



6PPD and 6PPD-quinone: Finding a Solution

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Washington Public Ports Association – 2023 Annual Meeting

Agenda

- What are 6PPD and 6PPD-quinone?
- Toxicology
- Actions in Washington State
- Actions by Federal Government
- Discussion

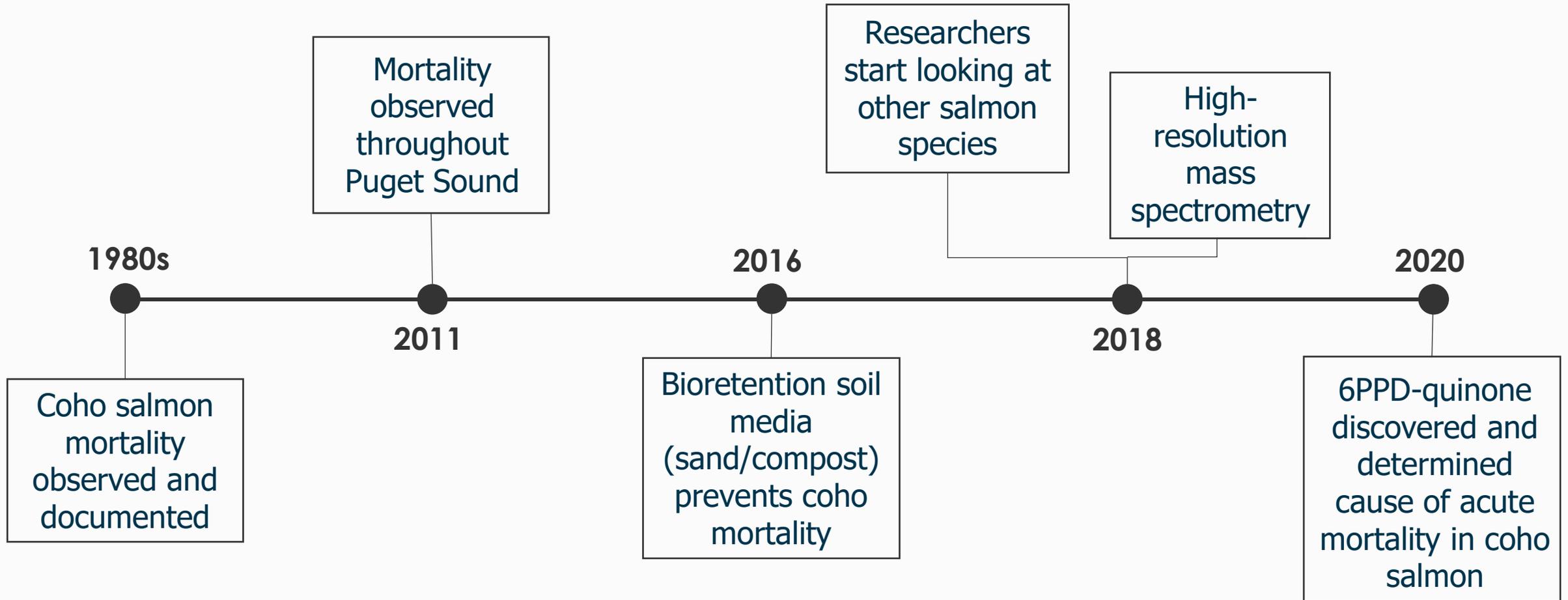
Mortality Observed

- Up to 100% of coho salmon died before they could spawn
- Female carcasses showed >90% egg retention
- Symptoms: disorientation, swimming on side, gasping
- Hypothesized cause as road runoff

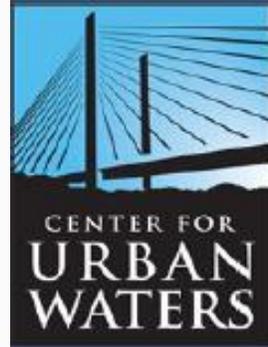
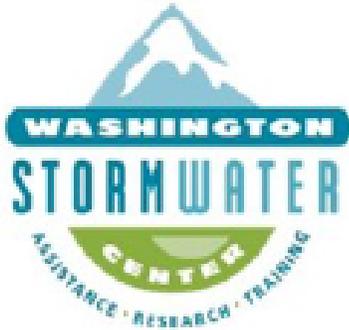


Photo: Wild Fish Conservancy, 2021

6PPD-quinone Discovery

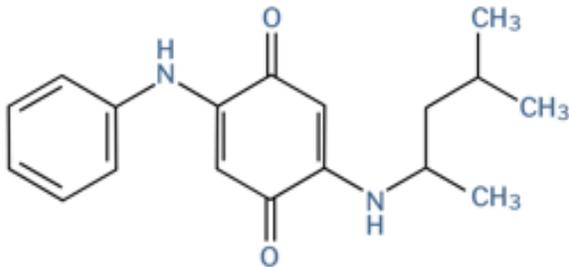


Discovery of the Cause



6PPD-quinone

2-anilino-5-[(4-methylpentan-2-yl)amino]
cyclohexa-2,5-diene-1,4-dione



CASRN 2754428-18-5

- Began research in 2018
- Over 2,000 chemicals in tire wear particle leachate
- High-Resolution Mass Spectrometry
- Fractionation processes based on chemical characteristics
- Discovered 6PPD-quinone in 2020

6PPD in Tires

- Chemical anti-degradant that prevents tire rubber from cracking when exposed to ozone
- Tire industry started using in 1960s
- Improves performance and longevity
- Makes up 1-3% of tire composition
- Assumed to be used in all tires

With 6PPD



Without 6PPD

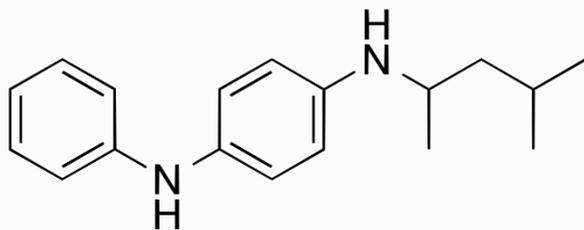


Photo credit: U.S. Tires Manufacturer's Association

How 6PPD-quinone forms

6PPD

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

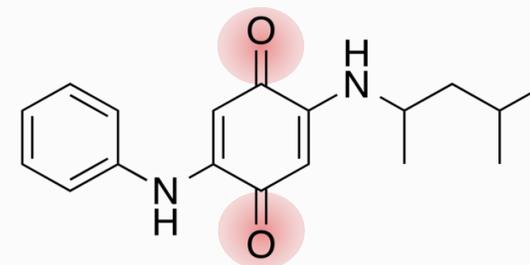


ozone and
tire wear
particles



6PPD-quinone

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



Conceptual Exposure Model

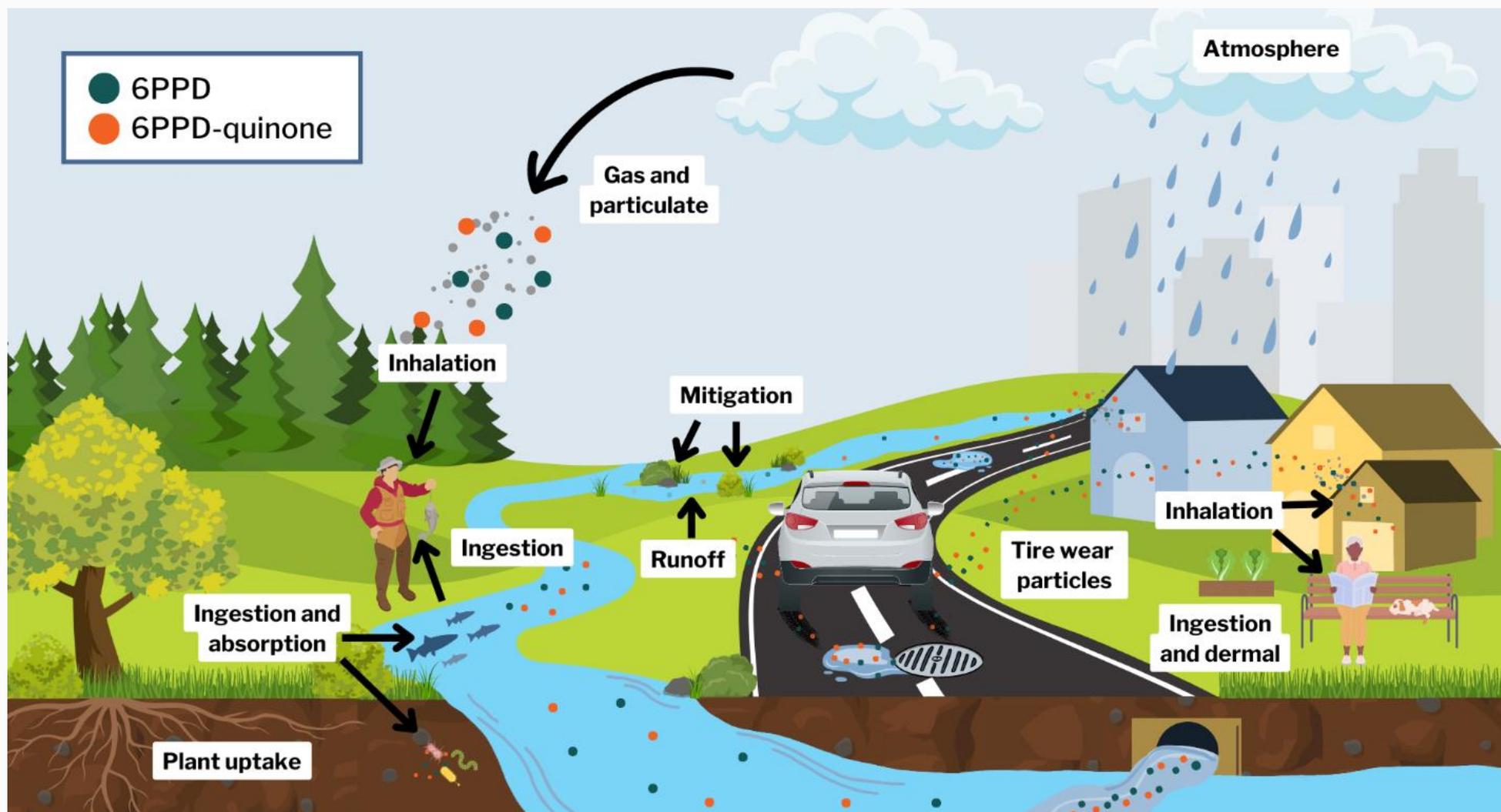


Figure credit: Hannah Vinyard, WA State Dept. of Ecology

Acute Toxicity in Salmonids

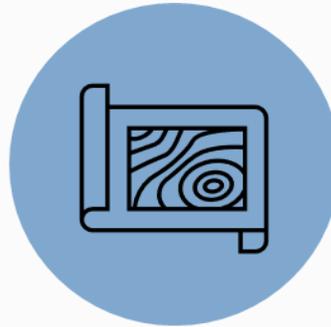
Species	LC ₅₀ (µg/L)
Coho salmon (<i>Oncorhynchus kisutch</i>)	0.08 (median)
White-spotted char (<i>Salvelinus leucomaenis pluvius</i>)	0.51
Brook trout (<i>Salvelinus fontinalis</i>)	0.59
Rainbow trout/steelhead (<i>Oncorhynchus mykiss</i>)	1.0 (median)
Chinook salmon (<i>Oncorhynchus tshawytscha</i>)	82.1
Sockeye salmon (<i>Oncorhynchus nerka</i>)	Not acutely toxic at 50
Atlantic salmon (<i>Salmo salar</i>)	Not acutely toxic at 12.2
Brown trout (<i>Salmo trutta</i>)	Not acutely toxic at 12.2
Arctic char (<i>Salvelinus alpinus</i>)	Not acutely toxic at 12.7

Not acutely toxic to: White sturgeon, zebrafish, medaka, fathead minnow, Daphnia, amphipod

Ecology's 3-Part Approach



Reducing sources of
6PPD & evaluating
alternatives



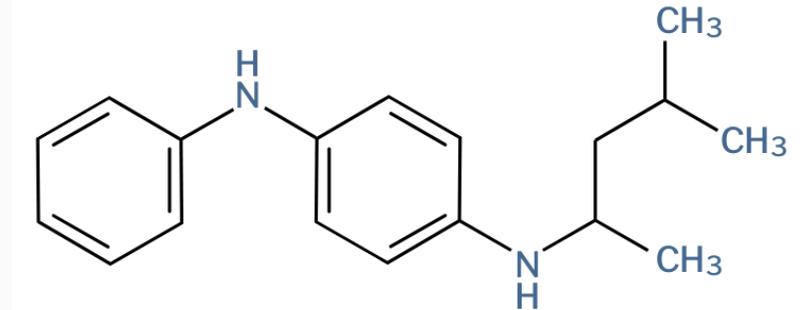
Mapping and
assessing to
support planning



Stormwater Best
Management Practices
(BMPs)

Complete a Safer Alternatives Assessment

- Identify, compare, and select safer alternatives to 6PPD
- Review requirements for toxicity, performance, feasibility, and availability
- **Hazard Criteria**
 - Specific data requirements and standards
 - Requires toxicity analysis on ozonated alternative
 - Requires testing on **three trophic levels**



Develop a 6PPD Action Plan

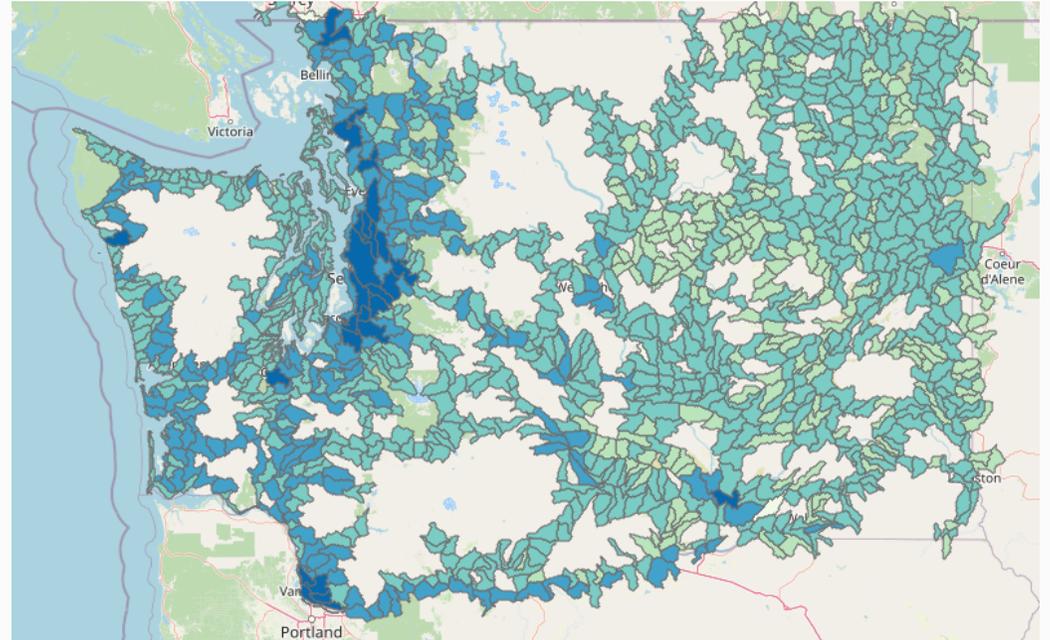
- Provide **actionable recommendations**, including regulatory, policy, or legislative
- Phase 1 recommendations submitted to the legislature in **November 2024**
- **Advisory Committee** – January 2024



Photo credit: [Rubberecycle Mulch](#)
Changes made: cropped to square.

Identify Areas of Concern

- **Mapping** sensitive species presence and proximity to tire contaminant loading
- Helping to **focus studies and site evaluations** to support solution-based modeling and risk assessments



Monitor in Water & Sediment

- Fate and Transport
 - Where and when the **risks** to salmon are highest
 - **How long** toxic concentrations of 6PPD persist
- Projects to determine **best sampling approaches**
- 6PPD-quinone in **sediments**





Effective Stormwater Best Management Practices

- **Capture and treat 6PPD-quinone** before it reaches receiving waters
 - **Remove from roadway** before rain or snow melt events
 - **Treat stormwater**
- Informs changes to **stormwater permits** and stormwater management manuals

Washington State Department of Ecology

**STORMWATER TREATMENT OF TIRE CONTAMINANTS
BEST MANAGEMENT PRACTICES EFFECTIVENESS**

Final Report | June 2022



Completed: Osborn & Evergreen StormH2O Consulting

- Researched and conducted a literature review on how effective current BMPs are at addressing tire contaminants
- Published a report describing the potential effectiveness of:
 - Source Control BMPs
 - Flow Control BMPs
 - Runoff Treatment BMPs

BMPs – Needed Research

- Testing BMP effectiveness
 - Geographic regions and under climate change conditions
- Bridging policy and research
- Cost effectiveness
- Stormwater land use characterization



EPA Grants Tribal Petition

- August 2023
 - Petition – prohibit the manufacturing, processing, use, and distribution of 6PPD in tires
- September 2023
 - ATNI passed resolution supporting the petition
- November 2023
 - EPA granted petition with identified first steps

Contact Information



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For more information:

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Just in Case...

Regulatory Response: Stormwater Management Manuals (SWMMs) and MS4 Phase I and II Permits

- **Phase I and II Permit changes** - Reduced project thresholds to require runoff treatment with new and redevelopment; Street sweeping requirements; Incentives for watershed collaboration in retrofit projects
- **Just Phase I** - New minimum requirements for structural stormwater facility retrofits; Incentives for retrofit projects in High Pollutant Generating Transportation areas
- **Just Phase II:** Stormwater retrofits required
- **SWMMs:** Guidance within section [I-1.5 Stormwater Pollutants and Their Adverse Impacts](#); [Emerging guidance](#) added on an ongoing basis