Questions from Committee Members

Oversight Hearing titled, "Are Toxic Chemicals From Tires And Playground Surfaces Killing Endangered Salmon?"

Questions from Chair Katie Porter for Dr. Jenifer McIntyre, Assistant Professor, Washington State University

1. In the hearing, some suggested that the science behind 6PPD-quinone and salmon mortality was too young to merit action without further study. What is your response?

Response:

The suggestion that the Tian et al.[1] study requires replication before it can be acted upon risks delaying needed action to prevent extirpation of coho populations when scientific confidence in the study's results are already high. We welcome any research group to replicate our study, but competition for limited research funds greatly reduces the likelihood that this will occur. In the meantime, we rely on reproducing our own findings using robust, peer-reviewed methodology. Multiple lines of evidence over the past decade support roadway runoff as the source of the acute mortality of coho in urban-impacted streams[2-5] and multiple studies further link the mortalities to tire chemicals[6, 7]. These impacts affect coho at all free-swimming life history stages. Over the course of the two years of the Tian et al. study, coho salmon of different stocks showed the same acute mortality response to collected roadway runoff, chemicals leached from tires, and 6PPD-quinone. In total, across 27 exposures to mixtures of chemicals from tires containing 6PPD-quinone, 98.5% of the 135 juvenile coho used died. In concurrent exposures to clean control water, control water with solvent added (a blank for trials in which specific tire chemicals were tested), or chemicals in the tire mixture other than 6PPD-quinone, none of the 125 coho used died. Coho died rapidly from exposure to 6PPD-quinone regardless of whether the quinone was isolated from tire leachate, created from ozonolysis of 6PPD, or (in tests since our publication) synthesized 'from scratch' by other groups. Finally, we showed that the rate of mortality of coho exposed to complex mixtures containing 6PPD-quinone (stormwater, tire leachate) can be explained by assessing just the concentration of 6PPD-quinone. This would not occur if the toxicity was caused by multiple/other chemicals in the mixtures.

2. You and your research partners are part of interdisciplinary centers, at the University of Washington and Washington State University, including the Washington Stormwater Center, with a heavy focus on urban ecology. Please estimate the cost of the green infrastructure improvements that would be necessary to prevent 6PPD-quinone from entering our waters. Are there private, or public-private models for funding such projects? What are the limitations of such infrastructure with respect to aquatic habitats and 6PPD-quinone? With respect to terrestrial habitats and people?

Response:

Costs to install sufficient green stormwater infrastructure (GSI) to protect against 6PPD-quinone are high. While there are yet no assessments specifically for 6PPD-quinone, public

capital costs to build out several types of stormwater infrastructure to improve stream health in the main watershed of King County (WRIA 9) are estimated at $210 million (2013 dollars) each year over 30 years.[8] Annual public operating costs once all facilities are built are estimated to be $650 million per year. Extending the program to all watersheds in the Puget Sound was estimated to cost the public $12-14 billion per year.[8] In California, the Department on Toxic Substances Control estimated that treatment for a single creek basin to prevent pollution from zinc in tires would be more than $5 billion.[9] Models do exist for public-private financing of GSI.[10] One example of an innovative partnership brought private developers and Seattle business owners together with non-profits and State entities to treat runoff from the many high-traffic bridges crossing Lake Union and Lake Washington (https://cleanlakeunion.org/current-projects/). For new and re-developed lands, current regulations in Washington State require that property owners finance the costs of constructing GSI to comply with National Pollution Discharge Elimination System permit requirements.

Limitations of relying on GSI to protect aquatic organisms from 6PPD-quinone include that the lifespan of GSI is not well known, making replacement costs an important consideration. The longevity of GSI is one area currently being studied at the Washington Stormwater Center. Another limitation is on space for GSI installations. I am aware of one assessment of installing GSI to prevent coho mortalities in a watershed of Puget Sound (Puyallup River).[11] Whereas installing GSI was expected to reduce risk to coho from runoff, the authors concluded that it may not be possible to install enough GSI to protect populations in watersheds with high impervious area.

Finally, following the publication of our research paper in December 2020, USTMA stated that "We have invested tens of millions of dollars [since 2005] in peer-reviewed research with the World Business Council for Sustainable Development's Tire Industry Project [TIP] to assess the impact of tire materials on the environment, wildlife and human health, including tire and road wear particles".[12] These studies conclude that there are no environmentally relevant impacts. Notably, no salmonids were included in TIP-funded studies of toxicity to aquatic animals, despite the reputation that salmonids have for being sensitive to chemical contamination and reports in the literature since the 1990s that chemicals from tires can kill the Pacific salmonid *O. mykiss* ('steelhead', aka 'rainbow trout'), which is a very common fish model in toxicology studies. It would be helpful to have cost estimates from tire manufacturers on a safer replacement chemical for 6PPD.

3. The paper in Science that you co-authored specially mentioned the potential risks of 6PPD-quinone exposure posed by playing surfaces. Why did you single that out, given the wide range of potential 6PPD-quinone sources?

Response:

Although 6PPD is used in many rubber applications, the wearing of tire treads and the end-of-life use of tires in playgrounds and artificial turf with crumb rubber infill makes tires the most important source of 6PPD-quinone exposure for humans. Many studies of risks associated with these playing surfaces already exist and most conclude that risks to human health are low.[13] However, risk assessments are based on the toxicology of a limited number of previously studied chemicals in tires, which may not capture the full scope of potential effects. For example, a recent assessment of cancer risk from exposure to crumb rubber athletic fields based the

assessment on 306 identified chemical constituents[14], whereas we reported more than 2000 chemicals leached from tires[1], many of which have yet to be identified. Important to assessment of risks to human health, 6PPD-quinone has never been assessed for toxicity to humans. It will be important to assess risks to humans associated with fine tire particles from playing surfaces in addition to air pollution from particles released from vehicular traffic.

4. Please provide your views on the potential harm to terrestrial species and human health posed by 6PPD-quinone.

Response:

Risk assessment specific for 6PPD-quinone needs to be conducted for terrestrial species, including humans. This requires research on the toxicology of 6PPD-quinone to relevant species, including humans. As we have seen in our research with salmon, even very closely-related species can have very different responses to the same chemical, so species-specific testing is needed, for example using human lung cell lines.[15]

5. Are there pollutants from tires that put aquatic ecosystems at risk in addition to 6PPD-quinone? If so, please characterize these pollutants and the associated risks.

Response:

Yes. Previous research focused on tire-derived chemicals have identified many chemicals that are hazardous to aquatic animals.[6, 16-18] Research is also needed to identify and characterize toxicity from the many additional chemicals documented as tire-derived.[6, 19]

6. Are coho salmon at risk of extirpation in the absence of action to address if 6PPD- quinone in receiving waters? If so, what are the estimated timelines for those extirpations?

Response:

Yes, coho populations impacted by human development are at risk of extirpation from 6PPD-quinone without action to address the loading of this chemical into aquatic ecosystems. In modeling studies of coho populations exposed to roadway runoff, extirpation was predicted within decades for the most impacted systems.[20] Importantly, these models were conservative in only including impacts on adult spawners rather than extending those impacts to other vulnerable life history stages. Additional risk assessment is needed.

7. To your knowledge are there ongoing or planned efforts in academic or research settings to characterize the relative loadings of 6PPD-quinone into the environment by the various reuses of old tires, such as asphalt and crumb rubber?

Response:

Yes, some research into 6PPD-quinone loadings from crumb rubber and other sources is taking place in the lab of my colleague through the Washington Stormwater Center, Dr. Edward

Kolodziej (University of Washington). More research is needed to characterize loadings from various sources.

8. You estimated that it would cost at least $1 million per year to adequately fund research on the risks posed by 6PPD-quinone. What is the basis for that recommendation? Please describe the scope and scale of research such funding could support.

Response:

The progress of research depends on perseverance and ingenuity, however the main limitation is salaries to support sufficient numbers of researchers dedicated to a topic. Over the past 20 years, the equivalent of at most 2 full-time research positions have been dedicated to studying the mortality phenomenon in coho salmon that is now attributed to 6PPD-quinone. For $1 million per year, the Washington Stormwater Center (including the state's two premier research institutions: Washington State University and the University of Wahsington) would be able to fully fund a small team of chemists and ecotoxicologists dedicated to addressing various aspects of the risks posed by 6PPD-quinone in aquatic ecosystems. The team would include 3 PhD-level researchers, 4 technicians, and 4 graduate students studying 6PPD-quinone generation, fate and transport, mechanisms of toxicity, and treatment. Comparing this proposed level of effort with that realized over the past 20 years, a team of this size would be able to rapidly address the critical questions facing resources managers and policy makers.

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