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Abstract Book

Note: * Preceding title indicates presentation is entered in the Student Awards Competition.

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Lightning Talks

L1. Environmental Contaminants

L1.1 Columbia River Basin Contaminants of Concern Framework

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In 2007, the Columbia River Restoration Program Working Group (Working Group) developed a list of priority Contaminants of Concern (CoC) in the Columbia River Basin. In 2019, a new subgroup was formed to develop an updated CoC list, based on consideration factors and existing data. The CoC framework, published in August 2020, can be used to support collaboration and implementation of toxics monitoring and reduction efforts across the Columbia River Basin. It is primarily intended as a reference for members of the Working Group and other entities working to assess, reduce, and/or clean up toxics in the watershed. In the framework, pollutants are grouped by different pathways into the environment (e.g., agriculture) and by the types of actions that could potentially be taken to address particular contaminants or classes of contaminants (e.g., keeping sediment in place). The framework does not prioritize contaminants based on ecological or human health risks. The actions provided are intended to connect to more specific best management practice (BMP) guides readily available through the governmental and non-governmental organizations. The toxic pollutants within the scope of this project include synthetic organic chemicals, metals and other inorganic chemicals, and relevant pesticide degradants based on existing data and knowledge. Other types of pollutants that may be considered toxic, such as fertilizers/nutrients, pH, temperature, microplastics, or other similar contaminants are not currently included in scope of the framework.

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L1.2 Prevalence of Contaminants of Emerging Concern in Soils, Carrots, and Kale Irrigated with Sammamish River or Recycled Water

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National and regional interest in promoting circular economies for local food has sparked anxiety about contaminants in water and soil amendments. Environmental contamination from yard waste compost and biosolids is one community concern, and there are additional questions about chemicals accumulating into soils or crops when irrigating with recycled water from wastewater treatment. Very little data exist on presence of contaminants from irrigation waters in the Pacific Northwest.

This study investigated the presence and accumulation of contaminants of emerging concern (CECs) from both surface water irrigation and recycled water irrigation. In the summer of 2020, we drip irrigated carrots and kale with either Sammamish River surface water (which does not receive wastewater effluent) or Washington State Class A membrane bioreactor produced recycled water. We used 16 randomized raised cedar beds with each crop-water combination replicated four times. Samples of the two irrigation waters, soils, carrots, and kale were submitted for analysis of 141 pharmaceuticals, six bisphenol compounds, 33 perfluorinated compounds, glyphosate and two metabolites, agronomic nutrients, conductivity, and soluble salts.

68 CECs were detected in the recycled water, while 30 were detected in the Sammamish River water. Before any irrigation waters were applied, 12 CECs were detected in soils. At the season end, 17 CECs were detected in river water irrigated soils, while 15 were detected in recycled water irrigated soils. 18 CECs were found in recycled water irrigated kale, 16 were detected in river water irrigated kale. Nine CECs were found in recycled water irrigated carrots, while 15 CECs were detected in river water irrigated carrots. Detections in both water types, soils, carrots, and kale were variable but small (parts per trillion). The implications of these data on the local food movement and the use of recycled water to reduce irrigation withdrawals from surface waters will be emphasized.

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I would like to judge student presentations: No

L1.3. *Longevity of Bioretention Depths for Preventing Acute Toxicity from Urban Stormwater Runoff

Maguire, L.W.[1]*; *McIntyre, J.K.*[1]; *and Davis J.W.*[2].

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

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L2. Assessing Toxicity

L2.1. Toxicity of PFOS and PFOA to four standard marine species

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Per- and poly-fluoroalkyl substances (PFAS) are emerging contaminants that are coming under increasing scrutiny. Currently, there is a paucity of effects data for marine aquatic life, limiting the assessment of ecological risks and compliance with water quality policies. In the present study, the toxicity of perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) to four standard marine laboratory toxicity testing species, encompassing five endpoints, were evaluated: 1) 96-h embryo-larval normal development for the purple sea urchin (*Strongylocentrotus purpuratus*); 2) 48-h embryo-larval normal development and normal survival for the Mediterranean mussel (*Mytilus galloprovincialis*); 3) 96-h survival of opossum shrimp (*Americamysis bahia*); and 4) 24-h light output for the bioluminescent dinoflagellate *Pyrocystis lunula*. All species were tested using standard United States Environmental Protection Agency and/or American Society for Testing and Materials (ASTM) International protocols. For both PFOS and PFOA, the order of species sensitivity, starting with the most sensitive, was *M. galloprovincialis*, *S. purpuratus*, *P. lunula*, and *A. bahia*. The range of median lethal or median effect concentrations for PFOS (1.1 – 5.1 mg /L) and PFOA (10 – 24 mg/L) are comparable to the relatively few toxicity effect values available for marine species. In addition to providing effects data for PFOA and PFOS, this study indicates these species and endpoints are sensitive to PFAS such that their use will be appropriate for deriving toxicity data with other PFAS in marine ecosystems.

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L2.2. *Toxic Effects of Tires Particle Eluate in Marine Environments

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My research is based on the emerging body of work on the impacts of microplastic accumulation in marine environments. Specifically, I am quantifying the toxicity of weathered tire particles to marine organisms through acute toxicity testing using mysid shrimp, *Americamysis bahia*. Toxicity is assessed through a limit test followed by 96-hour acute toxicity tests using eluate created from several tire treatments (e.g. weathered or not and age of the tire) of the same brand and model. These solutions are used to determine the LC50 for *A. bahia*. Additionally, eluate from each test treatment will be analyzed for metals with ICP-MS, and non-target analysis of organic chemicals with liquid chromatography coupled to a quadrupole time-of-flight high-resolution mass spectrometer (LC-QToF-HRMS). The limit test results showed 100% mortality to mysid shrimp from eluate concentrations between 1 to 10 g/L for all non-weathered tire particle treatments. The limit tests indicate that eluate from non-weathered tire particles are 2.5 to 5 times more toxic than conventional microplastic fibers being studied under the same conditions in our lab. Toxicity to mysid shrimp based on 100% mortality in the limit tests for tire particle treatments that were weathered in the marine environment remained constant at 10 g/L for all but two treatments, which had lower toxicity. These results for weathered tire particles also differ from what was found for microplastic fibers, which showed a large decrease in toxicity after weathering in a marine environment. This research is ongoing and additional results will be presented as they are available.

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Student: Student (MSc)
Student Presentation Award Competition: Yes
I would like to judge Student Presentations: NA

L2.3. *Assessment of Metal Bioaccessible to Human Lungs Using *Orthotrichum lyellii* as a Bioindicator of Whatcom County Air Pollution

Shimkus, P.A.; La, C; Simmons, A; Flynn, K,R; Sofield, R.M.*

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The use of naturally occurring moss as a bioindicator of air pollution provides an opportunity for researchers to characterize metal emissions across large and urbanized areas, without the cost and effort required with traditional deployment/passive sampling methods. Through different laboratory processing approaches, moss samples can provide data about total metal or the metal fraction that is hypothesized to be bioaccessible to human lungs. In Whatcom County, Washington, *Orthotrichum lyellii* was harvested from 80 dispersed sites across four census tracts. This study aims to compare the fraction of atmospheric metals to human lungs using two different extraction techniques. The stems of moss samples are homogenized and one sub-sample is extracted with a Simulated Lung Fluid for 24 hours at 37ºC. The second sub-sample is digested with microwave digestion to provide a total metal concentration. These moss samples are collected every 60 days and include times of Covid limitations and beyond full vaccine deployment. The results reported will focus on samples collected in November 2020.

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I would like to judge Student Presentations: No

L3. Micro and Nano-Plastics Assessments

L3.1. Virgin Micro and Nanoplastic Fragments Elicit Minimal Effects on Embryonic Zebrafish Development

Cunningham B, Harper B, Brander SM, Harper S*

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Annual production of plastics has grown to several hundred million tons, nearly 80% of which will eventually enter the environment. There small particles of degraded plastic are internalized by aquatic organisms. Though plastic pollution is often discussed as a single entity, the category of plastics actually encompasses many chemical compositions, colors, morphologies, additive, and sizes. However, the vast majority of research on the fate and effects of micro- and nanoplastics investigate the effects of plastics using only spherical polystyrene (PS) particles. Environmental sampling has documented a diversity of microplastic compositions present in water and soil. Detailed sampling in the San Francisco Bay revealed fragments to be the second most common shape of microplastic, following fibres; yet spheres remain the most studied shape for microplastic toxicity. With these research gaps in mind, we designed experiments to assess the toxicity of a diverse suite of micro- and nanoplastic fragments. To assess the effects on development, zebrafish embryos were exposed to various concentrations (2.5x102 - 9.8x109 particles/ml) of either micro (1-20 µm) or nano (<1 µm) – sized polyvinyl chloride (PVC), polyethylene terephthalate (PETE), polypropylene (PP), or polylactic acid (PLA) fragments (n = 12 per plastic type and concentration). Exposures began 8 hours post fertilization (hpf) and lasted a total of 5 days covering the periods of gastrulation through organogenesis. Embryos were evaluated at 24 hpf for mortality, developmental progression, and spontaneous movement; and again at 120 hpf for mortality, morphological abnormalities, and touch response. Surprisingly, exposures up to extremely high concentrations (PVC: 8.7x108, PETE: 9.8x109 , PP: 4.5x107 and PLA: 6.0x108 particles/ml) of virgin micro or nanoplastic fragments had minimal acute effects on developing zebrafish embryos. However, these results cannot be interpreted to mean that environmental exposures of such micro- and nanoplastics carry no toxicity. Data is needed reflecting environmentally relevant exposures, including exposures in mixtures and with co-contaminants that may alter effects.

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Student Presentation Award Competition: Yes

L3.2. Particle Agglomeration over a Salinity Gradient Depends on Nanoplastic Type and Surface Chemistry

Shupe, H.J.[1,,‡]; Boenisch, K.M.[1,*,‡]; Harper, B.J.[1]; and Harper, S.L.[1,2]*

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‡These authors contributed equally to this work.

Agglomeration of nanoplastics in waters can alter their transport and fate in the environment. Agglomeration behavior of four nanoplastics differing in core composition (red- or blue-dyed polystyrene (PS)) and surface chemistry (plain or carboxylated poly (methyl methacrylate) (PMMA)) was investigated across a salinity gradient. No agglomeration was observed for carboxylated PMMA at any salinity, while the plain PMMA agglomerated at only 1 g/L. Both the red and the blue PS agglomerated at 25 g/L. Results indicate that both composition and surface chemistry can impact how environmental salinity affects plastic nanoparticle agglomeration.

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Student Presentation Award Competition: No
I would like to judge Student Presentations: No

L3.3. *Behavioral Alterations in *Daphnia magna* from Chronic Exposure to Polystyrene Nanoplastics

Brown J.G., Bryan B.J., Harper S.L.*

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The chronic and sublethal effects of nanoscale plastic particle exposure on freshwater species remain unclear. Preliminary studies involving *Daphnia magna* have shown no significant effects on survival or mobility when exposed acutely to 0-750 ppm polystyrene nanoplastics. Developing a model for chronic nanoplastics exposure using environmental indicator species at the base of the food web, like *Daphnia magna*, is critical for assessing questions regarding the effects of plastics on long-term environmental health. In this study neonatal *Daphnia magna* were exposed to a single concentration of aged 50 nm red polystyrene Visiblex™ nanospheres at 80 ppm. Each triplicate of exposures and unexposed controls contained 5 individuals that were reared for 21-days. Mortality, immobility, and reproductive output were assessed daily with feedings. All offspring were removed and placed into clean media during bi-weekly solution changes. Following the 21-day exposure, individuals were assessed for behavioral endpoints under light and dark conditions using Noldus EthoVision XT software and imaged for growth comparisons. The data showed a statistically significant difference in movement behavior between the exposed and control sets. Differences in movement behavior include freezing and burst-movement frequency and duration, all of which can impact the ecological survivability of the *D. magna*. Data analysis for growth comparisons and reproductive success will be reported. Further investigation and improvements in experimental design are required to assess mechanisms of toxicity, risk, and reproductive outcomes of chronic nanoplastics exposure on *D. magna*.

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Thunder Briefs – Track 1

T1. Micro and Nanoplastics Occurrence and Uptake

T1.1. Including the Public in Addressing Environmental Issues, a Plastic Example

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Solving problems associated with the unintended environmental consequences of the immense growth of plastic use over the last several decades involves not just science, but public awareness of the problems and solutions. One major obstacle to this effort is the media's nearly exclusive focus on human interactions (such as politics, sports, and fashion), leading to the media's marginalization of environmental issues. Addressing the environment's minor presence. In the media, particularly in the Pacific Northwest, is the core of SEA-Media's mission and values. Salish Magazine is our primary tool for environmental education. It uses art, poetry, and engaging stories to give readers a path toward a better understanding of the ecosystem processes of our Salish Sea region. One relevant example of our informative yet artistic outreach is the magazine's Spring 2020 issue titled: "Welcome to the Plastocene." This issue offers seven articles, a collection of paintings, and poems that highlight some of the plastic related problems we are facing — as well as approaches to addressing them. For example, one article offers an overview of the situation, and another, by a research scientist at the University of Washington, dives into the topic of microplastics. An article by the director of Zero Waste Washington, discusses ways of addressing the plastic problem. One article gets to the heart of inspiring people by presenting a fashion show that featured clothes made from discarded items (the Trashion Show). This mix of art, community, humor, and concern helps engage the public as well as point them in the direction of our other related articles.

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I would like to judge Student Presentations: No

T1.2. *The Presence and Abundance of Microplastics in Juvenile Black Rockfish (*Sebastes Melanops*) from Oregon Estuaries.

Arnold, M.A.; Lasdin K.S.; Brander, S.M[1]*

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Microplastics are pieces of plastic 5mm or smaller that are a significant environmental pollutant and pose a threat to a wide variety of marine taxa. The juvenile Black Rockfish (*Sebastes melanops*) is at risk of consuming microplastics directly from the water as well as through their prey (e.g. planktonic crustaceans). Juvenile rockfish were collected from two locations, one an Oregon Marine Protected Area (Otter Rock) established to protect the marine species it inhabits, the other an unprotected sampling site (Cape Foulweather). We are comparing microplastic ingestion in these juveniles to discern whether there are any disparities between the protected estuary and its unprotected counterpart. The gastrointestinal tracts of the juveniles (54 from the protected area, 14 from unprotected) were removed and then digested chemically, to identify any potential microplastics. Once separated via vacuum filtration, suspected particles were identified via Fourier transform infrared spectroscopy. Results thus far suggest that juvenile black rockfish are ingesting microplastics in both estuaries. Overall, this research alludes to the larger predicament of protecting all marine species from the harmful effects of microplastics. Further research into varying marine ecosystems could provide additional evidence on the scope of the microplastics problem and, potentially influence future legislation to protect both the water systems and marine species of the West coast.

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T1.3. Seasonal Variability of Anthropogenic Debris in the Salish Sea: Microplastics Monitoring at the Seattle Aquarium

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Microplastic (MP; plastic <5mm) and other anthropogenic debris are ubiquitous in marine environments. The Salish Sea is home to charismatic megafauna and economically important species, however, it is also home to effluents of large coastal cities. This juxtaposition of ecologically and economically valuable ecosystems with a substantial urban population makes the Salish Sea one of the best locations to study temporal marine debris contamination. Here, we present findings of seasonal baseline anthropogenic debris contamination in the Salish Sea, WA for water at depth (30ft) collected at the Seattle Aquarium. Our goals are two-fold: 1) determine if anthropogenic contamination in the Salish Sea is dependent on seasonality and 2) describe long term baseline MP contamination data including concentration, particle type, and particle size. We sampled 100 L of seawater every two weeks from January 2019- December 2020 and used an oil extraction protocol. Preliminary results suggest that anthropogenic contamination in the Salish Sea is not dependent on seasonality, but rather differs between the two years sampled. Concentrations raged from 1-0.02 particles/L where fibers were the most common type of particle observed and fiber length did not differ across years or seasons. This study is unique in that it sampled water from the same location over two years demonstrating the temporal variability of microfibers in the Salish Sea, potentially affected by freshwater influx from the Duwamish River, city sewage overflow events, or waterfront tourism activity decreased by Covid-19.

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T1.4. *The spatial variability of the occurrence of ingested microplastics in *Sebastes melanops* off the Oregon coast

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Microplastics are the most common plastic debris type and pose a hazard to organisms that ingest them. Opportunistic feeders, such as rockfish (*Sebastes spp*.), are susceptible to microplastic ingestion and are found along populated coastlines. Black rockfish are being compared across several locations off the Oregon coast, in the vicinity of marine reserves or closer to populated areas, Newport, Oregon. This is of interest as the monitoring of the marine reserves started between 2010 and 2014 and restrictions happening between 2012 and 2016 and will be assessed in 2023 to see if they aid in the protection of fish. Digestive tracts were examined to determine whether they contained suspected microplastics, and undigested prey items were analyzed separately. Data thus far shows a variety of microplastics morphologies and colors found within these fish. Suspected microplastics have and will continue to be confirmed with micro-Fourier transform infrared spectroscopy. These data show that nearshore species may be impacted by waste management shortfalls and are consuming synthetic materials. These results potentially demonstrate that the spatial distribution of plastic is not solely dependent on the locality of humans, but rather on oceanography. Continued research is needed to determine how much plastic is found in surrounding waters, the amount ingested or accumulated by other marine organisms in this food web, and how it impacts vital species to better understand the health of the Pacific Northwest marine ecosystem and ecosystems around the world.

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T2. Micro and Nanoplastics Transport, Fate and Effects

T2.1. *Investigating the Transport, and Behavior of Microplastics in Estuarine Systems Through the Application of Metal-Doped Plastic Analogs using spICP-MS

*Rauschendorfer, R.J.[1,] *; Whitham, K.[2]; Rider, D.[2]; Montaño, M.D.[1]*

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Plastics waste is a ubiquitous global contaminant infiltrating aquatic and terrestrial environments. A central issue with plastic debris is material fragmentation which generates micro- and nanoplastics. Upon release into the environment, these microplastics are subject to varying conditions that alter their transport, behavior, and environmental impact. Current analytical methods are limited in detecting and characterizing submicron plastics at environmentally relevant concentrations. This limitation requires new analytical tools and techniques with the requisite sensitivity and selectivity to detect these particles in complex environmental and biological matrices. In order to address this, nanoparticle labeled proxies have been developed which provide a means by which to study particle transport in environmental contexts. In this study, polystyrene-based proxies labeled with gold nanoparticles are employed to study colloidal plastic behavior, transport, and fate in aquatic systems. Among the transport phenomena studied, the partitioning of colloidal plastics between sediment and aqueous media is quantified using single particle ICP-MS. This allows for an individualized approach to address particle behavior and transport as it relates to varying environmental parameters. These proxies are anticipated to partition largely to the sediment with the strength of association being dependent on sediment size and carbon content. Likewise, proxy aggregation and deposition would be favored by increased salinity and divalent metal concentrations; while the presence of dissolved organic carbon would serve as a stabilizing agent. This work aims to expand the current knowledge surrounding colloidal plastics by investigating the mechanisms that influence contaminant behavior, fate, and transport and how this can be extended to address broader environmental impacts.

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T2.2. *Effects of Polymer Type and Environmental Aging on the Acute Toxicity and Chemistry of Microplastic Fiber Leachates

Johnson, A. M., Roberts, M., Marcus, W., Ells, C., DeVore, E., and Sofield, R. M.*

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Many monitoring studies have found microplastic particles and fibers to be ubiquitous in the environment, and many researchers have examined possible detrimental effects of microplastic exposure. However, the role of plastic additives, sorbed chemicals from the environment, and possible plastic degradation products on microplastic toxicity is not well understood. Microplastics can contain many types of additives which can be released into surrounding water, and microplastics also tend to sorb and concentrate chemicals from their surrounding environments, which can be released again later. The goal of our study is to investigate how the toxicity and chemical composition of three microplastic fiber leachates, created by soaking fibers in 25 ppt seawater for 48 hours, changes based on the source fiber polymer type and whether the fiber has been aged in the environment. Microplastic fibers used to create the leachates were either stored in the laboratory (non-deployed) or left in semi-permeable bags in Bellingham Bay for 2.5 months (deployed). The acute toxicity of these leachates is assessed by exposing juveniles of the saltwater crustacean *Americamysis bahia* using limit tests followed by tests with a range of concentrations. Mortality at 96 hours is the endpoint. Results to date show that leachates from non-deployed fibers are toxic, while leachates from deployed fibers are nontoxic at the same plastic concentrations. Chemical analysis of the 6 leachate types was performed with LC-QTOF-MS, and it shows unique chemical features differentiating the toxic leachates (created from non-deployed fibers) and the non-toxic leachates (created from deployed fibers).

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T2.3. Micro and Nanoplastics: Effects of Environmentally Relevant Concentrations of Tire Wear Particles on Estuarine Indicator Species

Dickens JM, Cunningham B, Siddiqui S, Hutton S, Pederson E, Harper S, Harper B, Brander SM.*

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Plastic debris is a ubiquitous source of pollution in marine and estuarine ecosystems with adverse health impacts on marine organisms. There is relative risk across different salinities, polymer types, concentrations, and sizes (e.g., micro vs. nano). There is still a gap remain in our knowledge of species response to environmentally relevant concentrations, particularly in estuaries where salinity can influence particle behavior and also potentially toxicity. Less is known about the effects of tire wear particles (TWP) as an organic aquatic contaminant. Generated from automobile traffic, there is an estimated 1,121,000 t/a of TWP in the United States alone, frequently detected in the coastal environment near urban areas. In this study, we used *Menidia beryllina* and *Americamysis bahia* as indicator species to study the sublethal effects of environmentally relevant concentrations of synthetic TWP in estuarine and bay environments. We exposed seven-day-old *Mysid* shrimp (n = 9) to 3 concentrations of TWP in two size ranges (< 20µm and < 1µm) as well as leachate across salinities (15, 20, and 25 ppt) for seven days. Subsequently, we exposed *M. beryllina* from 5-7 days post fertilization to 96 hours post-hatch (n=6) at three salinities (5, 15, and 25 ppt). A subset of fish and shrimp were used for behavioral analysis, while the rest were euthanized, preserved for growth and Reactive oxygen species analysis. Preliminary results suggest that TWP size influenced swimming behavior in *M. beryllina* and *A. bahia*. This could potentially have consequences for trophic transfer as prey species may act as transport vectors, transferring TWP to predator species. Though species exhibit varying sensitivities to low doses of TWP, the presence of adverse effects in *M. beryllina* and *A. bahia* indicates that even at current environmental levels, which are expected to continue to increase, aquatic ecosystems experience impacts dependent on the physical properties of the plastic.

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I would like to judge Student Presentations: Yes

T2.4. Microplastic Deposition in Puget Sound: One Size Fits None

Sackmann, Brandon S.[*1], Whitehead, Kenia[1], Premathilake, Lakshitha[2], Khangaonkar, Tarang[2]*

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Microplastics are an increasing concern in the Puget Sound ecosystem with both ecological and human health impacts. Potential ecological impacts due to microplastics can result from mechanisms related to intrinsic toxicity (of the plastic itself, additives, or associated pollutants) or from physical impacts. Efforts to evaluate environmental exposure lack information on environmental distributions, therefore information on the fate and transport of microplastics from different sources supports larger-scale ecological risk assessments and planning for field studies. However, one challenge is that fate and transport modelling efforts for microplastics often characterize them as passive, neutrally-buoyant particles, whereas natural populations often have a wide range of sizes, shapes, densities, and settling velocities. The Salish Sea Model (SSM) accurately describes how water moves through the Salish Sea, and is widely used by resource and regulatory agencies in the region. Here we have expanded the capabilities of the SSM to include a 3-D Lagrangian particle tracking model to simulate microplastic particles with different settling velocities to better understand where/when microplastics are deposited on the sediment surface to support benthic assessments. Microplastic particles with higher settling velocities tend to deposit and accumulate closer to their sources, but the simulated spatial distributions differ depending on local stratification and circulation patterns. With these improvements, the SSM has the fidelity to characterize and compare/contrast a wide range of microplastics (e.g., tire and road wear particles entering Puget Sound from distributed non-point sources vs. microplastic fragments associated with effluent from wastewater treatment facilities). The refined depositional maps for particles with different settling velocities help to identify and characterize exposure pathways and footprints to support risk assessments for microplastics in both surface waters and sediments and help to understand microplastics as an emerging contaminant of concern in Puget Sound.

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Student judge: Y

T3. Risk Assessment

T3.1 Ecological Risk Assessment for the Upper San Francisco Estuary of California using the Bayesian Network-Relative Risk Model

Landis W.G.[1]; Eikenbary S.E.[1]; Elmstrom S.R.[1]; Johnson A.M.[1]; Lawrence E.J.[1]; Markiewicz, A.J.[1]; Sharpe, E.E.[1] Whitney E.[1].*

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We are conducting a program to build a Bayesian network relative risk model to estimate risk and then apply an adaptive management process to the Upper San Francisco Estuary in California. Recently we have begun to build individual models for the endpoints Striped bass, Chinook salmon, Delta Smelt and macroinvertebrate community structure. Another development is the building of a dataset that incorporates unique entries for water quality variables, species counts, precipitation, contaminant concentrations and appropriate GIS data. We are adopting GitHub for the data storage and processing. R is the programming framework for data analysis. Netica is the software being used to construct the Bayesian networks. A major issue has been the organizing of the 100,000 entry dataset that comprises observations from 2010-2019, does not have duplication, and with each entry georeferenced. This data set is being used to establish the relationships between macroinvertebrate structure and water quality necessary to parameterize the BN-RRM models. We connected the macroinvertebrate data with the water quality data by linking macroinvertebrate samples to water quality samples that were taken on the same day and within 500 meters. The spatial analysis was carried out using the “sf” package in R Statistical Software. The data specifications limited the analysis to four risk regions: Central Delta, Confluence, Sacramento River, and Suisun Bay. At least three distinct groupings can be identified from the NMDS plot with Suisun Bay, Central Delta, and Sacramento River in separate groups and samples from Confluence falling into each of the three clusters. Temperature, pH, and conductivity were identified as potential influences on macroinvertebrate community structure. Next contaminants will be added. The presentation will summarize our current status and present how the data and models will play a part in adaptive management.

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T3.2 *Ecological Risk Assessment for Micro- and Nano- Plastics in the San Francisco Bay

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The goal of this project is an ecological risk assessment for micro- and nano- plastics for the San Francisco Bay. There has been an increased interest in understanding and managing the impacts that micro- and nano- plastics may have on ecological systems because recent studies have shown that plastic particles are widespread in the environment and that exposure to these particles has toxicological effects. Up to this point, an ecological risk assessment for micro- or nano- plastics has not been conducted to current standards. This study lays the groundwork for future ecological risk assessments of micro- and nano-plastics and will identify key uncertainties that need to be addressed. Using a Bayesian network relative risk model (BN-RRM), we are determining risk for Chinook salmon, Olympia oysters, Northern anchovy, and Pacific herring. In past studies, BN-RRM has been a successful framework for regional scale ecological risk assessments of multi-stressor systems, allowing for the creation of a model with predictive capability and adaptive potential as new data become available. We have chosen to break our conceptual models into two different pathways, (1) tire wear particles and (2) other micro/nanoplastics, based on likely differences in sources, transport, and toxicity. Our study site is broken into four risk regions based on watershed boundaries and land use patterns. The BN-RMM is parameterized for each risk region using microplastic abundance data collected by the San Francisco Estuary Institute, plastic particle toxicity data generated by Oregon State University, and site-specific water quality, chemical, and land use data from regional databases. Relative risk is calculated for each of the four risk regions. This study is funded by the National Science Foundation Growing Convergence Research Grant (1935018) program.

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T3.3. Prevalence and persistence of microcystin in shoreline lake sediments and porewater, and associated potential for human health risk.

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Midlatitude waterbodies are experiencing increased cyanobacteria blooms that necessitate health advisories to protect waterbody users. Although surface waters may contain cyanotoxins such as microcystin (MC), at concentrations that pose potential public health risks, little is known about MC contamination of shoreline sediments. Based on growing evidence that lake and reservoir sediments can accumulate MCs, we hypothesized that shoreline sediments (i.e., recreational beaches) may accumulate MCs and thereby pose a potential health risk to recreational users even if people stay out of contaminated water. We sampled nearshore surface water, shoreline sediment, and porewater from seven Washington State, USA, lakes/reservoirs recreational beaches to determine MC presence/absence during or immediately following cyanobacteria blooms. We found MCs in shoreline sediments at all waterbodies using ELISA and LC-MS/MS. MC concentrations in shoreline sediments and porewaters persisted for 20 days following dissipation of cyanobacteria blooms when MC concentrations were near analytical reporting limits in corresponding surface waters. A human health risk assessment based on potential MC exposure through incidental ingestion of porewaters and sediments found, even when very high MC concentrations occur in surface waters (i.e., >11,000 mg/L), estimated ingestion doses are below MC World Health Organization tolerable daily intake and U.S. Environmental Protection Agency's risk reference dose. Our findings suggest MCs in Washington State recreational beaches in 2018 did not present a significant human health risk, but the findings provide evidence of an exposure pathway for MCs via shoreline sediment/porewater exposure.

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Short Course: No
Special Session: No

Thunder Briefs Track 2

T4. Sustainable Solutions to Environmental Pollution

T4.1. *Sustainable Linen Management at Providence Portland Medical Center

Church, K.K.

Oregon Applied Sustainability Experience Program, Portland, OR

The healthcare industry in the United States contributes significant greenhouse gas emissions and waste to the environment. A large proportion of this pollution is attributed to the manufacture, consumption, and loss of reusable hospital linens. Providence Health & Services, a healthcare system with over 50 hospitals and 1000 clinics across the western U.S., is seeking to achieve a system-wide carbon negativity goal by 2030. In partnership with the Oregon Department of Environmental Quality and Oregon Sea Grant, I was hired as a summer intern for Providence to better understand their baseline carbon emissions. In the summer of 2020, I conducted a quantitative assessment and life cycle assessment (LCA) of linen consumption and researched alternative laundry options after finding that a current laundry product contained the chemical nonylphenol polyethoxylate (NPEs), an endocrine-disrupting EPA Contaminant of Concern in the Columbia River Basin. Results of the LCA indicate an annual contribution of greenhouse gas (943 MTCO2e), water (1.5 Mgal), and solid waste (35,000 lbs) pollution associated with linen consumption practices at the hospital. As a function of consuming linens, the Linen Processing and New Linen Injection life cycle stages were found to have the largest environmental impacts across EPA TRACI2.1 indicators of acidification, eutrophication, ecotoxicity, global warming air, fossil fuel, and smog air. Results of researching alternative laundry products included several known product and process alternatives with equal cleaning functions. I provided Providence management recommendations for safer chemical alternatives and overall linen consumption reductions in accordance with source reduction management. In my presentation at the PNW-SETAC conference, I will review the methodology and detailed results and recommendations of the LCA, barriers encountered during the Covid-19 pandemic, and alternatives for safer laundry.

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T4.2. *Comparative Model Organism Toxicity Screening of Alternative PFAS, GenX, Reveals Cardiac, Neurological, and Developmental Toxicities

Gong, S.[1,2]; Vu, J.P.[1,2]; Feng, Z.1,2; Bozinovic, G.[1,2]*

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Legacy per- and polyfluoroalkyl substances (PFAS) were phased out due to their bioaccumulative, carcinogenic, liver and endocrine toxicity properties. Emerging PFAS have been in use despite far less toxicological information available. We utilize a multi-species approach with *D. rerio*, *D. melanogaster*, and *C. elegans*, to evaluate exposure effects of an emerging replacement PFAS, hexafluoropropylene oxide-dimer acid (GenX). Zebrafish embryos exposed to 0.5 - 20,000 mg/L GenX from 4 to 72 hours post fertilization revealed LC50 of 12,000 mg/L and increased heart rates at 1 mg/L. Oregon wild-type fruit flies exposed to 10 - 10,000 mg/kg-day GenX and subjected to a negative geotaxis assay at 3, 7, or 14 days showed a reduced median lifespan among males at 100 mg/kg-day and among females at 1000 mg/kg-day ($p < 0.01$). Doses above 10 mg/kg-day decreased locomotor ability ($p < 0.0001$) in both sexes. Worm larvae exposed to 20 - 10,000 mg/L GenX until adulthood displayed developmental delays at 4,000 mg/L and above. Our multi-species approach show that physiological observations integrating the advantages of individual model organisms allow for diversified evaluation of the adverse effects of GenX, revealing potential cardiac, neurological, and developmental GenX toxicities. We will perform a comparative transcriptomic analysis to investigate the mechanisms of toxicity at and below levels of observed adverse effects.

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T4.3. Use of Low-Cost Sensors for Air Quality Monitoring Across the Downtown Core of the City of Kitchener

Neil, L.[1]; Al-Abadleh, H.[2]; Shantz, N.[2]; Mohammed, W.[2]; Bennet, C.[3]; Zinn, C[3]; Townend, T.[4] and Eastman, Z.[5]

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Air pollution is recognized as a public health issue and an invisible killer by the World Health Organization. Air quality indices for large geographic regions are often based on a single monitoring location using USEPA reference, or equivalent, methods. However, air quality can vary significantly over short spatial and temporal scales due to factors such as topography, meteorology, and source distribution, which may not be well captured by regulatory monitoring networks. The use of "low-cost" sensors is an emerging application in the study of air quality in cities and municipalities and allows for the mapping of large spatial scales with a dense network due to their low cost. This talk addresses air quality monitoring using "low-cost" sensor systems at multiple schools in Kitchener, ON, to highlight the usefulness of these systems in measuring air quality across the city. The sensors were chosen to monitor carbon dioxide, nitrogen oxides, sulfur dioxide, ozone, and PM2.5, along side meteorological parameters such as temperature, relative humidity, and noise levels. Comparison of “low-cost” sensor data to that from the provincial monitoring station that uses equivalent methods shows good correlations for ozone and PM2.5. Extremely low levels of NO and NO2 in Kitchener make correlations difficult with data from reference methods. Preliminary analysis of site-specific Air Quality Health Index (AQHI) values highlights the sensitivity of these values to contaminant concentrations. The collected data was analyzed to highlight the geographical variation in air pollution across the downtown core of the City of Kitchener.

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T4.4. Phthalates Research for Source Control Phase II

Trim, H

Zero Waste Washington, Seattle, WA

Sediment cleanups in Puget Sound cost millions of dollars. Source control is critical to reduce the potential for recontamination of these sites. Phthalates, which are endocrine disrupting chemicals, have been identified as a major recontamination threat. This project will help reduce phthalates entering waterbodies via the stormwater pathway, thus reducing the potential for recontamination and decreasing the load of phthalates in aquatic organisms. To date, phthalates have been primarily been studied in indoor environments and not assessed in exterior use products which may contribute directly to stormwater. In Phase I (2019), we analyzed 213 products for 9 phthalates. 46 products contained phthalates above laboratory detection limits (100 ppm). This project extends Phase I work to assess additional products and examine leachability into stormwater.

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Preference:	Thunder brief
Student:	Not a student
Student competition:	NA
Judge:	No

T5. Toxicological Evaluations

T5.1 *High-dose BPA Exposure Regulates A549 Cell Growth and Morphology

Jackson, K. and Comstock, C.E.*

Salish Kootenai College, Pablo, MT

Plastics are so recalcitrant and omnipresent that every population on the planet has been exposed at some level. Studies continue to support the notion that humans ingest and/or inhale microplastics and a recent survey of Montana rivers suggests that microplastics are readily detectable. Montana health statistics suggest that lung and bronchial cancers may be higher in Native American populations, consistent with disproportionately higher lung cancer incidence among Native Americans in the United States. To better understand the potential impact of plastic constituents on lung-associated cellular processes, the A549 lung cancer cell model system was exposed to Bisphenol A (BPA) a classic endocrine disrupting compound (EDC). A549 cells were evaluated for mRNA expression of classic nuclear hormone receptors which are generally considered the primary mediators of BPA action. Following high-dose BPA exposure, cell growth and morphological assessment was determined by phase-contrast and fluorescence microscopy. High-dose BPA exposure reduced cell growth, a result consistent with other cell model systems. Interestingly, preliminary evidence suggest that high-dose BPA induced unique cellular morphologies (i.e., pronounced crescent shaped cells) compared to control treatments. Current efforts are centered on validating the status of nuclear hormone receptors and morphological changes in A549 and other lung cancer cell model systems. Future studies will focus on the mechanistic underpinnings and biological relevance of the validated findings. Currently, these data suggest that high-dose plastic constituents, such as BPA, may induce or exacerbate endogenous pathways in lung cancer cells that control cellular shape or associated metastatic pathways that frequently require morphological changes. The current project was funded by GMaP Region 6 through the Huntsman Cancer Institute.

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I would like to judge Student Presentations: No

T5.2. Low Levels of Crude Oil Disrupt Ventricular Outgrowth and Subsequent Cardiac Trabeculation in Embryonically Exposed Pacific herring

Peck, KA[1]; Incardona, JP[1]; Linbo, TL[1]; French, BL[1]; Cameron, J[1]; Laetz, CA[1]; Hicks, MB[2]; Hutchinson, G[2]; Allan, SE[3]; Boyd, DT[1]; Ylitalo, GM[1]; Scholz, NL[1]*

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Pacific herring (*Clupea pallasi*) are a keystone species in the food web and are particularly susceptible to oil spill toxicity. Sublethal exposure of Pacific herring embryos to low levels of crude oil causes early developmental cardiotoxicity which is known to evolve into long-term impacts on cardiorespiratory fitness in juveniles. The aim of this study was to gain a deeper understanding of specific crude oil-induced changes in heart shape and function that progress gradually through embryonic, larval, and juvenile life stages. Pacific herring embryos were exposed to low-level, environmentally relevant crude oil concentrations throughout embryogenesis, then transferred to clean sea water for hatching and growth to the juvenile stage. At the embryonic stage, molecular initiating events involved differential expression of genes that control calcium handling, muscle contractility, and ventricular trabeculation (development of finger-like projections in the spongy myocardium of the heart). At the hatching stage, analyses at the genetic, functional, and morphometric levels revealed that corresponding gene expression changes continued, along with tissue and whole organ alterations which included reduced ventricular ballooning (posterior outgrowth of the ventricle) and reduced cardiac contractility, as well as altered morphology in both the ventricle and atrium. Months later, during the late larval and early juvenile stages, these early developmental alterations had evolved into various ventricular impacts which included abnormal trabeculation, tissue hypertrophy (increased tissue density), and overall changes in ventricular shape. These results provide a framework for mechanistically and chronologically linking subtle, crude oil-induced cardiac changes during embryogenesis, to functional and morphological impacts at the early and late larval stages, to pathological cardiac remodeling during the early juvenile stage -- and finally, to delayed, long-term consequences on cardiorespiratory performance that persist until the juvenile stage.

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Student: Not a student
Student Presentation Award Competition: NA
I would like to judge Student Presentations: Yes

T5.3. Evaluation of the Mode of Action of Perchlorate as a Reproductive Endocrine Disruptor

Gardell, A.M.[1]; von Hippel, F.A.[2]; Petersen; A.M.[3]; Dillon, D.M.[4]; Parrocha, C.M.T.[5]; Postlethwait, J.H.[6]; Cresko, W.A.[6]; and Buck, C.L.[4]*

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Perchlorate is a pervasive environmental contaminant that out-competes iodide at the sodium-iodide symporter (NIS, SLC5a5) in the thyroid, thereby disrupting thyroid hormone synthesis. In threespine stickleback (*Gasterosteus aculeatus*), physiological effects of chronic exposure to perchlorate extend beyond the thyroid. Chronic exposure to perchlorate disrupts development and function of reproductive phenotypes that are not predicted based on the known mechanism of action at the NIS. We investigated the hypothesis that the mechanism by which perchlorate disrupts sex-specific development of gonads and kidney (which produces the male-specific nest glue) in stickleback is independent of the thyroid. We chronically exposed stickleback beginning at fertilization to three concentrations of perchlorate (10, 30, 100 ppm) or control water with and without iodide or thyroxine (T_4) supplementation and sampled fish within one year. Subadult stickleback exposed to perchlorate experienced hypertrophy of kidney tubules and epithelial cells; iodide and T_4 supplementation fully ameliorated kidney tubule and epithelial cell hypertrophy. In adults, T_4 supplementation significantly increased kidney cross-sectional area. We did not detect a significant effect of perchlorate on ovarian development or cross-sectional area of testes. However, we found that perchlorate exposure induced increases in whole-body embryonic concentrations of androgens (11-ketotestosterone (11-KT) and testosterone (T)). The increase in 11-KT content was ameliorated by T_4 supplementation, but not iodide. Neither supplement was effective in rescuing perchlorate-induced T content in the embryo. These data suggest that the underlying mechanism for some perchlorate-induced reproductive phenotypes have a thyroidal basis.

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Student: Not a student
Student Presentation Award Competition: NA
I would like to judge Student Presentations: Yes

T5.4. Molecular Signatures of Ribosomal and Mitochondrial Dysfunction in Wild American Kestrel (*Falco sparverius*) Hatchlings Exposed to Chlorinated and Brominated Flame Retardants

Greer, J.B.[*1]*; Henry, P.F.P*[2]*; Fernie, K.*[3]*; Karouna-Renier, N.K.*[2]

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Short-chain chlorinated paraffins (SCCP) and tetrabromobisphenol A (TBBPA) represent two classes of widely-used flame retardants that are persistent organic pollutants found ubiquitously in the atmosphere, sediments, and wildlife. Although each has been measured in birds globally, studies assessing their biological impacts in wild avian species are limited. SCCPs suppress glandular total thyroxine and circulating triiodothyronine (TT_3) in kestrel hatchlings and induce carcinogenic, neurotoxic, and immunotoxic effects in other species. TBBPA, an unregulated brominated flame retardant with high production volume, has low acute toxicity at environmental concentrations. However, toxicity of low-dose chronic exposure is currently under-studied and may be more relevant long-term. We assessed the developmental effects of environmentally relevant SCCP and TBBPA concentrations (100 ng/g ww) in developing American kestrel hatchlings. Fertile eggs were exposed *in ovo* via injection at E5 and artificially incubated until hatch (E27/E28), when livers were harvested for RNASeq analysis. Differential expression revealed extensive effects of SCCP, with > 400 DE genes, compared to fewer than 50 for TBBPA. Iodothyronine deiodinase 1 (*dio1*), which catalyzes activation and inactivation of thyroid hormone, including bioactivation of T4 into T3, was the one of most significantly upregulated transcripts following SCCP exposure, providing a potential mechanism for previously observed thyroid hormone disruptions. KEGG and GO pathway enrichment analysis indicated that SCCP significantly affected translational processes, protein localization, metabolism, pathways of neurodegeneration, and fatty liver disease. Network analysis of KEGG pathways revealed two distinct clusters for disrupted pathways, with extensive alterations of ribosomal and mitochondrial subunits as the primary drivers of toxicity. Similar hepatic disruptions in rodents have been linked with carcinogenic effects and mitochondrial uncoupling, suggesting relevant SCCP concentrations may impact wild avian populations. TBBPA, in comparison, showed low toxicity in all analyses.

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Student Presentation: No
Willing to judge student presentations: Yes

T6. Pesticides

T6.1. *Influence of salinity and pesticide toxicity on behavior in a model estuarine organism (*Menidia beryllina*)

Hutton, S.J.[1]; Siddiqui, S.[1], Pedersen, E.I.[1]; Segarra, A.[2]; Hladik, M.L.[3]; Connon, R.E.[2]; Brander, S.M.[1]*

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Rising sea levels and changes in precipitation patterns are linked with changes in salinity in many estuaries, making the differences in toxicity across a salinity gradient a topic of increasing interest in assessing risk to estuarine fish species. Recent studies have shown that pyrethroid toxicity can change across a salinity gradient. Pyrethroid pesticides are commonly used globally in agricultural, industrial, and household settings. Early life exposures in fish species to pyrethroids has been found to cause toxicity at environmentally relevant concentrations and alter behavior. Behavior has been demonstrated to be a sensitive endpoint and can detect the toxic effects of environmentally relevant concentrations of aquatic pollutants. Therefore, Inland silverside (*Menidia beryllina*) were exposed from 5 days post fertilization (approximately 1-day pre-hatch) for 96 hours to six different pyrethroids: bifenthrin, cyfluthrin, cyhalothrin, permethrin, cypermethrin, and esfenvalerate at three salinities relevant to brackish estuarine habitat (0.5, 2, and 6 PSU) and 3 concentrations, either 0.1, 1, 10, and/or 100 ng/L determined from previous experiments to be sublethal and environmentally relevant. After exposure, changes in behavior were analyzed between salinity and chemical gradients. Preliminary results indicate some significant behavioral changes with pyrethroid exposure and increasing salinity. Additionally, these results indicate that there may be different behavioral responses to pyrethroids depending on pyrethroid type. These data will provide knowledge to managers and environmental planners to help further protect threatened and endangered fishes in estuarine and bay regions.

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Preference: Thunder
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Student Presentation Award Competition: Yes
I would like to judge Student Presentations: NA

T6.2. *The effects of sediment organic carbon and chemical residence time on the acute lethal toxicity of sea lice chemotherapeutants to benthic invertebrates

Jacova, R.; Kennedy, C.J.

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The use of chemotherapeutants is a common method for controlling sea lice outbreaks in salmonid aquaculture. Among the classes of chemotherapeutants used are avermectins; these tend to persist in sediments underneath salmon farms and may directly impact nearby benthic fauna of marine ecosystems. The effect of abiotic/biotic factors on the bioavailability and toxicity of avermectins in the context of aquaculture has not been well researched. The aim of the present study was to determine how two environmental factors, sediment organic carbon (OC) and chemical residence time, modify the acute lethal toxicity of emamectin benzoate (EB; formulation: Slice®) and ivermectin (IVM) in the benthic amphipod *Eohaustorius estuarius.* Nine combination treatments of sediment OC (< 0.05, ~ 0.2, and 0.42% total OC) and chemical residence time (0, 2, and 4 months) were used in the study design. Increasing sediment OC content in sediment significantly mitigated the lethal toxicity of IVM, but not EB. The 48-h LC50 values for IVM ranged between 2.3- and 3.9-fold higher (depending on chemical residence time) in the high-OC treatment relative to the low-OC treatment. Therefore, sediment OC is an important consideration for understanding the risk of ecological impact of IVM but not for EB. Furthermore, 4 months of chemical residence time significantly reduced the lethal toxicity of both EB and IVM in *E. estuarius* relative to 0- and 2-month treatments. Given that EB and IVM remain bioactive after 2 months in sediment, adequate temporal spacing of avermectin treatment on salmon farms is an important consideration to reduce potential non-target organism impacts.

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Student Presentation Award Competition: Yes
I would like to judge Student Presentations: No

T6.3. *The Silence of the Clams: The Sub-lethal Effects of Environmentally Relevant Concentrations of Forestry Use Pesticides on Adult Soft Shell Clams

Alexandra Tissot[1], Elise F Granek[1], Michelle L Hladik[2], Patrick W Moran[3], Kaegan Scully Engelmeyer[1], Anne W. Thompson[2]*

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The US forestry industry commonly applies an array of pesticides to control plant and insect pests. A recent study confirmed the presence of these pesticides in water as well as the tissues of various bivalve species in Oregon coastal watersheds. Though studies have been carried out to determine the individual effects of these compounds on organisms and the environment in which they live to establish lethal limits, environmentally relevant concentrations of these chemicals in combination have not been tested for sub-lethal effects. We conducted laboratory experiments to examine the effects of four commonly used forestry pesticides; Atrazine, Hexazinone, Indaziflam, and Bifenthrin, on the soft shell clam *Mya arenaria*, a common estuary species. Growth, feeding rates, and condition index were measured, as well as mortality. Initial results indicate effects of some combinations on condition index as well as clam mortality, even at environmentally relevant concentrations.

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T6.4 *Multi- and trans-generational effects of chlorpyrifos exposures to *Daphnia magna*

Maggio, S.A. and Jenkins, J.J.

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Chlorpyrifos (CPF), a broad-spectrum organophosphate insecticide, is subject to transport in air and water from application sites to aquatic ecosystems. Patterns of exposure to aquatic receptors reside on a spatial and temporal scale, and are often determined by seasonal use practices. CPF elicits neurotoxic effects by inhibiting acetylcholinesterase, which prolongs nerve transmission and can result in neurotoxic symptoms. While adverse effects have been investigated in aquatic receptors for acute and chronic exposures, effects on fitness and survival following long-term, multi-generational exposures to CPF are largely unknown. We employed a multi- and trans-generational bioassay where *Daphnia magna*, a sensitive aquatic species, were exposed to ecologically relevant CPF concentrations of CPF over multiple generations. The multi-generational assay included continuous exposures across four consecutive 21d chronic assays, using progeny from the previous assay. The trans-generational assay consisted of dosing the 1st generation with CPF to assess adverse effects in the unexposed 2nd, 3rd, and 4th generations. Data were analyzed for survival and reproduction across treatments and generations. Results showed a decrease in survival following 21d chronic exposures to the highest treatment. While decreased survival continued in subsequent exposed generations, effects became less drastic overtime, and subsequent unexposed generations did not show a change in survival. Also, at the highest treatment, results showed a decrease in reproduction. In the trans-generational assay, this change was only observed in the parent generation, whereas this change persisted throughout the multi-generational assay. However, reproductive effects were difficult to analyze due to mortality bias. When reproduction was normalized to each generation's controls, decreases in reproduction were no longer significant. Analyzing organismal response over multiple generations and patterns of exposure, and studying the potential for inheritance and recovery across generations, can be indicative of a population's response to ecologically relevant exposure scenarios.

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I would like to judge Student Presentations: N/A

T7. Puget Sound Contaminants

T7.1. Assessing Nearshore Contamination in Sinclair and Dyes Inlets in the Puget Sound: Identifying Potential Sources from the Distribution of Polycyclic Aromatic Hydrocarbon Compounds in Mussel (*Mytilus* spp) Tissue Residues

Johnston, R.K[1]; Strivens, J.E.[2]; Brandenberger, J.M.[2]; Kuo, L.J.[2,3]; and Richardson, T.J.[4]

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The distributions of individual parent and alkylated polycyclic aromatic hydrocarbon (PAH) compounds have been used to identify potential sources of PAHs in sediments and mussel tissues. Generally, the source of PAHs can be ascribed to pyrogenic (from burning of fossil fuels, biomass, and other combustion sources), petrogenic (refined petroleum sources), and biogenic (biological and geochemical diagenesis) sources. The PAH distribution pattern in mussels contaminated by a diesel fuel spill in Penn Cove, the response of mussel PAH accumulation to creosote piling removal in Commencement Bay, and isomeric ratios of methylated and parent compounds were used to determine if PAH accumulation patterns were characteristic of petrogenic, pyrogenic, diesel fuel, and/or creosote sources. Twenty-five indigenous mussel watch monitoring sites were sampled biennially for a total of five campaigns between 2010 and 2018. Indigenous mussels (*Mytilus* spp.) were collected at sites located near suspected pollution sources (industrial, wastewater, and storm water outfalls; marinas, stream mouths, and other sources) as well as stations that were representative of ambient conditions in Sinclair and Dyes Inlets, the adjoining passages, and Liberty Bay in the Puget Sound, Washington. Whole body tissue samples were analyzed for 42 PAHs as well as trace metals and polychlorinated biphenyl congeners (PCBs). Tissue residue data from the monitoring network were evaluated to assess spatial differences, evaluate trends, assess potential ecological impacts, and compare the results to regional and national data sets. Ecological effects were evaluated by comparing residue levels to Critical Body Residue (CBR) thresholds of mussel tissue concentrations below which effects to mussel growth, reproduction, and survival are not expected. Data from the mussel tissue monitoring showed that ΣPAH measured was high and effects levels were exceeded at many locations necessitating the ability to determine the likely sources of PAHs to better inform management and identify possible corrective actions.

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I would like to judge Student Presentations: Yes

T7.2. Hydroxylated Polycyclic Aromatic Hydrocarbon (OHPAH) Metabolites in Bile of Pacific herring (*Clupea pallasii*) from Puget Sound

da Silva, Denis A.M.[1]; O'Neil, Sandra M.[2]; West, James E.[2]*

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Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous environmental contaminants. PAHs are widely monitored in marine biota from urbanized areas or regions that support petroleum activities, due to their toxicity to aquatic organisms. Teleost fish can quickly metabolize PAHs into hydroxylated forms (OHPAHs) that, in some cases, are more toxic than the original so-called parent PAHs. This metabolism is primarily done in the liver and metabolites are stored in the gall bladder before excretion. Therefore, the analysis of OHPAH metabolites in bile, in addition to parent PAHs, minimizes underestimating the exposure to these chemicals in the environment. While the metabolism pathway of the PAHs is fairly understood, there is a substantial lack in the literature on environmental levels of OHPAH in fish, which are usually limited to a few metabolites from a reduced group of parent PAHs. In this study, we analyze bile of Pacific herring (*Clupea pallasii*) collected from 5 different areas of Puget Sound for 28 individual OHPAH metabolites, derived from 2-5-ring parent PAHs, using liquid chromatography coupled with tandem mass spectrometry. In addition, we also measured several metabolites of alkylated homolog series of the parent PAHs. Mean summed OHPAH concentrations (± std dev) ranged from 200 ± 80 to 2,800 ± 860 ng/mL of bile. Metabolites of phenanthrene (PHN), fluoranthene (FLA), naphthalene (NPH) and fluorene (FLU) were the most abundant compounds measured. In the most contaminated area, their relative alkylated metabolite levels represented 30% of the summed PHNs, 45% of the FLUs and 79% of the NPH. No alkylated forms of FLA metabolites were detected. For the best of our knowledge, this is the first study where alkylated OHPAH metabolites were measured in bile of field caught fish samples, which substantially improve the PAH exposure assessment and source-analysis of these contaminants.

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Preference: Thunder Brief
Student: Not a student
Student Presentation Award Competition: NA
I would like to judge Student Presentations: Yes

T7.3. Access to recreational shellfish and its implications for environmental justice in the Puget Sound

Katz, B.G.; Fleming, W.; Wrathall, D.J.; and Biedenweg, K.*

Oregon State University, Corvallis, OR

Shellfish harvest closures may prevent people from accessing shellfish beds used for subsistence, livelihoods, or recreational harvest in the Puget Sound watershed. The purpose of this study was to identify where and when the impacts of shellfish harvest closures may have resulted in differential impacts to local shellfish harvest in 2020, and especially for non-white communities. We explored the relationships between shellfish harvest closures, self-reported harvest frequencies, and self-reported race across Puget Sound watershed sub-basins. A geovisualization tool was developed by integrating pre-existing data on shellfish harvest closures and survey data on human well-being indicators. Statistical analyses were performed through spatial clustering sub-basins by the three indicators explored, and to test for correlations between each relationship. Findings suggest an inverse relationship between closures and harvest frequency, a direct relationship between non-white population and closures related to runoff, and no difference between harvest frequency of non-white versus white populations. The geovisualization tool revealed at least four sub-basins where, in 2020, shellfish harvest closures may have coincided with non-white communities who frequently harvested shellfish for subsistence: Dungeness-Elwha, Nooksack, Strait of Georgia, and Puget Sound. However, the timing, duration, and type of closures varied between and within those sub-basins. We conclude that the relationships mapped and analyzed here may provide an entry point into further action planning efforts aimed at reducing risk or addressing environmental justice.

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I would like to judge Student Presentations: No

T7.2. Evaluating Stormwater Impacts on Chemical Habitat Quality in Urban Receiving Waters

Peter, Katherine T.[*1,2,3,+], *Jessica I. Lundin*[4,+], *Christopher Wu*[2], *Blake E. Feist*[4], *Zhenyu Tian*[1,2], *James R. Cameron*[4], *Nathaniel L. Scholz*[4], *Edward P. Kolodziej*[1,2,7]

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Chemical habitat quality is an important conservation issue, particularly in watersheds affected by urban stormwater runoff. Current regulatory and restoration efforts evaluate a limited suite of conventional parameters and chemical pollutants. However, urban runoff transports hundreds to thousands of organic contaminants that are currently unmonitored, unregulated and/or have poorly understood fate and toxicity outcomes. Accordingly, the objective of this study was to provide a framework for identifying next-generation water quality metrics or specific contaminants that delineate land-use activities or key chemical sources and can effectively correspond to diverse ecotoxicological impacts. Sampling occurred across a landscape-based urbanization gradient, with stream samples collected during baseflow conditions in September/October 2017, with repeat storm event sampling during in November through June 2017-2018 in 15 regional watersheds (Puget Sound, WA, USA). Surface water chemical composition was characterized via liquid chromatography coupled to non-target high resolution mass spectrometry (7,068 unique chemical detections across 65 water samples). Water sample chemical composition was highly correlated with landscape-based urbanization gradient ($p<0.01$), season ($p<0.01$) and storm events (compared to baseflow conditions) ($p<0.01$). Landscape-scale changes in chemical composition were also closely aligned with two anchors of biological decline: coho salmon (*Oncorhynchus kisutch*) mortality ($p<0.001$) and macroinvertebrate richness ($p<0.001$), indicating the complex water quality gradient effectively captured both specific and non-specific biological effects. We isolated and identified 32 chemical indicators that represent urban runoff impacts and corresponding ecological health of receiving waters, including well-known anthropogenic contaminants (e.g., caffeine, organophosphates, vehicle-derived chemicals), two parent-transformation product pairs, and a previously unidentified (methoxymethyl)melamine compound. Several of these urbanization indicators were previously observed to exhibit broad pollutographs with respect to relatively sharp storm hydrographs, indicating transport-limited source dynamics with implications for urban stormwater management efforts. Outcomes of this study support data-directed selection of next-generation chemical water quality indicators for integration with existing metrics.

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Late-Breaking Presentations

LB1.The Encyclopedia of Puget Sound: Connecting Science across Disciplines

Rice, Jeff

UW Puget Sound Institute, Center for Urban Waters

The recovery of the Puget Sound ecosystem is as much an information challenge as it is a scientific one. The complexity and scale of ecosystem recovery efforts require broad collaboration among many organizations and experts to determine the most effective courses of action. Quick and easy access to the best possible information improves collaboration and efficiency and leads to better policy decisions. The Encyclopedia of Puget Sound was established at the University of Washington to provide scientists, policymakers and planners with online information about the science of Salish Sea ecosystem recovery. In addition, it catalogs and summarizes important facts about the region's biodiversity, its physical environment and major environmental threats such as toxic contaminants. In this presentation, we provide an overview of the Encyclopedia of Puget Sound and the ways that it connects scientific information across disciplines. We use toxic contaminants as a case study and show how we organize topical articles on the subject. We then show how this information is used in support of state and federal strategies for Puget Sound cleanup. The Encyclopedia of Puget Sound receives major funding from the Environmental Protection Agency and is available online at: eopugetsound.org.

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LB2. Big Data Management for Ecological Risk Assessment

Elmstrom, S.R[1]; Whitney, E.[1]; and Landis, W.G.[1]

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As the number of tools for analyzing data and the availability of large, complex environmental datasets increases, the way that we manage and store data must also evolve. Our team at the Institute of Environmental Toxicology & Chemistry (IETC), Western Washington University is developing methods using R and GitHub to integrate and utilize two large datasets on water and sediment chemistry for ecological analyses and Bayesian network relative risk models (BN-RRM): the California Environmental Data Exchange Network (CEDEN) and the California Department of Pesticide Regulation's Surface Water database (SURF). CEDEN and SURF are comprised of data from environmental monitoring studies conducted in the State of California. Preparing and integrating these data-rich sources for analysis and modelling was challenging and time consuming. Our questions, solutions, and compromises provide insights into data management, QA/QC procedures, and reproducibility that may benefit other researchers, agencies, and institutions. We will share our perspective on improvements that can be made to *how* you store your data, *what* can be done with that data in the future, and *why* data cleaning methods such as duplication detection and the use of common conventions are important to include in your data management plan.

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LB3. *Comparison of Metal Concentrations Found in *Orthotrichum lyellii* in Four Census Tracts of Whatcom County WA, using Modified Gamble's Simulated Lung Fluid

Flynn, K,R; Simmons, A; La, C; Shimkus, P; Sofield, R.M..*

Western Washington University, Bellingham, WA.

The air pollutants that humans are exposed to is well demonstrated to change depending on the socioeconomic status of a community. Moss is well-established in biomonitoring as they collect atmospheric chemicals. To assess bioaccessible metals, many formulas for simulated lung fluids have been developed, including modified Gamble's solution, which mimics the interstitial fluid within the deep lung. To determine the different ranges of atmospheric metals, we collected moss from near the centroid of 20 randomly selected, 400 m grids, in four predetermined census tracts. These tracts that represent the range of the Washington Tracking Network's social vulnerability index found in Whatcom County, WA. These locations also include industrial, urban, and rural development. When processing the stems are removed from the base of the moss, homogenized, and then exposed to modified Gamble's solution for 24 hours at 37 degrees C to simulate the body. Metals in the Gamble's solution are then analyzed with ICP-MS. Results will be presented.

Presenter: Kaitlyn Flynn, Western Washington University

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Short Courses

Short Course #1. Ecosystem Approach to Environmental Assessment and Management

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https://esa.org/history/kapustka-lawrence-2009/

I have produced 18 narrated PowerPoint presentations plus 2 non-narrated exercises that describe the critical steps of using an ecosystem approach to conduct robust Environmental Assessments needed to inform Environmental Management Decision-making. This begins with considerations used in framing and assessment, including the identification and empowerment of potentially affected stakeholders as a necessary step to understand how to meet their needs. The modules work through the Problem Formulation, Assessment, and Characterization phases of risk assessment while keeping in mind the need for effective communication with stakeholders throughout the effort. Two fictitious case studies provide first a simple and then a complex case study that can become an interactive exercise to explore the challenges in setting up the parameters of an assessment. An exercise in predicting populations effects is also available.

The module titles are: M1-Some of my biases; M2-Why we assess risk; M3-Frameworkds for Risk Assessment; M4-PF – Setting Goals; M5-PF – Identifying Receptors; M6-PF – Conceptual Models; M7-PF – Assessment Endpoints; 8-MPF – Data Quality Objectives; M9-PF – Choosing Measurement Endpoints; M10-PF – Sampling and Analyses Plans; M11-PF – Quality Assurance Project Plan; M12-PF – Closure; M13-Analysis; M14-Landscape Perspective; M15-Risk Characterization; M16-Ecosystem Endpoints; M17-Ecosystem Services; M18-AOP Considerations; Case Studies; and Predicting Population Effects.

A link to this free, self-guided training will be provided upon signing up for this course. A live discussion session on this topic is scheduled for April 15, 2021 11:15 – 11:45.
For any questions accessing the course material please contact:

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Short Course #2. Introductory Short Course in Human and Ecological Risk Assessment

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A group of twelve Society of Environmental Toxicology and Chemistry (SETAC) and Society of Risk Assessment (SRA) members prepared a 1-day short course on Human and Ecological Risk Assessment for a joint 2019 SETAC/SRA meeting in Cape Town, South Africa. The course materials are available as modules in PDF slides and as integrated audio/video/slide formats for the following topics:

- Introduction and purpose including bios for the 12 Lecturers
- Overview of the risk assessment process and distinctions between hazard and risk
- Case study introductions (a case study on pesticides and one on lead)
- Problem formulation and planning
    - Problem formulation break out
- Concept of tiered approaches
- Overview of Exposure Assessment
- Exposure assessment for human health risk assessment
    - Group discussion of exposure assessment
- Overview of Effects / Dose-Response Assessment
- Effects Assessment for human health risk assessment
- Derivation of toxicity reference values
- Overview of Risk Characterization
- Risk and Science Communication to public, policy makers, and risk managers

A link to this free, self-guided training will be provided upon signing up for this course. A live discussion session on this topic is currently scheduled for April 15, 2021 11:15 – 11:45.
For any questions accessing the course material please contact:

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Short Course #3. Overview on Laboratory Use Exclusions and their Reporting Requirements for Asbestos and Other Toxics Under Canadian Law

Kiu, Amanda

Environmental Protection Branch, Environment and Climate Change Canada

The *Prohibition of Asbestos and Products Containing Asbestos Regulations* (PAPCAR) and the *Prohibition of Certain Toxic Substances Regulations, 2012* (PCTSR) are regulations made under the *Canadian Environmental Protection Act, 1999* and managed by Environment and Climate Change Canada. The PAPCAR regulates the import, sale and use of asbestos and the manufacture, import, sale and use of products containing asbestos in Canada with a limited number of exclusions, and the PCTSR prohibits the manufacture, use, sale, offer for sale and import of certain toxic substances, as well as products containing them. This short training presentation will provide an overview on these regulations, with a focus on laboratory use exclusions and their reporting requirements.

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Presenter: Amanda Kiu, Environmental Protection Branch
Preference: Special Short Course
Student: No
Student Presentation Award Competition: N/A
I would like to judge Student Presentations: Yes

Short Course #4. How Much is too Much? Measuring Effects of Micro and Nanoplastic Debris in Aquatic and Terrestrial Organisms

Brander, Sussane and Harper, Stacey

Oregon State University

Plastic is a defining pollutant in the Anthropocene, ubiquitous in the environment globally and presenting a sizable environmental challenge that extends throughout food webs, threatening organism and ecosystem health. Micro and nanoplastic debris are of particular concern since ingestion of synthetic particles and fibers has been documented in a variety of organisms, from aquatic to terrestrial. Although occurrence is widely documented, large knowledge gaps persist regarding the effects these micro and nanoscopic debris items may have in organisms that internalize, ingest, or respire them. Understanding the interactions that occur within (e.g. oxidative damage) and between organisms (e.g. trophic transfer) at different levels of biological organization in an environmentally relevant context is critical to accurately measure and predict the impacts of plastic pollution, to assess risk, and to predict potential population level impacts. This short course will cover the potential challenges presented by exposure to micro and nanoplastics in model and non-model organisms across marine, freshwater, and terrestrial taxa. We will highlight both field and laboratory research investigating responses to micro and nanoplastic exposure, some of which will be considered in the context of conditions induced by multiple stressors such as abiotic factors related to climate change or plastic exposure in the presence of other pollutants. We will present the state-of-the-science on micro and nanoplastic occurrence, highlight data gaps that need to be addressed, and will lead a discussion on the analytical techniques currently available and what we need in the future.

A live discussion session on this topic is scheduled for _____.

Short Course #5. Bayesian Networks and Risk Assessment Applied to the Adaptive Management of Ecological Structures and Human Well-being

Landis, Wayne

Western Washington University

The history and the current state of the art in employing Bayesian networks to risk assessment and adaptive management assessments was clearly demonstrated in the 40 years of ecological risk assessment session at the 2019 SETAC North America annual meeting in Toronto. It has been demonstrated in recent papers that the Bayesian network relative risk model and similar methods can be applied to both ecological and human well-being endpoints. In the past the methods have been seen as different due to different terminology and regulatory goals. However, they share the fundamentals of the exposure-response paradigm and deal with cumulative effects and heterogeneous endpoints. Now it has been demonstrated that Bayesian network relative risk models (BN-RRM) can be built to describe risk to ecological endpoints and human well-being. It is also possible to build adaptive management tools that assist in the planning of long-term management actions. In this class, attendees will learn some of the basic definitions of risk assessment, the application of Bayesian networks, learn how societal values are an integral part of the process, and how adaptive management is critical to assessment, restoration and protection. Numerous case studies will be presented as examples as well as some current research. The course will begin with a review of the basic principles of risk assessment and risk calculation methods. The second half will be spent in the exploration of case studies and answering questions.

A live discussion session on this topic is scheduled for _____.

Training Opportunities

Training Opportunity #1: "Getting Started in Indigenous Relations" and "Reconciliation 101"

Maaria Curlier, Training Advisor, maaria@ictinc.ca, Indigenous Corporate Training (ICT) Inc.
Port Coquitlam, BC

Indigenous Corporate Training (ICT) Inc. is offering two free – self-guided training classes to attendees of the PNW-SETAC 2021 Virtual Conference that provide basic understanding of Indigenous Awareness from a Canadian perspective: "Getting Started in Indigenous Relations" and "Reconciliation 101". The mission of ICT is to provide training to get everyone Working Effectively with Indigenous Peoples® in their day-to-day jobs and lives by providing a safe training environment for learners to acquire the knowledge, skills, and attitude required to be effective. The free, self-guided training modules are available at:
https://www.indigenousrelationsacademy.com/collections/free-resources

In addition, ICT Inc. is offering "Working Effectively with Indigenous Peoples®" self-guided training for PNW-SETAC Members who wish to get beyond just awareness to understand the true nature of reconciliation with Indigenous Peoples. The course, which is normally offered for $150.00CD is available at a 10% discount to PNW-SETAC members who register for the course within 30 days of the Virtual Conference (by May 16, 2021). If you wish to take advantage of this offer, please sign up by sending a request to the contact information below:

Robert K. Johnston, PhD
pnwsetactreasurer@gmail.com
PNW-SETAC Board (Treasurer)
PO Box 24
Bremerton, WA 98337
360-627-7631 (office)
360-998-9086 (mobile/txt)
360-824-6279 (fax)

Training Opportunity #2: QGIS Level I & II: Remote Attendance

Hailey Ross, Executive Director, office@cmiae.org, Columbia Mountains Institute of Applied Ecology (CMIAE), Revelstoke BC, Canada

The QGIS mapping program has become the go-to software for people that want to map and analyze geospatial data using a free, open-source product. Supported and continuously developed by designers world-wide, the program is easy to download and use but requires a bit of orientation for people that are new to mapping software. An introductory and second level course is being made available to PNW-SETAC Members. In this course the student meets with the instructor in a video-chat environment (Zoom). With screen sharing, they work through the basics, using the program to create topographic maps, add data layers such as roads, cut blocks, mine sites and a vast selection of data from public sources as well as data from their own GPS projects. Satellite image data can easily be added as well as Open Street Map layers. The usual time required for the on-line sessions is 5 hours for each course and these can be scheduled into bite sized pieces scheduled to the convenience of the student. More information about the course is available at:
https://cmiae.org/event/qgis-introduction-remote-attendance/

CMIAE is making the courses “QGIS Level I” and “QGIS Level II” available at a discounted price of $250CD for each course to PNW-SETAC members who register for the course within six months of the Virtual Conference (by Sept. 16, 2021). If you wish to take advantage of this offer, please sign up by sending a request to the contact information below:

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Training Opportunity #3: Northwest Environmental Training Center Course Offerings (NWETC)

Sybil McIntyre, Program Manager, NWETC, smcintyre@nwetc.org, 425-270-3274 ext. 105

Northwest Environmental Training Center (NWETC) delivers tailored live and online courses on current policy, standards, technology and regulations for professionals. NWETC provides opportunities for continued education in a wide variety of topics. Custom on-site training is offered by request both regionally and nationally, and E-Learning options such as on-demand modules, live or recorded webinars, or online broadcasts of live training can be developed and delivered for any topic. NWETC is offering a $50US discount to PNW-SETAC and SETAC members for all of their currently scheduled courses. A chronological list of current course offerings is available at:
https://nwetc.org/chronological-course-offerings

If you wish to take advantage of this offer, please sign up by sending a request to the contact information below:

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