts to soybeans and their root-associated microbiome are dependent on the concentration and age of CeNPs. In this case, CeNPs produced agriculturally and ecologically relevant changes in the plant-soil system. These results highlight the non-monotonic effects of CeNPs in soil that may change dramatically over time and the potential for microbiome-mediated plant toxicity.

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## **Effects of Diluted Bitumen on Survival and Physiology of the Zebra Finch (*Taeniopygia guttata*)**

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Given the ongoing shipment of conventional and potentially unconventional crude oil such as diluted bitumen (dilbit) out of the port of Vancouver, there is a need for toxicology data to assess the impact of a catastrophic petroleum spillage on marine wildlife. Peer reviewed literature on the effects of diluted bitumen on marine wildlife is limited to teleost fish, despite the importance of coastal waters as habitat for a diverse bird fauna, including listed species. To our knowledge, this is the first diluted bitumen dosing study conducted on adult avian species, specifically zebra finches (*Taeniopygia guttata*). Here we lay down important ground work for the characterization of toxicological effects of dilbit on avian species. Adult male zebra finches were dosed twice a day for 14 days with Cold Lake diluted bitumen (CLB) via oral gavage at a low dose (8 mL/kg bodyweight/day), a high dose (12 mL/kg bodyweight/day), or a vehicle control (safflower oil with egg yolk). CLB was weathered for 36 hours and subsequently mixed into an egg yolk and safflower oil slurry. Finches were blood sampled 7 days prior to dosing, 7 days into dosing, and on day 14 during exsanguination. Physiological endpoints included: survival, body mass, organ mass, aerobic capacity, and oxidative stress. Plumage was scored daily for percent secondary oiling, and treatment groups were video recorded for activity and maintenance behaviours. By day 14 finches in the high dose group experienced significant decrease in body mass ( $\bar{x} = 2.58$  g) and mortality (100%). Additionally, percent plumage oiled increased in both low and high dose groups over the 14 day exposure, while activity behaviours decreased. Mean hematocrit values were not significantly different between treatment groups, even with 100% mortality in high dose finches.

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## **Embryonic Exposure to Mercury in a Marine Bird, the Rhinoceros Auklet, and Investigations into Associated Hepatotoxicity**

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Seabirds can bioaccumulate considerable persistent contaminant body burdens, and maternal transfer to eggs may expose sensitive embryos to high concentrations. Yet, deleterious effects inferred from tissue residue concentrations suffer from uncertainty, and high-throughput techniques to assess biological effects caused by persistent bioaccumulative contaminants or potential environmental disasters like oil spills are lacking in wildlife sentinel species. Our research focuses on the rhinoceros auklet (*Cerorhinca monocerata*), a seabird of the continental shelf, as a sentinel species and aims to demonstrate the utility of hepatic gene expression for linking embryonic contaminant burdens to transcript-level effects throughout the eastern North Pacific Ocean. To quantify embryonic body burdens, we measured the concentrations of polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), brominated and chlorinated flame retardants (FRs), and total mercury (THg) in developed *C. monocerata* embryos from two breeding colonies in British Columbia in 2017. Three THg observations (0.3-0.6  $\mu\text{g g}^{-1}$  ww) fall within literature values for embryotoxicity in this order of seabirds ( $LC_{50}$  0.3-4.3  $\mu\text{g g}^{-1}$  ww). We are currently profiling hepatic gene expression in the sampled embryos to determine whether THg exposure is indeed linked to a response in toxicity-associated genes. Together, these data will signal whether an embryotoxicity hazard from THg and other persistent halogenated contaminants to *C. monocerata* and similar seabirds exists, and further sampling conducted in 2018 is adding to this initial evidence.

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## **Pharmaceuticals and Alkylphenols in Transplanted Pacific Oysters in Oregon and Washington**

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Wastewater discharge, a potential stressor to estuarine species and ecosystems, frequently contains contaminants of emerging concern as many are not fully removed during treatment. These compounds are increasingly identified at low levels in U.S. water bodies, posing unknown risks to ecological communities and human consumers. In this project, we assessed the occurrence of pharmaceuticals and alkylphenols in transplanted Pacific oysters (*Crassostrea gigas*) in Coos Bay, OR, Netarts Bay, OR and Grays Harbor, WA. In July 2016, we collected juvenile oysters from a hatchery and placed them at sites near wastewater treatment plant outfalls and at oyster growout sites. At the wastewater sites, oysters were placed along a hypothesized pollution gradient, with one site adjacent to a wastewater treatment plant outfall and the others at increasing distances (100-1500 meters) from the outfall to assess spatial variation in concentrations. In April (subsample) and July 2017, oysters were collected and abundance, mass and shell size were measured. Composite oyster tissue samples were analyzed for a suite of pharmaceuticals and alkylphenols at SGS AXYS Analytical in Sydney, British Columbia. Two pharmaceuticals were detected in the April 2017 samples (miconazole and virginiamycin M1) and four alkylphenols (NP1EO, NP2EO, NP and OP) were detected in the July 2017 samples. Overall, concentrations were low in comparison to other studies and did not show much variation based on distance to the outfall. Alkylphenols and virginiamycin were detected at oyster growout sites indicating potential for human consumption. This research fills important data gaps on contaminant accumulation in shellfish at sites exposed to emerging contaminants from wastewater. Results may be useful for coastal water quality monitoring and regulations in Oregon and Washington.

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## **The Acute Effects of Anti-sea Lice Pesticides to Brachyuran and Porcelain Crab Zoea**

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The concern for the quality of near-shore coastal waters and estuaries is growing, particularly as these ecosystems become increasingly threatened by anthropogenic chemical inputs. In recent years, the aquaculture industry has become a major contributor to the Canadian economy, however, this industry's use of chemicals to treat sea-louse infestations has resulted in the contamination of local net pen areas, posing a risk of exposure and subsequent toxicity to non-target organisms. Planktonic organisms or those that inhabit the water column for specific life stages, such as larval zooplankton, have been found to be among the most sensitive organisms to these pesticides. This study investigated the lethal and sublethal effects to *Brachyuran* and *Porcelain* crab zoea following acute exposure to one of two sea louse treatments, Salmosan® or INTEROX®Paramove®50. Following 1-h exposures to Salmosan®, Porcelain zoea were found to have an EC<sub>50</sub> of 103 µg/L, while *Brachyuran* zoea were found to have an EC<sub>50</sub> of 206 µg/L. After a 1-h exposure to INTEROX®Paramove®50, *Porcelain* zoea were found to have an EC<sub>50</sub> of 46 mg/L, while *Brachyuran* zoea were found to have an EC<sub>50</sub> of 55 mg/L. This study will contribute necessary information concerning planktonic sea-louse pesticide sensitivities, contributing to the regulation and environmentally vigilant application of aquaculture chemicals in Canada.

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**The Sublethal Effects of the Anti-Sea Lice Pesticides Ivermectin and SLICE® on the Swim Performance, Camouflage and Avoidance Behaviour of the Starry Flounder (*Platichthys Stellatus*) Following Exposure to Dosed Sediments**

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Aquaculture is an important part of Canada's economy, and open net-pen Atlantic salmon (*Salmo salar*) aquaculture is a key facet of this industry. Chemotherapeuticants, including anthelmintics, are often used in salmon aquaculture to prevent the loss of stock due to various pathogens. The formulation SLICE® (active ingredient: emamectin benzoate) and ivermectin (IVM) are two chemicals used in salmon aquaculture in Canada to treat and prevent sea lice infestations. SLICE® and IVM have low water solubilities and long half-lives in sediment (225 d and >100 d, respectively). Due to the persistence of these pesticides and their tendency to accumulate in marine sediments, it is crucial to understand the long-term effects of these compounds on wild benthic fauna, including fish. The sublethal effects of these chemotherapeuticants on Pacific benthic teleosts (Starry Flounder [*Platichthys stellatus*]) using a sediment exposure system were examined. Ecologically relevant endpoints were assessed including: swim performance, growth, oxygen consumption, as well as their camouflage ability and avoidance behaviour and ability to perceive and avoid these pesticides. This work will not only develop several new and novel methods for assessing the effects of chemicals on benthic marine species exposed in sediments, but will also contribute to estimating the risk of these chemotherapeuticants to benthic Pacific fauna, including fish. These findings aid in the development of policies, regulations, and guidelines associated with the use of these chemotherapeuticants, in order to minimize the sea lice infection rates on the farmed Atlantic salmon and increasing yield, while also minimizing the risk to benthic species present below the open-net pens.

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**Avoidance Behaviour of a Pacific Marine Amphipod to Aquaculture Chemotherapeuticant-Contaminated Sediment**

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Salmon farms are an important coastal industry in British Columbia, providing economic stability to coastal communities and a sustainable food source for humans. Operating a finfish aquaculture facility requires effective monitoring methods to reduce potential financial and ecological impacts. Due to the significant implications of sea lice infestation for both farmed and wild salmonid populations, the aquaculture industry in Canada utilises anti-sea lice chemotherapeuticant strategies, polluting the marine environment. Gaps in data have made it difficult to predict the persistence and toxicity of these chemicals, and the potential risks associated with exposure. Benthic organisms are at risk of exposure to two chemotherapeuticants that tend to partition to sediments, ivermectin (IVM) and SLICE® (0.2 % emamectin benzoate [EB]). This study investigated the sublethal effects of chronic sediment exposures of these chemicals to the most potentially susceptible marine organisms. Sediment avoidance assays were performed on the pacific marine amphipod *Eohaustorius estuaries* to assess chemosensory behaviour and toxicity to a benthic species. Animals (n=20) were placed in test vessels that allowed congruent placement of two sediments (one contaminated) and movement of organisms was assessed after 48 h. In the two-chamber system, sediment was spiked with 4 concentrations of SLICE®, IVM, or a combination of both and a control sediment. Prior to the avoidance assay, animals were unexposed or previously exposed to environmentally relevant concentrations of either 5 µg/kg EB, 0.5 µg/kg of IVM, or both for 30 d to assess toxicity and potential for adaptive behaviour. Animals displayed toxicity and avoidance to IVM and the combination exposure. Animals pre-exposed to these chemotherapeuticants suggested adaptive ability, increasing avoidance at almost all concentrations. No avoidance or toxicity was observed for EB. The data obtained from this research will be used to inform policy and regulatory actions regarding sea lice management at aquaculture facilities in Canada.

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## **Analysis of Additive Migration from Bio-Based Plastic during Simulated Food Contact**

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Traditional petroleum-based plastic is a well-known environmental contaminant. Bio-based plastics such as polylactic acid (PLA) are marketed as “green alternatives” to traditional plastics. During manufacturing, chemical additives such as bisphenols are incorporated into both PLA and traditional plastics to give them different properties. Previous research has demonstrated that for traditional plastics used in food storage, bisphenols can migrate out of the plastic and into the stored foods and beverages. This is a concern because bisphenols are classified as endocrine disrupting compounds. Quantitative data on bisphenol migration from bio-based plastics during food storage has not yet been reported. The goal of this research is to identify and quantify bisphenols that can migrate out of PLA during simulate food contact. In this research, PLA cups and straws were taken through migration tests based on FDA recommended methods. Samples were incubated in different simulant solutions to represent sugary, acidic, and alcoholic and fatty foods and beverages. The samples were cleaned up using a liquid-liquid extraction and analyzed for bisphenol migration using HPLC. Current results of this research suggest that bisphenol S (BPS) can migrate from PLA in sugary, acidic, and alcoholic and fatty foods or beverages under extreme conditions. This is significant because previous research has suggested that BPS is commonly used as a replacement for BPA in BPA-free plastics, despite having similar endocrine-disrupting properties.

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## **Achieving Water Quality Goals for Coastal and Estuarine Ecosystems: Case Study of Ambient Monitoring in Sinclair and Dyes Inlets in the Puget Sound, WA, USA**

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Achieving water quality goals for coastal and estuarine ecosystems requires an effective monitoring and assessment program to provide metrics that can inform effective management of water quality. Here we report on an ambient monitoring program within Sinclair and Dyes Inlets in Puget Sound, WA, that was established to characterize environmental conditions, assess potential impacts, and track environmental quality trends within the Inlets. A network of water and biota monitoring locations were selected that were located near suspected sources as well as representative of ambient marine and nearshore conditions for periodic sampling. Water column stations and effluents from industrial outfalls were sampled seasonally for trace metals (Cd, Cr, Cu, Hg, Pb, and Zn) using analytical procedures appropriate for seawater, conventional parameters, and toxicity. Effluent and water column toxicity tests included mysid shrimp (*Americanasys bahia*) 96 hr survival, sand dollar (*Dendraster excentricus*) or purple sea urchin (*Strongylocentrotus purpuratus*) 96 hr embryo development, QwikLite – dinoflagellate (*Pyrocystis lunula*) 24 hr bioluminescence response, mussel larvae (*Mytilus* sp.) 48 hr larvae survival and development, and kelp (*Macrocystis pyrifera*) 48 hr growth and germination. Additionally, indigenous mussels (*Mytilis* spp.) were sampled biennially for contaminant residues of metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), lipid content, and stable isotopes of C and N. Results showed water quality in nearshore areas appeared to improve after best management practices for industrial process were implemented. Toxicity from exposure to samples of whole effluent discharges were not observed and ambient water samples were not toxic to test organisms, except during the presence of toxic algal blooms. Mussel tissue residues were below effects benchmarks at most locations, however areas with elevated levels of contamination were detected. The monitoring results are being used to evaluate ecosystem recovery and assess progress toward meeting environmental quality goals for the watershed.

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## **Acute and Chronic Toxicity Monitoring by Grab Sampling and Diffusive Gradients in Thin-Films of Marine Waters Impacted by Copper**

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As part of an ambient monitoring program being conducted for the Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF) in the Puget Sound, receiving waters of Sinclair and Dyes Inlets are routinely monitored for trace metals and toxicity to assess water quality status, track progress in achieving water quality goals, and demonstrate protection of aquatic life. Beginning in 2016, field monitoring of aqueous metal bioavailability, using diffusive gradients in thin-film (DGT) passive samplers, has been incorporated into the program. Toward regulatory interpretation of bioavailable Cu, as measured by DGT, PNNL's Marine Sciences Laboratory and SPAWAR are conducting ongoing validation of an uptake response that reliably mimics that of aquatic organisms in seawater at varying dissolved organic carbon levels. This effort allows concurrent grab and passive sampling efforts to reflect water quality at time intervals closely related to aquatic life criteria acute and chronic concentration threshold parameters. The three campaigns presented reflect temporal shifts induced by natural winter, spring, and summer runoff conditions of the study area. Results indicate that bioavailability, within PSNS&IMF, has remained well below a preliminary chronic threshold for Cu, and does not directly reflect spatial fluctuations seen in the operationally defined dissolved fraction of grab samples currently used for comparison to regulatory benchmarks.

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## **Developing a Powerful and Novel Chemical Forensic Tool for Source-Tracking Pollutants**

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Water bodies are chemical data loggers for watersheds, containing tens of thousands of chemicals that discharge from overland runoff or subsurface seepage. While many compounds are widespread and are derived from multiple sources, we hypothesize that all sources contain highly unique suites of compounds or unique compound ratios. When transported to receiving bodies of water, we predict that these chemical "fingerprints" can be used as forensics tools to unequivocally identify the dominant pollution sources contaminating surface bodies of water. Our aim is to extract non-polar organic compounds from both water samples at/near pollution sources, and then use high-resolution mass spectrometry (HRMS) data in conjunction with machine learning tools to identify the non-target chemicals that are diagnostic of each source. Grab samples ( $n = 18$ ) were collected and analyzed in triplicate from different sources including headwater streams and runoff from urban, suburban, and industrial surfaces. Preliminary machine learning results indicate that each sources is entirely separable with near perfect classification. Future fingerprints will be developed for agricultural runoff, and together, these chemical libraries will be used to identify dominant sources of pollution to surface bodies of water in the central Willamette Valley of Oregon.

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## Resolving the Natural Nano-Environment on an Individual Particles Basis Using spICP-TOF-MS

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The advent of engineered nanotechnology required the development of analytical tools and techniques capable of detecting and characterizing engineered nanoparticles (ENPs) in complex environmental and biological matrices. With the development and implementation of some of these techniques, particularly single particle ICP-MS (spICP-MS), there are many opportunities to explore not only anthropogenic sources of nanomaterials, but also the naturally-occurring nanoparticulates (NNPs) and colloids. Many environmental processes are driven at the nanoscale, and the ability to resolve these processes on a particle- by-particle basis could significantly add to our understanding of the mechanisms of colloidal transport and contaminant fate and transport. However, many NNPs contain similar elemental compositions, and most current spICP-MS utilize quadrupole mass analyzers, limiting the mass quantification to only a single element in a given particle event. The development and commercialization of an ICP-time-of-flight-mass spectrometer (ICP-TOF-MS) allows for the detection and quantification of the atomic mass range (7-250 m/z<sup>+</sup>) at the requisite integration times (33-46μs) to permit the quantification of elemental ratios in individual particle ionization events. The capabilities of this new technique were first assessed using known engineered nanomaterials to explore its potential to assess its ability to differentiate isotopically and elementally similar particle compositions. It was then applied to environmental systems, examining varying watersheds including the Athabasca River (Canada), Clear Creek (Colorado, USA), and the Seine River (Paris, France). The composition and quantity of nanoparticulates was assessed, and other processes, such as the colloid-facilitated transport of toxic metals lead and thorium were characterized. Though this technique is still in its infancy, it shows great promise in becoming a routine technique for assessing the nanogeochemical environment and providing a better understanding of how this size regime impacts ecotoxicological health.

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## Ground Water Tracer Study, Bunker Hill Superfund Site, East Fork Ninemile Basin

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Sources of metals to an impacted watershed in the Bunker Hill Superfund Site in Northern Idaho have been evaluated through investigations and ongoing water quality monitoring. Site observations, investigations, water quality monitoring programs and historical research identified several potential metal loading sources that may be contributing to EFNM Creek through a groundwater seep. A groundwater tracer study was used to establish if mine waste piles were the primary source of metals into the seep and, subsequently, the East Fork Ninemile Creek, and to eliminate the possibility of the seep being an additional source of metals loading. A water chemistry comparison between sampling locations indicated similarities between the seep and the groundwater at two mine waste piles. Metal concentrations were generally higher in the seep than in the groundwater, which introduced uncertainty about the hydraulic connectivity between locations. A tracer study was used to establish if one or both mine waste piles contributes to the seep contamination and the nearby segment of the EFNM Creek. Tracer solutions of bromide and chloride were injected into groundwater and surface water locations. Ion selective electrode data loggers were installed in the seep to monitor for tracer solutions. Bromide was detected in the seep five days after injection at the Interstate Millsite, indicating it as the likely primary source of contamination to the seep and the adjacent portion of EFNM Creek. Tracers from the Tamarack Complex were not detected, possibly indicating its lack of connectivity to the seep. The study indicates the Interstate Millsite mine waste pile as the primary source to the seep and nearby segment of EFNM Creek.

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## **Using Integrative Passive Sampling Devices to Obtain More Meaningful and Cost-Effective Data on Metal-Associated Impacts from Stormwater Runoff**

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In many cases, stormwater compliance monitoring is labor intensive, expensive, and largely unsuccessful in providing the data needed to support stormwater management goals. To help address these issues, the time-integrative, heavy metal passive samplers, Diffusive Gradients in Thin film (DGTs) are being used to monitor stormwater runoff for copper. DGTs were co-located with traditional autosamplers within the stormwater conveyance systems at Naval Base San Diego (NBSD) to provide a direct comparison with composite sampling. In a more controlled fashion, DGTs were exposed in the laboratory to composite samples from NBSD stormwater conveyance systems. These controlled experiments showed increasing uptake over time (range = 1.5 to 24 h) for copper, with statistically significant positive, linear correlations ( $r^2 > 0.980$ ) between time exposed and metal mass accumulated. However, it appears that the corresponding calculations of the DGT-labile fraction relative to the dissolved fraction fluctuated across the different exposure durations. In general, trends observed for DGT-labile measurements from the field were consistent with trends seen in the lab DGT exposures and traditional dissolved metal measurements from composite samples. Finally, time-weighted, average concentrations of copper from DGTs that were deployed for the first half and second half of a storm event were within 30% of measurements from DGTs that were deployed for the entire storm event in the same stormwater vault. Cumulatively, these results show promise for continuous monitoring with DGTs as an approach that produces concentrations more representative of those in the receiving environment during episodic events, than those concentrations measured from traditional grab or composite chemistry sampling.

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

**28<sup>th</sup> Annual Meeting**



**Poster Presentation Abstracts**  
(in alphabetical order)

### **The Presence of Metals on Algae Cells from the North Cascade Mountains**

Benoit, K.\*; Tauer, R.; Thomas, K.; Kodner, R.; Sofield, R. Western Washington University, Bellingham, WA

The presence of metals in the environment can be vital to the growth and survival of organisms, but exposure at elevated concentrations can cause adverse effects to populations. Metals may be transported by long range atmospheric transport or originate locally, and variability in metal concentrations on algae cells may be due to nearby environmental features like rocks or plants. This study aims to determine metals present in North Cascade Mountains snow and snow algae. Thirty-nine snow and snow algae samples were collected over the Summer of 2018 at Bagley Lakes in the Mt. Baker-Snoqualmie National Forest, WA (elevation 4280 ft). A Tescan Scanning Electron Microscope (SEM) was used to determine relative metal concentrations present on the surface of algae cells. Preliminary results show sodium, silicon, sulfur, chlorine, calcium, aluminum, and iron levels vary significantly among sites on the same sampling day. Potassium, phosphorous, and magnesium levels were not significantly different from site to site on the same day. Filtered and unfiltered snow samples collected from the same location as the snow algae were analyzed with an ICP. Those results and completed SEM analyses will be compared and presented. In a parallel study, the Kodner lab at WWU is investigating genetic structure of the snow algae. Our results will be used in to inform those differences.

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### **Investigation of Oxidative Stress in Juvenile Coho Salmon (*Oncorhynchus kisutch*) Exposed to Highway Runoff**

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Toxic modes of action and causal contaminants responsible for acute mortality of coho salmon (*Oncorhynchus kisutch*) exposed to urban runoff remain unknown. Urban stormwater contains a complex mixture of contaminants, which elicit behavioral and physiological responses in coho indicating cardiorespiratory impairment may be a key pathway. Induction of oxidative stress may result from a number of organic and inorganic contaminants known to be present in urban runoff. Oxidative stress can alter endothelial functioning and vascular permeability, which may have implications for the osmorespiratory disturbance in stormwater-affected coho salmon. Markers of oxidative stress in stormwater-affected coho were investigated, including the formation of oxidized hemoglobin and plasma antioxidant power disturbance. Increases of total hemoglobin and hematocrit in symptomatic coho corroborate previous studies. Markers of oxidative tissue damage may provide additional clues as to the involvement of an oxidative-stress linked pathway in so-called coho urban runoff syndrome.

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## **Measuring Different Metal Valencies in Hard Water via Stabilized Liquid Membrane Devices**

Bonnard, J., Brown, E.; Eberle, C.N., Jensen, W.J., Gempler, A, Gallant, J., Jones, H., Tauer, R., Hernandez-Kaempf, N., Sofield, R.M. Western Washington University, Bellingham, WA.

In the field of environmental monitoring, the implementation of Stabilized Liquid Membrane Devices (SLMDs) in freshwater environments is becoming an increasingly viable way to test ionic metal concentration. SLMDs are comprised of sealed permeable tubing containing oleic acid and Kelex-100, a chelating agent. Calcium and magnesium ions from the aquatic system bind with the oleic acid to create an outer layer where the environmental metals bind to the chelating agent. SLMDs provide an effective way to test time-weighted average concentrations of metal in a freshwater environment. These devices were used in past controlled laboratory experiments to test the affinity and concentration of divalent metals. For our experiment equimolar concentrations of silver (1+), copper (2+), zinc (2+), and aluminum (3+) were tested to determine whether the Kelex-100 had a different affinity for each metal valence. A mixture of these metals was also tested. Following EPA Whole Effluent Testing recipes, the SLMDs were deployed in chambers containing a prepared mix of hard water (180 mg/L as CaCO<sub>3</sub>). Static renewals were completed every four days. The chambers were maintained in an environmental chamber at 16:8 hours (light:dark) and 20°C. Preliminary results indicate that aluminum and zinc have high affinities for the SLMDs while copper and silver are relatively lower.

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## **Nano-Scale Components of a Commercial Fungicide Formulation Alter Pesticide Risk in a Size-Dependent Manner**

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Chlorothalonil (CTL) is the most commonly used fungicide applied in the US. Commercial formulations of CTL normally do not mention the presence of nano-scale active ingredients. Despite this presence of nanoparticles, the risk associated with nano-sized active ingredients is unknown. Therefore, this study performed a risk assessment to characterize the toxicity of CTL nanoparticles on a freshwater macroinvertebrate. To evaluate the toxicity of CTL, a commercially available, wet-milled pesticide formulation was separated into two distinct size fraction: a small fraction (SF) with an average hydrodynamic diameter (HDD) of 194 nm, and a large fractions (LF) with an average HDD of 395 nm. An acute immobilization test with a *Daphnia magna* revealed that the LF was significantly more toxic than both the SF and the freely suspended (FC) chlorothalonil treatment (LC50 = 49.7 µg/L, 98.3 µg/L, and 113.7µg/L, respectively). This study also highlights the influence of particle size on CTL degradation. Degradation experiments in freshwater media revealed the LF was significantly less susceptible to degradation when compared to the SF. These findings help inform manufacturers, suppliers, and applicators of the changes in environmental risk from nano-sized active ingredients of chlorothalonil.

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## **Rotenone Attenuation in High Latitude Lakes and Laboratory Assessment of Photolytic Vs. Microbial Degradation**

Couture, J.M.<sup>1\*</sup>, Bozzini, J.<sup>1</sup>, Briggs, B. R.<sup>1</sup>, Massengi R.<sup>2</sup>, Dunker, K.<sup>1</sup> and Tomco, P. L.<sup>1</sup>

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Northern Pike (*Esox lucius*) are an invasive fish species in the waterways of Southcentral Alaska. Pike have been found across the region after being illegally introduced for sport fishing. Once established, pike destroy salmon and other native fish populations and must be eradicated before native species can be reintroduced. In combination with mechanical removal techniques, integrated pest management plans often utilize the pesticide rotenone. The mechanism of rotenone toxicity is through inhibition of electron transport within cell mitochondria, disrupting oxygen transport on the cellular level. This has implications for heterotrophic respiration and requires careful planning to ensure residues are degraded to avoid prolonged exposure. Rotenone attenuation is difficult to forecast in high-latitude regions with seasonally ice-associated waterways. Application rates and predicted degradation rates are commonly based on models developed in more temperate climates. In northern regions with seasonally frozen lakes, rotenone may persist over cold, dark winters. The aim of this study was to develop a regionally-accurate model of the degradation rates of rotenone in eight lakes on the Kenai Peninsula, Alaska, during treatment in October 2018. We assessed attenuation through field and laboratory studies in collaboration with the Alaska Department of Fish and Game (ADFG) field crews, combined with data gathered from laboratory incubation experiments, to establish attenuation DT-50 values at XX lakes on the Tote Road system near Soldotna, Alaska. We also assessed the concentrations of rotenone, the primary rotenone transformation product. As a supplement, the individual effects of light, temperature, and microbial activity in the overall degradation rate of rotenone were assessed in controlled laboratory incubations at 4 and 12°C.

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## **Exposure to EDCs Influences Development, Reproduction and Gene Expression across Generations in an Estuarine Fish, with Notes on Co-Exposure to Elevated Temperature**

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Understanding anthropogenic impacts, such as climate change and pollution, on aquatic ecosystems is critical for preserving biodiversity and maintaining water quality. The pyrethroid pesticide bifenthrin is a known endocrine disrupting compound (EDC) that enters watersheds through urban and agricultural runoff. Ethinylestradiol (EE2) is a common pharmaceutical that enters watersheds via wastewater effluent. Little is known about how elevated temperatures associated with climate change may affect the estrogenic activity of bifenthrin and EE2, particularly in species that exhibit temperature-dependent sex determination (TSD), such as the estuarine species *Menidia beryllina*. This study investigated the effects of temperature and bifenthrin exposure on development, reproductive output and gene expression in *M. beryllina* across multiple generations. Fish in the parental generation were exposed to environmentally relevant concentrations of bifenthrin and EE2 (positive control), as well as methanol (solvent control) at 22°C and 28°C for 14 days prior to spawning. Embryos in the F1 generation were exposed to EDCs as larvae (until 21 dph) and then reared to adulthood (8 months) in clean water at experimental temperatures. Sex ratios of the F1 generation were influenced by both elevated temperature and EDCs, resulting in alteration of adaptive TSD. In all F2 treatments, elevated temperature resulted in fewer viable offspring, with effects of individual EDCs affecting offspring production at lower temperatures. Fish exposed to bifenthrin during development exhibited developmental deformities. Changes in gene expression were observed in larval fish across generations, including those exposed indirectly as germ cells during early life-stage exposure of parents. Findings from this study will be useful in determining how EDCs will impact organisms and community structure in the face of global climate change.

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## Copper Accumulation of Stabilized Liquid Membrane Devises in Varying Water Hardness

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Stabilized liquid membrane devises (SLMD) are integrative samplers for metals in freshwater environments. The SLMD is a 2.5 cm wide by 9 cm long, low-density polyethylene (LDPE) sealed flat tubing, encasing a 0.5 ml 1 to 1 mixture of oleic acid and Kelex-100, a chelating agent. In water, the mixture diffuses to the outer surface of the membrane where the oleic acid complexes with calcium and magnesium from the environment to create a hydrophobic waxy layer. This layer binds to the Kelex-100 which continuously sequesters metals for up to multiple weeks. This type of passive sampler is low cost and easy to use, and is able to concentrate trace amounts of metals that are not always detectable by analytical instrumentation, as well as can provide an average of metal over time.

This experiment was conducted to test the SLMD absorbance of copper in very soft, moderately hard, and very hard water (48, 100, and 180 mg/L as CaCO<sub>3</sub>) using EPA WET testing recipes. There have been no laboratory studies to date that test these passive samplers outside of the conditions of hard water, which is not representative of all freshwater environments that the samples have been deployed in. The SLMDs were exposed to 0.0122 mg/L Cu for 40 days, with static renewal every 4 days at 20°C. Preliminary results suggest that copper accumulation is similar in very soft and moderately hard waters, but has a high rate of accumulation in very hard water, which could potentially be explained by the elevated calcium and magnesium in the very hard water.

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## Addressing the Need for Risk Assessment of Gene Drives

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Bayesian networks have proven to be an appropriate risk assessment tool for quantitatively and probabilistically examining complex systems involving multiple stressors acting on multiple endpoints in a wide variety of situations. An emerging field that has the capacity to drastically alter ecological systems is the use of gene drive modified organisms as a vector to control species population dynamics. The point of the release of a gene drive organism is for the introduced genetic material to propagate within the wild type population and persist within the environment. Currently there are many proposed gene drive designs but no quantitative methods to assess the risk associated with the use of gene drive modified organisms have been developed. This study proposes the use of Bayesian network relative risk assessment tools as a way to fill this current gap in our knowledge of the possible outcomes and effects of the use of gene drives. I present a case study involving the release of two gene drive modified species of mosquito, *Aedes aegypti*, a vector for the zika virus and the primary vector for dengue fever, and *Aedes albopictus*, a vector for both diseases, in an attempt to reduce incidence of zika and dengue fever in San Juan, Puerto Rico. The purpose is to assess how the gene drive may spread through the populations of wild type mosquitoes, decrease rates of disease, and probabilistically assess effects to other endpoints that arise from the use of gene drives.

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## **Hybrid Lipid-Coated Silver Nanoparticles with Long-Chain Hydrophobic Thiol Surface Coatings Show Decreased Toxicity Compared to Those without Robust Surface Coatings**

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Silver nanoparticles (AgNPs) are one of the most widely used and advertised nanomaterials due to their well-documented antimicrobial properties. They are used in a variety of consumer and commercial products as well as used in industrial applications such as wastewater treatment. While the antimicrobial properties of the AgNPs are due to their physiochemical properties, these same physiochemical properties could also lead to differential toxicity of the AgNPs. Most studies of AgNPs focus on the particles ability to undergo Ag<sup>+</sup> dissolution. Due to their wide and varying use there is a need to understand the biological interactions of AgNPs with diverse physiochemical characteristics while controlling the Ag<sup>+</sup> dissolution of the AgNPs. Here we exposed embryonic zebrafish to hybrid lipid-coated spherical and triangular plate shaped AgNPs with increasing complexity of long-chain hydrophobic thiol surface coatings. Exposure concentrations ranged from 0.03125 mg Ag/L to 4 mg Ag/L confirmed by ICP-MS for each of the synthesized AgNPs. Decreased rates of mortality and morbidity were observed in the AgNPs with the most longest chain thiol surface coatings. At the concentrations tested, no significant toxicity was observed for the longest chain surface composition in both the spherical and triangular plate geometries. In contrast, AgNPs smaller chain thiol surface coatings allowed for Ag<sup>+</sup> leaching or increased surface oxidation which resulted in higher mortality rates across both geometries. The higher surface area spherical AgNPs showed increased toxicity over the triangular plate AgNPs with the same surface coating. The ability to control the Ag<sup>+</sup> ion dissolution of the AgNPs allowed us to gain a better understanding of the physiochemical properties that drive the toxicity of AgNPs.

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## **Variability of Carbonate Chemistry in Association with Land Use in a Tillamook Bay Tributary: Tracing Acidification from the River to the Bay**

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Acidification from rising atmospheric carbon dioxide can be exacerbated by local factors such as land inputs of inorganic carbon. In Tillamook Bay, OR, there is oyster aquaculture in the bay and large amounts of agriculture above it, which makes acidification from inputs of inorganic carbon a concern. The US EPA has monitored water conditions in Tillamook Bay tributaries from 2017 to 2018, and preliminary findings show increased dissolved inorganic carbon (DIC) downstream of agricultural areas. To determine the causes of elevated DIC, changes attributed to land-based inputs must be distinguished from temporal variability and in-stream processing. To measure temporal variability, three day-long time series of DIC and pH were measured at locations upstream and downstream of agricultural areas along the Trask River. Time series data show that DIC is lower and decreases more throughout the day upstream. To account for in-stream processing (photosynthesis and respiration of periphyton), stream rocks were placed in sealed containers for 7 hours. Initial and final conditions (dissolved oxygen (DO) and DIC) in each container were compared to the conditions in the stream. In containers, the ΔDIC:ΔDO ratio is consistent with photosynthesis-respiration stoichiometry at both sites, while in stream water, the ΔDIC :ΔDO ratio is much lower downstream. In-stream processing can therefore account for most of the changes in DIC in the containers, but not in the streamwater, suggesting that elevated DIC levels can be attributed to inputs of inorganic carbon from land-based sources.

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### **Oxidative Stress Decreases the Efficiency of Photoreactivation in Chlamydomonas**

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We are interested in understanding the ability of plants to successfully respond to multiple DNA-damaging stressors. Our work is carried out using the single-celled alga *Chlamydomonas reinhardtii*, a powerful model system for understanding basic processes in plant cells. In the present study we are examining the effect of an oxidative stress (acridine orange/visible light) on photoreactivation in Chlamydomonas. We find that an oxidative pre-treatment significantly decreases the survival of UV-exposed Chlamydomonas allowed to recover under photoreactivating conditions. We also find that this deficit in photoreactivating capability is not detectable in the bulk genomic DNA by alkaline gel electrophoresis, implying that chloroplast processes are responsible for this deficit. Our findings have interesting implications for understanding the effect of multiple anthropogenic stressors on plants.

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### **Use of Stabilized Liquid Membrane Devices to Measure Trace Silver in Different Levels of Water Hardness**

Jensen, W.\*; Bonnard, J.; Brown, E.; Eberle, C.N.; GEMPLER, A.; Gallant, J.; Jones, H.; Tauer, R.; Hernandez-Kaempf, N.; Sofield, R.M. Western Washington University, Bellingham, WA.

Passive sampling has been an effective measure of contaminants in many water systems. However, there remains a need for methods of detecting trace metals in such systems. Stabilized liquid membrane devices (SLMDs) utilize a chelating agent and oleic acid which, combined in a semi-permeable membrane, can be used to measure amounts of metals sorbed from the aquatic environment. The oleic acid forms a waxy layer with calcium and magnesium ions that retain the chelating agent, Kelex-100, and provides a location for metal ions to bind. To understand the ability of the SLMDs to work in a variety of freshwater systems, silver solutions at 8.5 µg/L were used with three different freshwater hardness: very soft, moderately hard, and very hard (48, 100 and 180 mg/L as CaCO<sub>3</sub>). We believe that testing multiple levels freshwater hardness is important as the thickness of the waxy layer may be altered by the amount of hardness ions. Test chambers were placed in environmental chambers at 20°C for a variety of deployment intervals ranging from 4-40 days with renewals every 4 days. Preliminary data indicates that accumulation rates are unaffected by difference in freshwater hardness suggesting that SLMDs would be applicable for determining average water concentrations in a range of freshwater systems.

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## **Quantifying Marine Microplastic Ingestion in Black Rockfish (*Sebastes melanops*) on the Oregon Coast**

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Increased plastic production and mismanagement of the waste is widely documented to impact marine and terrestrial ecosystems. Microplastics, a large class of pollutants, are < 5mm in size and are hazardous in the marine environment. Organisms may ingest them, being exposed to harmful contaminants found within the plastics or on their surface. Rockfish are one such organism that are susceptible to microplastic ingestion as they are opportunistic feeders. Rockfish were sampled from three coastal Oregon locations, outside two Oregon marine reserves (Cape Perpetua, Cascade Head), and off the coast of Newport, OR. Their digestive tracts were examined to determine whether they contained suspected microplastics. Undigested prey items were analyzed separately. The percent of fish in the given population obtained from outside marine reserves (n=61) and Newport (n=68) that contained suspected synthetics or microplastics lies between 11.03% and 31.59% and 3.07% and 17.5%, respectively, within a 95% confidence interval. Fish caught outside of Cascade Head and Cape Perpetua contained more suspected microplastics than those sampled near Newport, OR (p-value = 0.01596). The suspected synthetics were identified following digestion in potassium hydroxide and further categorized under a stereoscope. Suspected microplastics need to be confirmed using Raman spectroscopy, Fourier transform infrared and gas chromatography-mass spectroscopy. These data show that nearshore species may be impacted by waste management shortfalls and are consuming synthetic materials. Continued research is needed to determine how much plastic and synthetic material is found within water, the amount ingested or accumulated by marine organisms, and how it impacts vital species.

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## **Quantitative Determination of Microhematocrit in Fish Blood with Computer Vision and K-Means Clustering**

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Hematocrit levels in fish are often used to measure generalized stress during toxicant exposures. The typical method for measuring bulk hematocrit from whole blood in fish and other organisms is quite simple and has not improved much over the last century. The process involves using a centrifuge to separate heavier red blood cells (erythrocytes) from lighter white blood cells (leukocytes), platelets (thrombocytes), and plasma. A capillary tube containing the blood fractions can then be read against a microhematocrit reader. This allows researchers to determine hematocrit (HCT) as percent packed cell volume (%PCV) and is representative of the blood volume occupied by red blood cells. To improve the microhematocrit method a computer vision based technique was developed. The goals were to minimize user-error, subjectivity, and effort while maximizing the reliability and interpretability of results. Blood from returning adult salmon (coho and steelhead) from the Skookumchuck fish hatchery, smolt juvenile coho salmon from the Squaxin Island netpens, and parr juvenile salmon from the Aquatic Toxicology Lab at the Puyallup Research and Extension Center were used to develop and assess this approach. After collection, samples were homogenized by inversion and drawn into capillary tubes. Capillary tubes were centrifuged for 5 minutes at 13,000 g and placed into a 3d printed carriage plate. An Epson Perfection V300 flatbed scanner imaged the capillary tubes at high resolution (2400 dpi). Prior to analysis images were cropped in ImageJ. Each cropped image was loaded into R (v3.5.0) as a cimg object using the imager package. All samples analyzed were correctly grouped into respective blood fractions using k-means clustering in R (RPD between replicates less than 1%). Accurate and consistent results were found using three cluster centers (centroids), 100 random starting points, and 500 iterations.

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## **The Effects of Salmonid Aquaculture Anti-Sea Lice Chemotherapeutants on Non-Target Benthic Polychaete (*Nereis Virens*) Locomotion and Burrowing Behaviour**

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The aquaculture industry along the North Pacific coast is continuously expanding to meet consumer demand. This coastline is home for vast populations of wild fish and invertebrates, and this industry could potentially alter these communities. Sea lice (*Lepeophtheirus salmonis*) are ecto-parasites of fish and are a significant problem in salmonid aquaculture. The control of these parasites is an essential element in the protection of cultured fish as well as wild stocks and often involves the strategic use of chemotherapeutics. Effects to non-target organisms associated with the use of these chemicals in open net pens has emerged as a significant problem. Compounds used in disease and parasite control are of immediate concern, including the anti-parasitic chemotherapeutants ivermectin and SLICE®. These anti-sea lice pesticides have been known to bind with sediment and therefore could have the highest impact on benthic communities. This study assesses sub-lethal effects of ivermectin and SLICE® observed on the benthic marine polychaetes (*Nereis Virens*). Behavioural endpoints including daily burrowing, locomotion and burrowing speed on day-14 and day-28 were observed after exposure to various concentrations of ivermectin, SLICE®, and a combination of the two chemotherapeutics.

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## **Longevity of Bioretention Depths for Preventing Acute Toxicity from Urban Stormwater Runoff**

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The migration of coho salmon every fall from the ocean to freshwater streams coincides with increasing rainfall in the Pacific Northwest. Much of this rainfall runs off of asphalt and other impervious surfaces found in urban areas, such as the Puget Sound Basin, and into the very streams where salmon spawn. Exposure to urban stormwater runoff, which contains a complex mixture of contaminants, can be acutely toxic to coho salmon. Previous studies have demonstrated the effectiveness of bioretention treatment systems in treating urban runoff and preventing acutely lethal and sublethal effects to aquatic organisms. Municipalities are especially motivated to incorporate bioretention treatment systems into existing infrastructure in order to comply with National Pollutant Discharge Elimination System (NPDES) permit requirements. NPDES permits are administered by the Washington Department of Ecology (Ecology) and require local governments to manage polluted stormwater in order to mitigate the effects of pollution and contamination on downstream waters. The current study aims to determine the effectiveness and longevity of bioretention soil media over time at various infiltration depths, including those shallower than 18 inches, the depth currently required by Ecology. Stormwater runoff is being collected from a busy, urban road site and applied to experimental columns, containing five different depths of bioretention soil media. Runoff is applied at an accelerated rate in order to simulate 10 water years over two calendar years. The chemical and biological effectiveness of the columns in treating urban stormwater runoff will be assessed using analytical chemistry and the health of two fish species: juvenile coho salmon and zebrafish embryos. The study outcomes are expected to help inform stormwater managers, National Pollutant Discharge Elimination System (NPDES) permit coordinators, and others involved in stormwater management.

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## Degrading Contaminants of Emerging Concern Using In Situ Stream and Wastewater Microbiomes

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Degradation of contaminants of emerging concern (CECs) in natural systems can occur through synergistic action within microbial communities. This study investigated the ability of microbial communities to degrade a suite of 21 known CECs across time and space in the wastewater and stream environments. Target chemicals including pharmaceuticals, pesticides, and personal care products were identified using high resolution mass spectroscopy. Microbial community composition was identified using 16S Illumina sequencing. Machine learning tools such as support vector regression and random forest were used to determine which microbial taxa best predicted decreasing concentrations of the target CECs. The result was the core microbiome most important to CEC removal. Identification of such a core microbial community can be utilized to seed wastewater treatment plants such that CECs removal can be improved prior to wastewater discharge into surface water.

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## The Potential of Early Life Exposure to Endocrine Disruptors to Cause Transgenerational Epigenetic Changes in a Fish Model

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The inland silverside, *Menidia beryllina*, is a euryhaline fish native to the Eastern United States and a model organism in ecotoxicology. We previously showed that low-level exposure to endocrine disrupting chemicals (EDCs) can cause a variety of effects in *M. beryllina*, from changes in gene expression to phenotypic deformities. In the present study, we explore the potential for early life exposure to EDCs to cause epigenetic changes in inland silversides, with a particular focus on transgenerational effects. EDCs included contaminants of emerging concern (the pyrethroid insecticide bifenthrin and the synthetic progestin levonorgestrel), as well as an estrogen (17-β ethynodiol), and an androgen (trenbolone) at exposure levels between 3 and 9 ng/L. In a multigenerational experiment, we exposed parental silversides to EDCs from fertilization until 21 days post hatch (dph). We assessed DNA methylation patterns for three generations (P0, F1, and F2) in whole body larval fish using reduced representation bisulfite sequencing (RRBS). We found significant ( $p < 0.05$ ) differences in promoter and/or gene body methylation in treatment fish relative to controls for all EDCs. Differentially methylated genes in EDC treatments included hormone receptors, genes involved in steroidogenesis, prostaglandin synthesis, sexual development, DNA methylation, protein metabolism and synthesis, cell signaling, and neurodevelopment. Differential gene methylation relative to control was often present in the F1 generation, exposed as primordial germ cells within larval parents, and sometimes noted into the F2 generation, which was unexposed to EDCs. These findings show that EDCs can cause altered methylation in genes that are functionally relevant to impaired phenotypes documented in EDC-exposed animals, and that EDC exposure has the potential to have effects on subsequent generations of unexposed fish.

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## Testing Potential Bioretention Soil Media Amendments for Removal Potential of Polycyclic Aromatic Hydrocarbons and *Escherichia coli*

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Current stormwater permitting regulations in the state of Washington do not include performance goals for the treatment of pollutants like certain organic contaminants (Polycyclic Aromatic Hydrocarbons - PAHs) and bacteria (total and fecal coliforms, enterococci, *Escherichia coli*). As a first step in determining Best Management Practices (BMPs) for the treatment of these contaminants from stormwater runoff, a bench scale study will be conducted to assess the contaminant removal efficiencies of several emerging bioretention soil media (BSM) amendments. The following treatments will be compared in a bench scale stormwater filtration experiment: 1) sand (control), 2&3) sand amended with two different high temperature pyrolysis biochars, and 4) sand amended with alum (i.e., aluminum sulfate). These treatments have been chosen for their adsorptive properties, availability, and ability to enhance desirable hydraulic properties in stormwater bioretention systems. In a series of three dosing experiments, small bioretention columns will be dosed with 1) deionized water (to condition columns) 2) PAH spiked stormwater (used motor oil mechanically dispersed in water), and 3) *E. coli* spiked synthetic stormwater. Influent and effluent from the columns will be analyzed for standard parent PAH compounds and *E. coli* concentrations. *Danio rerio* (zebrafish) embryo bioassays will be conducted on samples from the column conditioning experiment to test the potential for the tested medias to leach toxicants. Additional *D. rerio* bioassays will be conducted on the PAH spike experiment samples to estimate the ability of the medias to prevent PAH toxicity. The results from this study will help inform the experimental design of a larger planted bioretention experiment focused on understanding the broader mechanisms of bioremediation in stormwater bioretention systems.

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## Assessing Coho Salmon (*Oncorhynchus kisutch*) Sensitivity to Stormwater Toxicity

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Urban stormwater runoff poses a direct threat to the health of aquatic ecosystems. Coho salmon (***Oncorhynchus kisutch***) have become a highly recognized sentinel species threatened by urban runoff, wherein adults exposed to runoff die from stormwater toxicity prior to spawning. Research to date has been directed towards preventing lethal impacts of urban runoff to coho salmon, yet no assessment of coho tolerance to stormwater had been conducted. The current study uses 24-hour stormwater dilution exposures across multiple storms to determine mortality response in juvenile coho salmon and to assess variables affecting runoff toxicity. Results indicated stormwater runoff to be highly lethal to coho salmon, where 1:4 dilutions of stormwater to system water resulted in up to 100% mortality and 1:50 dilutions of stormwater to system water were necessary to prevent mortality. Storms were not found to have considerable variation in toxic effect despite differences in season, traffic conditions, and storm characterizations. Additional research is being conducted to assess the relationship between concentration and duration of stormwater exposure. This will address whether fish exposed to lethal dilutions of stormwater runoff have the potential to recover from durations of exposure less than 24 hours more representative of rain events. Gaining a comprehensive understanding of the effects of stormwater exposure to aquatic organisms is critical for implementing appropriate regulatory actions and preserving aquatic communities in the face of a perpetually urbanizing world.

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## **Considerations for Creating a Simplified Food Web Model: An Application of the Arnot and Gobas Bioaccumulation Model**

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The use of site-specific aquatic bioaccumulation models in work at contaminated sediment sites is well documented. Such models are intended to provide reliable and reasonably accurate site-specific tools to assess the bioaccumulation of organic compounds in species that are of interest for human health or ecological risk assessments. These models are often complex and can include numerous abiotic inputs (e.g., sediment and water) and biotic compartments (e.g., invertebrates, small fish, and higher-trophic-level species). Parameterization of these complex models can impart uncertainty, — the process typically relies on a combination of site-specific data (when available), available information from the literature, and best professional judgment (BPJ). Depending on the objective of the modeling work, developing and applying a simplified model with fewer compartments may reduce the uncertainty associated with model parameterization. The purpose of this poster is to explore the pros and cons of complex and simplified food web models.

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## **Exploring Biophysical Linkages between Forestry Practices and Oregon's Freshwater and Estuarine Shellfish**

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Understanding cross-ecosystem processes and impacts of terrestrial/riverine conditions on marine species is a challenging but essential step in designing effective and comprehensive land-sea planning, management, and conservation. Prolonged exposure to runoff from pesticides has the potential to disrupt hormonal, reproductive, and developmental processes in aquatic organisms. Non-point sources of pollution such as these are difficult to trace and hard to quantify due to the transient nature of the contamination, but exposure can be explored through examination of bioconcentration. In Oregon, state and federal forestry pesticide regulations differ in regards to buffer size and aerial spraying but both are designed to meet regulatory requirements for water quality. We have collected soft-shell clams (*Mya arenaria*), Pacific oysters (*Crassostrea gigas*), and Western Pearlshell mussels (*Margaritifera falcata*) in estuaries and rivers along the Oregon Coast for analysis of forestry-specific chemical compounds. We examine concentrations of compounds found in tissues to determine variation in levels among estuaries. Gradients of land use, ownership, and management practices are characterized using GIS and relationships to concentrations explored across watersheds of varying land use types and ratios.

Identifying the relationships between land use and chemical accumulations provide insight into effectiveness of current management practices in controlling transport of potentially harmful compounds.

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## **EDuCation about Endocrine Disruptor Chemicals: Bridging the Gap between Scientists and the General Public**

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Many people are unaware that everyday products in our homes and workplaces contain toxic chemicals that disrupt hormones. This topic is not commonly taught in schools. Scientists often communicate only with other scientists. However, it is important for the general public to be informed about endocrine disruptor chemicals (EDCs) because they can harm the functioning of organs and organ systems such as the brain, pancreas, and reproductive and immune defense systems in humans and other species. Based on my teaching experiences, I recommend reaching out to diverse audiences such as non-science university students, environmental nongovernmental organization (NGO) members, food co-op members, community science café participants, retirees, cancer survivors, and incarcerated populations. Effective techniques for teaching adults about EDCs include: avoiding scientific jargon, defining technical terms, telling personal stories, showing how the information relates to the audience's experiences, engaging the audience via hands-on activities, small group discussions, and questions, suggesting actions for individuals to take to reduce their exposures to EDCs, and asking individuals to develop their own action plans. Audiences should be encouraged to share what they have learned with their families, friends, and colleagues in order to create a ripple effect, thereby informing more people about this important topic.

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## **Microclimate-Induced Variation in the Community Structure and Cell Morphology of Snow Algae in a Pacific Northwest Snow Algae Alpine Lake Ecosystem**

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Snow algae represent a diverse array of photosynthetic microorganisms that live on the surface of snow and ice, typically in high alpine environments. Although previous research has detailed the distribution of snow algae over large geographic regions, little is known about the microclimatic conditions that inform the occurrence and community structure of algal populations. Our objectives are to observe the spatiotemporal patterns in cell morphology and community composition with respect to varying microhabitat conditions. To evaluate how local snow algae communities develop geospatially, we sampled visible populations of snow algae weekly over the duration of the 2018 summer season from snow and ice atop Bagley Lake and the surrounding basin, which represents a geographically confined, yet climatically diverse alpine lake environment in the North Cascades. Using microscopic imagery and DNA sequencing techniques, we are in the process of identifying changes in algal bloom community composition and cell morphology as induced by their local environment. Preliminary results indicate that algal communities from snow on the lake surface resembled similar communities on the lake shore and surrounding basin later in the season. The community development between these two distinct habitats was offset by approximately three weeks, which coincided with an increase in liquid water availability from elevated snowmelt. This suggests a growth dependence on metabolically available water. To further inform which microclimatic conditions support these communities, we are in collaboration with another research lab from Western Washington University that evaluates the presence of metals in snow and algal cell surfaces to further assess the chemical environment of this ecosystem.

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