

6PPD State of the Science Forum

Presenter Bios and Abstracts



Dec. 9, 2025

Nathan Ivy: Canary in the creek bed: real-time evidence of 6ppdq-induced mortality and developmental impairment in coho

Nathan Ivy is a graduate researcher in the Aquatic Ecotoxicology Research Lab at Washington State University, working with Dr. Jen McIntyre. His work focuses on the how chronic stormwater exposure constrains salmonid physiological development, altering life-stage transitions and migration timing.

nathan.ivy@wsu.edu

Presentation abstract: Roadway runoff delivers short, intense contaminant pulses into salmon streams, but most toxicity tests still use static exposures and simplified mixtures. We used a flow through exposure system on Miller Creek, an urban stream in Burien and Normandy Park, Washington with a history of coho mortality, to test how real stormwater affects early life stage coho.

In Phase 1, juvenile coho were held side by side in untreated creek water or clean well water. Across three spring storms, creek fish showed classic 6PPDQ symptoms and 80 percent mortality. Mortality coincided with 6PPDQ peaks of 72 to 110 ng/L, concentrations above published LC50 values for juveniles. This is the first field-based study to assess acute mortality in environmentally realistic 6PPDQ pulses within a natural stream.

In Phase 2, embryos were fertilized on site and reared under the same side by side design. Creek reared fry showed delayed yolk absorption, reduced head growth, and caudal fins that were roughly 30 percent smaller, and these fin deficits were associated with poorer swim performance.

Together, these results show that stormwater in this system can both kill juvenile coho outright and alter development in survivors in ways that reduce performance. They are consistent with 6PPDQ as a major driver of acute mortality and point to the need for risk frameworks that account for exposure history, functional endpoints, and life stage specific sensitivity, rather than focusing only on short, single dose tests in naïve fish.

Amirah Casey: Increasing temperatures magnify the uptake of tire-wear contaminant 6PPD-Q in juvenile coho salmon (*Oncorhynchus kisutch*)

Amirah Casey (University of Washington), Nathaniel Scholz (NOAA, retired), Julann Spromberg (NOAA), Denis da Silva (NOAA), Mark Scheuerell (University of Washington, USGS)

acasey2@uw.edu

<https://storymaps.arcgis.com/stories/10191d13de91434189598150212919c2>

Presentation abstract: Urbanization and climate change are two of the greatest threats to freshwater ecosystems. While their isolated impacts are well studied, their combined effects are increasingly

concerning. Pacific salmon (*Oncorhynchus* spp.) are culturally, ecologically, and economically important, yet many populations remain threatened despite recovery efforts. Coho salmon (*O. kisutch*) are especially vulnerable to urban stormwater runoff, with pre-spawn die-offs up to 90%. The driver of this mortality syndrome is the globally ubiquitous tire-wear chemical 6PPD-Quinone (6PPD-Q). Additionally, warming surface waters are intensifying physiological stress in salmon. Although both climate change and urbanization independently elevate extinction risk, the interactive effects of temperature and 6PPD-Q remain poorly understood. To address this, we exposed juvenile coho to environmentally relevant 6PPD-Q concentrations (~50 ng/L) across a temperature gradient (8-14°C). Water chemistry analyses and state-space modeling showed uptake at 12 and 14°C was nearly 50% faster than at 8 and 10°C. Combining these results with future stream temperature projections for Puget Sound, we find juvenile salmon will increasingly face conditions that accelerate 6PPD-Q uptake, even under moderate warming scenarios. By linking contaminant uptake with rising temperatures, our work highlights emerging threats to salmon survival and critical challenges for conservation.

Dylan Ahearn and Chelsea Mitchell: Treating Conventional and CECs in Stormwater with a High Performance Bioretention Soil Media

Dylan Ahearn is a hydrologist who has spent the past 20 years studying the environmental consequences of human alteration to aquatic systems. He is currently Director of Science with Herrera Environmental Consultants and an adjunct professor of Geology at Edmonds College. Dylan helps his clients conduct research on pollutants of emerging concern with a particular focus on contaminants of emerging concern, Green Infrastructure, and stormwater treatment research and development.

dahearn@herrerainc.com

Chelsea is a senior ecotoxicologist in the Water and Land Resources Division of King County. Her work centers around understanding sources of water pollution and practical solutions for managing contaminants to protect ecosystem health. Chelsea leads a program which monitors contaminant concentrations in fish and crab in King County marine waters. She also works on all things 6PPD-quinone, from environmental monitoring to strategic planning, mitigation research, and public outreach.

chemitchell@kingcounty.gov

[Bioretention effectiveness for 6PPD and PFAS - Washington State Department of Ecology](#)¹

Presentation abstract: Bioretention systems are increasingly used for stormwater treatment, but conventional designs often struggle to meet water quality goals and address contaminants of emerging concern (CECs) such as 6PPD-quinone. This study evaluates the field performance of a high-performance bioretention soil media (HPBSM) designed to treat conventional pollutants and CECs while minimizing nutrient leaching. The HPBSM incorporates coconut coir, biochar, activated alumina, and iron aggregate in a layered configuration to target total suspended solids (TSS), dissolved metals, phosphorus, and stormwater toxicity. Over 20 storm events, we monitored TSS, nutrients, metals, and 6PPD-quinone, in influent and effluent samples. Results show that HPBSM met Washington State treatment goals for TSS, phosphorus, and zinc, but not copper due to low influent concentrations. Importantly, 6PPD-quinone was completely removed in all sampled events, reducing toxicity to coho

¹ <https://ecology.wa.gov/regulations-permits/reporting-requirements/stormwater-monitoring/stormwater-action-monitoring/sam-effectiveness-studies/bioretention-effectiveness-for-6ppd-and-pfas>

salmon. These findings confirm that HPBSM can effectively address both conventional pollutants and CECs in real-world conditions, supporting its use as a robust stormwater management solution.

Tanya Brown: Characterizing 6PPD-Q concentrations and hotspots in salmon bearing creeks in Southwest British Columbia

Tanya is an Assistant Professor in the Department of Biological Sciences at Simon Fraser University, British Columbia, Canada. She is also an Adjunct Professor at the University of Windsor, Ontario with the School of Environment. Prior to her current position, she was a Research Scientist at Fisheries and Oceans Canada (DFO) with the Ocean Sciences Division in West Vancouver from 2019-2023. During which time she led DFO's Whale Contaminant Program in support of the Government of Canada's Whales Initiative. She has published over 55 articles and book chapters on contaminants in the environment with a focus on marine mammals, fish, and their habitats. She is currently conducting a regional study of the effects of 6PPD-quinone on salmonids in Southwestern British Columbia.

tanya_brown@sfu.ca

www.tbrownlab.com

Presentation abstract: Report on 6PPD-Q concentrations and hotspots in salmon bearing creeks in Southwest British Columbia. Concentrations will be discussed in the context of associations with other road runoff associated contaminants and land use. As well as interpreted in the context of risk to Pacific salmonids.

Hannah Byun: Regioselective In Vitro Toxicity of Aromatic Hydroxylated Metabolites of 6PPD-Quinone

Hannah is from Port Moody, BC, and obtained an HBC degree in Environmental Chemistry and Biomedical Toxicology at U of T in 2025. She is currently a Masters student in Dr. Hui Peng's lab at U of T and is working on identifying the toxicity of PPD transformation products using the coho salmon embryonic cell line.

Presentation abstract: Alkyl-OH-6PPD-Q and aryl-OH-6PPD-Q are two major hydroxylated metabolites of 6PPD-Q formed via rapid enzymatic reactions within salmonid species. Alkyl-OH-6PPD-Q was previously found to be nontoxic, but the toxicity of aryl-OH-6PPD-Q still remains unclear. This talk will present toxicity assessments of three aryl-OH-6PPD-Q isomers in a coho salmon (*O. kisutch*) embryo (CSE-119) cell line, and show that the toxicity of aryl-OH-6PPD-Q isomers are highly regioselective. A potential explanation for the regioselective toxicity will be described based on preliminary DFT calculation results, where steric repulsion and rotational restrictions may play an important role.

Mason D King: How much 6PPD-quinone is in urban salmon streams? Concentrations and catchment loading with time-resolved water sampling

Mason is a postdoctoral fellow at Simon Fraser University. He is a fish and wildlife toxicologist, and his current projects focus on road runoff in urban salmon streams and their effects in sensitive taxa.

masonk@sfu.ca

Presentation abstract: Automobile-source 6PPD-quinone (6PPD-Q) is flushed from roadways and other reservoirs to streams during wet weather. Therefore, assessing temporally dynamic contaminant transport and hazard to aquatic species can be achieved with time- and flow-resolved

stream 6PPD-Q concentration data. At small, wadable, urban streams where salmonids spawn and rear, we monitored stream conditions during dry weather (baseflow) before rainfall and for a duration of 72 hours from the initial rise in stream flow (stormflow) after the start of rainfall. For five streams in the metropolitan area of Vancouver, British Columbia, Canada, we collected water samples with portable autosamplers that were then analysed for 6PPD-Q, and obtained data on rainfall and stream flow (discharge). Stormflow concentrations of 6PPD-Q regularly exceeded published government guidelines (e.g. 10-12 ng/L BC, WA, US EPA) and toxicity thresholds (e.g. coho salmon LC50s 41-95 ng/L) for multi-hour time periods, but not during baseflow conditions. Accordingly, estimates of 6PPD-Q transport must account for high-flow periods to generate accurate watershed loads. We conclude that high-concentration, multi-hour 6PPD-Q pulses are widespread in the urban salmon streams of metropolitan Vancouver, a phenomenon likely representative of other urban watersheds with high roadway density.

Laura Baker and Timmarie Hamill: Stormwater 6PPD-Q Monitoring in the Bar-Built Gualala River Estuary/Lagoon: Baseline Conditions and Hotspot Identification

Laura Baker (Friends of the Gualala River): Laura holds an M.A. in Ecology and Systematic Biology from San Francisco State University. Now retired, she has since spent many years leading conservation initiatives and volunteering on conservation and environmental advocacy projects with non-profit organizations including the Friends of Gualala River, the Redwood Coast Land Conservancy, and the California Native Plant Society. She lives in the Gualala River Watershed.

lbake66@aol.com

Timmarie Hamill (CA Urban Streams Alliance-The Stream Team): Timmarie holds a B.S. in Biology and a Secondary Math and Science Teaching Credential from California State University at Chico. As a biologist, she has planned and conducted water quality inventories as they relate to fish and wildlife in the private and public sectors for over 20 years. She has served as an Industrial Waste Inspector for the City of Chico, Pretreatment Plant Operator for the City of Oroville, HAZMAT biologist for Army Corp. of Engineers, consultant preparing CEQA and NEPA reports, science teacher for a small Charter School, and most recently, project manager for watershed assessment, and storm water education grants.

timmariehamill@gmail.com

Presentation abstract: In 2022, CA Urban Streams Alliance-The Stream Team (The Stream Team) expanded its long-standing watershed monitoring program and began collaborating with Friends of the Gualala River (FoGR) to investigate 6PPD-Quinone (6PPD-Q)—a tire-derived pollutant highly toxic to Coho Salmon and Steelhead—in the Gualala River estuary. Using an updated monitoring plan and QAPP, storm-event samples were collected at four sites upstream and downstream of major road surfaces and analyzed for 6PPD-Q, zinc, oil and grease, and standard field parameters. Results show elevated 6PPD-Q (up to 170 ng/L), zinc, conductivity, and turbidity, with highest concentrations at sites influenced by Highway 1, gas stations, and parking lots. These findings indicate roadway runoff as the primary pollution source and establish critical baseline conditions ahead of planned estuary restoration and the Caltrans Gualala Downtown Streetscape Enhancement project. Data will support targeted recommendations for green infrastructure and stormwater-mitigation measures to reduce toxic runoff and protect sensitive salmonid habitat.

Rhea Smith: Sentinels of Aquatic Recovery and Resiliency

Rhea Smith is a senior natural resource scientist at the Washington Department of Ecology who leads the agencies 6PPDQ monitoring program and collaborates with local, tribal, state, and federal partners to assess 6PPDQ in priority habitats. She has decades of experience designing and establishing aquatic research and monitoring programs to assess human-based disturbances and applied solutions.

Rhea.Smith@ecy.wa.gov

<https://ecology.wa.gov/6ppd>

Presentation abstract: Salmon recovery is a priority in Washington State and the Pacific Northwest. 6PPD-quinone (6PPD-Q) toxicity demonstrates species-specific variability and Coho salmon are the most sensitive to 6PPD-Q. Furthermore, coho salmon prefer small lowland streams that are significantly impacted by urbanization. The Puget Sound regional monitoring programs have mainly focused on a multi-agency assessment of marine and estuarine habitats for status and trend monitoring and recovery resources tend to favor Chinook salmon recovery. Salmon recovery funding and implemented projects have focused on the availability of physical habitat required for spawning and rearing, yet chemicals of emerging concern have highlighted the need to assess the quantity and quality of salmon habitat. Correlated assessments of coho salmon and 6PPD-Q provide a metric for salmon recovery in urban areas and a prioritization tool for where to focus limited resources to reduce the impact of urban runoff on salmon recovery. The fate and transport of 6PPD-Q make it difficult to study on a regional scale and requires orchestrated efforts with collaborative research partners to establish a sampling network that uses standardized, novel sampling strategies. Sentinels of Aquatic Recovery and Resiliency monitoring opportunistically builds upon existing monitoring initiatives. Adaptations include the incorporation of passive samplers and mapping strategies to locate 6PPDQ hotspots.

If you would like more information, please follow Ecology's 6PPD website for updates, we are working on a monitoring specific website that will be available soon.

Robert (Bob) Symons: Analytical Testing for 6-PPD quinone in stormwater runoff from Perth, Western Australia

Bob Symons is the Regional Technical Manager for Eurofins Environment Testing Australia, responsible for contaminants of emerging concern, and sits on its PFAS global peer group. Bob has a PhD in Environmental Analytical Chemistry from La Trobe University and an undergraduate degree from Victoria University in Melbourne. Bob is a past member of NATA (National Association of Testing Authorities, Australia) Life Sciences Accreditation Advisory Committee and a current Technical Assessor for ISO/IEC 17025. Bob's research interests include the analysis of persistent organic pollutants (POPs), including dioxins, polychlorinated biphenyls, brominated flame retardants, and PFAS, as well as emerging contaminants, viz., PPCPs, microplastics and tyre additives, using advanced mass analytical techniques

bob.symons@eurofinsanz.com

www.eurofins.com.au/environmental-testing

Presentation abstract: Urban runoff from roadways is a significant source of emerging contaminants, primarily derived from vehicle tyre wear. This presentation focuses on the occurrence of tyre-derived additives—specifically the toxicant 6-PPD quinone and the co-additives HMMM

(hexamethoxymethylmelamine) & 1.3-DPG (1.3-diphenyl guanidine)—in stormwater runoff in Perth, Western Australia. Analysis of Perth stormwater samples confirms the presence of all targeted tyre additives. HMMM was found at the highest concentrations, ranging from <0.05 µg/L to 11 µg/L. The highly toxic 6-PPD quinone was also consistently detected, with concentrations ranging from 0.0006 µg/L to 0.34 µg/L. These findings, particularly the levels of 6-PPD quinone, which approach acute toxic thresholds for sensitive aquatic species, highlight a potential, previously unquantified risk to the unique aquatic ecosystems of this biodiverse region. The results underscore the need for ongoing monitoring and further toxicological assessment to understand the impacts on local fauna.

Haley Tomlin: Integrating Citizen Science, Automated Data Processing, and Rapid Analysis to Track 6PPDQ at Scale

Haley Tomlin is a Biologist working for the British Columbia Conservation Foundation's Aquatic Research & Restoration Centre. Haley has been co-leading a 6PPDQ monitoring initiative with Vancouver Island University since 2022, including the current BC Salmon Restoration and Innovation Fund project monitoring tire wear toxicants. This program engages over 150 volunteers along the east coast of Vancouver Island in the collection of discrete samples from their respective watersheds.

htomlin@bccf.com

www.tireweartoxins.com

Presentation abstract: The BC Conservation Foundation and Vancouver Island University have developed an innovative, community-based monitoring program to assess the tire wear toxicant 6PPDQ. Using high-throughput chemical analysis integrated with a mobile sampling app and automated data processing, the project enabled a wide-scale citizen science campaign spanning 300 km of eastern Vancouver Island (Victoria to Campbell River).

To date, over 6,000 samples from more than 180 sites across 85 waterways have been collected with support from 37 organizations (local First Nations and community-led stewardship groups). This presentation will provide a summary of preliminary monitoring findings, including spatial monitoring findings, detection frequency, and variability between point sources and stream samples. All results are hosted in an interactive public database that supports data exploration and informed stormwater management.

This project highlights how citizen science, digital tools, and rapid analysis can generate actionable insights into emerging contaminants at watershed scales.

Erik Krogh and Angelina Jaeger: Leveraging High-Throughput Real-Time Chemical Analysis of 6PPDQ for Fate and Distribution Studies

Erik Krogh is a Professor of Chemistry at Vancouver Island University and co-Director of the Centre for Health and Environmental Mass Spectrometry. His current research interests include the development and application of real-time, on-line mass spectrometry to directly investigate the fate and distribution of emerging contaminants and environmental chemical processes in complex, real-world samples. Recently, he has co-led a large-scale project with the BC Conservation Foundation characterizing tire wear toxicants in urban waters on Vancouver Island.

erik.krogh@viu.ca

www.tireweartoxins.com

Presentation abstract: High-throughput screening of 6PPDQ in stormwater and urban streams has revealed a high degree of variability over time (mins-hours) and space (102-103 m). We leverage this analytical capacity to characterize physicochemical properties of PPDQs with applications related to leaching and sorption studies including the rate and extent to which organic particulates can act as a source and sink of 6PPDQ in aqueous solution. We will also present preliminary data from the first on-site real-time measurement of tire toxicants in an urban stream during a storm event. This work is relevant to understanding environmental exposures, inform risk assessments, and improve mitigation practices.

Kiersten Maxwell: Detecting Tire-Derived Chemicals in Puget Sound Tire Reefs

Kiersten Maxwell is a graduate student in Civil and Environmental Engineering at the University of Washington. She works with Dr. Edward Kolodziej to investigate sources, transport, and impacts of urban stormwater contaminants, particularly tire-derived chemicals in waterways across Puget Sound.

kjmaxwel@uw.edu

Presentation abstract: In the 1960s and 1970s, used tires were often used to construct artificial tire reefs, with some estimates suggesting that over one million tires were dumped into the Salish Sea by the 1980s. We now recognize that tires are a known source of rubber-derived chemicals, including 6PPD and its transformation product 6PPD-quinone (6PPDQ), that have been identified as highly toxic to coho salmon and other aquatic species. Therefore, tire reefs may be a legacy source of various tire wear chemicals to Puget Sound marine environments. Using environmental mass spectrometry techniques, this project investigated the relative pollution potential of these subsurface tire reefs to the Puget Sound and the composition of tire-derived chemicals they contain. At three tire reefs in the Puget Sound, a suite of tire-derived chemicals were measured in whole tires along with adjacent sediment and water. Complementary laboratory experiments were conducted by submerging tire fragments in seawater for controlled time intervals to assess chemical leaching over time. Our results demonstrate the legacy chemical contributions of tire reefs and show that tire rubber retains some chemical additives, including 6PPD, even after decades underwater. This work provides new insight into the fate of toxic tire-wear chemicals from tire reef installations in Puget Sound.

Stephanie Gordon: National-scale 6PPD-quinone Relative Heat Index and Map Tool

Stephanie is a physical scientist with the US Geological survey where she co-leads a geospatial analyses and application lab. Her work is focused on identifying landscape sources of contaminants and linking them to human and other biological endmembers to understand risk and relationships to various health outcomes.

sgordon@usgs.gov

<https://doi.org/10.5066/P1WBVJEU>

<https://geonarrative.usgs.gov/6ppdqsource dashboard/>

Presentation abstract: This presentation describes USGS work developing a National Relative Heat Index by evaluating and ranking landscape features, environmental characteristics, relevant industry facilities, etc. to identify "hot spots" and areas of fish-related risk at management-relevant scales.

Mallory Little: Human Toxicity and Exposure to 6PPD and 6PPD-quinone

Mallory Little, MPH, is a toxicologist at the Washington State Department of Health (DOH). Her work centers around evaluating hazards and exposures of toxic chemicals and identifying actions needed to protect human health. Her focus areas include management of illicit drug residue, tire antiozonants, and drinking water contamination. Before joining DOH, her experience was in consulting at a toxicology consulting firm as well as in clinical microbiology at the Centers for Disease Control and Prevention. Mallory received her MPH in Environmental and Occupational Health from the University of Washington and her BS in Genetics and Microbiology from the University of Georgia.

mallory.little@doh.wa.gov

<https://doh.wa.gov/community-and-environment/contaminants/6ppd-and-6ppd-quinone>

Presentation abstract: 6PPD-quinone is a recently identified transformation product of the tire antiozonant 6PPD that is highly toxic to coho salmon. While salmon mortality is the primary focus of the research community, toxicologists at the Washington State Department of Health have been focused on evaluating the possible impacts these chemicals have on human health through exposure and non-chemical health stressors due to diminished salmon populations. This lightning talk will provide the audience with a brief overview of the state of the science of 6PPD and 6PPD-quinone as they relate to human health toxicity and the various exposure pathways through which people may be exposed. This presentation will also highlight the remaining research and data gaps that need to be explored to inform public health recommendations.

Andrew Patterson: Determining Potential Mass Transfer of 6PPD-quinone from a Suburban Roadway to Hands via Basketballs During Neighborhood Play

Andrew is the VP of Innovation and Development for Eurofins Environment Specialty Services. He brings over 24 years of experience in the environmental laboratory industry with a focus on GC-HRMS and LC-MS/MS analyses. These approaches have focused on PCBs, Chlorinated Dioxins, PBDEs, PFAS, emerging contaminants and human biomonitoring. He is passionate about passive sampling, microplastic analysis and contaminants of emerging concern. Andrew is the originator of the PFAS Exposure™ fingerprick blood test and lead developer for EPA draft method 1634, 6PPD-quinone analysis in aqueous samples. Andrew holds a bachelor's of science in Microbiology from Cal Poly, San Luis Obispo.

andrew.patterson@et.eurofinsus.com

Presentation abstract: Portable basketball hoops are a common sight in many neighborhoods, especially on quiet streets and cul-de-sacs. Since these recreational games utilize the street surface as the field of play, the potential exists for roadway particles and associated chemicals to transfer from the street surface to the basketball and ultimately the user's hands. This study aims to quantitate the potential presence of 6PPD-quinone on the basketball and the participants hands before and after 30 minutes of play on a suburban roadway. The primary matrix will consist of wipe samples of key elements of gameplay. The wipe samples will then be extracted via an adopted EPA 1634 wipe workflow utilizing the same isotope dilution quantitation scheme. Results will be reported on a nanogram per sample basis

Rachel Scholes: Green infrastructure case studies for treatment of 6PPDQ

Dr. Rachel Scholes is an Assistant Professor of Environmental Engineering at the University of British Columbia. Her research focuses on emerging contaminants that adversely impact human health and aquatic ecosystems. She has been highlighted as an Emerging Investigator by the Royal Society of Chemistry and was appointed by the Peter Wall Institute for Advanced Studies at UBC as a Catalyst Scholar addressing the Climate and Nature Emergency. She currently leads the Salmonid Toxic Runoff Exposure and Mitigation (STREAM) project, focused on road runoff contaminants and their treatment in green infrastructure systems in British Columbia.

rachel.scholes@ubc.ca

Presentation abstract: Our research group has evaluated 6PPDQ fate in stormwater retention ponds and bioretention systems using a combination of field sampling and laboratory experiments. This presentation will focus on the results of field tests and on recommendations to enhance 6PPDQ capture in green infrastructure systems.

Dec. 10, 2025

Jeff Nichol: Analysis of 6PPD-Q from Aqueous Samples Using Automated system in reference with US EPA Draft 1634 method

Jeff Nichol joined PromoChrom Technologies in 2021, where his current position is Sales Manager. He received his B.Sc. in Chemistry from the University of British Columbia in 2010. His professional interests have included GC/MS method development in the academic laboratory as well as real-time monitoring of occupational exposure to dust in mining environments. In his role at PromoChrom, his core focus is collaborating with laboratories to solve complex Solid Phase Extraction (SPE) challenges through automation, utilizing PromoChrom's established solutions as well as its innovative new technologies.

jeffrey_nichol@promochrom.com

<https://www.promochrom.com/>

Presentation abstract: 6PPD-quinone (6PPD-Q) is a transformation product of a chemical used in tires to prevent degradation. As tires wear down, particles containing 6PPD-Q are released onto roads and eventually washed into waterways during rainfall. This has raised significant environmental concern, as studies have shown the compound to be harmful to aquatic life and ecosystems.

In response to these growing concerns, the EPA introduced draft Method 1634 to support laboratories in detecting and monitoring 6PPD-Q in water samples.

To assist labs in this effort, PromoChrom has developed a complete solution that pairs the SPE-03 Automated Extractor with the new Aquaris reverse-phase SPE cartridges. This setup automates the extraction for up to eight samples in parallel, minimizing manual handling and improving throughput. It has also demonstrated excellent recoveries and consistency, giving labs confidence in their 6PPD-Q testing results and helping them stay compliant with evolving regulatory standards.

John Stark: What is the 6PPP-Quinone Concentration that is Protective for Coho Salmon?

John Stark is a professor of ecotoxicology and entomology at Washington State University. John is also the Director of the Washington Stormwater Center, a member of the Washington State Academy of Sciences, and a Fellow of the Entomological Society of America. John's research deals with protection of endangered species and ecological risk assessment of pollutants with particular emphasis on the effects of pollutants on salmon and their food. Recent projects involve determination of the effects of polluted stormwater runoff on salmon and aquatic invertebrate health. John has published over 145 peer-reviewed papers in scientific journals, numerous book chapters, and a book on ecological risk assessment entitled "Demographic Toxicity: Methods in Ecological Risk Assessment".

starkj@wsu.edu

<https://pubs.acs.org/doi/10.1021/acs.estlett.5c00969>

Presentation abstract: The USEPA developed an Aquatic Life Screening Value (ASLV) of 11 ng/L for 6PPD Quinone (6PPD-Q), a breakdown product of 6PPD, an antiozonant in automobile tires. Because some coho populations are listed, "Take" requires that no individuals be harmed. The question asked in the present study is whether the ASLV for 6PPD-Q is protective for coho salmon. To answer this question, a concentration-response regression was developed for juvenile coho salmon from the raw data used to generate the three published acute mortality studies. The % mortality from the ASLV was read from the concentration-response regression resulting in a mean predicted mortality (95% confidence limits) of 2% (1-14%). Because of the Take restriction on harming a threatened or endangered species, the protective concentration of 6PPD-Q in coho-bearing streams should be set below the concentration-response curve. The LC1 and 95% CL are 8.5 (1.3-17.8) ng/L. The lower CL is 8.5 times lower than the EPA ASLV. A concentration of 6PPD-Q that does not result in mortality of one individual coho salmon should be below the lower 95% CL of the LC1 (approximately 1 ng/L). Results of this study show that the EPA ASLV is not protective for coho.

Curtis Hinman: High Performance Bioretention Soil Media Performance for Removing 6PPQ-Q and Preventing Coho Salmon Mortality

Curtis Hinman is a Senior Stormwater Scientist based in Bellingham, Washington. Mr. Hinman has led academic programs and managed a diverse portfolio of projects ranging from bioretention media research, green stormwater infrastructure (GSI) design, and statewide and national low impact development (LID) training programs. His most current research focused on developing high-performance plant-soil systems for filtering stormwater. Prior to leading filter media research and LID education programs at Herrera Environmental Consultants, Curtis was faculty with Washington State University (WSU) Extension and Department of Biological Systems Engineering. As the University's Green Stormwater Infrastructure Specialist he co-designed and was lead scientist for the WSU Low Impact Development (LID) Research Program which is one of the largest LID research facilities in the U.S. Mr. Hinman is the author of the "Low Impact Development Technical Guidance Manual for Puget Sound" and the "Rain Garden Handbook for Western Washington". Curtis also serves on American Society of Civil Engineers committees developing national guidelines for green infrastructure and bioretention systems.

curtis@curtishinmanassociates.com

Presentation abstract: Stormwater is the primary pathway for 6PPD-quinone to enter streams and cause Urban Stream Mortality Syndrome (URMS) in coho salmon. Accordingly, there is an urgent need to identify stormwater Best Management Practices (BMPs) that provide effective treatment for 6PPD-quinone. Previous studies have shown that bioretention can protect coho from stormwater toxicity using Washington Department of Ecology's (Ecology) default mixture of 60% sand and 40% compost (60:40 BSM). However, due to nutrient and metals export from compost, the 60:40 BSM is no longer recommended for use where effluent may release to nutrient sensitive receiving waters. Ecology recently approved a new High Performance Bioretention Soil Media (HPBSM) for use in nutrient-sensitive areas. King County sponsored a laboratory-scale project to test three different HPBSM formulations (types 1, 2 and 3 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 Ship Canal Bridge in Seattle, WA over 3 storm events. Stormwater influent and bioretention effluent were analyzed for 6PPD-quinone and toxicity to coho salmon. Results show that all the bioretention soil medias (BSMs) reduced stormwater 6PPD-quinone concentrations and prevented mortality in juvenile coho; however, the HPBSM provided a higher level of performance for reducing 6PPD-q concentrations. This presentation will provide a brief background on HPBSM and focus on 6PPD-Q concentration reduction and coho salmon exposure results.

Aimee Navickis-Brasch: Non-Vegetated Bioretention Soil Media

Aimee Navickis-Brasch, Evergreen StormH2O

aimee@evergreenstormh2o.com

Presentation abstract: The presentation focuses on a field study that is evaluating the effectiveness of non-vegetated bioretention soil media (BSM) for reducing 6PPDQ. Two BSM are being tested at the site: the 60% sand and 40% compost BSM (60:40 BSM) and the new high performance BSM. The presentation will include an overview of the research project and results from 6PPDQ testing.

Lizbeth Seebacher: Floating Treatment Wetland/Biomedial Modules Reduce Contaminants (6PPDQ) in Stormwater

Dr. Lizbeth Seebacher is a Senior Research Scientist at the University of Washington, where she evaluates Floating Treatment Wetland/Biomedial (FTW/Biomedial) technologies for their effectiveness in mitigating stormwater contaminants. She also works independently as a consultant, supporting firms on projects involving stormwater treatment, lake management planning, invasive plant surveys, vegetation management, and wetland restoration.

Previously, Dr. Seebacher served for 12 years as a Wetland and Aquatic Biologist with the Washington State Department of Ecology. Her career also includes roles as a Wetland Biologist with the U.S. Army Corps of Engineers, focused on wetland mitigation compliance, and as Executive Director of the Pacific Northwest Invasive Plant Council, where she led Early Detection Rapid Response initiatives.

She holds a Master of Science in wetland science and restoration and a Ph.D. in wetland restoration, specializing in invasive species biology and water quality, both from the University of Washington.

lizabetha@uw.edu

<https://sites.uw.edu/lizabetha/ftw-biomedial-modules-for-treatment-of-stormwater-contaminants/>

Presentation abstract: We are evaluating a nature-based solution for stormwater contaminant removal using Floating Treatment Wetland (FTW) and biomedica modules as an in-situ treatment approach. In Phase 2, a mesocosm experiment tested stormwater treated with a new biomedica blend and planted FTWs on juvenile coho salmon, resulting in 100% survival and no detectable 6PPD-quinone symptoms. Phase 3 assessed module performance in the field by comparing pre- and post-treatment contaminant levels. Currently, in Phase 4, we have deployed a redesigned module within the same stormwater pond to substantially increase the biomedica-to-water ratio. Ongoing monitoring includes pre- and post-treatment sampling for stormwater contaminants, with a focus on 6PPD-quinone. This phase also examines fish interactions with the modules to evaluate their potential ecological benefits or unintended impacts on resident fish populations.

Tatiana Dreisbach and Tony Bush: WSDOT Stormwater & 6PPDQ Mitigation Efforts

Both Tatiana Dreisbach and Tony Bush have worked in Washington State Department of Transportation's (WSDOT) Environmental Services Office since the early 2000s. They both worked for many years in WSDOT's Wetland Program. Tony managed the Wetland Program before moving to WSDOT's Stormwater Branch, as the Stormwater Branch Manager in 2022, where he manages WSDOT's programs on National Pollutant Discharge Elimination System (NPDES) permit, Stormwater Science, Monitoring & Research, Stormwater Features Inventory, Stormwater Retrofits, and WSDOT's environmental stewardship related to statewide water quality. Tatiana worked as the Wetland Assessment Lead before moving to the Stormwater Branch in 2023 as the Stormwater Retrofit Outreach and Innovation Lead. Together they are working on WSDOT's stormwater retrofit program and prioritizing where to improve water quality and quantity, benefit salmon and other species and habitats, consider environmental justice and tribal rights and interests, and incorporate best available science into WSDOT stormwater retrofit planning decisions.

tatiana.dreisbach@wsdot.wa.gov

tony.bush@wsdot.wa.gov

<https://experience.arcgis.com/experience/eb79642c00d74aca72841bcf3ba22ab>

<https://ftp.wsdot.wa.gov/public/StormwaterRetrofitMoveAheadWashington>

Presentation abstract: WSDOT will share our stormwater retrofit prioritization web map identifying top priority locations to make limited stormwater retrofit investments inclusive of engagement input from interested parties and tribes. WSDOT uses the Web Map to prioritize where to improve water quality and quantity, benefit salmon and other species and habitats, consider environmental justice and tribal rights and interests, and incorporate best available science into WSDOT stormwater retrofit planning decisions.

We will discuss innovative solutions to stormwater and 6PPDQ mitigation incorporating partnerships, novel best management practices (BMPs), and community co-benefits into stormwater retrofit projects. We will overview a few project examples including:

- WSDOT's largest standalone stormwater retrofit project to-date, the I-5 Ship Canal Bridge Stormwater Treatment Facility in Seattle
- New modular treatment technology focused on treating 6PPDQ from bridge downspouts
- A community driven stormwater partnership project

Katie Holzer: Porous pavement as a cost-effective and space-saving way to reduce 6PPD-Q loads

Katie Holzer, PhD, is a Senior Environmental Specialist at the City of Gresham, Oregon where she conducts studies on stormwater pollution and treatment.

katie.holzer@greshamoregon.gov

Presentation abstract: Porous pavements of various types allow water to flow through them rather than running off of the surface. This has the potential to reduce loads of 6PPD-Q right at the source before the runoff enters the storm system. This treatment technology is unique in that it occurs within the footprint of the road without the need for additional space. Porous pavement has taken off as a technology in many parts of the country and around the world primarily to increase road safety through reduced road spray and increased traction. These benefits are often achieved by using only a surface layer of porous asphalt (a.k.a. porous wearing course or porous friction course) on top of conventional asphalt. The water quality benefits of this porous wearing course have been studied recently and are surprisingly high. Preliminary samples of runoff from real-world roads indicate that both full-depth porous pavement and porous wearing courses have the ability to substantially reduce 6PPD-Q concentrations along with other stormwater pollutants. This presentation and subsequent breakout session will discuss recent water quality studies as well as the barriers and advances for widespread adoption of this technology.

Audrey Batoon: CCPD: A Promising Safer Alternative to 6PPD – Comparative Aquatic Toxicity and Environmental Fate Assessment

Dr. Audrey Batoon is a Regulatory Toxicology Manager at LANXESS Corporation. She specializes in product safety evaluation, and human health and environmental hazard characterization. With 17 years of experience in the industrial chemicals sector, Dr. Batoon, has contributed to projects focused on developing less hazardous, sustainable chemical alternatives, including 6PPD alternatives. Her research interests include application of new approach methodologies in chemical safety assessments.

audrey.batoon@lanxess.com

Presentation abstract: 6PPD and its ozonation transformation product 6PPD-quinone (6PPD-Q) are significant aquatic toxicants, with 6PPD-Q causing acute mortality in coho salmon (*Oncorhynchus kisutch*) via stormwater runoff. In response, regulators in Washington State and California are actively working to phase out or identify safer alternatives to 6PPD in tires through their respective Safer Products programs, while the EPA is pursuing federal regulations under TSCA to address 6PPD and 6PPD-Q concerns.

This study presents environmental fate and aquatic toxicity data for N,N'-dicyclohexyl-p-phenylene-1,4-diamine (CCPD, CAS 4175-38-6) and its ozonation product CCPD-Q (CAS 1653-85-6), developed using safe-by-design principles as a 6PPD alternative. CCPD demonstrated significant environmental degradation: 61% biodegradation in 28 days (OECD TG 301D), and hydrolytic instability with DT₅₀ values of 2.5 h (pH 7) and 2.0 h (pH 8.5) under OECD TG 111 at 20 °C. Acute toxicity to coho salmon was assessed under flow-through conditions (OECD TG 203). CCPD had a 96h LC₅₀ of 32 µg/L (measured), while CCPD-Q was not toxic at the solubility limit (149 µg/L). CCPD also exhibited comparable toxicity to *Daphnia magna* (48h EC₅₀ = 58.5 µg/L, OECD TG 202). This contrasts sharply with 6PPD-Q, which has a 24h LC₅₀ of 0.095 µg/L to coho salmon. Flow-through acute toxicity testing in rainbow trout (*Oncorhynchus mykiss*, OECD TG 203) indicates lower sensitivity compared to coho

salmon. Additionally, static 48 h tests in rainbow trout (EPA OCSPP 850.1075) are underway to simulate transient exposure scenarios, where the instability of CCPD and co-exposure to transformation products will be apparent. Preliminary data suggest that rainbow trout may be more sensitive to transformation products of CCPD. Due to hydrolytic instability precluding standard algal tests, a flow-through Lemna growth inhibition test (OECD TG 221) is also in progress. These studies complete the short-term dataset for classification and hazard assessment. Future long-term studies will further define CCPD's suitability as a safer, functional alternative to 6PPD in tire and rubber goods.

Troy Tack: Graphene Additions to Tire Formulations: Enhanced Performance and Reduced 6PPD Potential

Troy has a background in alloy development, including alloy 2195 that reduced the weight of the Space Shuttle by 7000 pounds and several scandium alloy variants for the sports equipment and firearms industry. His role as with Faradyne Power is to develop applications and markets for graphene to augment the company's production of renewable diesel.

ttack@faradynepower.com

www.faradynepower.com

Presentation abstract: Graphene can be added to tire formulations to enhance key properties that affect performance, durability and wear rate. In addition, recent publications show that graphene can be used to reduce the amount of 6PPD by 70% while maintaining antiozonant performance. Faradyne Power produces renewable diesel and graphene utilizing a number of biomass inputs. A new plant in Montana will use wood chips from pine beetle killed forests as input material. With virtually limitless input material and the ability to scale up quickly, graphene supply could scale with increased use in the tire industry and substantially decrease the amount of 6PPD used in tires, and by extension, reduce the 6PPD-containing wear particles that are toxic to aquatic life.

Neil Smith: Progress Towards a Sustainable 6PPD Replacement

Neil Smith is the Chief Technology and Sustainability Officer for Flexsys in Akron, Ohio.

ansmit@flexsys.com

Presentation abstract: Flexsys will present a brief overview of our goals for a 6PPD replacement molecule, the work that has been completed, and the results achieved thus far.

Alix Lee-Tigner: Broadening Partnerships to Track 6PPDQ

Alix Lee-Tigner is the Urban Wildlife Refuge Partnership Manager for Trout Unlimited in King County, leading community-driven salmon recovery, watershed restoration, and education programs throughout the Lake Sammamish basin. She brings a collaborative, big-picture approach to conservation—connecting partners, volunteers, and local communities to protect and restore habitat for kokanee and other salmon species.

alix.lee-tigner@tu.org

Presentation abstract: Trout Unlimited (TU) is partnering with the Washington Department of Ecology, King County, and others to monitor 6PPD-quinone in waterways across the Lake Sammamish and Lake Washington basins. TU recently launched an expanded monitoring effort using passive samplers deployed monthly in the fall and spring to generate higher-resolution data. The program

also aims to engage community members directly in sampling efforts to strengthen local awareness and stewardship.

Craig Manahan: 6PPD Regulation under the Safer Products for Washington Program

Craig is a Safer Ingredients Chemist in the Hazardous Waste and Toxics Reduction section at Ecology. He specializes in finding safer alternatives to chemicals of concern in consumer products, and has worked on products such as laundry detergent, can linings, receipts, and most recently 6PPD in tires.

Craig.Manahan@ecy.wa.gov

<https://ecology.wa.gov/waste-toxics/reducing-toxic-chemicals/washingtons-toxics-in-products-laws/safer-products>

Presentation abstract: This presentation will provide an overview of the Safer Products for Washington regulatory program and how it will interact with 6PPD in tires.

Justin Greer: Overview of 6PPDQ research within the USGS

Justin Greer is a computational biologist and toxicologist at the U.S. Geological Survey and is based at the Western Fisheries Research Center in Seattle, WA. His work utilizes in vivo and in vitro assay systems to examine the biological effects of tire wear chemicals on sensitive species and the toxicology of proposed 6PPD alternatives for use in tires.

jgreer@usgs.gov

Presentation abstract: The U.S. Geological Survey's Environmental Health teams have established a comprehensive, interdisciplinary research program on 6PPD-quinone that integrates toxicology, environmental chemistry, and national-scale ecological risk assessment. Our work aims to understand and mitigate risks from this tire-derived contaminant. Biological research at the USGS is conducted at multiple locations and includes studies on the toxic mode of action and variability in species sensitivity using both in vivo and in vitro assays. USGS scientists have also developed advanced analytical chemistry methods to detect 6PPD-quinone in water, sediments, and biological tissues, enabling detailed evaluation of exposure and bioaccumulation. Further, in collaboration with Federal, academic, and industrial partners, the program is evaluating environmentally safer alternatives to 6PPD that still meet consumer protection standards.

Together, these integrated research efforts are aimed at providing the scientific foundation needed to assess occurrence, biological effects, and spatial distribution of 6PPD-quinone to inform strategies to protect aquatic species. The talk will present an overview of the USGS 6PPD-related projects and teams nationwide.

Andrew Kenefick: Proposed State Legislation for Phasing Out 6PPD in On-Road Motor Vehicle Tires

Andrew is a semi-retired environmental attorney from Seattle. He currently serves as the Chair of the Advocacy Committee for the Washington Council of Trout Unlimited.

Andrew@WashingtonTU.org

Presentation abstract: While supportive of ongoing efforts to study the effects of 6PPD-quinone and strategies for mitigating its impacts, Trout Unlimited believes that the only practical and permanent

long-term solution to the enormous impacts of this chemical is removing it from tires. Working with other environmental and salmon-focused groups in Washington, Trout Unlimited will propose a bill to the Washington State legislature to phase out 6PPD in on-road motor vehicle tires in Washington. We expect that the final draft will have two components. First, it will set a deadline after which the import, sale, and distribution of 6PPD-containing tires will be prohibited. Second, it will establish a modest fee on 6PPD-containing tires for the period prior to the ban's deadline. The intent of the bill is to incentivize the tire industry to develop alternatives to 6PPD, while allowing enough time to ensure that 6PPD-free tires will meet performance and safety standards.

Negonnekodoqua (Stephanie) Blair and Dianne Barton: Indigenous Knowledge and Chemicals Management: Lessons from 6PPD

Negonne is the Environmental Toxicologist for the Confederated Tribes of the Umatilla Indian Reservation, Department of Natural Resources, Energy and Environmental Sciences Program. She is an enrolled member of the Sault Sainte Marie Tribe of Chippewa Indians in Michigan and Nome Eskimo Community in Alaska, and a descendant of the Garden River First Nation of Ojibwe in Ontario.

stephanieblair@ctuir.org

Dianne Barton is the Water Quality Coordinator for the Columbia River Inter-Tribal Fish Commission and Chair of the National Tribal Toxics Council, an EPA Tribal Partnership Group with the Office of Pollution Prevention and Toxics (OPPT).

Presentation abstract: Barton demonstrates how Tribal engagement under the Toxic Substances Control Act (TSCA) has shifted EPA risk evaluations toward models that explicitly incorporate Tribal lifeways, subsistence practices, and treaty-protected exposures. Blair shows how emerging mechanistic resolution of 6PPD-quinone toxicity in coho salmon can align risk evaluations with Tribal governance priorities and treaty-based management objectives for chemical screening and development of safer products.

Sandra L. Dorning: A Codeveloped 6PPD/6PPD-Q Research Agenda for Puget Sound

Sandra Dorning (MSc) is the Research and Monitoring Coordinator at the University of Washington Puget Sound Institute, where she coordinates the co-development of research agendas to support the EPA's Puget Sound Program. Sandra manages the Grand Uncertainties Matrix (GUM), a database of scientific uncertainties related to Puget Sound ecosystem recovery topics including Toxics in Aquatic Life. The identification of topical research priorities is intended to inform regional research and funding activities that lead to improved information for environmental managers. Sandra has a multidisciplinary research background in the fields of marine ecology, marine spatial management, and international environmental politics.

Presentation abstract: Recovery of Puget Sound ecosystems requires identifying and filling scientific knowledge gaps that pose barriers to environmental management and restoration. The University of Washington Puget Sound Institute (PSI) supports the EPA Puget Sound Program by codeveloping topical research agendas that inform funding, research, and planning. In 2024, PSI built on the work of the Interstate Technology Regulatory Council (ITRC) to produce a 6PPD/6PPD-Q research agenda for Puget Sound. PSI convened regional toxics experts and practitioners who prioritized among ITRC-identified research needs about 6PPD/6PPD-Q to identify five top priority uncertainties: understanding toxic effects (lethal and sublethal) on species of multiple trophic levels, determining

other product sources of multiple PPDs, understanding the transformation products and toxicity of potential alternatives to 6PPD, and assessing stormwater treatment effectiveness for 6PPD-Q. The full 6PPD/6PPD-Q research agenda includes 26 uncertainties which are documented in the Grand Uncertainties Matrix (GUM), a public database of regional research priorities. Researchers and funders (both inside and outside Puget Sound) are encouraged to use the codeveloped research priorities to focus and coordinate investments and projects on those topics that are most applicable to management. Future activities to track research progress and communicate new scientific findings to managers and planners can be organized around these uncertainties.

Toxics research agenda fact sheet: <https://www.pugetsoundinstitute.org/wp-content/uploads/2025/09/Toxics-Factsheet-Final-2025.09.25.pdf>

More information about Puget Sound Institute's work to codevelop research agendas for Puget Sound: <https://www.pugetsoundinstitute.org/analysis/codeveloping-a-research-agenda-for-puget-sound/>

Amy Salamone: Assessing Toxic Chemicals in Stormwater Runoff from Artificial Turf Fields and in Artificial Turf Components

Amy Salamone is the product replacement study lead in the Product Studies Unit of Ecology's Environmental Assessment Program. With experience leading multiple studies assessing consumer products to ensure compliance with Washington's laws and to inform data-driven decisions by Ecology, her current work focus will inform artificial turf replacement guidance.

amy.salamone@ecy.wa.gov

Presentation abstract: Artificial turf and ground cover installations, like youth athletic playfields, school and university playfields, and community playgrounds, have been installed in many communities across Washington. The majority of artificial turf installations use plastic blades as artificial grass and recycled tire crumb rubber as infill. Concerns about the health and environmental effects of crumb rubber materials have encouraged a growing market of alternative infills, like cork, coconut fiber, or olive pits. Artificial ground covers can include rubber surfacing used as playground flooring and running tracks, as well as rubber mulches used in a variety of applications. The materials used in artificial turf and ground cover installations have changed over time, and are variable among installations, complicating the task of assessing potential environmental impact.

Two assessment studies by Ecology's Product Studies Unit are underway to measure specific toxic chemicals, including 6PPDQ, in stormwater runoff from artificial turf installations and in currently installed artificial turf and ground cover components. Findings from these studies will inform the Product Replacement Program in the development of artificial turf replacement guidance.