



6PPD/q: History, Toxicity, & Best Management Practices

NEIWPC Contaminants of Emerging Concern Workgroup

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Urban Runoff Mortality Syndrome (URMS)

- Up to 90% of female coho salmon were dying before they could spawn
- First observed in urban creeks
- Symptoms: disorientation, swimming on side, gasping, and pre-spawn mortality

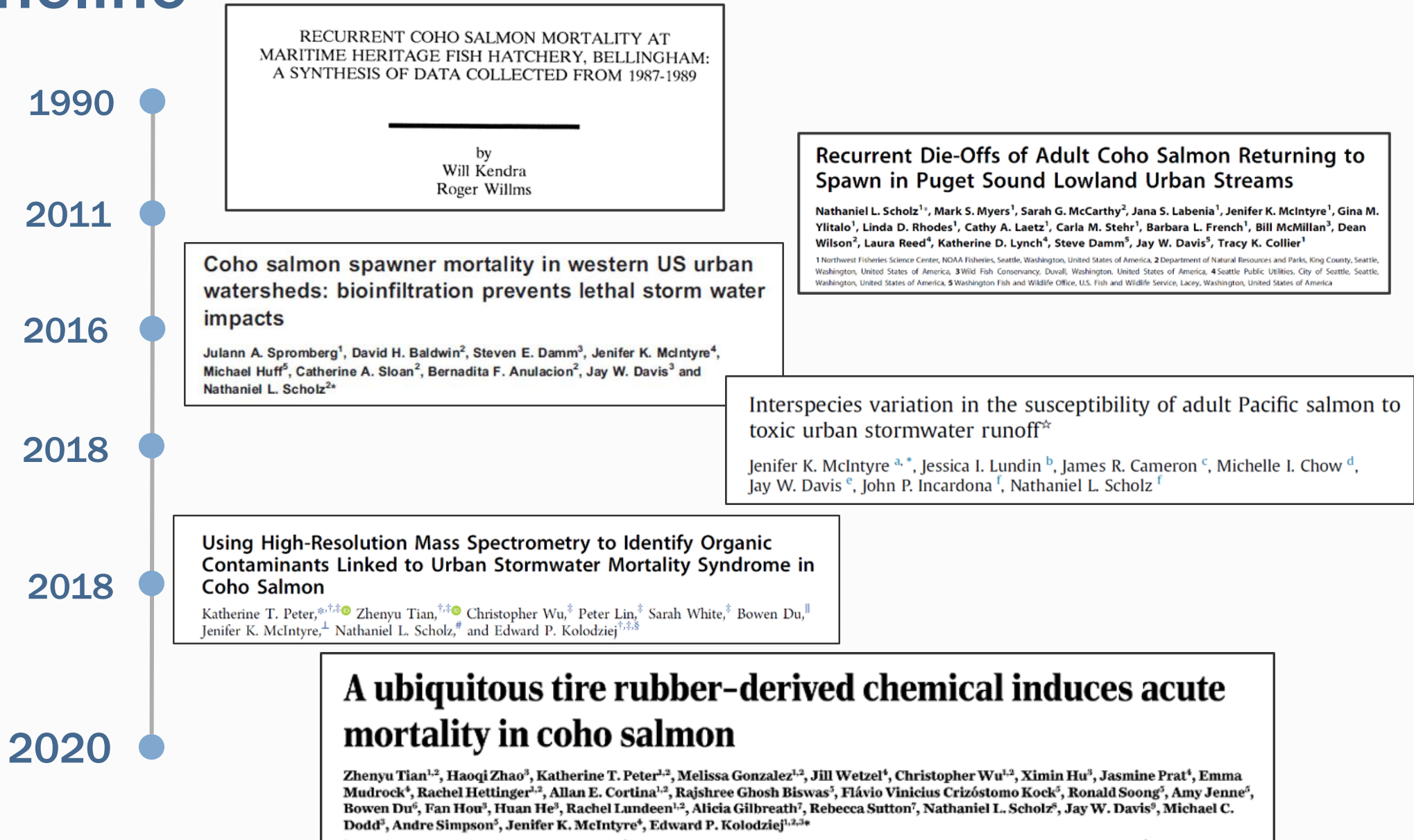


Data: Scholz et al. 2011; Tian et al. 2020, 2022

Photo: Clear Creek coho (courtesy of Wild Fish Conservancy, 2021)

URMS Timeline

URMS has been a problem since the 1980's and most likely longer

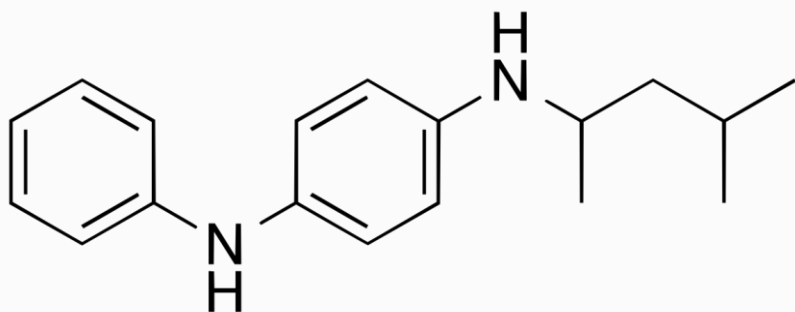


6PPD and 6PPD-quinone

6PPD

N-(1,3-dimethylbutyl)-*N'*-phenyl-*p*-phenylenediamine

Added to tires since the 1960's



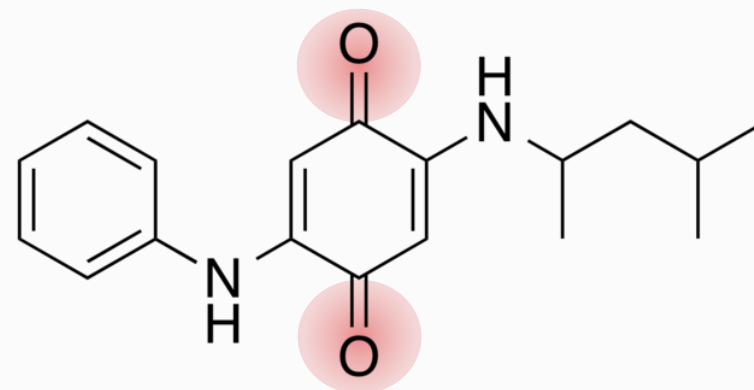
ozone in the
environment



6PPD-quinone

N-(1,3-dimethylbutyl)-*N'*-phenyl-*p*-phenylenediamine-*quinone*

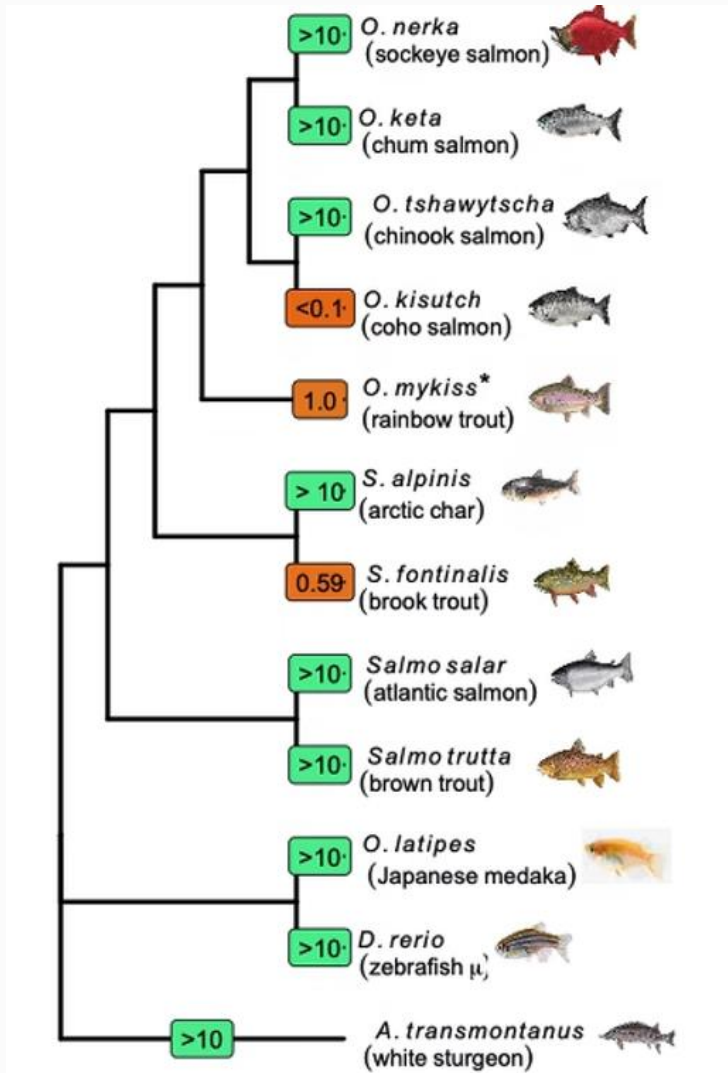
Discovered in 2020



tire wear
particles



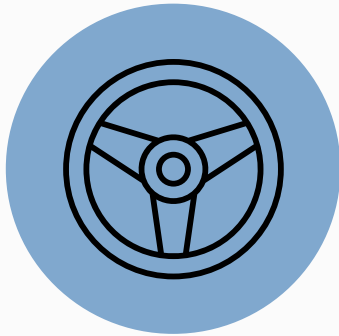
Variability of Toxicity



Species	Concentration at which 6PPD-q is toxic ($\mu\text{g/L}$)
Coho salmon	< 0.10
Steelhead/rainbow trout	0.60
Brook trout	0.59 – 1.00
Chinook salmon	> 10.00
Sockeye and chum salmon	> 10.00
Zebrafish	> 10.00
Arctic char and white sturgeon	No mortality even at 14.20 $\mu\text{g/L}$

Photo: John Hansen, US Geological Survey
 Data: McIntyre et al., 2022 Memo for 6PPD Proviso,
 Brinkmann et al., 2022

Ecology's 3-Part Approach



Reducing sources of
6PPD & evaluating
alternatives



Stormwater Best
Management Practices
(BMPs)



Mapping the problem
& developing lab and
field methods



Photo: Mugdha Flores and Rhea Smith,
WA Department of Ecology

Water Quality Strategies & Stormwater BMPs

- Outreach to the tribes, local governments, agencies, businesses, research groups, & communities
- Increasing grant funding capacity
- Updating guidance for regulations
- BMPs research: \$1.5 million/year for 4 years from the legislature
 - *Anticipated starting July 2023*



Best Management Practices (BMPs)

- "Schedules of activities, prohibitions of practices, maintenance procedures, and structural and/or managerial practices, that when used singly or in combination, prevent or reduce the release of pollutants and other adverse impacts to waters of WA State" - *2019 Stormwater Management Manual for W WA*
- Have researched how effective current BMPs are at addressing 6PPD-q and published a report on:
 - *Source Control BMPs*
 - *Flow Control BMPs*
 - *Runoff Treatment BMPs*

Source Control BMPs

Prevent stormwater contaminants from entering
municipal separate storm sewer systems (MS4s)

*Examples: Roofing to prevent mixing or street sweeping to capture
trash and sediment*



Photo: Bortek 2023

Flow Control BMPs

Slow runoff and reduces runoff volume through on-site management of water

Examples: Detention ponds, vaults, infiltration basins, and bioretention



Runoff Treatment BMPs

Reduce concentrations of targeted pollutants through means of physical filtration and chemical sorption

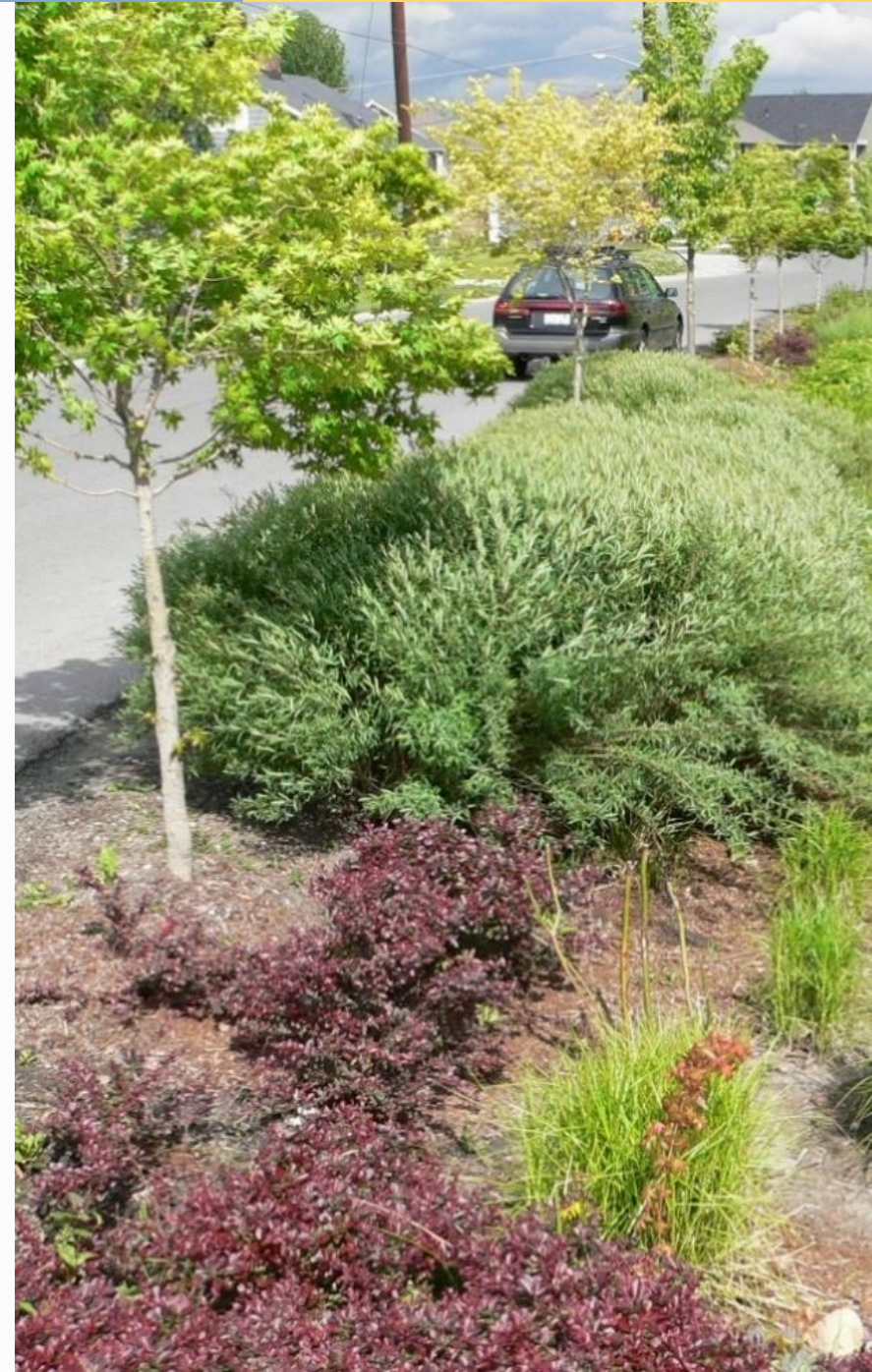
Examples: Trash racks, sorbent media, bioretention soil mix



Photo: BioCycle 2021

Current 6PPD-q BMPs Projects

- **WSU-Puyallup** – longevity of bioretention media
- **Redmond** – street sweeping effectiveness
- **Osborn & Evergreen StormH2O Consulting** – BMPs report, 6PPD subgroup, and particle size study
- **UW-Tacoma** – soils and sorbents effectiveness
- **King County** – High Performance Bioretention Soil Mix (HPBSM) testing
- **King County Environmental Lab** (in development) – stormwater highway & residential characterization study



Key Takeaways

- Addressing 6PPD/q will have important implications for:
 - Tribal Treaty Rights
 - Environmental Justice
 - Commercial, recreational, & subsistence fisheries
 - Ecosystem health & resilience
 - Human health
- Many knowledge gaps still to fill
- Challenge: Actively implementing BMPs and policy solutions amidst uncertainty





Questions?

Contact Information

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