**Pacific Northwest Society of Environmental Toxicology & Chemistry**

# Meeting Program


## 33rd Annual Meeting
## McMenamins Edgefield, Troutdale, OR

# May 13-15, 2024

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# Agenda

## Monday, May 13, 2024

| Start Time | Speaker | Platform Presentation Title |
|---|---|---|
| 8:30 AM | Conference Opens | |
| 9:15 AM | Check-in and Networking | |
| 10:05 AM | Plenary: Sarah Marie Wiebe | Pollution Exposure and Democratic Deliberation: The Promises and Paradoxes of Public Engagement, Lessons from Canada's Chemical Valley for Environmental Justice |
| 11:05 AM | Break | |
| **Session 1: Temporal and Spatial Monitoring**<br>**Moderator: Michelle Knowlen, Location: Blackberry Hall** | | |
| 11:20 AM | Alex Gipe | Passive Samplers: A Useful Tool for Identifying Sources of Toxics Impacting Juvenile Chinook |
| 11:35 AM | Julann Spromberg | Land use-based mapping of lethal stormwater threats to wild coho in Puget Sound |
| 11:50 AM | Kara Hitchko | Evaluation of Grande Ronde River Basin Water Quality to Identify the Cause of High Mortality to Chinook Salmon Smolt |
| 12:05 PM | Lunch, Blackberry Hall | |
| **Session 2: Temporal and Spatial Monitoring**<br>**Moderator: Kenia Whitehead, Location: Blackberry Hall** | | |
| 1:20 PM | Dwight R. Causey | Predictive relationship between PAH concentrations in whole-body and stomach contents of juvenile Chinook salmon |
| 1:35 PM | Molly Shuman-Goodier | Fish at the pharma-sea: Pharmaceuticals and personal care products in Puget Sound aquatic life |
| 1:50 PM | Claire Detering | Relationships in Selenium Concentrations Among Fish Tissues: Monitoring and Regulatory |
| 2:05 PM | Networking Event – Meet the Sponsors, Blackberry Hall | |
| *2:30 PM* | Tammi Fierro | Tiny Fish, Big Problems; Quantifying Relationships between Microplastics Presence and Morphology in Early Life Stage Salmonids |
| *2:38 PM* | Sruthee Govindaraj | Investigating Microplastics Contamination in the Yukon Territory's Surface waters and Fish |
| 2:46 PM | Holly Suther | Legacy and emerging contaminants of concern in edible seaweeds of interest for Washington state aquaculture development |
| 3:01 PM | Break | |
| **Session 1: Temporal and Spatial Monitoring**<br>**Moderator: Julie Layshock, Location: Blackberry Hall** | | |
| 3:20 PM | William Hobbs | PDBE Source Identification in the Nisqually River Basin, WA |
| 3:35 PM | Samreen Siddiqui | Chemicals of Emerging Concern in Salmon Spawning and Rearing Habitat |
| 3:50 PM | Summer L. Sherman-Bertinetti | Understanding and Mitigating the Dominant Sources of PFAS to Wastewater Treatment Plants from Domestic, Commercial, and Industrial Sectors Utilizing a Mass Balance Approach |
| 4:05 PM | Abigail Nickelson | Pesticide Monitoring in Washington State Surface Water |
| 4:20 PM | Ariel Blanc | Human Health Risk-Based Monitoring Program for a Working Harbour |
| 4:35 PM | Announcements | |
| 05:30 PM | POSTER SESSION I: hors d'oeuvres and refreshments, Ballroom (Ends 7:30 PM) | |

# Agenda

## Tuesday, May 14, 2024

| Start Time | Speaker | Platform Presentation Title |
|---|---|---|
| 8:00 AM | Coffee, Refreshments, and Networking, Blackberry Hall | |
| 8:55 AM | Announcements | |
| **Session 4: Temporal and Spatial Monitoring**<br>**Moderator: Claire Detering, Location: Blackberry Hall** | | |
| 9:05 AM | April Reed | Enhancing the Federal Natural Resource Damage Assessment Process through Bayesian Networks |
| 9:20 AM | Tate Libunao | Does the Utility of Sentinel Organism's Change Seasonally? |
| 9:35 AM | Alexandra G. Tissot | A Tale of Two Estuaries: Environmental detections of human-use contaminants across estuarine Zostera marina communities |
| 9:45 AM | Sydney Gonsalves | Does Depuration Reduce Filter-feeding Clam Contaminant Concentrations in Esquimalt Harbour, British Columbia? |
| 9:55 AM | Curtis Hinman | Connecting Science to Stormwater Management Solutions - Part 1: The Evolution and Promise of High-Performance Bioretention Media to Mitigate the Impacts of Stormwater on Receiving Waters |
| **Session 5: Perspectives**<br>**Moderator: Heidi Siegelbaum, Location: Blackberry Hall** | | |
| 10:10 AM | Wayne G. Landis | Forty years since the Redbook and ten hence, a review of the development of ecological risk assessment with multiple stressors, endpoints and management goals and steps forward. |
| 10:25 AM | Alice England | Challenges in determining sediment clean-up levels for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans in urban waterways |
| 10:40 AM | Break | |
| 11:00 AM | Allie Tissot, Tammi Fierro, Elise Granek | **Panel Discussion: Inclusive Perspectives on Contaminant Solutions** |
| 12:15 PM | Lunch, Blackberry Hall | |
| **Session 6: Cause and Effect**<br>**Moderator: Kaley Major, Location: Blackberry Hall** | | |
| 1:35 PM | Lillian Pavord | Impact of anticoagulant rodenticides on coho salmon (Oncorhynchus kisutch): assessing lethal and sublethal effects |
| 1:50 PM | Mackenzie Morshead | How differential phenanthrene substitution alters toxicity, Cyp1a Spatial Expression, and AHR Dependence in Early Life Stage Zebrafish |
| *2:05 PM* | Chloe Kotik | Effects of anthropogenic contamination on mortality and fecundity of mammal-eating killer whales |
| 2:45 PM | Chelsea Mitchell | Connecting Science to Stormwater Management – **Part 2**: Lab-Scale Treatment of 6PPD-quinone using Default and Alternative Bioretention Soil Medias |
| 3:00 PM | Jenee Colton | Connecting Science to Stormwater Management Solutions - **Part 3**: Using Science in Policy and Stormwater Management at King County |
| 3:15 PM | Nat Scholz | An evolving mechanistic understanding of 6PPD-q toxicity to Pacific salmonids |
| 3:30 PM | Ellie Dalsky | Assessing the Toxicity of Tire Wear Particles Using Cell Line Models |
| 3:45 PM | Stephanie Gill, Rhea Smith & Amanda Gillen | 6PPD-Q Perspectives from WA Dept of Ecology |
| 4:15 PM | Announcements | |
| 05:30 PM | POSTER SESSION II: hor d'oeuvres and refreshments, Ballroom (Ends 7:30 PM) | |
| 9:00 PM | Student Mixer, TBD (Ends 7:30 PM) | |

# Agenda

## Wednesday, May 15, 2024

| Start Time | Speaker | Platform Presentation Title |
|---|---|---|
| 8:00 AM | Coffee, Refreshments, and Networking, Blackberry Hall | |
| 8:30 AM | President's address | |
| 8:45 AM | Treasurer's Report | |
| 9:00 AM | SETAC NA | |
| 9:15 AM | Board Nominations | |
| 9:25 AM | Feedback from Members | |
| 9:40 AM | Student Presentation Awards | |
| 9:55 AM | Break | |
| **Session 7: Cause and Effect**<br>**Moderator: Michelle Knowlen, Location: Blackberry Hall** | | |
| 10:15 AM | Mary Ann Rempel-Hester | Acclimation of Freshwater Sediments for Marine Bioassay Testing |
| 10:30 AM | Melissa K. Driessnack | Evaluating the potential hazards of anticoagulant-containing bait pellets to early life stage pink (Oncorhynchus gorbuscha) and coho salmon (O. kisutch) |
| 10:45 AM | Sam Lohse | Comparison of Eco-Corona and Protein Corona Binding Constants on Functionalized Gold Nanoparticles Using Spectroscopic Methods |
| 11:00 AM | Sarah Alaei and Alison Gardell | Characterizing the Impacts of Legacy Arsenic Contamination on Freshwater Lake Microbiomes |
| 11:30 PM | Closing | |
| 12:00 PM | Stacey Harper & Susanne Brander | In-Person Short Course (with Lunch for participants) Sign up is required (Ends 3:30 PM):<br>From the basics to the state-of-the-science on micro and nanoplastics research |

# Monday May 13, 2024

## Plenary Speaker: Dr. Sarah Marie Wiebe

**Pollution Exposure and Democratic Deliberation: The Promises and Paradoxes of Public Engagement, Lessons from Canada's Chemical Valley for Environmental Justice**

Dr. Sarah Marie Wiebe grew up on Coast Salish territory in British Columbia, BC. She is an Assistant Professor in the School of Public Administration at the University of Victoria and an Adjunct Professor at the University of Hawai'i, Mānoa with a focus on community development and environmental sustainability. She is a Co-Founder of the FERN (Feminist Environmental Research Network) Collaborative and a Board Member of the Climate Disaster Project. Her book Everyday Exposure: Indigenous Mobilization and Environmental Justice in Canada's Chemical Valley (2016) with UBC Press won the Charles Taylor Book Award (2017) and examines policy responses to the impact of pollution on the Aamjiwnaang First Nation's environmental health.

# Monday Platform Presentations

## Session 1: Temporal and Spatial Monitoring

**Passive Samplers: A Useful Tool for Identifying Sources of Toxics Impacting Juvenile Chinook**

Alex Gipe* and Will Hobbs. Washington State Department of Ecology.

Chinook salmon play a vital role in the Puget Sound ecosystem as prey for endangered southern resident killer whales and are culturally and economically important to the tribes and residents of Washington State. Chinook populations are in decline in part due to toxics accumulated during their outward migration in Puget Sound rivers. Toxics accumulation in juvenile Chinook occurs across the Puget Sound with over 30% of juveniles sampled in a 2013 study containing body burdens of toxics that could cause sublethal impacts. The first step in reducing toxics burden in juvenile Chinook is determining the sources of toxics within a waterbody. Source identification can be a difficult due to the complicated nature of chemical partitioning and transport within complex environmental systems. Passive samplers may provide a useful tool in the characterization of toxics at adequate spatial and temporal resolutions to identify sources. The Washington State Dept. of Ecology used passive samplers in a multi-year study to identify sources of toxics impacting juvenile Chinook salmon in the Snohomish Watershed. We used semi-permeable membrane devices (SPMDs), a form of passive sampler, to determine PBDE water concentrations from 2019-2022 and analyzed spatial and temporal trends to identify sources of PBDEs. Samplers were deployed throughout the river system during low and high flow conditions over six deployment events. SPMDs accumulate PBDEs over a 30-day deployment period, providing an estimated water concentration of the bioavailable fraction. Their ability to be deployed simultaneously at various locations and integrate water concentrations for several weeks allows for the spatial and temporal comparison of in-river toxics concentrations across large river systems. SPMDs are limited by their ability to uptake chemicals based on their partitioning coefficient and molecular size, but are a useful tool in the monitoring of low-level hydrophobic chemicals. SPMDs proved useful in identifying several seasonal sources of PBDEs in the Snohomish Watershed associated with the discharge of treated wastewater.

**Land use-based mapping of lethal stormwater threats to wild coho in Puget Sound**

Julann Spromberg[*1], Blake Feist [1], Eric Buhle [2], and Nat Scholz [1]. [1]NOAA Fisheries, Northwest Fisheries Science Center; [2]Mount Hood Environmental.

Urbanization threatens virtually all ecosystems, creating a species conservation challenge. Our understanding of urbanization impacts has focused on physical habitat, as agricultural and forested lands are replaced with human infrastructure. However, aquatic habitats are also chemically degraded by urban development, often in the form of toxic stormwater runoff. Since the late 1990s, coho salmon adults returning to their natal urban streams in Puget Sound experience high rates of spawner mortality syndrome. Evidence to date identifies toxic urban stormwater runoff as the causative agent, which poses a population level threat to wild coho. In addition, steelhead are also vulnerable to this toxic mix of stormwater. Identifying stream basins currently at risk for this syndrome is critical to conservation efforts. This presentation summarizes our understanding of the landscape ecology of this syndrome across an urban gradient in the Puget Lowlands, based on nearly two decades of research that uses spatial analyses to identify relationships between in situ spawner mortality time series, and climate and landscape scale characteristics of the built environment. The resulting predicted coho spawner mortality heat-maps that encompass the Puget Sound region have already been leveraged for conservation planning and numerous related studies. For the next generation of landscape ecotoxicology modeling, we will revise and update our analyses using a longer time series of data, processed through state-of-the-art statistical modeling frameworks. Salmon restoration spatial patterns can be combined with predictive heat-maps to minimize the risk of ecological traps associated with these projects. These analyses improve our understanding of the interplay between urbanization and climatic drivers of the mortality syndrome, are easily transferable to other regions that have similar available data, and can be used for planning restoration and conservation projects in the current built environment and in future development scenarios.

**Evaluation of Grande Ronde River Basin Water Quality to Identify the Cause of High Mortality to Chinook Salmon Smolt**

Kara Hitchko*[1], Dana Kurtz[2], Anderson Perry[2], and Jesse Steele[2]. [1]Floyd|Snider; [2]Grande Ronde Model Watershed.

Consistently high mortality rates (60 to 70 percent) have been observed for migrating Chinook salmon smolt within the Grande Ronde River basin since 2010. It has been widely presumed that water temperature was the main cause of the losses; however, mortality occurs during Chinook salmon smolt migration (February through May), when water temperatures are generally below lethal levels. A two-year water quality assessment was conducted on behalf of the Grande Ronde Model Watershed (GRMW) to investigate whether poor water quality plays a role in Chinook salmon smolt mortality in the Grande Ronde basin, particularly when smolt are outmigrating. Surface water grab samples were collected after storm events at ten locations during ten sampling events between November 2020 and September 2022. Water quality parameters were recorded, and samples were analyzed for conventionals, metals, polyaromatic hydrocarbons (PAHs), and currently used pesticides and herbicides. Sporadic exceedances of aquatic life criteria were observed for four metals (copper, zinc, chromium and nickel) and dissolved oxygen (DO). Exceedances of copper were the most widespread and frequent. Low DO was observed between February and May, coinciding with the timing of Chinook smolt outmigration. Based on these results, copper and low DO could potentially contribute to Chinook salmon smolt mortality. Additional information is needed to confirm the cause of mortality and to understand the relative impact of the multiple environmental stressors present in the Grande Ronde River basin on mortality. A second phase of this study is underway and includes characterization of the spatial extent of low DO at several locations, and collection of composite surface water samples and sediment samples for chemical analysis. The initial two-year assessment provides new information on potential water chemistry issues in the Grande Ronde River basin and provides a starting point for future work to confirm the cause of mortality to Chinook salmon smolt.

# Session 2: Temporal and Spatial Monitoring

**Predictive relationship between PAH concentrations in whole-body and stomach contents of juvenile Chinook salmon**

Dwight R. Causey*, Andrea J. Carey, Andrew Beckman, Danielle Nordstrom, Robert J. Fisk, Mariko M. Langness, James E. West, and Louisa B. Harding. WA Dept. of Fish & Wildlife.

Chinook salmon are a socio-economically important species distributed throughout the Salish Sea, however, in this region, they are listed as threatened under the Endangered Species Act due to habitat degradation and loss, climate change and overfishing. Recent studies have begun to elucidate the potential impact of aquatic contaminants on Chinook salmon, particularly for migrating juveniles which are exposed to a myriad of pollutants as they traverse the rivers, estuaries and near-shore habitats enroute to the Puget Sound and the Pacific Ocean where they reach adulthood. The smoltification process undertaken by juvenile salmon moving from fresh to marine waters is physiologically demanding, leaving migrating juveniles susceptible to stressors, including contaminants. Compared to other salmon species, juvenile Chinook salmon are particularly vulnerable to contaminant exposure due to their longer residency in the estuarine and nearshore habitats which receive high inputs of contaminants from multiple sources, especially in developed watersheds. A group of toxicants of interest are polycyclic aromatic hydrocarbons (PAHs), originating mainly from sources like burning fossil fuels, oil spills and creosote-treated pilings. However, PAHs are difficult to measure in teleost tissues due to their rapid metabolism and breakdown, resulting in lower concentrations. Instead, PAH exposure in teleosts has been examined by measuring PAHs in stomach contents or PAH metabolites in the bile. We hypothesize that PAH concentrations are lower in whole-body but correlated with levels in stomach contents. If correlated, either tissue is a suitable measure of PAH exposure in juvenile Chinook salmon, but whole-body samples are more accessible given the challenges associated with low sample volumes of stomach contents. Previous work has shown elevated PAH concentrations in stomach contents of juvenile Chinook salmon collected from urban sites. Consequently, we expect this urban-associated trend of higher PAH contaminant concentrations to continue in juvenile Chinook salmon for both stomach contents and whole-body samples. Preliminary data of the relationship between whole-body and stomach content PAH loads in juvenile Chinook salmon, along with the geographic distribution of PAHs will be presented.

**Fish at the pharma-sea: Pharmaceuticals and personal care products in Puget Sound aquatic life**

Molly Shuman-Goodier*, Louisa Harding, Andrea Carey, Mariko Langness, Robert Fisk, Danielle Nordstrom, Andrew Beckman, Sandra O'Neill. Washington Department of Fish and Wildlife.

In response to concerns about the large number of unregulated contaminants entering Puget Sound, the Washington Department of Fish and Wildlife (WDFW) has expanded its toxics research and monitoring program to include a suite of emerging contaminants that may pose a risk to the health of aquatic life. Here, we present results on exposure to a suite of pharmaceuticals and personal care products in four species that occupy distinct habitats throughout Puget Sound: caged bay mussels, juvenile and adult Chinook salmon, Pacific herring, and English sole. Sampling efforts took place during the winter and spring of 2013, 2016, 2017, 2018 and 2019 and included 214 samples spanning 133 unique sites. All samples were tested for 141 distinct pharmaceuticals and personal care products by SGS AXYS. Samples consisted of individuals (adult Chinook salmon) or composites of multiple individuals (mussels, herring, English sole, and juvenile Chinook salmon), and included different matrices: muscle, liver, and whole bodies. Across the entire dataset, we detected 61 % (86 /141) of the pharmaceuticals and personal care products that we tested for across species and years. Ten chemicals were detected in 75% or more of samples from a given year and species, including three antimicrobials (Virginiamycin M1, Oxytetracycline [OTC], and flumequine), two antidepressants (sertraline, 10-hydroxy-amitriptyline), an anti-diabetic medication (metformin), two medical contrast agents used in X-rays (iopamidol and diatrizoic acid), a synthetic hormone (hydrocortisone), and an antihistamine allergy medication (diphenhydramine). The largest number of chemicals were observed in juvenile Chinook salmon (67/141) followed by caged mussels (37/141), and English sole (27/141), which were sampled to characterize exposure in the estuarine, nearshore, and benthic environments, respectfully. This fits with our understanding that many pharmaceuticals and personal care products enter marine water from wastewater outflows, agricultural runoff, and leaky septic systems. However, we also detected numerous pharmaceuticals in Pacific herring (24/141), and a limited number in adult Chinook salmon (7/141), which illustrates that bioaccumulation of some pharmaceuticals is also occurring in the pelagic environments distant from original sources. Comparisons with biological effect concentrations and spatial analyses, when completed, will provide added context about potential impacts to fish and shellfish health. This study sheds light on the widespread presence of pharmaceuticals and personal care products in species that are representative of three marine environments throughout Puget Sound. Results can be used to identify areas where infrastructure improvement projects may be most impactful to prevent pharmaceuticals and personal care products from entering marine waters.

**Relationships in Selenium Concentrations Among Fish Tissues: Monitoring and Regulatory**

Claire Detering*[1], Kevin Brix[2], Barry Fulton[3], Marko Adzic[4], and David DeForest[1]. [1]Windward Environmental; [2] EcoTox LLC, Miami, FL, University of Miami, RSMAS, FL; [3] Benchmark Environmental LLC, McCall, ID, [4] Teck Resources Limited, Vancouver, BC, Canada.

Several regulatory jurisdictions in North America have adopted fish tissue-based selenium criteria or guidelines. The US Environmental Protection Agency (USEPA), for example, developed recommended selenium criteria of 15.1 mg/kg dry weight (dw) for fish eggs and ripe ovaries, 11.3 mg/kg dw for fish muscle, and 8.5 mg/kg dw for whole-body (WB) fish tissue. Similarly, Environment and Climate Change Canada has adopted guidelines of 14.7 mg/kg dw (eggs/ripe ovary) and 6.7 mg/kg dw (WB). Because selenium's primary mechanism of toxicity occurs via maternal transfer to eggs, which can impair larval development and survival, the Se criterion for fish eggs and ripe ovaries supersedes muscle and WB Se criteria. However, it can be logistically challenging to sample eggs or ripe ovaries in the field. In addition, it may be desirable to conduct non-lethal sampling of muscle tissue or to combine resources with other fish monitoring programs that may focus on collection of muscle or WB tissue in support of human health assessments. Relationships for estimating egg or ripe ovary Se concentrations from muscle or WB Se concentrations is desirable. In this study, we compiled a database of selenium concentrations that could be paired in two or more tissue types (eggs/ripe ovaries, muscle, and/or WB). When available, we also gathered information on the reproductive status of the fish sampled. Several fish species exhibited an inverse relationship between ovary selenium concentrations and spawning status (i.e., ovary selenium concentrations were lower in reproductively mature fish near spawning). Log-log linear relationships in selenium concentrations among fish tissues were derived for more than 15 freshwater fish species after datasets were reduced to only samples of ripe spawning status. These results emphasize the importance of utilizing ripe samples when evaluating tissue concentrations relative to criteria, which were developed based on eggs and ripe ovaries. Selenium relationships among fish tissues developed in this study may be a helpful resource as states and provinces continue to adopt and implement federal recommended fish tissue selenium criteria.

**Tiny Fish, Big Problems; Quantifying Relationships between Microplastics Presence and Morphology in Early Life Stage Salmonids**

Tammi Fierro*, Elise Granek, and Allie Tissot. Portland State University.

Chinook Salmon are both an ecologically and culturally critical species for the Pacific Northwest, with deep rooted ties to surrounding ecosystems that stretch from the Pacific Ocean to far into the interior landscape. However, with mounting threats to this species, it is more important than ever to quantify the magnitude of these threats to salmonid livelihoods. In order to help alleviate human pressure on wild populations, hatcheries across the Pacific Northwest cultivate Chinook and other salmonid stock, with the majority meant for human use and consumption. With this in mind, research into the presence of contaminates in hatcheries, such as microplastics, is needed for both protection of the species and human health. Thus, this research aims to detect, measure, and understand presence of microplastics in sac-fry and parr, by using spring Chinook from both state run and tribal nation run hatcheries. Microplastics presence in these young salmonids may indicate a transfer of these contaminants from parent to offspring, and furthermore, this study aims to measure any change in percentages of microplastics in between life these stages, and if possible, explore tentative connections between microplastics presence and rates of unusual internal morphology.

**Investigating Microplastics Contamination in the Yukon Territory's Surface waters and Fish**

Vicki Marlatt[1],Sruthee Govindaraj*[1], Eri Boye[2], Ethan Allen[2], Catherine Henry[2], Amelie Janin[3], and Devon O'Connor[3]. [1] Simon Fraser University; [2] Core Geoscience Services Inc.; [3] Government of Yukon.

The global concern over microplastics (MP) in freshwater and aquatic ecosystems extends to the Yukon Territory, where emerging data suggests the presence of MP in the Yukon River. In 2021, a pilot project was conducted on the Yukon River to develop water sampling and analysis methodologies relevant to the Yukon and its climate and a biannual monitoring program was then performed on five sites along the river in the fall and winter from 2021 to present. All water samples were analyzed by ALS Laboratories (Cincinnati, US) for particle size and count using fluorescent tagging and static image analysis. In three of the five sites, higher MP concentrations were detected in the winter water samples compared to the summer water samples. A second MP field monitoring experiment is currently under way to better to understand the extent of MPs contamination in the Yukon Territory's surface water, and the level of uptake within the food web. This study entails a comparison of MP size and quantities in surface waters and fish guts in two water bodies; a remote land-locked lake, and the Yukon River. In this study, water samples were collected (n=3) from 5 sites on the river and the lake, by pouring 500 L of water through a set of two metal sieves (8" brass 45 µm and 500 µm) into glass bottles. Two species of fish were collected from each water body, Arctic Grayling from the Yukon River and Arctic Char from the lake and the gastrointestinal tract was removed and analyses for MP particle size and quantities are under way. Collectively these studies will aid in assessing the concentrations and sources of MP in the Yukon in waters and wild fish downstream of urban communities as well as in remote freshwater bodies.

**Legacy and emerging contaminants of concern in edible seaweeds of interest for Washington state aquaculture development**

Holly Suther*, Ruth Sofield, and Kathy Van Alstyne. Western Washington University

Seaweed are cultivated and harvested around the world for many uses including food, pharmaceuticals, cosmetics, and fuel. Seaweed aquaculture has been on the rise globally, and interest has been expressed in the United States in furthering the development of the industry. Because seaweed can absorb contaminants into their tissues, an understanding of the risks to consumers is important for informing those consumers and maintaining public support for the industry. Seven species of seaweed that are either wild-harvested or of interest to aquaculture were collected from the Washington State Salish Sea and analyzed for differences in contaminants by season, site, algal type, and year. Water samples and blades of sugar kelp, Saccharina latissima, were collected from Blue Dot Sea Farm (US) during the growing season and post-harvest for analyses of metal content, PFASs, and PCBs. Common green seaweed Ulva sp. was collected monthly to measure seasonal variation and from 12 distinct locations simultaneously around the Salish Sea to measure spatial variation. Concentrations of legacy (PCBs, arsenic, cadmium, and lead) and emerging (per-and polyfluoroalkyl substances (PFASs)) contaminants were measured in the seaweeds. Concentrations of contaminants were compared to human health-based screening levels calculated from the USEPA and reported international limits. Legacy contaminants (metals, PCBs) differed between seaweed type (reds, greens, and browns) as well as by season, year, location, and age of blade. PFASs were detected in all seaweed samples. The ratio of inorganic arsenic to total arsenic within seaweed tissue varied by seaweed type, but remained low and below screening levels. Reference dose based screening levels (SLRfD) were exceeded in three samples of Nereocystis luetkeana for Cd, but all samples fell below SLRfD for Cr, Ni, Pb, V, Zn, and total PCBs. These measurements serve as a powerful baseline for directing current and future environmental monitoring, management, and aquaculture practices.

# Session 3: Temporal and Spatial Monitoring

### PDBE Source Identification in the Nisqually River Basin, WA

William Hobbs*[1], Andrea Carey[2], Alex Gipe[1], and Sandie O'Neill[2]. [1]Washington State Department of Ecology; [2] Washington Department of Fish and Wildlife.

A contaminant study conducted by Washington Department of Fish and Wildlife (WDFW) in 2014 and 2015 found 33-50% of steelhead trout (Oncorhynchus mykiss) migrating from the Nisqually River basin contained polybrominated diphenyl ethers (PBDE) concentrations above the threshold critical-body-residues (CBRs) for increased disease susceptibility. In 2017 and 2021 WDFW and the Washington State Department of Ecology (Ecology) completed contaminant source assessments to identify localized sources of the PBDEs within the river basin. Passive water samplers, biofilms (algae, microbes and organic detritus) and invertebrates were used to identify the possible in-stream locations with the greatest likelihood for uptake of PBDEs by juvenile steelhead. The initial study survey (2017) concluded that PBDEs were present in three major tributaries, the Mashel River, Muck Creek, and Ohop Creek. In particular, the Mashel River contained the highest concentrations in water and biofilm samples. Follow-up sampling showed that only the Mashel River had concentrations reliably above background. Sampling throughout the Mashel River identified the Eatonville WWTP as a likely source for PBDEs to the river. A single event of grab samples from the influent and effluent of the treatment plant confirmed the discharge of PBDEs. All in-stream sampling took place during summer low flow periods, which represent a worst-case scenario for the dilution of effluent. The attenuation of PBDEs in the Mashel River from the source is evident over ~3.5 miles downstream until reaching background levels before flowing into the Nisqually River.

**Chemicals of Emerging Concern in Salmon Spawning and Rearing Habitat**

Samreen Siddiqui*[1], Andy James[2], and Jenee Colton[1]. [1]King County; [2] University of Washington.

Chemicals of emerging concern (CECs) present uncertain but potentially significant risk of health impacts to salmon yet have rarely been monitored in waters that serve as salmon spawning and rearing habitat. We collected samples from three rivers (Duwamish, Cedar, and Sammamish) and three streams (Juanita, Little Bear, and Swamp) in areas adjacent to and upstream and downstream from stormwater outfalls, during eight different storm events (2021-2023). Samples were analyzed by targeted, nontargeted and suspect screening methods to examine the association of CECs with stormwater outfalls. Targeted analytes included 6PPD-Q, chlorinated paraffins (CPFs), alkylphenols (APs) and alkylphenol ethoxylate (APE) surfactants, polybrominated diphenyl ethers (PBDEs), and per- and polyfluoroalkyl substances (PFAS), 6PPD-Q concentrations ranged from 2.9-479 ng/L. Overall, 6PPD-Q concentration exceeded the acute LC50 for juvenile Chinook (41 ng/L; Lo et al., 2023) at ~68% of all samples collected adjacent to the outfalls; the LC50 was exceeded at ~14% of samples collected upstream of the outfalls. Concentrations of Alkylphenol (0.26 - 118 ng/L (median= 49.4 ng/L)), PBDE (1.02 - 11,200 pg/L (median = 59.1 pg/L)) and PFAS (0.54-125 ng/L (median = 78.3 ng/L)) analyzed across three sampling events were below thresholds for freshwater fish at various life stages. PBDE and PFAS were at higher concentrations near stormwater outfalls indicating stormwater is a pathway of these CECs to King County rivers and streams. We found no correlation of CPF and AP with stormwater outfalls because these were not detected in most samples. A total of 213 compounds were identified via the High-Resolution Mass Spectrometry analysis of these, 48 were associated with the stormwater outfalls in that they were absent from upstream sampling sites, but present adjacent (or downstream). These included anthropogenic compounds such as pharmaceuticals and drugs (nicotine, caffeine, amphetamine, methamphetamine, lidocaine), pesticides (prometon, carbendazim), plasticizers (bis(2-ethylhexyl) hexanedioate, bis(8-methylnonyl) phthalate, diisodecyl phthalate), and industrial compounds (2-hydroxybenzonitrile, 4-hydroxyquinoline, 5-methyl-1H-benzotriazole, tributyl phosphate), and some natural compounds. We conclude some but not all the outfalls affect water quality of the receiving waters in the area near to the outfalls. Our most notable finding was that 6PPD-Q commonly exceeded toxicity thresholds for juvenile and adult coho at areas adjacent to outfalls. Other sensitive species such as brook trout may also be affected in these areas.

**Understanding and Mitigating the Dominant Sources of PFAS to Wastewater Treatment Plants from Domestic, Commercial, and Industrial Sectors Utilizing a Mass Balance Approach**

Summer L. Sherman-Bertinetti*, Scott Mansell, Amanda McGarry, and Bob Baumgartner. Clean Water Services.

PFAS are a contaminant of major concern for Wastewater Treatment Plants (WWTPs) due to current and imminent state and federal regulations as well as increasing concern from the public about the impacts of land application of biosolids, discharge of effluent, and water reuse. WWTPs are passive receivers of PFAS in wastewater discharged from domestic, commercial, and industrial sources. Because WWTPs are not designed to remove PFAS and treatment options applicable for wastewater are still in their infancy, source control is a critical mechanism for reducing PFAS concentrations discharged from WWTPs. However, the source control mechanisms differ greatly depending on if the source is industrial, commercial, or domestic. For WWTPs, it is imperative to understand PFAS loadings from different sources as well as the fate of PFAS discharged from the WWTPs in effluent, biosolids, and reuse in order to make cost-effective, data-driven decisions for addressing coming regulations and protecting environmental and public health. Since 2019, Clean Water Services (CWS) has been conducting regular PFAS monitoring at the WWTPs, the collection system, and industries to identify and track down sources of PFAS and address them by creating PFAS Management Plans. CWS has been able to characterize PFAS compounds in the four WWTPs and in discharging industrial users (IUs). Certain industries, such as semiconductor manufacturers, can have a range of PFAS concentrations, however the PFAS ‘signature’ (compounds present and relative amounts) remains largely consistent over time and across the sector. Other industries, such as metal finishers, have a range of PFAS concentrations and compounds that vary both over time and across the sector. Understanding the concentrations and loadings from these industries has helped to focus CWS’ source control efforts towards the large contributors which has already resulted in reduced PFAS influent concentrations at the four WWTPs. But additional sources remain, mainly within the commercial and domestic sectors. In 2023, CWS collected samples at nine representative locations in the collection system with uniform, single-sector contributing areas. These were combined with the industrial discharge concentrations to create a PFAS mass balance by source/sector for each WWTP. This effort showed that the dominant sector varied by WWTP which is informing where additional source control efforts should be focused in each sewershed to be most effective.

**Pesticide Monitoring in Washington State Surface Water**

Abigail Nickelson*. Washington State Department of Agriculture.

The Washington State Department of Agriculture has been monitoring streams for pesticides across the state since 2003. The Ambient Monitoring for Pesticides in Washington State Surface Water program was established in response to questions regarding the exposure of endangered salmon to pesticides. Sample collection has occurred weekly during the application season (March through October) as a matter of routine sampling every year. In 2023, the US Environmental Protection Agency released both the Herbicide Strategy and Vulnerable Species Pilot. These draft documents represent a fundamental shift in how applicators will be responsible for avoiding off-target movement of pesticides by listing conservation practices, like those available through the Natural Resources Conservation Service, on the label as required mitigation strategies. Conservation practices that are currently well known for preventing soil erosion, nutrient transport, and improving soil quality are now gaining attention for their ability to mitigate pesticide movement. Refining exposure estimates, providing outreach, measuring the effectiveness and promoting the adoption of conservation practices to minimize off-target pesticides has become relatively important in contrast to routine monitoring. In recent years the program has implemented several projects to reflect the changing priorities. This presentation will address the results, successes and limitations of those projects and the challenges ahead for the program.

## Human Health Risk-Based Monitoring Program for a Working Harbour

Ariel Blanc*[1], Amy Corp[1], Mark Larsen[1], Michelle Havey[1], Eric Crawford[2], and Fiona Wong[3]. [1] Anchor QEA; [2] Transport Canada; [3] Public Services and Procurement Canada.

Victoria Harbour on Vancouver Island, British Columbia, is part of the traditional territories of the Esquimalt Nation and Songhees Nation and has been a busy commercial and industrial harbour since the mid-1800s. Contaminants in sediment are elevated from the harbour's historical past, and there are ongoing sources of contaminants to the harbour, including stormwater. Targeted early action and source control have addressed some contamination, and decades of monitoring data suggest that recovery is occurring. Harbour-wide sediment surface weighted average contaminant concentrations have decreased between historical and current sediment datasets. Dioxins/furans and polychlorinated biphenyls (PCBs) have decreased 51% and 44%, respectively. Sediment lead and carcinogenic polycyclic aromatic hydrocarbon (cPAH) concentrations have also shown notable reductions. Improving sediment quality appears to be affecting reductions in sea life tissue contaminant concentrations. Between 1995 and 2019, Dungeness crab hepatopancreas dioxin/furan and PCB toxic equivalent (TEQ) concentrations decreased by more than 75%. The recent human health risk assessment identified potential risk to First Nations consumers of sea life and from direct contact with intertidal sediments. These findings indicate that the sediment and tissue contaminant reductions to date have not been sufficient to reduce human health risks below thresholds. A Source Control and Sediment Management Plan (SCSMP) outlining the remedial strategy for the Victoria Harbour Floor is being developed. This plan will include elements of active remediation, source control, and monitored natural recovery. A monitoring program extending for the next 80 years has been developed to track harbour recovery. This monitoring program includes four cycles of sampling (with multiple events in each) occurring over progressively longer time periods as harbour conditions improve. A complete updated harbour sediment and sea life tissue dataset will be collected during each of the cycles. Caged bivalves will also be tested to evaluate impacts of surface water quality on bivalves. The sediment data from each cycle will be used to evaluate changes in sediment contaminant concentrations harbour-wide and on a subarea basis, and intertidal data will be used to evaluate progress towards human health direct contact numeric objectives. Updated human health risks associated with First Nations consumption of individual sea life types and the consumption of a mixed diet will be quantified with the sea life tissue data collected from each cycle. A decision-making framework has been developed to identify potential monitoring data outcomes and responses.

# Monday Poster Presentations

## Session: Puget Sound

**Poster 1. Characterizing Arsenic Contamination and its Effects On the Microbiomes of South Central Puget Sound Lakes**

Aseel Al Karawi*, Victoria Zalutskiy, Christopher Robles, Christian Gombio, and Trevor Rivers. Division of School of Interdisciplinary Arts and Sciences, University of Washington Tacoma

Legacy arsenic (As) contamination in terrestrial and freshwater ecosystems in the south-central Puget Sound region is a product of prolonged pollution from many sources, with the ASARCO copper smelter (1912-1993) in the city of Tacoma, WA being one of the contributors. We hypothesize that As is a significant selective pressure for As-tolerant and resistant microbiota in freshwater lakes. To test this hypothesis, water, sediment, periphyton, and Chinese mystery snails (CMS) were sampled from three lakes with differing concentrations of As; Lake Killarney (20 ppb As), Steel Lake (2 ppb As), and Trout Lake (< 1 ppb As). Previous studies have shown that As accumulates in periphyton and thus, we hypothesized that primary consumers who ingest periphyton containing As within contaminated lakes will be exposed to As that influences their gut microbiota. Previous studies have shown that primary consumers of periphyton such as freshwater snails have the highest levels of As in their tissues relative to animals at higher trophic levels within the contaminated lakes. Thus, snails can be indicators of the ecosystem's health overall. The overall goal of this project is to determine how varying levels of As contamination in freshwater lakes influence the existing compartmental microbiomes in the water, sediment, periphyton, and CMS populations of these ecosystems. Inductively coupled plasma-mass spectrometry (ICP-MS) and 16S rRNA amplicon sequencing were performed for all four sample types in order to quantify total arsenic levels and to identify the microbial composition in each sample type and lake, respectively. Preliminary experiments comparing As contaminated and control lakes have shown that bacterial community composition in periphyton differs, suggesting selection for As-tolerant species. Because the phyla found in lake periphyton communities have anoverlap with those in snail guts, it is possible that the exposure of snails to As contamination can contribute to their microbiota. Ongoing work involves the optimization of a quantitative polymerase chain reaction (qPCR) assay of total bacterial load and As metabolism genes; aioA, arrA, arsC, and arsM. These genes of interest are widespread across bacteria and confer resistance/tolerance to arsenic via respiratory arsenite oxidation, respiratory arsenate reduction, inorganic arsenic detoxification, and organic arsenic methylation, respectively.

**Poster 2. In vitro approaches for addressing orca health**

John D. Hansen*[1], Mary J. See[2], Mark D. Jankowski[3], Dawn P. Noren[4] and Brad Hanson[4]. [1]USGS Western Fisheries Research Center; [2]USEPA National Exposure Research Laboratory; [3]USEPA Region 10; [4]NOAA Northwest Fisheries Science Center.

Puget Sound contains a rapidly growing human population where contaminants have and will continue to uniquely impact aquatic animal health relative to other regions in Washington. Contaminants can be lethal to aquatic species as well as contribute to sublethal effects including immunosuppression. Importantly, the southern resident killer whale population is critically endangered and recent studies have predicted the potential collapse of orca populations due in part to pollution (Desforges et al. 2018) and other stressors. To learn more about the effects of environmental stressors on orca health, the USGS, NOAA, and EPA teamed up to develop new in vitro resources that can be used to address cellular responses to environmental stressors that might compromise orca health. The skin is the first line of defense against infection where epithelial and dermal fibroblasts work in cooperation with skin microbiota to defend against pathogens and to maintain tissue integrity. Through this joint agency partnership, we developed primary dermal fibroblast cultures from a skin biopsy taken from a Bigg's Killer Whale (e.g., transient killer whale). Two major areas of focus are currently being studied: 1) addressing the effects of contaminants on immune function and 2) using dermal fibroblast cultures for transcriptomic points-of-departure (tPOD) assays—dose response studies with environmental stressors to assess when an effect is no longer observed. In addition, we have assessed the potential susceptibility of orca skin to 6PPD-quinone, an emerging contaminant of concern for aquatic animal health. Through this joint agency effort, we will learn more about the potential effects of legacy and emerging chemicals of concern on orca skin health that can be used for risk assessment and management of orca populations.

**Poster 3. Using a periphyton feeding experiment to assess trophic transfer of arsenic and its impacts on host gut microbiome composition**

Christian Gombio*, Victoria Zalutskiy, Aseel Al Karawi, Christopher Robles, Trevor Rivers, Sarah Alaei, Jim Gawel, and Alison Gardell. University of Washington Tacoma

The ASARCO copper smelter, operational for almost a century in Tacoma, WA, has resulted in heavy metal (e.g., arsenic and lead) pollution in the local soil, air, and water bodies of the south and central Puget Sound region. Following the closure of the smelter, several studies characterized the fate and transport of As within freshwater lake ecosystems and demonstrated trophic transfer of As in the food chain. However, the effects of chronic As exposure on microbiome composition in primary consumers of lake ecosystems have not yet been investigated. We hypothesize that the introduction of As to primary consumers through their diet has implications for gut microbiome composition. Specifically, we predict to observe an increase in the fractional abundance of As-tolerant bacteria. To test this hypothesis, we fed As-contaminated periphyton (multi-microbial film) to lab-acclimated Chinese Mystery Snails (CMS) sourced from Trout Lake (< 1 ppb As) for 30 days. We obtained the As-contaminated periphyton by deploying submersible racks containing acrylic plates in Lake Killarney (20 ppb As) for three months. We will evaluate the trophic transfer of As from periphyton to the snails and whether their gut microbiome composition changes after feeding on As-contaminated periphyton compared to a control group that was fed commercial algae wafers. Upon completion, we extracted DNA for 16S rRNA gene amplicon sequencing and plan to perform statistical analyses such as alpha-diversity and beta-diversity indexes on the microbial composition of the CMS gut. Total As concentrations in the aquarium water, CMS gut, and periphyton will be measured using inductively coupled plasma-mass spectrometry (ICP-MS). We will evaluate trophic transfer of As from periphyton to the CMS gut using ICP-MS data. In addition, we are developing gnotobiotic juvenile CMS as a tool to further elucidate host-microbe interactions including the effects of As on the CMS immune system and other aspects of organismal health. While this work is still ongoing, we project that the results of the periphyton feeding experiment and development of gnotobiotic juvenile CMS will produce valuable insights for future research regarding As contamination in aquatic ecosystems.

**Poster 4. Perspectives of high-consuming immigrant and refugee fisher communities in King County**

Richard Jack*, Jennifer Lanksbur, and Jenée Colton. King County Water & Land Resources, Toxics and Contaminant Assessment Unit.

King County contracted for several fish consumption surveys in the 1997 to 2003 timeframe as part of capital improvement project planning efforts. About ten years later, the King County Council provided funding to establish our long-term marine and freshwater tissue monitoring programs, partly in response to Washington Department of Health fish consumption advisories in King County waters. These advisories are for consumers with average fish intake rates and are not protective of high consumers, e.g., subsistence fishers. While we were aware of other consumption survey that gathered fishing information from tribal and/or Asian Pacific Islander populations in the Puget Sound region, we had little direct dialogue with these populations. The geographic scope of these late 1990s era results also made them difficult to relate to our monitoring programs. In 2022, we helped the Refugee Federation Service Center (RFSC) of Kent, WA secure grant funding from the King County Wastewater Treatment Division. We then partnered with the RFSC on an outreach project targeting refugee and immigrant populations in King County. The main objectives of this project were to: 1) Sponsor educational seminars to reduce household hazardous waste, reduce toxic exposures, and encourage safer product use within their homes; 2) Conduct targeted fisher surveys among 16 different ethnic groups speaking nine different languages to better understand where immigrants fished, what species were being consumed, what parts of the fish were consumed, who fishers shared their catch with, and how fish and shellfish were prepared; 3) Conducted targeted angling over ten months in four new lakes and for two new marine species not previous sampled by our program. The fish collected were analyzed by the King County Environmental Laboratory for PCBs, PBDEs, mercury, and PFAS. We will be sharing the findings back to these traditionally underserved communities. These results will help inform risks to high consuming immigrant populations as well as help them make safer choices. Together with the RFSC, we have discovered mutual priorities and gaps in our understanding of how refugees and immigrants maintain their cultural practices in King County. This presentation will describe how King County is using science and partnerships with underserved communities often burdened by contaminants to advance King County's Clean Water Healthy Habitat goals of reducing toxics in fish and centering people in our work.

# Session: Salish Sea

**Poster 6. Estrogenic Activity of mixtures in the Salish Sea: The use of high throughput toxicity data with chemical information from fish bile and other matrices**

Maya Faber*[1], Ruth Sofield[2], Andy James[3], and Louisa Harding[4]. [1]University of Washington-Tacoma; [2] Western Washington University; [3]University of Washington-Tacoma; [4]Washington Department of Fish and Wildlife.

A subset of anthropogenic chemicals known as contaminants of emerging concern (CECs), are released into the aquatic environment through human activities. CECs occur in contaminant mixtures that may share a common mode of action such as estrogen receptor agonism, which can lead to reproductive disturbances in fish. This study explores the application of in vitro high throughput screening (HTS) data to evaluate estrogenic activity. Data were compiled from 18 studies, analyzing 387 CECs, across various matrices including water, wastewater treatment plant (WWTP) effluent, fish and mussel tissue, and fish bile. Novel estrogenic mixture thresholds were established. Thresholds for fish bile were validated using field measures of organism response. Field measures and in vitro estrogenic activity data were also used to identify field sites of concern. Samples were then evaluated to identify mixtures with high, medium, and low estrogenic activity. Four of nine WWTP effluent samples and 133 bile samples (38%) exhibited medium or high estrogenic activity. Priority chemicals were subsequently identified as “drivers” of estrogenic activity (not requiring input from additional chemicals in a mixture to exceed a threshold) or as “major” or “minor” contributors (resulting in an exceedance only when combined with other chemicals). Among fish bile samples with medium or high estrogenic activity, 62% of mixture response was explained by chemical “drivers” rather than a mixture of contributing chemicals. High Priority CECs, Estrone (E1), 17β-estradiol (E2), and to some extent, estriol (E3) were responsible for most of the estrogenic activity, illustrating the limited number of CECs leading to estrogenic activity in mixtures, and bisphenol A (BPA) was a “major” contributor. This study broadens the assessment of estrogenic CEC mixtures by incorporating chemicals lacking traditional benchmarks, utilizing HTS data, and developing an application for fish bile.

# Session: Tire Wear

**Poster 7. Tire Wear Contaminants Spatial and Temporal Monitoring Strategies**

Rhea Smith*[1] and Rachael Lane[2]. [1] WA Dept of Ecology; [2]USGS Environmental Organic Chemistry Lawrence, Kansas.

To reduce toxics effectively, we need to understand how they are transported and where they accumulate in the environment. 6PPD is a chemical added to tire rubber that slows down the weathering process. 6PPD reacts with ozone and transforms into 6PPD-q which is toxic to coho salmon and other salmonids at levels routinely observed in the environment. Despite tires and roads being relatively ubiquitous in urban watersheds, the mass loading, transport, and exposure to aquatic ecosystems will depend on landscape and land use characteristics that vary from one watershed to another. A biological effects-based map of vulnerable aquatic habitats was developed to help visualize the potential occurrence and exposure of 6PPD-q and focus sampling efforts. Sampling methods are being evaluated to provide technical guidance and support future studies to understand the fate, transport and occurrence of tire wear contaminants.

**Poster 8. Leveraging Multi-Omics Analyses to Explore the Toxicity of Urban Road Runoff Contaminants in Juvenile Salmonid Species**

Miranda Jackson*, Chloe Fender, Stacey Harper, and Manuel Garcia-Jaramillo. Oregon State University.

Urban roadway runoff is correlated to escalating pre-spawn mortality (PSM) events in Pacific Northwest salmon populations. Recently, a chemical derived from tires, N-(1,3-Dimethylbutyl)-N'-phenyl-p-phenylenediamine-quinone (6PPD-q), was isolated from roadway runoff and observed to induce acute mortality in salmonids, however sensitivity among salmonid species is varied. It is predicted that exposure to 6PPD-q will enhance salmonid sensitivity to other cooccurring contaminants commonly detected in surface waters, such as the polycyclic aromatic hydrocarbon 9,10-Anthraquinone (AQ). To determine sublethal concentrations, juvenile salmonid species (chinook, coho, and rainbow trout) were exposed to a range of concentrations of 0 – 10 µg/L 6PPD-q for 24-hours. A targeted multiple reaction monitoring (MRM) method was developed in a triple quadrupole mass spectrometer, coupled to an ultra-high-performance liquid chromatography system to quantify 6PPD-q and AQ in water samples. To better understand the mechanisms of toxicity of 6PPD-q, fish were exposed to established sublethal concentrations of 6PPD-q and AQ separately and in combination over a five-day period. AQ and 6PPD-q quantification in water tanks were validated and measured within a 15% margin of error. Coho and rainbow trout exhibited PSM symptoms leading to mortality at 6PPD-q concentrations after 24-hour exposure to 0.01 µg/L and 10 µg/L, respectively. PSM symptoms and mortalities were observed in coho and rainbow trout, but not chinook. Non-targeted mass spectrometry-based metabolomics analyses were performed on brain and liver samples from exposed and non-exposed fish. Using in-house and open-source spectral libraries we annotated 290 and 260 metabolites in the brain and liver tissues, respectively, with high level of confidence. A larger number of significant changes were observed in the liver tissues within each specie when compared to the brain tissues (Wilcoxon rank sum test, $p < 0.05$). Fatty acid biosynthesis was the pathway most significantly affected by 6PPD-q exposure in coho salmon, as revealed by metabolic pathway enrichment analysis. QuantSeq 3’ mRNA-sequencing transcriptomics analysis will be integrated with the metabolomics data. This study aims to clarify the impact of prioritized urban road runoff contaminants on salmonids health, contributing to a deeper understanding of the observed variations in toxicity among different salmonid species and mechanisms of action.

**Poster 9. Effects of Tire Wear Micro- and Nanoparticles in the Model Estuarine Species Fish Menidia Beryllina and Mysid Shrimp Americamysis bahia**

Clarissa Raguso*[1], Lauren Kashiwabara[2], Arriola Samuel[3], Stacey Harper[4], and Bryan Harper[4]. [1]Earth and Environmental Science Department, University of Milano Bicocca, Piazza della Scienza 1, 20126 Milano, Italy;[2]Fisheries, Wildlife, and Conservation Sciences; Coastal Oregon Marine Experiment Station, College of Agricultural and Life Sciences, Oregon State University, 97365, USA; [3]Department of Integrative Biology, College of Science, Oregon State University 97330, USA; [4]Environmental and Molecular Toxicology, College of Agricultural and Life Sciences, Chemical, Biological and Environmental Engineering, College of Engineering, Oregon State University, 97331, USA.

The increase in plastic production worldwide and the mismanagement of plastic waste are leading the oceans to become a big waste bin. Million tonnes of plastic enter our ocean every year and car tires are one of the biggest sources. In the US almost 1,524,740 metric tons of tire wear particles (TWP) are released each year into the environment, deriving from tires undergoing friction on the road. For our experiments, we used a cryo-milled tire tread (CMTT) composite provided by the U.S. Tire Manufacturers Association. The composite was a representative mixture of what may be in our environment and contained three types of tire in proportions that are estimated for the U.S. (41% Passenger Car Tire, 14% Light Truck Tire, and 45% Truck/Bus Tire). To better resemble what is happening in the real environment, leachate and micro- and nanoparticles were weathered through a solar simulator for 72h. Considering the limited available data regarding the toxicity of environmentally relevant tire particles on organisms, this study aims to provide information about TWP exposure impacts on larval growth, internalization, behavior, and intracellular reactive oxygen species (ROS) level in the model species Fish Menidia Beryllina and Mysid Shrimp Americamysis bahia. Particularly, 5-day post-fertilization M. Beryllina embryos and 7-day-old A. bahia were exposed to weathered and/or not weathered TP leachate and micro (1-20 μm) and nano (< 1 μm) tire particles at four concentrations (10, 100, 1000 and 10,000 particles/ml). At the end of the exposures, behavioral assays were performed using a DanioVision Observation Chamber, where each fish was subjected to a dark: light cycle stimuli. Growth measurements were assessed through the index W/L× d (W = width, L = standard length, d = days the organisms were exposed to tire particles) and organisms were cleared with CUBICTM clearing reagents (Cubic-L and Cubic-R solutions) to visualize and count the internalized particles. ROS level was measured using a total reactive oxygen species assay kit 520 nm. Previous studies have already demonstrated tire particles to have behavioral toxicity and negative effects on growth and ROS levels in our study species. This study has the potential to lead to a more comprehensive perspective of what organisms are experiencing in the real environment, reporting for the first time the toxicity due to environmentally relevant tire particles in the two model estuarine species Menidia Beryllina and Americamysis bahia.

### Poster 10. How Habitat, Population, and Life Stage Alter 6PPD-quinone Toxicity to Coho Salmon

Garrett Foster* and Jen McIntyre. WSU Puyallup Research and Extension Center.

Stormwater toxicity has been observed in adult and juvenile coho in the real-world environment at locations like Longfellow Creek, and the same symptoms and mortality have been replicated with analytical standards of 6PPD-quinone in laboratory settings. However, these laboratory tests were done in very specific water quality conditions and only with coho parr from hatchery populations of the Puyallup River. The toxicity of pollutants like 6PPD-quinone is known to change with habitat factors such as temperature, pH, conductivity, concentration of natural organic matter, and velocity of water flow. Toxicity can also feasibly change with life stage and population or river of origin. I will present on a series of toxicity tests I performed under a broadly inclusive, environmentally-relevant range of habitat factors, with every freshwater life stage of coho salmon, with coho salmon from a new river population - "B-run" coho from Bingham Creek, a tributary of the Chehalis River - and with a new species that's closely related to coho - Chinook salmon.

# Session: Plastics

### Poster 11. Utilizing an In vivo Human Health Model to Understand the Effects of Polyhydroxyalkanoate Nanoplastics on Polycyclic Aromatic Hydrocarbon Mixtures Toxicity

Elise Cordle*[1], Stacey Harper [1,2], and Bryan Harper[2]. [1]School of Chemical, Biological, and Environmental Engineering, Oregon State University Corvallis, OR, USA; [2]Dept of Environmental and Molecular Toxicology, Oregon State University, Corvallis, OR, USA.

Plastic and chemical pollutants are recognized as a worldwide threat to both humans and the environment. Interactions between nano-scaled plastics and organic pollutants can result in contaminants adsorbed to plastic particles, resulting in plastics acting as chemical carriers and modulating their exposure and potential for toxicity. We investigated how polyhydroxyalkanoate (PHA) nanoparticles, sourced from drinking straws, influenced the toxicity of polycyclic aromatic hydrocarbons (PAHs) to developing zebrafish. PHA drinking straws were cryomilled and fractioned into PHA nanoparticles <1 μm to generate particles with a hydrodynamic diameter of 314.6 ± 201.1 nm. These fractioned PHA particles were added to a mixture of the top ten PAHs in the ratio found at the Portland Harbor Superfund site. The toxicity of this mixture to dechorionated zebrafish was compared to the toxicity of the same ten polycyclic aromatic hydrocarbons without PHA nanoplastics. Exposure solutions containing 1.24x108 particles/mL had an LC50 value 0.40 ± 0.016 mg/L, compared to a significantly lower LC50 value of 0.56 ± 0.083 mg/L for the same exposure solutions without plastics. Although embryonic zebrafish exposed to PHA nanoplastics exhibited malformations like those exposed to the PAHs, the proportion of embryonic zebrafish with malformations decreased. The large decrease in LC50 value supported the prediction that the addition of PHA nanoplastic particles did in fact alter the toxicity observed for PAHs.

**Poster 12. Unraveling the combined effects of acidification and microfibers from textiles on a model estuarine organism, Americamysis bahia**

Lauren Miki Kashiwabara*[1], Clarissa Raguso[2], Patrick Reece[3], and Susanne Brander[1]. [1]Department of Fisheries, Wildlife, and Conservation Sciences, Oregon State University; [2]Earth and Environmental Science Department, University of Milano Bicocca; [3]Oregon State University.

Americamysis bahia, mysid shrimp, are a model estuarine invertebrate commonly used in toxicity testing. Mysid shrimp are major prey sources and the basis of nearly all estuarine and marine food webs, including those for economically and culturally significant species such as salmonids and gray whales. Estuaries and marine environments are subject to multiple stressors simultaneously, including climate change-induced acidification and pollution. Microplastics (plastic particles <5mm) are a ubiquitous contaminant found across environmental matrices and in biota globally. They are complex due to their varied shapes, sizes, polymers, chemical additives, and natural weathering processes. Microfibers, the most common environmental microplastic morphology, originate from textiles and can be synthetic (i.e. polyester, nylon, rayon) or natural (i.e. cotton, wool, hemp). Both synthetic and natural microfibers have been found to cause behavioral and growth effects in mysid shrimp. This may be due to the heavy chemical processing of natural textiles. However, the effects of each stage of manufacturing textiles, especially in conjunction with aquatic acidification, have not been explored. Here, using a solar simulator, I will expose mysid shrimp to both weathered and not-weathered textiles from different stages of fabric production at different pH levels. After a 7-day static renewal toxicity test, I will analyze behavior, growth, and caloric value, and I will explore ingestion using a tissue-clearing reagent and fluorescence microscopy. Behavioral differences are indicative of neurotoxicity and decreased growth and caloric value resulting in less nutritionally dense prey could lead to food dilution higher up the food chain. These results will provide insight into the impact of acidification and microfibers at various stages of textile production in estuarine organisms. Changes in these key physiological processes may have adverse bottom-up effects on estuarine food webs, potentially impacting estuarine and marine food webs.

# Session: The P's: Pesticides, Pharmaceuticals, PAHs, and Probabilistic Risk Assessment

### Poster 13. Phthalates and Phthalate Alternatives Analysis Using Gas Chromatography Mass Spectrometry With Demonstration using Silicone Passive Samplers and Real-World Samples

Kaley Adams*, Caoilinn Haggerty, Richard Scott, Steven O'Connell, and Kim Anderson. Oregon State University

Phthalates are anthropogenic chemicals having a wide array of commercial uses across the world, but resultant residues are frequently detected across a range of human exposures including foods and personal sampling devices. Countries around the world have added phthalates to environmental watch lists due to health effects that have been attributed to routine exposure, and interest in this chemical class has grown rapidly in the past decade. However, current analytical methods to measure phthalates are limited in the breadth of chemistry targeted, often targeting less than 15 compounds. We developed a selective ion monitoring (SIM) gas chromatography mass spectrometry (GCMS) method for quantitation of 28 phthalates and 2 phthalate alternatives covering boiling point ranges from 283-547 C°, and included several chemicals often understudied. Analytical parameters were optimized to improve resolution across the diversity of targeted chemicals, and the sensitivity of the method was compared to existing analyses. Instrument detection limits ranged from 17 to 231 ng/mL, with a median around 31 ng/mL. All phthalates were calibrated on a multi-level 6-point curve with r2 values greater than 0.99. Finally, the application of the method was assessed with real world samples including a range of human exposure matrices such as olive oil, honey, and passive sampling silicone wristbands. The silicone wristbands were worn from a diverse pool of participants and potential exposures: roofers, children, pregnant women and farmworkers. Overall, replicates of real- world samples were found to have a relative percent differences less than 9% representing a robust quantitative analysis.

**Poster 14. Probabilistic Risk Assessment as a Tool for Environmental Risk Assessment and Regulatory Criteria Development: Applications and Versatility**

Camille Flinders*[1], Brad Barnhart[1], Emily Morrison[2], Paul Anderson[2], and Wayne Landis[3]. [1]NCASI; [2]Arcadis; [3]Western Washington University.

Probabilistic Risk Assessment (PRA) is a collection of risk assessment methods that incorporates uncertainty and variability to estimate the likelihood of exposure, risk, or hazard. In contrast to other risk assessment approaches that often rely on single point estimates (typically, upper bound values) for the various inputs into a risk equation which are applied across all members of an exposed population, PRA facilitates transparency regarding uncertainty and risk estimates among different members of an exposed population (including sensitive groups or life stages). PRA allows policy-makers to input exposure parameters as distributions to develop target-specific, science-based margins of safety. Resulting criteria can be transparently linked to the actual population exposure characteristics and the stipulated risk targets selected for the population, which overcomes the phenomenon known as 'compounded conservatism' by using worst-case assumptions. Despite the recognition of the benefits of probabilistic methods and its use in certain programs (e.g., Superfund), PRA to evaluate risk and develop criteria is underutilized in certain regulatory programs such as the development of air and water quality criteria for the protection of aquatic life and human health. This may be due to the absence of guidance from the Environmental Protection Agency, perceived difficulty in developing PRA-derived criteria among agency personnel, and lack of freely-accessible calculation tools. This presentation describes various probabilistic methods suitable for environmental risk assessment and the benefits of their use, typical distributions of environmental data, and challenges to implementation. It also provides an overview of a special publication series that advances the understanding of probabilistic methodologies and their versatility for robust, transparent, data-based environmental risk assessment and standards derivation across a range of media that align with regulatory objectives to protect aquatic and terrestrial biota, human health, and vulnerable populations.

**Poster 15. Evaluating the Efficacy of Soil Amendments in Reducing the Impacts of Nanopesticides**

Brianna Benner* and Manuel Montaño. Western Washington University

As pesticides are necessary to meet current and future agricultural needs, nanopesticides have seen increased use resulting from their more targeted applications at lower doses. Copper-based nanopesticides have demonstrated efficacy, but there are also concerns about their potential toxicity to aquatic species. Unintended toxic exposures resulting from agricultural runoff containing these nanopesticides can be mitigated with riparian buffer zones. In this study, biochar and chitosan were investigated as soil amendments, as they can bind metals and excess nutrients. However, there are still open questions about how effective these amendments are in relation to different soil and nanopesticide types. In this study, soil columns and batch sorption experiments were performed to assess the ability of these two amendments to reduce copper and nutrient leaching. The columns were filled with soil from Padilla Bay, an estuary adjacent to agricultural fields, then amended and subsequently dosed with fertilizer and a nanocopper hydroxide pesticide. Copper and nutrient concentrations from the subsequent leachate were quantified using inductively coupled plasma-mass spectrometry and ion chromatography. The results of the study aim to provide insight on the utility of these amendments in riparian buffer zones in the Skagit valley region.

**Poster 16. Enemies of Anemones: How Environmental Concentrations of Pesticides Affect Anthopleura elegantissima Symbionts and Reproductive Ability**

Bria Bleil*. Portland State University.

Anthopleura elegantissima is an indispensable species due to their symbiotic relationships with zooxanthellae and zoochlorellae which contribute to high productivity and nutrient cycling in the intertidal zone. A. elegantissima undergoes asexual reproduction within aggregated colonies and annual sexual reproduction via spawning in the water column. Commonly used forestry herbicides and other pesticides, detected in Oregon coastal watersheds and rivers, which drain into Oregon coastal waters, can disrupt photosynthesis, kill off zooxanthellae symbionts, and disrupt reproduction in Cnidarians. Using passive samplers, this research will examine which pesticides are entering Oregon nearshore coastal waters, and at what concentrations. Using these measured environmental concentrations of pesticides, I will research how they affect A. elegantissima symbiont load and gonadal development. Pesticides are predicted to increase stress in A. elegantissima, causing a decrease in symbionts and reabsorption of their gonads, which results in no or low reproductive output. The results of this study aim to inform policy decisions regarding unsafe pesticide application and aid restoration efforts by establishing baseline data to assess changes over time, and guiding restoration plans based on predicted effects.

# Session: Airborne Pollutants

**Poster 17. Community-Engaged Investigation of Airborne PAH exposure in St. Helens, OR using Passive Sampling Techniques**

Alison Clark*[1], Emily Bonner[1], Diana Rohlman[1], Lisa Bramer[2], and Lane Tidwell[1]. [1]Oregon State University; [2]Pacific Northwest National Laboratory.

St. Helens, Oregon sits northwest of Portland, Oregon. Current and historic sources of polycyclic aromatic hydrocarbons (PAHs) may affect vapor phase exposure. PAHs are organic pollutants produced from carbon sources. Using passive samplers, we measured vapor phase PAH presence within the community of St. Helens. Our objectives are to ascertain local outdoor features that contribute to PAH exposure, explore the influence of demographics and personal habits on PAH exposure, and compare changes in outdoor air to changes in personal PAH exposure over time. Low-density polyethylene (LDPE) and silicone wristbands (WB) were used as passive biomimetic samplers to capture environmental and personal exposure for volatile and semi-volatile PAHs. Community participants were recruited randomly by mail and 49 total participants enrolled. Each filled out a personal habit questionnaire and were sent sampling kits. Each participant was part of a group asked to wear WB samplers for 7 consecutive days, 4 times each, over a period from Nov 2022 to June 2023. Participants sampled in two alternating groups. 21 of those participants also set up air cages containing 5 LDPE strips during the same sample periods and returned them by mail. Air cages were also deployed at 6 public sites during the same sample periods. After deployment, all samplers were cleaned by hand to remove external particulates before chemical extraction. WB samplers went through an additional solid-phase extraction step. 162 total silicone WB and 155 total LDPE strips were collected with a 90% overall return rate. Samplers were analyzed for parent and alkyl-substituted PAHs by GC/MS/MS and data collected for 62 total PAHs including 21 alkylated PAHs. Preliminary results discuss personal habit and local outdoor temporal trends. 50 PAHs were detected in at least one month of sampling and 47 detected in LDPE samplers with an overlap of 98%. A combination of generalized linear mixed models and lasso penalty for variable selection were used to identify significant variables. Total exposure and differential exposure to naphthalene were approximated by the first two principal components. Temporal trends were compared to trends in WB and LDPE samplers for future analysis. Future work includes continued analysis of LDPE samplers and analysis of spatial and temporal trends for both the personal exposure samplers and potential PAH sources within the city. Final report back to the community is planned for Spring of 2024.

**Poster 18. A community-engaged investigation of residential polycyclic aromatic hydrocarbon exposures in Western Eugene**

Francesca Germano*[1], Lane Tidwell[1], Arjorie Arberry-Baribeault[2], Lisa Arkin[2] and Michael Barton[3]. [1]Oregon State University; [2]Beyond Toxics, Eugene; [3]Pacific Northwest Center for Translational Environmental Health Research, Oregon State University.

In response to community concerns regarding industrial air pollution, Beyond Toxics (BT) and Oregon State University (OSU) initiated a community-engaged research study characterizing residential exposure to polycyclic aromatic hydrocarbons (PAHs) in West Eugene, OR. This neighborhood is next to a wood preservative facility known to emit PAHs via use of creosote. Stationary passive samplers were deployed by BT and OSU staff in residential and commercial areas in three rings around the facility at 17 locations: an inner (0.25-mile, n=4), middle (0.5-mile, n=4) and outer ring (1 mile, n=8) for seven days. Additionally, twelve residents in the area wore and returned personal passive wristband samplers. All samplers were analyzed for 63 PAHs. There were 38 PAHs detected across the stationary samplers. The five most abundant PAHs by average concentration in stationary samplers were 2,6-dimethylnaphthalene (3327.6 ng/m3), naphthalene (2883.6 ng/m3), 2-methylnaphthalene (2712.9 ng/m3), 1-methylnaphthalene (1479.1 ng/m3), and fluorene (686.1 ng/m3). Across the 12 wristbands, 16 PAHs were characterized, and eight chemicals were found in all samplers (1-methylnaphthalene, 2-methylanthracene, 2-methylnaphthalene, 2-methylphenanthrene, fluoranthene, phenanthrene, pyrene, retene). Independent of sampler type, PAH concentrations were highest in the inner ring. All 16 detected PAHs were also detected in the stationary samplers. The most detected PAHs were also chemicals that have been associated with creosote. PAH levels were generally highest in the north, downwind of the facility, followed by the south, which is zoned for industrial use. However, PAH levels also aligned with community observations of odors in the north-east. Overall, levels in the stationary samplers were comparable to those in densely populated industrialized cities, albeit lower than levels of concern to health.

# Tuesday May 14, 2024

## Session 4: Temporal and Spatial Monitoring

### Enhancing the Federal Natural Resource Damage Assessment Process through Bayesian Networks

April Reed* and Wayne Landis. Western Washington University.

The Federal Natural Resource Damage Assessment and Restoration (NRDAR) program gives Tribes and certain government agencies the authority to assess injury to natural resources and to pursue and implement compensatory action for any resources lost or injured due to unlawful releases of chemicals into the environment. This study was centered around the development of a Bayesian network (BN) decision support tool tailored to the needs of Natural Resource Damage Assessment and Restoration (NRDAR) practitioners. The goal was to design a BN tool that could lend quantitative insight into natural resource injury. We used a case study to develop and demonstrate the tool's functionality and propriety for NRDAR purposes. Our case study focused on the fish resources of an inactive PCB-contaminated Superfund Site in mideastern Indiana – the Little Mississinewa River (LMR) and the larger Mississinewa River, into which the LMR drains. We created a BN framework that models the causal relationships between PCBs released into the LMR environment and the resulting injury to fish resources across the study site. The BN model includes three common adverse effect pathways for PCB exposure in fish - mortality, growth, and reproductive effects. The BN also includes a combined mortality + growth (M+G) effects pathway and a combined largest effects model (CLEM) pathway. Each pathway's endpoint is an injury determination node which gives a probabilistic estimation of an injured or uninjured decision based on site-specific fish tissue concentration and toxicity data for the specified pathway from Berninger and Tillitt (2019). The probability distributions from our Bayesian network's CLEM percent effects results were linked to spreadsheets that automate injury quantification, with measurement in units of discount service acre years (DSAYs). Using our BN tools, probabilistic injury determinations and quantifications were performed for individual spatial subregions as well as the entire study site. Relative injury can be characterized across a spatial gradient as well as over time. Our preliminary sensitivity analyses indicate that, in areas that are farther away from the release site, PCB concentrations in fish tissue are low enough that it is more likely that these areas will only see adverse reproductive effects, while areas closest to the release have tissue concentrations that are high enough that they are more likely to see mortality and growth effects.

**Does the Utility of Sentinel Organism's Change Seasonally?**

Tate Libunao* and Alan S. Kolok. University of Idaho

The use of sentinel organisms as diagnostic tools for environmental perturbations has a long and storied history, however, these animals have their own biological agendas that can, and often do, impact their value as sentinels. One such agenda is sexual reproduction, as energetic resources and possibly body burden of chemicals, can change over the course of the breeding season. To further investigate how reproduction influences an environmental sentinel, we addressed how reproductive stages in female crayfish influenced tissue morphometrics and mercury concentration. In 2023, 19 virile crayfish (Faxonius virilis) in different reproductive stages were captured from Lake Roosevelt and the Spokane River Arm in eastern Washington in conjunction with the Spokane Tribe Fisheries Lake Monitoring Program. Total mercury concentration (THg) was analyzed in the gills, adductor muscle, hepatopancreas, ovaries, and eggs for stage IV females (n = 9), and embryonized female (n = 10) virile crayfish. Interestingly, the embryonized females were 2-fold larger in clawless body mass than stage IV females ($t(17) = 40.2$, $p < 0.0001$), however, the mass the of adductor muscle were not significantly different ($t(17) = 1.4$, $p = 0.3$). Significant differences in hepatosomatic indices (HPSI) ($t(16) = 48.7$, $p < 0.0001$) and adductor somatic indices (MSI) ($t(17) = 78.5$, $p < 0.0001$) were found between stage IV and embryonized females. Despite this, no significant differences in THg in either the hepatopancreas ($t(16) = -0.1$, $p = 0.9$) or adductor muscle ($t(17) = 0.6$, $p = 0.4$) were found between the two stages of reproduction. Additionally, the results indicated that neither the ovaries nor eggs accumulate appreciable levels of THg, suggesting that maternal transfer of mercury is not occurring in high quantities. Reproductively active crayfish rely on nutrient reserves in storage tissues, particularly during periods of intensive energetic investment into ovarian maturation and brooding behavior. These tissues undergo wholesale exchange of nutrients to be allocated towards reproductive development and, in turn, result in fluctuations of tissue mass and biochemical composition. Thus, it is curious that we do not observe significant differences in tissue THg under these circumstances. Crayfish undergo extensive, temporal reproductive changes that have significant effects on tissue morphometrics, however, this does not impact their utility sentinels for THg monitoring.

**A Tale of Two Estuaries: Environmental detections of human-use contaminants across estuarine Zostera marina communities**

Alexandra G. Tissot*[1], Janet C. Niessner[2], Elise F. Granek[1], Michelle L. Hladik[3], and Kim A. Brown[1]. [1] Portland State University; [2] Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians; [3] The United States Geological Survey.

Anthropogenic pressures are driving changes in eelgrass communities, altering baseline conditions in estuarine environments. Field detections have validated the transport of land-sourced pollutants to aquatic systems; however, studies rarely sample for both pesticides and pharmaceuticals and personal care products (PPCPs) in the same environmental compartments. Moreover, studies on contaminant uptake by eelgrass and associated species are even more limited. In collaboration with the Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians (CTCLUSI), we sampled water, eelgrass, clams, and sediment at sites of tribal significance in Southern Oregon to test for organic contaminants (i.e., herbicides and pharmaceuticals). We compared before and after the peak of the Spring industrial spray season, as well as potential impact by wastewater effluent. Additionally, we conducted paired sampling analyzed by the CTCLUSI along with the United States Geological Survey (USGS) in order to develop analytical standards for future sampling efforts by the Tribe.

**Does Depuration Reduce Filter-feeding Clam Contaminant Concentrations in Esquimalt Harbour, British Columbia?**

Sydney Gonsalves*[1], Amy Corp[1], Michelle Havey[1], Ariel Blanc[1], Kristen Ritchot[2], and Robert Thomas[2]. [1] Anchor QEA; [2] Public Services and Procurement Canada.

Clams are an important traditional resource to the Esquimalt Nation and Songhees Nation and that have contributed to potential unacceptable risks in the recent human health risk assessment for Esquimalt Harbour. Clams are sessile invertebrates that are ideal for tracking localized exposure associated with sediment and surface water sources and re-occurring clam sampling is included in the monitoring program for the harbour. The objectives of the clam monitoring include evaluating changes in human health consumption risk over time and evaluating tissue contaminant trends as a measure of improving harbour conditions. The human health risk evaluations use non-depurated clams, consistent with understood traditional uses, while depurated clams have been typically used to evaluate contaminant trends. A collocated depurated and non-depurated clam study was conducted in Esquimalt Harbour in 2023. The goals of the study were to 1) understand the difference between non-depurated and depurated clam contaminant concentrations; and 2) develop conversion relationships that will allow all clam tissue data to be pooled for future quantitative analysis. Collocated non-depurated and depurated clams were sampled from 10 locations within the harbour and 10 reference locations in August 2023. Up to three filter-feeding clam species preferred by the Esquimalt and Songhees Nations were sampled from each location. Depuration occurred for a minimum of 12 hours. To evaluate the data, clam samples were grouped by harbour contaminant and depuration treatment (depurated or non-depurated). Group-wise testing found that there was no difference in contaminant concentrations for depurated and non-depurated clams for all contaminants, although median concentrations tended to be higher in non-depurated clams. Results for linear model fitting showed that conversion relationships for arsenic, cadmium, copper, mercury, methyl mercury, and zinc concentrations were not different than the one-to-one line. Conversion relationships for chromium and lead had one-to-one slopes but had negative intercepts indicating that contaminants are detectable in non-depurated clams before depurated clams. Conversion relationships for inorganic arsenic, total cPAH TEQ, total PCB congener TEQ, total PCB congeners, and total PAH concentrations were found to be non-linear. An offset-only relationship was found for total dioxin/furan TEQ concentration in depurated and non-depurated clams.

**Connecting Science to Stormwater Management Solutions - Part 1: The Evolution and Promise of High-Performance Bioretention Media to Mitigate the Impacts of Stormwater on Receiving Waters**

Curtis Hinman*[1], Jenee Colton[2], and Chelsea Mitchell[2]. [1]Curtis Hinman and Associates; [2] King County DNRP

The current municipal National Pollutant Discharge Elimination System stormwater permit for Washington State requires the use of low impact development (LID) practices as the first option for managing stormwater where feasible. Bioretention is the most widely applied and flexible BMP in the suite of LID practices. To optimize bioretention performance for protecting receiving waters, scientists in western Washington have spent the past 20 years testing the ability of various bioretention media blends for physical and chemical characteristics with a focus on stormwater infiltration and water quality treatment. This presentation will briefly describe the evolution of bioretention media in the region for water quality treatment. Particular attention will be given to the development of a new high-performance bioretention media for Washington State that is demonstrating excellent performance for capturing sediment, metals, nutrients, hydrocarbons, and bacteria as well as protecting aquatic biota.

# Session 5: Perspectives

### Forty years since the Redbook and ten hence, a review of the development of ecological risk assessment with multiple stressors, endpoints and management goals and steps forward

Wayne G. Landis*. Western Washington University.

In 1983 the National Research Council published “Risk assessment in the Federal Government: Managing the Process. The report has stood as a landmark in the recognition of the importance of risk assessment in the decision making for chemical management. In 2003 I wrote reviewed the developments in risk assessment over the 20 years, specifically in ecological risk assessment at multiple scales with multiple stressors and with multiple endpoints. Incredibly another 20 years have passed and it is time to take stock and look to the future. My prediction was that in 2023 that ecological risk assessment would be a universal framework for ecological management. I said that “Risk assessment can provide an organizing framework, testable hypothesis and eventually a method for evaluating management scenarios.” This statement has turned out to be only partly fulfilled. Although the tools for accomplishing such a goal now exist, there has been an inability to leave the paradigms of the 1990s behind and to apply modern analysis of stressor-response relationships, nonequilibrium complex systems theory and probabilistic risk assessment to design long-term studies, to establish appropriate research programs, to evaluate management alternatives and to effectively manage the environment. I will point to examples of risk assessment case studies that meet these requirements from across the world and contrast them to the “standard” approach and the weaknesses of continuing on that same pathway.

### Challenges in determining sediment clean-up levels for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans in urban waterways

Alice England*. Verdantas.

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs) are principally different from most other CERCLA contaminants in that they are produced inadvertently via various industrial and non-industrial chemical processes. Even though historical PCDD/F-generating processes identified as PCDD/F sources have mostly ceased or have been adapted to minimize PCDD/F production (e.g., chlorophenol manufacturing, bleached chemical wood pulp and paper mills), PCDD/Fs continue to be generated during combustion processes (e.g., waste incineration, combustion of organic material) and are emitted to the atmosphere, where they can be transported through the environment via wind, water, and erosion pathways, resulting in accumulation of PCDD/Fs far from any localized point source. Furthermore, often in urban areas there aren’t major point combustion sources but rather many diffuse, non-point combustion sources that all to some degree contribute to low-level background PCDD/F contamination. This presents a unique challenge in establishing PCDD/F remediation goals in general, but especially difficult at urban waterway cleanup sites with PCDD/F contamination in sediment. PCDD/F remediation goals are typically driven by human health risk or in some cases are based on background levels. However, achieving remediation goals at or below background PCDD/F concentrations may be problematic given PCDD/Fs can be nearly ubiquitous in sediment due to ongoing non-point sources via atmospheric deposition or other overland pathways, and for this reason the risk of recontamination is often very high. Further complexities include analytical data uncertainty due to laboratory limitations in achieving PCDD/F detection limits and also differing opinions on PCDD/F remediation goals from stakeholders (e.g., regulators, tribes, community, and performing parties).

# Panel Discussion

**Inclusive Perspectives on Contaminant Solutions**

Organizers: Allie Tissot (she/they),Tammi Fierro (they/them), Elise Granek (she/her). Environmental Science & Management, Portland State University.

Panelists:
Diane Barton, Water Quality Coordinator, Columbia River Inter-Tribal Fish Commission, Bad River Band of the Lake Superior Tribe of Chippewa Indians
Tammi Fierro, Environmental Science and Management Undergraduate Student with both visible and invisible disabilities
Janet Niessner, Environmental Scientist with the Confederated Tribes of the Coos Lower Umpqua and Siuslaw Indians
Michael Pouncil, Chair of Portland Harbor Community Advisory Group
Allie Tissot, PhD Candidate with Invisible Disabilities

As a toxicology community, we work to quantify the distribution in and effects of numerous anthropogenic contaminants on humans and the environment. Building on this important research, we take the next step by engaging in ongoing discussions about solutions for many of these issues. However many of the commonly proposed solutions exclude people with marginalized identities, including individuals with disabilities, those who are low income, and from marginalized communities. This panel aims to highlight some of the barriers that marginalized populations face in reducing their use of contaminants, including plastics and pharmaceuticals. The session will comprise a panel presentations and group discussions surrounding such themes as racial inequities, economic barriers, and disability needs. As a group we will identify proposed solutions for creating more inclusive and equitable solutions to the management of environmental contaminants and ultimately aim to develop a Commentary piece for Environmental Toxicology and Chemistry.

# Session 6: Cause and Effect

**Impact of anticoagulant rodenticides on coho salmon (Oncorhynchus kisutch): assessing lethal and sublethal effects**

Lillian Pavord*, Melissa Driessnack, and Jenifer McIntyre. Washington State University

Invasive species have cascading negative effects on community structure and are detrimental to many ecosystems. Rat species have been especially problematic on islands that previously served as naval bases. Eradication efforts include aerial and ground-based applications of food pellets containing anticoagulant rodenticides. This has led to a large increase in the number of islands treated to mitigate damage caused by invasive rats. Aerial application makes an attempt to be precise; however, pellets do inevitably enter the aquatic environment. There have also been documented cases of accidental spills into water during pellet transport. Two of the most commonly used anticoagulant rodenticides are brodifacoum and diphacinone. Trace amounts of these rodenticides have been detected in several captured fish species as well as fish carcasses after pellet applications on rat infested islands. Great Sitkin Island in the Aleutians Archipelago of Alaska is infested with brown rats (Rattus norvegicus) and under consideration for eradication by the US Fish & Wildlife Service. This island includes spawning and rearing habitat for Pacific salmon. There is a large information gap for the aquatic toxicology of brodifacoum and diphacinone. To address this gap, we are using coho salmon (Oncorhynchus kisutch) to generate lethal and sublethal dose-response curves for estimating median effects doses of brodifacoum and diphacinone. Our estimated 96 hour LD50 by intraperitoneal injection for brodifacoum is 83.7 µg/g (95% CI: 65.3-102.0 µg/g). Sublethal effects include blood clotting time which is increased by exposure to anticoagulants. This data will help inform policies regarding the future use of these chemicals for whole island eradication.

**How differential phenanthrene substitution alters toxicity, Cyp1a Spatial Expression, and AHR Dependence in Early Life Stage Zebrafish**

Mackenzie Morshead*, Lisa Truong, Michael Simonich, Jessica Scotten, Kim Anderson, and Robyn Tanguay. OSU.

With an increasing demand for fossil fuels and a growing frequency of wildfires, polycyclic aromatic hydrocarbons (PAHs) are an environmental contaminant of continued concern. Although PAHs occur in complex mixtures, our knowledge mostly focuses on unsubstituted parent PAHs. Understanding the toxicity of substituted PAHs is important as they often occur in higher abundance than their parent compounds in environmental matrices. Substituted three-ring PAHs, particularly phenanthrenes, comprise a substantial fraction of petrogenic and pyrogenic PAHs. Eighteen substituted phenanthrenes were screened in a high-throughput developmental zebrafish assay as part of a larger two-part screen of over 200 PAHs. Embryos were exposed to concentrations between 0.1 to 100 µM and evaluated for morphological and behavioral effects. The aryl hydrocarbon receptor (AHR) is often implicated in the toxicity of PAHs and the induction of cytochrome P4501A (Cyp1a) is an excellent biomarker of AHR activation. Embryos were evaluated for spatial cyp1a expression using an AHR-responsive reporter line. The AHR dependence for compounds eliciting morphological effects was assessed using an AHR2 knock-out line, an AHR1a knock out line, and an AHR1b knock out line. All the compounds screened had activity in at least one of the endpoints, and 83% had a phenotypic effect. Unsubstituted phenanthrene in comparison, had no activity in our screen. Oxygen containing compounds were the most potent in the screen and had similar BMD50 values for morphological effects but variable Cyp1a expression. Generally, the non-alkyl substituted phenanthrenes had more biological activity compared with alkyl-phenanthrenes. Our results indicate that none of the non-alkyl substituted phenanthrenes had AHR dependent toxicity, while retene toxicity was partially AHR2 dependent. Our results demonstrate that induction of Cyp1a does not always correlate with AHR dependence and that the type and location of phenanthrene substitution can change the potency and mechanism of toxicity. This research was supported by the NIEHS of the National Institutes of Health under Award Number P42 ES016465, P30 ES030287, and T32 ES007060.

**Effects of anthropogenic contamination on mortality and fecundity of mammal-eating killer whales**

Chloe Kotik*[1], Lara Horstmann[1], Jared Towers[2], and Thomas Doniol-Valcroze[3]. [1]University of Alaska Fairbanks; [2]Fisheries and Oceans Canada, Bay Cetology; [3]Fisheries and Oceans Canada.

Ranging from California through Alaska, Bigg's killer whales (Orcinus orca, hereafter BKWs) are recovering top predators whose abundances were severely affected by marine mammal removal up through the 1960s. Since the implementation of marine mammal protections outlawed the large-scale removal of their preferred prey (seals, sea lions, porpoises, and whales), BKW numbers have begun to recover, but they remain listed as Threatened in Canada due to concerns over their small population size, vulnerability to perturbation, and most critically, their extremely high levels of toxic, persistent anthropogenic pollutants including polychlorinated biphenyls, per- and polyfluoroalkyl substances, alkylphenols, and polycyclic aromatic hydrocarbons. As a result of feeding at a high trophic level, anthropogenic contaminants accumulate at higher concentrations in BKWs than any other marine mammal; compounds are also offloaded from mothers to their calves during pregnancy and lactation. Despite these concerns, the impacts of anthropogenic contaminants upon BKW survival and reproduction are not well understood. Our study utilized an existing multi-decadal photographic identification database to relate parameters of life history in this population to the effects of contamination upon their survival and reproduction via estimates of juvenile mortality and female fecundity. We inferred maternally-offloaded contaminant concentrations through a non-invasive life history parameter, the pre-birth interval (PBI), estimated as the number of years that an individual's mother was reproductively inactive prior to its birth. Using binomial generalized linear models (GLMs), we examined the effects of PBI on juvenile mortality (i.e., mortality at or before three years) and the onset of female maturity, as defined by the age at which a female successfully recruits a calf that lives at least one year. We found no significant effect of PBI on the onset of female fecundity ($p = 0.614$) and a significant, positive effect of PBI on juvenile mortality ($p = 0.005$). There are many ecological factors likely to affect juvenile mortality (maternal experience, group size and structure, calf sex, habitat usage, prey preference, etc.) but these results may also indicate a negative impact of contaminant offloading on the survivorship of young BKWs.

**Connecting Science to Stormwater Management – Part 2: Lab-Scale Treatment of 6PPD-quinone using Default and Alternative Bioretention Soil Medias**

Chelsea Mitchell*[1], Jenee Colton[1], and Curtis Hinman[2]. [1]King County; [2]Curtis Hinman & Associates.

Since 2021, when the tire chemical, 6PPD-quinone, was discovered as the cause of Urban Stream Mortality Syndrome (URMS) in coho salmon, mitigating 6PPD-quinone pollution has become a priority for environmental managers. Accordingly, there is now an urgent need to identify stormwater Best Management Practices (BMPs) that provide effective treatment for 6PPD-quinone. Bioretention has previously been demonstrated to protect coho from stormwater toxicity using a mixture of 60% sand and 40% compost (60:40 BSM), which is no longer recommended for use in nutrient sensitive areas. The Washington State Department of Ecology recently approved a new High Performance Bioretention Soil Media (HPBSM) for use in nutrient-sensitive areas. King County obtained Ecology funding to complete a laboratory-scale project testing three different HPBSM formulations (designed for various water quality objectives) for their ability to reduce effluent 6PPD-quinone concentrations in stormwater and prevent toxicity to juvenile coho salmon. Lab-scale bioretention columns containing 60:40 BSM, and HPBSMs Types 1, 2, and 3 in triplicate were dosed with stormwater collected from the I-5 in Seattle, WA over 3 storm events. Stormwater influent and bioretention effluents were analyzed for 6PPD-q and toxicity to coho salmon. Results of all three storms will be presented but those for the first two storms show that all the tested bioretention soil medias (BSMs) reduced stormwater 6PPD-quinone concentrations and prevented mortality in juvenile coho. Stormwater influent concentrations for the first two storms were 0.754 µg/L and 0.225 µg/L with 95% and 100% mortality observed in exposed juvenile coho. 6PPD-q removal rates were > 97% for all tested bioretention medias. All bioretention medias completely prevented mortality in exposed juvenile coho. Our findings thus far suggest that both HPBSM and 60:40 BSM are effective BMPs for mitigating 6PPD-q pollution.

**Connecting Science to Stormwater Management Solutions - Part 3: Using Science in Policy and Stormwater Management at King County**

Jenee Colton*[1], Curtis Hinman[2], and Chelsea Mitchell[1]. [1]King County; [2] Curtis Hinman and Associates

King County has not allowed bioretention as a water quality treatment option in its stormwater manual due to concerns about the Washington State Department of Ecology (Ecology) default soil mix (60% sand: 40% compost) releasing nutrients and metals. Scientific studies have shown compost in the default soil mix can release metals and nutrients raising elevating effluent levels above influent, making stormwater quality worse. King County and other jurisdictions supported development of an alternative mix that does not contain compost. This new high performance bioretention soil mix performs better for water quality treatment than the default soil mix, has been adopted by Ecology and we are now adding it to our King County Surface Water Design Manual (i.e., stormwater manual). Our early testing has shown effective treatment of 6ppd-q for acute mortality in coho salmon by this new mix. This presentation will describe how King County is using science to make resource management and stormwater policy decisions that reduce toxic discharges to the environment and meet two King County Executive Dow Constantine's Clean Water Healthy Habitat goals - reducing toxics in fish and producing cleaner and controlled stormwater runoff.

### An evolving mechanistic understanding of 6PPD-q toxicity to Pacific salmonids

Nat Scholz*[1], Julann Spromberg[1], and Denis da Silva[2]. [1]NOAA Fisheries, Northwest Fisheries Science Center, Ecotoxicology Program; [2]NOAA Fisheries, Northwest Fisheries Science Center, Environmental Assessment Program.

The tire-derived chemical 6PPD-quinone (6PPD-q) – the causal agent in the coho urban runoff mortality syndrome – is highly toxic to the cardiorespiratory system of coho salmon and, to a lesser extent, steelhead. The different dimensions of the syndrome have been an ongoing research focus for NOAA's Northwest Fisheries Science Center (and partners) since the early 2000s, and yet the underlying mechanisms, or molecular initiating events, remain poorly understood. This presentation will highlight the results of recent studies to characterize acute 6PPD-q impacts to the coho heart, as well as functional effects on vascular circulation and respiratory motor control in early life stages (alevins). The NOAA team is also investigating sublethal toxicity in juvenile steelhead, with a focus on whole-animal respiration and swimming performance. The overarching goal is to identify the molecular targets for 6PPD-q in salmonids, as a basis for understanding differences in vulnerability across closely-related members of the genus Oncorhynchus. In turn, this information will help NOAA manage at-risk populations in urbanizing watersheds, particularly those listed for protection under the U.S. Endangered Species Act.

### Assessing the Toxicity of Tire Wear Particles Using Cell Line Models

Ellie Dalsky*, John Hansen, Prarthana Shankar, Rachael Lane, and Justin Greer. US Geological Survey

Tire wear particles and car tire additives are regularly washed into urban streams and waterways via stormwater runoff. One such pollutant, 6PPD-quinone (6PPDQ), a transformation product of the car tire antiozonant and antioxidant 6PPD, has recently been discovered as the cause of pre-spawn mortality events in adult coho salmon in urban streams in the Pacific Northwest. Although 6PPDQ is highly toxic to coho salmon, the sensitivity of other salmonids to 6PPDQ and other car tire transformation products is highly variable and largely unknown. Research progress on this topic is limited due to only a small number of facilities being equipped to house salmonid species sensitive to 6PPDQ. In vitro experiments using immortalized cell line models have shown promise as an alternative model to investigate species sensitivity to 6PPDQ. Our research group recently found that metabolic and cytotoxic effects from 6PPDQ are apparent in a coho salmon cell line (CSE-119), but not in Chinook (CHSE-214) or sockeye (SSE-5) cell lines, mirroring in vivo differences in toxicity. We are currently investigating other cellular endpoints via fluorescence assays including reactive oxygen species, calcium flux, and mitochondrial membrane potential to further our understanding of how 6PPDQ causes toxicity in salmon. Using in vitro models for 6PPDQ eliminates the need for sacrificing salmon for experiments. Furthermore, cell lines could also provide a useful platform for investigating potential toxicity of other tire wear particles and their transformation products that are likely to be prevalent in waterways traversing urban areas where salmonids species spawn.

# Tuesday Poster Presentations

## Session: Puget Sound

**Poster 19. Effects based, chemical characterization of biota in Puget Sound**

C. Andrew James*, Hayley Mathews, and Dave Wark. University of Washington Tacoma.

There is evidence that anthropogenic contaminants are in Puget Sound and that some of them occur at levels that may affect exposed organisms. There are, however, important data gaps. The occurrence, fate, and potential biological impacts for many of the chemicals that we use every day is not well understood. As such, we are performing ongoing research in order to better understand where chemicals are in the environment, how they get there, and whether their presence is affecting humans or wildlife. One approach is to perform effects-based characterization where we monitor both the chemical profiles and biological status of organisms in the environment. We can use that information to highlight which chemicals are associated with poor health to help identify those that cause harm. Metabolomics, which is the study of metabolites within an organism, can provide information on physiological condition. In this study, we used a combination of metabolomics and chemical characterization of bay mussels (Mytilus trossulus) to understand: 1) whether metabolomics are a useful tool for characterizing the condition of bivalves, 2) to measure metabolomic profiles of lab- and field-deployed mussels to understand the range of conditions, and 3) to identify chemicals that are associated with altered metabolic profiles. We found that metabolic profiles changed between exposures both in the laboratory and field, and that specific changes may be able to inform modes of impact. Further, we were able measure differences in chemical profiles associated with the changes in condition.

**Poster 20. Spatial Distribution of Legacy Chemicals in Puget Sound Sediments from 1997-2023**

Sandra Weakland* and Dany Burgess. Washington State Department of Ecology.

The Washington State Department of Ecology's Marine Sediment Monitoring Program has studied Puget Sound surface sediments since 1989. Sediment quality is a key indicator of a healthy ecosystem, and high-quality sediments support a diverse and important biological community. Ecology conducts long-term status-and-trends monitoring of marine sediments as part of the Puget Sound Ecosystem Monitoring Program (PSEMP). A probability-based sampling design is utilized to assess sediment quality at multiple scales, from bay-wide to Puget Sound-wide. From 1998 to 2023, Ecology analyzed for 89 priority pollutant chemicals in the top 2 to 3 cm of sediment at 50 locations throughout Puget Sound and at 30-36 locations in six urban bays: Bellingham Bay, East Possession Sound, Elliott Bay, Bainbridge Basin, Commencement Bay, and Budd Inlet. Several of the individual chemicals measured were not present at concentrations above the reporting limit of the analytical methods, particularly those in the polybrominated diphenylether (PBDE), polychlorinated biphenyl (PCB), and phthalate chemical classes. Metals and polycyclic aromatic hydrocarbons (PAHs) were most often detected. While the majority of stations in Puget Sound did not have elevated levels of the chemicals measured, the highest concentrations were found in urban bays, where chemical concentrations were found to exceed the Washington State Sediment Quality Standards (SQS) (Ecology, 2013). Except for Elliott Bay, average contaminant levels have decreased over time in the urban bays. Sediment contamination generally changes very slowly; we expect most areas currently meeting the threshold values to continue to do so unless contaminant inputs increase. It is, therefore, important to continue monitoring for these chemicals.

### Poster 21. PCBs Monitoring in Major Puget Sound Rivers

Elisa J Rauschl* and Brandee Era-Miller. WA State Department of Ecology.

In 2020, Washington State won a settlement against Monsanto, the largest producer of PCBs in the United States. The State Legislature directed some of the settlement funds to support monitoring of PCBs. The Toxics Studies Unit in the Environmental Assessment Program at the Department of Ecology created a Statewide PCB Monitoring Program (PCB-MP) to address the long-term problem of PCBs in our waterways. The PCB-MP has 2 components – Long-term Monitoring on 8 major rivers that feed into the Puget Sound and Exploratory Monitoring which will focus on collaborating with regional partners to further our understanding of how PCBs affect the waters of the State. For the long-term component, PCBs will be monitored using high volumes (up to 500 liters) of surface water passing through an onsite pump and filter system to create a robust estimate of the annual PCB load in both suspended material and dissolved/colloidal fractions. Initially, the exploratory component will provide PCB data to support modelling efforts for fate and transport in aquatic food webs, and characterization and source identification of PCBs in specific waterbodies.

### Poster 22. Enhanced Watershed Monitoring and Toxicological Analysis of Contaminants of Emerging Concern

David Wark* and C. Andrew James. University of Washington – Tacoma.

There are key data gaps regarding the spatial and temporal variation of concentrations of emerging contaminants, and mixtures thereof, in the aquatic environment. This project will perform enhanced monitoring of two watersheds in the Puget Sound region – the Puyallup and Stillaguamish – to improve our understanding of CEC occurrence patterns in those areas and improve information on pollutant sources to help guide management actions. The project will utilize passive samplers deployed over a thirty-day period, with at least two sampling events, to develop time-weighted average concentrations for detected chemicals. Samples will be analyzed using high resolution mass spectrometry for non-target detection of a wide range of CECs, focusing on a set of approximately 100 CECs that were determined to have high potential for biological impact.

**Poster 23. Current Status and Future Directions for Sediment Monitoring in the Central Basin of Puget Sound**

Wendy Eash-Loucks*. King County

King County, formerly METRO, has been monitoring sediments within the Central Basin of Puget Sound since the 1960s. The current sediment monitoring routine, which was last updated in 2007, was established to help us evaluate current conditions of marine sediments in the Central Basin and understand how they are changing over time. We sample subtidal (offshore) locations within Elliott Bay, deep stations within the Central Basin, and smaller embayments on either two- or five-year cycles. We also sample intertidal sediments from King County beaches every five years. Some of these stations have been sampled consistently and for similar parameters since the mid-1980s. All sediments are sampled for conventional parameters (e.g., particle size distribution, total solids, organic carbon content), metals, and organic chemicals (e.g., phthalates, polycyclic aromatic hydrocarbons [PAHs], polychlorinated biphenyls [PCBs], and polybrominated diphenyl ethers [PBDEs]). We have also collected information on the benthic community (taxa and abundance) since 2015 at offshore stations. Combined, this physical, chemical, and biological information has allowed us to obtain an understanding of what the bottom of the Central Basin looks like and how it is changing. For example, we have demonstrated that most of the sites we monitor meet sediment quality criteria except for mercury and PCBs at a few of sites. We've also been able to identify decreases of chemical concentration for some metals, PAHs, and PCBs over the last 30+ years. However, it's time to check-in and evaluate if we are still monitoring the right things in the right places to support our goals and answer questions most relevant to the region. I'll be using this poster to share some of what we've learned over the last 30+ years and solicit feedback on what changes we could make moving forwards, such as: *What additional sediment quality information should we collect? *Are there new technologies we should incorporate? *Are there things that we currently don't measure that are more important than what we currently measure? *What other questions could be answered with or without changes made to the program?

**Investigating the impact of dietary-based stressors on the health and survival of juvenile Chinook salmon (Oncorhynchus tshawytscha)**

Melissa K Driessnack*, Jenifer K. McIntyre, and John D. Stark. Washington State University.

Ongoing efforts are being conducted to improve the survival of juvenile Chinook salmon in the Pacific Northwest, with extensive remediation projects being completed on the Duwamish River, which flows alongside the city of Seattle. Despite all these improvements made to the river as well as surrounding watersheds, fall run Chinook continue to show low rates of return to the Duwamish. This has led to increased focus on the health and survival of juvenile Chinook preparing to migrate into the Puget Sound. To undergo that migration salmon must successfully complete the physiologically stressful process of smolting. However, juvenile salmon undergoing smolting are not faced with multiple stressors including exposure to legacy chemicals (e.g., PCBs), emerging contaminants of concern, and altered prey availability. Current toxicological effect data, specific to fall run Chinook salmon for the region, are insufficient to determine if contaminant exposure, alone or in combination with other relevant stressors, is contributing to the low survival of estuarine-reared Chinook. As such, this research is the first of three projects that will assess how restricted and contaminated feed impacts the health and survival of juvenile Chinook undergoing smolting. The first study used a simplified PCB (Aroclor 1254) spiked diet at an environmentally

relevant concentration of 200 ng/g to evaluate the health and survival of juvenile Chinook over a 30-day exposure period. Four treatments were a Control diet at Full Feed, Control diet at Restricted Reed, PCB-spiked diet at Full Feed, and PCB-spiked diet at Restricted Feed, with 12 replicate tanks per treatment each containing 10 juvenile Chinook. Following the 30-day exposure, increased mortality was observed in both the feed restricted and contaminated feed treatments as well as changes in condition factor and whole-body PCB accumulation. Initial results of this three-part research project support that food availability is a valid factor to consider in contributing to the sustained high mortality rates for Chinook in the Duwamish.

# Session: Tire Wear

**Poster 25. Chronic exposure to 6ppd-q has concentration-dependent effects on developing coho salmon embryos**

Prarthana Shankar*[1], Ellie Dalsky[1], John Hansen[1], Rachael Lane[2], and Justin Greer[1]. [1]USGS Western Fisheries Research Center; [2]USGS Kansas Water Science Center.

Stormwater runoff is known to carry hundreds of pollutants into surrounding waters such as streams and lakes. One such pollutant prominent in urban watersheds is N-(1,3-dimethylbutyl)-N′-phenyl-p-phenylenediamine (6PPD)-quinone (6PPD-Q), a transformation product of 6PPD, a globally ubiquitous car rubber tire antioxidant additive. 6PPD-Q was recently implicated in inducing mass pre-spawn mortality events in adult coho salmon (Oncorhynchus kisutch) in the Pacific Northwest, USA. Since then, studies have reported life stage susceptibility differences with acute exposures. However, the toxicological effects of chronic exposure to 6PPD-Q during early development in salmonids are still unknown. Here, we conducted a 13-day exposure of three concentrations of 6PPD-Q, 100, 500, and 1000 ng/L (n=4 replicated treatments, with 40 embryos each), using a semi-static system. Daily observations of mortality, hatch, and blood pooling were made, and any hatched living fish were monitored in fresh water. While no mortality was observed with 100 ng/L 6PPD-Q, 500 and 1000 ng/L induced significant mortality, with majority of mortalities occurring by day eight. Timing of hatching was significantly perturbed by all three 6PPD-Q concentrations, and exposed individuals tended to hatch before controls. Interestingly, with 1000 ng/L, ~50% of the mortalities occurred during hatching (“partial hatch mortalities”). Significant blood pooling was visible in embryos exposed to 500 and 1000 ng/L 6PPD-Q starting at day three, but this phenotype was minimally observed with 100 ng/L. In addition, at both the high concentrations, hatched fish that survived showed significant deficiencies in their “touch response” several days post chemical exposure, and mortalities continued to occur for up to one week after removing fish from chemical exposure. Our data so far suggests that the chorion offers some level of protection from 6PPD-Q to coho salmon embryos, and significant effects on hatching occur even at 100 ng/L, an environmentally relevant concentration. Current and future investigations will examine differences in gene expression during chemical exposure, delayed behavior abnormalities in buttoned up exposed fish, and morphometrics markers related to 6PPD-Q exposure. Our study is relevant to environmental scenarios where coho salmon embryos develop and hatch in stream habitats impacted by urban stormwater runoff.

**Poster 26. Evaluating the relative acute toxicity of PPD chemicals on coho salmon (Oncorhynchus kisutch)**

Caitlin Lawrence* and Jenifer McIntyre. Washington State University.

6PPD, a critical component of automobile tires, reacts with ozone in the environment to prevent rubber from cracking. The identification of 6PPD-quinone, a transformation product of 6PPD, as the causal toxicant of urban runoff mortality syndrome in coho salmon (Oncorhynchus kisutch) has led to increased efforts to find an alternative for 6PPD use in tires. Other chemicals in the PPD family are at the top of the priority list in the search for alternatives because they are likely to provide a similar antiozonant property. However, little is known about the toxicity of the PPD compounds and their transformation products. In this project we investigate the toxicity of six chemicals in the PPD family; 6PPD, 7PPD, 77PD, 44PD, IPPD, and CCPD. Coho salmon were exposed to 6PPD, 7PPD, and 77PD for 24 hours to estimate median lethal concentrations (LC50s). The nominal estimated 24-hour LC50s are 509.5 +/- 98.3µg/L, 706.5 +/- 123µg/L, and 159.6 +/- 27.7µg/L respectively. Toxicity tests for 44PD, IPPD, and CCPD are currently being performed. Following the initial toxicity tests, the PPD chemicals with equal or lower toxicity than 6PPD will be ozonated, and acute toxicity tests will be performed to assess the toxicity of the mixture of transformation products produced. The results from this study will help to guide further investigations in the search for alternatives to 6PPD.

**Poster 27. Assessing the Toxicity of Zinc and Zinc Oxide Nanoparticles to Freshwater Algae**

Christina-Ann Groening*[1], Bryan Harper[1], and Stacey Harper[1,2]. [1]Oregon State University, Department of Chemistry, Department of Environmental and Molecular Toxicology; [2]Oregon State University, School of Chemical, Biological and Environmental Engineering.

Zinc oxide nanoparticles have a high production value due to their versatile applications and extensive utilization in various products such as sunscreen, solar cells, tires, and pigments. As various products that contain zinc oxide nanoparticles, such as tires, are broken down and disposed of, they will release the particles which are often transported into aquatic ecosystems. Once the nanoparticles have entered the environment, they can have an adverse effect on the organisms living in the ecosystem, such as algae. Since algae plays a critical role as a primary producer in aquatic ecosystems, understanding the impacts of released zinc oxide nanoparticles is essential. This research aims to understand the size-dependent toxicity of zinc oxide nanoparticles and compare their toxicity to that of free zinc ions. Microplate algal toxicity experiments using the freshwater algae species Raphidocelis subcapitata as a model organism were conducted on three different-sized zinc oxide particles, 1 µm, 70 nm, and 50 nm, along with zinc chloride salt to determine the minimum inhibitory concentration affecting algal growth. The results revealed that all of the particles had significant inhibitory effects on algal growth. The 1 mm, 70 nm, and 50 nm particles had minimum inhibitory concentration values of 0.30, 0.12, and 0.08 mg/L, respectively; while zinc chloride salt had a minimum inhibitory concentration of 0.04 mg/L. This suggests that smaller nanoparticles are more toxic to freshwater algae, likely due to the increase in surface area to support oxidative dissolution. This implies that the toxicity of zinc oxide nanoparticles can be attributed to the release of zinc ions with higher surface area per unit mass particles having the largest impacts on algal growth. While none of the minimum inhibitory concentrations were significantly different from each other, there is a clear trend indicating that size and the release of zinc ions are the main drivers of zinc oxide nanoparticle toxicity to freshwater algae. It is important to understand the toxicity of zinc and zinc oxide nanoparticles as this information can be used to set regulations on the amount of zinc oxide nanoparticles that can be utilized in consumer products.

# Session: Plastics

### Poster 28. The Acute Toxicity of Microplastics to Daphnia magna and Caenorhabditis elegans Co-Exposed with Atrazine at Environmentally Relevant Concentrations

Kelsey Arthur*, Mikkos Willard Argyres, Stacey Harper, and Bryan Harper. Oregon State University Department of Environmental and Molecular Toxicology.

The presence of microplastics in aquatic ecosystems, along with the co-occurrence of chemical contaminants, poses significant ecological concerns. This study investigates the acute toxicity of microplastics generated from agricultural films co-exposed with atrazine at environmentally relevant concentrations on two widely studied organisms, Daphnia magna and Caenorhabditis elegans. The D. magna and C. elegans are useful model organisms due to their standardized use, the ability to expose whole organisms and because of their sensitivity to pollutants. Micro and nano plastics (MNPS), ubiquitous in aquatic environments, have been recognized as vectors for various contaminants, including pesticides like atrazine, which is commonly detected in water bodies worldwide. In this study, environmentally relevant concentrations of MNPs (concentrations ranging from 1000 mg/L to 31.25 mg/L), and atrazine (1mg/L) were selected to mimic real-world exposure scenarios. Acute toxicity tests were conducted using standard protocols for D. magna and C. elegans and were assessed for immobilization and mortality. The experiments were designed to elucidate potential synergistic or antagonistic effects resulting from the co-exposure to MNPs and atrazine. Preliminary findings suggest that the co-exposure of microplastics with or without atrazine at environmentally relevant concentrations do not induce adverse effects on D. magna and some toxicity of the biodegradable plastic and LDPE with atrazine in the C. elegans. There is a significant difference in toxicity between the biodegradable plastic and LDPE MNPs with the biodegradable plastic at all concentrations, inducing more toxicity than the LDPE. The plastics were also co-exposed with the commonly used pesticide, atrazine, at a static concentration. In these experiments there was no effect in the D. magna acute assessment. For the C. elegans there was no significant change between the exposures with just the biodegradable MNPs, but for the LDPE plastics co-exposed with the static concentration of atrazine there was an increasing trend in toxicity with the increase in plastics. Understanding the acute toxicity of microplastics co-exposed with atrazine provides essential knowledge for environmental risk assessment and informs strategies for mitigating the adverse impacts on aquatic biota and ecosystem health.

### Poster 29. Attitudes and Concerns on Microplastics in Oregon: A Need for Policy, Education, and Innovation

Amanda Gannon* and Elise Granek. Portland State University.

Due to their ubiquity across environments, microplastics present a mounting threat to a broad array of ecosystems as well as human health. In order to enact actionable and effective policies, it is important that decision-makers have up-to-date information on their constituents' concerns and levels of knowledge surrounding this salient environmental issue. An online survey of Oregon-based interest groups and registered voters was conducted covering a breadth of MP related topics, including general knowledge, concerns, and thoughts on responsible entities and potential solutions. The preliminary results of this survey point towards a greater need and desire for accessible public education on MPs, investment in plastic alternatives, and further work on the efficiency and accessibility of environmentally friendly technology such as microplastic filters for washing machines.

**Poster 30. Pacific Lamprey: An Indicator, A Way of Life, A Connector Between Our Past and Future A Collaborative Correlation Study into Microplastics and Methyl Mercury**

Venecia Rollins*[1], Susanne Brander[1], Stacey Harper[1], and Christina Wang[2]. [1]Oregon State University; [2]USFWS Fisheries Program

The Pacific lamprey, Entosphenus tridentatus, is not a commodity good by industry standards. Because of this, the health of these fish and that of the people who consume them has been largely overlooked. As of 2022, a consumption advisory was released for Pacific Lamprey due to high levels of mercury, polychlorinated biphenyls (PCBs), and dioxins in this important protein source for the Tribes in this region (Oregon Health Authority, 2022). Coupled with the prevalence of microplastics (MPs) in the environment, and the ability of contaminants, like mercury and PCBs to adhere to MPs, the need to understand the effects of bioaccumulation of microplastics was the main objective of this research (Madenjian, C.P., 2021; Meador, J.P., 2016; Melnyk, L.J., 2016). All of the lamprey collected for this study were collected in 2021 from the Bonneville Dam in the Mid-Columbia River Basin. Through the dissection, digestion, and micron filtration of the muscle tissue, the MPs are then counted, and identified, when possible. Through this process, the source of these plastics and the potential compounding effects of the contaminants in these fish can be better understood. As this research is currently ongoing, results have not yet been determined and will be available by the beginning of March 2024. Upon completion, however, with these data, the traditionally underserved Tribal communities will gain more control over their health and more funding can go into protecting this keystone species (Noble, M, et al. 2016). References: Madenjian, C.P., Unrein, J.R., Pedro, S., 2021. Trends and biological effects of environmental contaminants in lamprey. Journal of Great Lakes Research, Supplement on Sea Lamprey International Symposium III (SLIS III) 47, S112–S128. Meador, J.P., Yeh, A., Gallagher, E.P., 2018. Adverse metabolic effects in fish exposed to contaminants of emerging concern in the field and laboratory. Environ Pollut 236, 850–861. https://doi.org/10.1016 /j.envpol.2018.02.007 Melnyk, L.J., Lin, J., Kusnierz, D.H., Pugh, K., Durant, J.T., Suarez-Soto, R.J., Venkatapathy, R., Sundaravadivelu, D., Morris, A., Lazorchak, J.M., Perlman, G., Stover, M.A., 2021. Risks from mercury in anadromous fish collected from Penobscot River, Maine. Sci Total Environ 781, 146691. https://doi.org/10.1016/j.scitotenv.2021.146691 Noble, M., Duncan, P., Perry, D., Prosper, K., Rose, D., Schnierer, S., Tipa, G., Williams, E., Woods, R., & Pittock, J. 2016. Culturally significant fisheries: keystones for management of freshwater social-ecological systems. Ecology and Society, 21(2). https://doi.org/10.5751/ES-08353-210222 Oregon Health Authority, Public Health Division, Environmental Public Health Section. Consumption Advisory for Lamprey: Columbia River and its Oregon Tributaries Technical Report. Portland, OR. 2022 July.

# Session: The P's: Pesticides, Pharmaceuticals, PAHs, and Probabilistic Risk Assessment

### Poster 31. Sublethal Toxicity Testing of Commonly Used Pesticides at Varying Salinities in Menidia beryllina

Kate Berreman*[1], Sara Hutton[2], and Susanne Brander[1]. [1]Oregon State University; [2]GSI Environmental Inc.

Various stressors due to climate change including sea-level rise and drought impact estuarine ecosystems and contribute to fluctuations in salinity levels. When there is a high salt concentration in an ecosystem, the salting out effect may occur and decrease solubility of compounds present. This is due to an increase in competition between salt ions and other compounds for interactions with water molecules, which reduces the amount of a compound dissolved in water and causes the chemicals to have a higher octanol-water partition coefficient, Kow, or the likelihood for a compound to dissolve in fats and lipids. As a compound becomes more lipophilic, coastal organisms may be more sensitive to chemical exposure as bioaccumulation may occur. Pesticides are chemical compounds commonly used for agricultural and household purposes, and they can enter estuarine ecosystems through runoff. To determine if there is a difference of pesticide toxicity at varying salinities, Menidia beryllina embryos at five days post fertilization were exposed to sublethal levels of six pesticides (bifenthrin, chlorpyrifos, dicloran, myclobutanil, penconazole, triadimefon) at two salinities (5 PSU and 25 PSU) for 96 hours. Menidia beryllina (Inland silverside) are a euryhaline model species, which allows for the ability to observe stressor effects over a broad range of salinities. Behavior, growth, and gene expression are endpoints that will be analyzed for effects at sublethal exposure levels as impacts observed at early life stages of fish could have potential population effects due to organism fitness contributing to overall survival.

### Poster 32. A PBPK Model to Predict PAH Tissue Burden in Plate-Based Developmental Zebrafish Exposures

Christian Rude*[1], Jordan Smith[2], Richard Scott[1], Kim Anderson[1], and Robyn Tanguay[1]. [1]Oregon State University; [2]Pacific Northwest National Lab.

Polycyclic aromatic hydrocarbons (PAHs) are a diverse class of compounds derived mainly from fossil fuels and incomplete combustion. They are widely distributed in the environment and many are carcinogens and cardiotoxins. Developmental toxicity assays in Zebrafish (Danio rerio) enable testing with hundreds of PAHs; however, many studies report nominal exposure concentrations which hampers their interpretability and relevance to risk assessment. To address this, we developed a physiologically based pharmacokinetic (PBPK) model to describe waterborne PAH exposures in 96 well plates. We describe zebrafish physiology by modeling volume and surface area with measurements of fish width, length, and yolk size and scale metabolism to liver volumes measured by fluorescent imaging of Tg(l-fabp) fish. PAHs partition between exposure media, plate walls, and fish tissue and are lost from the system due to metabolism and volatilization. We optimized the model with experimentally determined concentrations of ten PAHs in tissue, media, and plate walls at five time points from 8 to 120 hours post fertilization (hpf) following a mixture exposure. Uptake of PAH into embryos was limited by diffusion and peaked before 48 hpf. Model predictions were comparable to tissue burdens reported by Geier et al. Predicted tissue burdens indicate low doses for volatile (pKh < 2) and hydrophobic (logP > 5.5) compounds. Future work will focus on expanding the model domain to other PAHs. This research was funded by NIH awards numbers: P42ES016465, P30ES030287, and T32ES007060.

**Poster 33. Temporal Variability of Amphetamine and Methamphetamine at a Municipal Wastewater Treatment Facility**

Aven M Lantz*, Zoe J Franklin, and Karin L Lemkau. Western Washington University.

Wastewater-based epidemiology has been a useful tool in monitoring drug usage in communities. However, different sampling strategies can result in variations in reported concentrations and trends for the analytes of interest. Here, we examine influent and effluent concentrations of amphetamine and methamphetamine at a municipal wastewater treatment facility to evaluate variability in influent concentrations and removal efficiency. We compare longer-term (seasonal) and short-term (daily) variability. Flow-proportional composite samples were collected from Post Point Wastewater Treatment Plant, in Bellingham Washington bi-weekly from July through January, and daily for 2 weeks in March. Samples were processed using solid-phase extraction and analytes were monitored using high performance liquid chromatography tandem mass spectrometry (HPLC-MS/MS). Observed variations in influent analyte concentrations on seasonal and daily timescales indicate timing of sampling is an important consideration, especially when concentrations are used to reflect consumption levels within a population. Variation in removal efficiency is examined through comparing influent and effluent concentrations.

**Poster 34. Suspect and Nontarget Screening of Environmental High-Resolution Mass Spectrometry Data to Address Community Concerns Related to Surface Water Contaminants and their Toxicity**

Chloe Fender*[1], Jason Schindler[1], Mackenzie Morshead[1], Jason Schindler[1], and Cassie Cohen[2]. [1]Oregon State University;[2]Portland Harbor Community Coalition.

Industrial activity and urbanization over the last 100 years has led to the degradation of water quality in Portland Harbor USA. In 2000, the US EPA designated the lower 10 miles of the Willamette River as a Superfund Site mostly due to concerns over persistent pollutants. Current and historic surface water monitoring have focused on legacy pollutants associated with industry in the area and overlook several other sources and contaminants. Local community organizations are concerned about overlooked and emerging contaminants in surface water. Following a community engaged approach we aimed to address these concerns by monitoring surface water samples over a 6-month period across six locations in the Willamette River. We used two different methods to process and analyze collected water, covering a range of highly polar and moderately polar compound classes. Samples were analyzed using ultra-high performance liquid chromatography coupled to high-resolution mass spectrometry. Chemical data was processed using both suspect and nontarget screening approaches, allowing for the detection of compounds not routinely monitored. Using suspect screening we annotated 983 organic compounds, encompassing pesticides, pharmaceuticals, food additives and natural products. Suspect and nontarget analysis revealed that chemical profiles significantly differ over time. Spatial differences were observed within each month with Site 6 being the most divergent. These observed differences in Site 6 may be due to its proximity to the confluence with Columbia River or its proximity to the city's wastewater treatment plant. Prioritization of compounds was performed based on feature abundance, statistical differences, frequency of detections and hazard of annotated compounds. To assess the potential hazards of these water contaminants, we utilized the high-throughput embryonic zebrafish platform. Collected water was tested before and after preconcentration for developmental toxicity outcomes and behavioral endpoints in zebrafish. We observed behavioral and morphological changes in fish exposed to water collected from Site 3 during the September 2022 campaign. The combination of these approaches will allow us to further prioritize water contaminants for assessment and monitoring. These results can help to inform community groups and regulatory agencies about the hazards associated with emerging water contaminants and potential risks of exposure in the Portland Harbor.

# Session: Airborne Pollutants

**Poster 35. Assessing potential environmental impacts of open loop exhaust gas cleaning system (EGCS) discharges in the Puget Sound**

Jay Word*[1], William Stubblefield[2], Valerie Chatterly[3], Joy McGrath[4], and Dayang Wang[5]. [1]EcoAnalysts; [2]Oregon State University; [3]VEnvEco; [4]McGrath Consulting; [5]Exponent, Inc.

Emissions from the combustion of heavy fuel oil (HFO) containing sulfur dioxide have been suggested to increase risks to human health and the environment. Beginning in 2020, the International Maritime Organization International Convention for the Prevention of Pollution from Ships (MARPOL) required vessels to comply with new sulfur air emission standards by: 1) using a very low sulfur fuel oil (VLSFO) or 0.1% sulfur marine gas oil (MGO), or 2) installing an “appropriate exhaust alternative method”. To comply with the new standards, most cruise ship operators installed Exhaust Gas Cleaning Systems (EGCS) on their vessels. The EGCS removes sulfur oxides from the emissions, as well as a portion of both pyrogenic and petrogenic PAHs and metals, by spraying ambient seawater into the engine exhaust prior to vessel release. The goal of this study was to evaluate potential environmental risks associated with the operation of open-loop EGCS washwaters to the Puget Sound. A combination of analytical chemistry (PAHs and metals), modeling of washwater toxicity and post-discharge environmental concentrations, and validation of model predictions using Whole Effluent Toxicity (WET) bioassay methods were employed. Differences in exhaust gas composition has been attributed to: engine load, characteristics of the fuel used, and engine differences (e.g., engine make, size, etc.). Possible differences attributable to fuel type was controlled by limiting the study to vessels powered by similar HFO with a typical range of sulfur content (2.0-3.5%) from a common source. Engine energy demand could directly affect fuel consumption and washwater composition. Two engine loads were evaluated in this study, low load (≤ 50%, represents “in port operations”) and high load (≥70% represents normal transit operations). A representative set of samples were collected from six ships operated under low and high engine loads. Environmental samples were collected from the seawater intake, EGCS waters, and overboard discharge for each scenario. Analytical determinations (PAH and metals) were conducted on all samples. Additionally, WET testing was performed for each overboard discharge sample to determine potential toxicity to the organisms in the receiving waters. Results of all determinations will be discussed.

**Poster 36. Modeling the extent of the potential environmental impacts of open loop exhaust gas cleaning system (EGCS) discharges in the Puget Sound**

Jay Word*[1], William Stubblefield[2], Valerie Chatterly[3], Joy McGrath[4], and Dayang Wang[5]. [1]EcoAnalysts; [2]Oregon State University; [3]VEnvEco; [4]McGrath Consulting; [5]Exponent, Inc.

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**Poster 37. Wildfire Smoke Characterized for 1500 Potential Chemicals**

Kelly O'Malley*, Christine Ghetu, Diana Rohlman, Brian Smith, and Richard Scott. Oregon State University.

There is an increasing number of large wildfires (>1000 acres) in the Western United States (U.S.), resulting in a need for rapid responses to measure human exposure to wildfire smoke. Wildfire smoke is a complex mixture that can vary based on fuel types, weather, and heat of the fire. Recent research has shown wildfires increase levels of vapor-phase polycyclic aromatic hydrocarbons (PAHs), yet there still are persistent knowledge gaps of vapor-phase organic contaminants in wildfire smoke. The objectives of this study are to explore the composition of wildfire smoke to identify potentially novel wildfire-specific organic chemicals, and to characterize these chemicals based on source and/or use. Paired air and soil pore-air low-density polyethylene passive samplers were deployed by trained community members before, during, and/or after wildfires at seven locations in the Western U.S. All air and soil pore-air wildfire samples were screened for 1530 chemicals using a gas chromatography mass spectrometer (GC-MS) semi-quantitative method that quantifies concentrations within a factor of 2.5 of the true value. A chemical was determined to be potentially wildfire-specific if it was either not detected in the sample deployed pre-wildfire and then detected in the sample during a wildfire (same location), or it is detected in a wildfire sample at a 50% higher level compared to pre-wildfire. Source and uses of potential wildfire-specific chemicals were characterized from CompTox, PubChem, Google Scholar, and Web of Science. A total of 44 chemicals were detected either before, during, or after a wildfire. Twenty-three of these are potentially linked to wildfire smoke, most notably dibenzofuran, 4-methoxyphenol, 1,2,4-trichlorobenzene, and N, N-diethyl-m-toluamide (DEET). Overall, most potential wildfire-specific chemicals fell into multiple common categories. These included pesticides, and industrial/household, personal care, combustion, natural, and degradation products. Characterizing the potential wildfire-specific chemicals may indicate probable sources to determine if a chemical originates from natural or anthropogenic sources already present in the environment, or it is released from organic materials during a wildfire. Identifying components of wildfire smoke can improve human exposure assessment to wildfire events and can facilitate further understanding of health impacts from wildfire smoke.

# Wednesday Platform Presentations

## Session 7: Cause and Effect

### Acclimation of Freshwater Sediments for Marine Bioassay Testing

Mary Ann Rempel-Hester*, Dani Mulligan, and Samantha Heineke. EcoAnalysts.

Dredged materials destined for marine disposal often require bioassay testing with marine species to ensure that no adverse effects will occur at the disposal site. Occasionally freshwater dredged material is designated for marine disposal, necessitating the need to test freshwater sediments for effects on marine species. When freshwater is placed under marine conditions for testing, the change in environment negatively affects the sediment chemistry and biome, leading to detrimental effects on water quality including and increase in ammonia and a drop in pH that can cause significant but transient toxicity. A study was conducted to determine the best method to acclimate freshwater sediment to marine conditions prior to toxicity testing to minimize the non-anthropogenic toxicity that may interfere with suitability determinations. Varying duration, renewal frequency and sediment to overlying water ratios were examined. Water quality was monitored during acclimation, and once the acclimation regime was complete a mussel (Mytilus galloprovincialis) larval development test was conducted following the standard Puget Sound Estuary Protocol for marine sediments. Results indicated that a thin layer method of acclimation, with renewals every day or every-other-day provided the best results. pH took longer to reach acceptable testing conditions than either salinity or ammonia and should be used as the marker for when acclimation is near completion. A mock test chamber should be prepared and pH, along with ammonia, salinity, and sulfides, measured in the mock chamber to ensure that conditions will be acceptable upon test set up.

**Evaluating the potential hazards of anticoagulant-containing bait pellets to early life stage pink (Oncorhynchus gorbuscha) and coho salmon (O. kisutch)**

Melissa K. Driessnack*, Lillian Pavord, and Jenifer K. McIntyre. Washington State University.

Cereal bait pellets containing anticoagulant rodenticides (AR) are frequently employed to control rodents (e.g., rats) in domestic, municipal, agricultural, and conservation settings. The USDA engages in whole-island eradication of invasive rats using aerially dropped cereal bait pellets containing AR chemicals to support the conservation efforts of native species. Currently, the USDA and Alaska Fish and Wildlife are developing eradication plans to target invasive Norway rats (Rattus norvegicus) on the Aleutian Islands. As part of this planning, surveys are being conducted on targeted islands to evaluate the potential for non-target organism mortalities, which has identified Pacific salmon, including coho (Oncorhynchus tshawytscha) and pink (O. gorbuscha), as potentially impacted species due to aerially broadcast pellets often unintentionally entering waterways. The timing for these eradication efforts is important as they often occur in late summer to early fall and overlaps with the spawning and developmental timeline for pink and coho embryos and potentially alevin. Spawning salmon deposit their fertilized eggs in gravel redds, where the embryos develop over the winter. These redds could unintentionally receive AR-containing bait pellets during aerial broadcast resulting in embryos and possibly alevin developing and rearing in the presence of the ARs. Work in 2022-2023 began estimating the effects of pellets containing brodifacoum (BROD) and pellets containing diphacinone (DIPH) to early life stage coho embryos and alevin. Exposure to AR pellets resulted in significantly increased incidences of mortality and cranial hemorrhaging for alevin exposed to BROD. Tissue accumulation of BROD also increased over time in the developing coho, with accumulation beginning in the embryo stage. This research was expanded in 2023-2024 to assess impacts on pink embryos and alevin as well as to explore critical windows for early life stage coho exposed to BROD pellets. Again, increased rates of mortality and cranial hemorrhaging were noted for coho embryos and alevin for each of the three BROD pellet exposure scenarios. Data collected from the pink alevin also showed a sensitivity to BROD exposure, but not DIPH, which was observed as increased mortality and cranial hemorrhaging. Collectively these studies highlight a need to better understand the movement of ARs in aquatic environments and develop models on AR toxicokinetics and toxicodynamics in aquatic species.

**Comparison of Eco-Corona and Protein Corona Binding Constants on Functionalized Gold Nanoparticles Using Spectroscopic Methods**

Sam Lohse*[1], Oluwaseun Akinsola[1], Jennifer Hanigan-Diebel[1], Robert Costin[2], and Jarrod Schiffbauer[2]. [1]Central Washington University;[2] Colorado Mesa University.

Engineered nanoparticles (ENPs) are slowly becoming prevalent in a variety of products and applications, with more nano-enabled products poised to enter the marketplace in the next decade. In biomedicine, nanotherapeutics and nanotheranostic agents are enabling new imaging and drug-delivery applications, while in the environment, ENPs and microplastics represent a new class of contaminant. In both biological systems and the environment, ENPs adsorb biomolecules and polymeric species ("corona" formation), which changes the biological or ecological identity of the NP. Understanding and the chemistry behind the formation of coronas around ENPs is essential for both modelling NP fate and transport and accurate toxicology interpretation. Here, we present the results of several spectroscopic studies (absorbance spectroscopy, dynamic light scattering, fluorescence spectroscopy) performed on functionalized gold nanoparticles to determine the strength of binding (Ka) between common components of protein and eco-coronas (bovine serum albumin, lignin etc.). We compare values for Ka determined across the spectroscopic techniques, and comment on the limitations of the spectroscopic investigations. We correlate what we know about the strength of binding for the proteins and biopolymers to the structure of the corona (as established by DLS, ζ-Potential, and circular dichroism measurements). In addition, we will compare experimental results and MD simulations of proteins interacting with the nanoparticle surfaces.

**Characterizing the Impacts of Legacy Arsenic Contamination on Freshwater Lake Microbiomes**

Sarah Alaei*, Alison Gardell*, and Jim Gawel. University of Washington Tacoma.

This study characterized microbial communities within environmental compartments of freshwater lakes impacted by legacy arsenic (As) contamination in the Puget Sound lowlands. We hypothesized that As-exposed environmental microbes contribute to the structure and function of primary consumer microbiomes in lake systems. Freshwater snails and environmental samples were collected from three lakes (Killarney, Steel, and reference) with differing levels of As and used 16S rRNA gene amplicon sequencing to evaluate microbiome composition. Our preliminary results indicate that environmental As acts a selective pressure for determining taxonomic composition within microbial communities among our study lakes. We found that Proteobacteria was the most abundant phylum in our reference lake, whereas the most abundant phylum in As-exposed sediment microbiota was Firmicutes. Similarly, we detected a shift from Proteobacteria dominated gut microbiota in reference lake snails to an increased prevalence of Bacteroidetes in the gut microbiota of As-exposed snails. While our sample size was small, these preliminary data lead us to predict that environmental microbial communities found in distinct environmental compartments (water, sediment, and periphyton) can influence the composition of freshwater snail microbiomes. This work is part of an ongoing effort to engage UW Tacoma undergraduate students, through coursework and independent study, in an interdisciplinary project focused on a local environmental problem. Our future studies will focus on expanding our preliminary dataset to increase statistical power and will include lab-based exposures of reference lake snails to As contaminated lake microbiota to determine the time-course and extent of microbiome modification that occurs when As is introduced.

**Investigating the impact of dietary-based stressors on the health and survival of juvenile Chinook salmon (Oncorhynchus tshawytscha)**

Melissa K Driessnack*, Jenifer K. McIntyre, and John D. Stark. Washington State University.

Ongoing efforts are being conducted to improve the survival of juvenile Chinook salmon in the Pacific Northwest, with extensive remediation projects being completed on the Duwamish River, which flows alongside the city of Seattle. Despite all these improvements made to the river as well as surrounding watersheds, fall run Chinook continue to show low rates of return to the Duwamish. This has led to increased focus on the health and survival of juvenile Chinook preparing to migrate into the Puget Sound. To undergo that migration salmon must successfully complete the physiologically stressful process of smolting. However, juvenile salmon undergoing smolting are not faced with multiple stressors including exposure to legacy chemicals (e.g., PCBs), emerging contaminants of concern, and altered prey availability. Current toxicological effect data, specific to fall run Chinook salmon for the region, are insufficient to determine if contaminant exposure, alone or in combination with other relevant stressors, is contributing to the low survival of estuarine-reared Chinook. As such, this research is the first of three projects that will assess how restricted and contaminated feed impacts the health and survival of juvenile Chinook undergoing smolting. The first study used a simplified PCB (Aroclor 1254) spiked diet at an environmentally relevant concentration of 200 ng/g to evaluate the health and survival of juvenile Chinook over a 30-day exposure period. Four treatments were a Control diet at Full Feed, Control diet at Restricted Reed, PCB-spiked diet at Full Feed, and PCB-spiked diet at Restricted Feed, with 12 replicate tanks per treatment each containing 10 juvenile Chinook. Following the 30-day exposure, increased mortality was observed in both the feed restricted and contaminated feed treatments as well as changes in condition factor and whole-body PCB accumulation. Initial results of this three-part research project support that food availability is a valid factor to consider in contributing to the sustained high mortality rates for Chinook in the Duwamish.

# In-Person Short Course

**From the Basics to the State-of-the-Science on Micro and Nanoplastics Research**

Taught by: Stacey Harper and Susanne Brander. Oregon State University