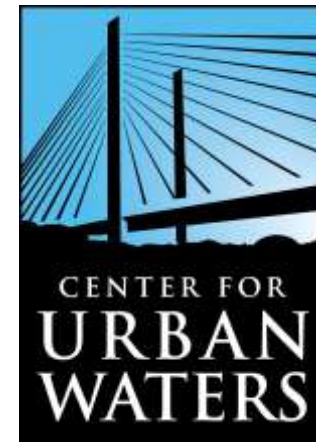


River TALC: Toxics Assessment of the Lower Columbia

Testing for Roadway Runoff Chemicals

North Coast Watershed Association

Kelli Daffron



Objectives

- Data gaps
 - First sampling for some Chemicals of Emerging Concern (CECs) in our area
- Educational gaps
 - Outreach and education on water contamination in general in the Lower Columbia
- Partnerships with/support from:
 - Environmental Protection Agency
 - Center for Urban Waters at University of Washington, Tacoma
 - Clatsop Community College
 - Clatsop County
 - Lower Columbia Estuary Partnership

Targeted Chemicals in River TALC

Vehicle-related chemicals
(+)1,3-Diphenylguanidine
(+)Hexa-(methoxymethyl)melamine
(+)N-cyclohexyl-1.3-Benzothiazole-2-amine (NCBA)
6PPD-quinone
Benzothiazoles & Benzotriazole
(+)Benzotriazole
(+)5-methyl-1-H-Benzotriazole
(+)2-amino-Benzothiazole
(*)2-hydroxy-Benzothiazole
(+)2-(4-morpholinyl)Benzothiazole
Pesticides
(+)Clothianidin
(+)Imidacloprid
(+)Thiamethoxam
(+)Fipronil
(+)Carbendazim
(+)Iprodione
(+)Pentachlorophenol
(+)Diazinon
(+)Diuron
(+)Mecoprop
(+)Prometon
(+)4-Nitrophenol

Pharmaceuticals and personal care products (PPCP)
(+)Caffeine
(+)Cetirizine
(+)Cotinine
(+)DEET
(*)Diclofenac
(*)Ibuprofen
(+)Metformin
(*)Triclosan
Industrial/Commercial chemicals
(+)1,3-Dicyclohexylurea
(*)Bisphenol A
(*)Caprolactam
(*)4-Nonylphenol
(*)4-tert-Octylphenol
Substituted diphenylamine antioxidants & benzotriazole UV stabilizers (SDPA & BZT-UV)
(+)SDPA-diAMS
(+)SDPA-C4C8
(+)SDPA-C8C8
(+)SDPA-C9C9
(+)BTZ & UV-234
(+)BTZ & UV-326

Sites

- 10 sites on 6 systems
 - Big Creek
 - Bear Creek
 - Columbia River
 - Klaskanine River
 - Lewis & Clark River
 - Skipanon River
- 2 major roadways
 - Hwy 101
 - Hwy 30
- 2 minor roadways
 - Hwy 202
 - Lewis & Clark Road

River TALC Sites



NCWA EPA Toxics monitoring sites

Esri, NASA, NGA, USGS | State of Oregon GEO, WA State Parks GIS, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA | U.S. Forest Service; Rocky Mountain Research Station; Air, Water, and Aquatic Environments Program (AWAE). https://www.fs.fed.us/rm/boise/awae_home.shtml

Sampling

- 3 antecedent dry days
- 3mm of rain within an hour
- Overnight iced samples to Tacoma
- Lots of difficulty getting to sites when conditions are right . . .
- Great volunteers are helpful!



6PPD: precursor to 6PPD-Quinone

- 6PPD is added to nearly all tires to prevent degradation of rubber—it's highly reactive by design
 - 6PPD is toxic to algae
 - “used to protect the rubber in transmission belts, hoses, automotive mounts and bushings, and other mechanical products” (26)
 - Relatively short half-life in water, 2.9-6.8 hours
- Combines with oxygen to create 6PPDQ
 - Half life in water unknown, estimated to be longer than 6PPD
- Every American generates around 10lbs of tire wear particles every year! (26)



6PPD-Quinones

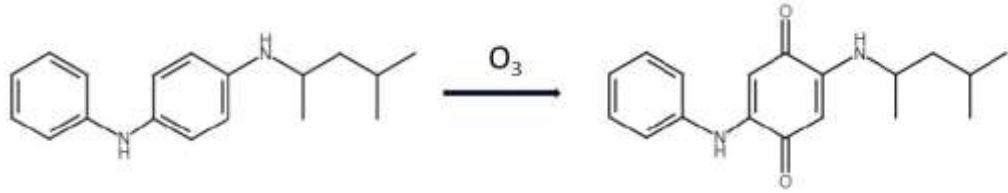
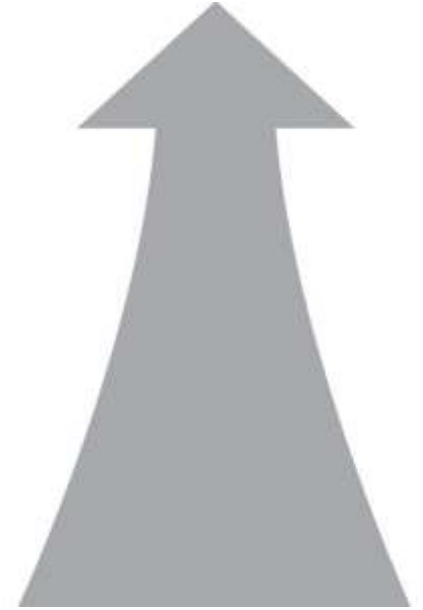


Figure 2: Reaction of 6PPD with ozone (O₃) to produce 6PPD-quinone.

Image: (26)

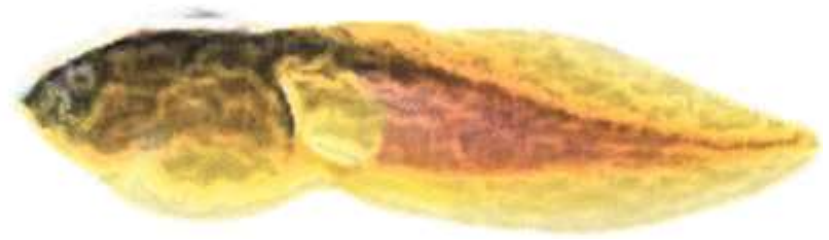
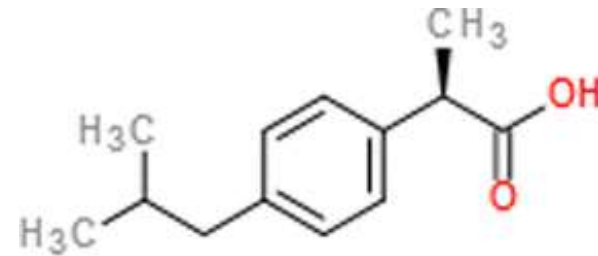
- One of the most deadly chemicals in roadway runoff (23; 24).
- Has been linked to the observed sudden coho death in the Puget Sound area (24)
 - Potentially caused by malfunction of the blood brain barrier (26)

- Salmonid toxicity
 - Coho
 - Coastal cutthroat trout
 - Steelhead
 - Chinook
 - Sockeye
 - Chum
- Sublethal effects
 - Eye development
 - Slower/less vigorous
 - More research needed
- LC₅₀=95 ng/L (Center for Urban Waters)
 - Results vary 40-100 ng/L



Anti-inflammatories: Ibuprofen and diclofenac

- Both considered biodegradable, BUT:
 - Not completely removed modern treatment systems
 - 'pseudo-persistent' (6)
- Inhibit prostaglandin synthesis
 - Prostaglandin causes inflammation in humans
 - In invertebrates prostaglandin effects:
 - Reproduction
 - Temperature control
 - Ion flux regulation (6)



- Ibuprofen shown to disrupt hormone-mediated metabolic pathways in the liver of bullfrog tadpoles (7)

PCPs: Caffeine and Cotinine

- Caffeine study on Zebra fish:
 - ≥ 0.0088 mg/L caused locomotion/acetylcholinesterase inhibition
 - ≥ 40 mg/L caused tail deformities
 - 100 mg/L caused edemas
 - Concentrations often found in natural environs (19)
- Caffeine increases growth in *Pseudomonas* bacteria
 - Aquarium developed oily sheen
 - Dramatically increases amount of ammonia
 - Ammonia is toxic to fish (20)



Image: shutterstock

- Cotinine study
 - 70-80% of nicotine is metabolized in humans into cotinine
 - Of that, 10-15% is not further metabolized and is instead excreted in urine
 - 100% of wastewater globally
 - concentrations between 0.06 $\mu\text{g/liter}$ and 51 $\mu\text{g/liter}$
 - Toxic to frog embryos and rainbow trout hepatocytes
 - “*Nocardioides* sp. strain JQ2195, capable of degrading and utilizing cotinine as a sole carbon and nitrogen source” (21)

Pesticides:

- 2016—The global annual consumption of pesticides is around two million tons!
 - Europe accounts for 45 %,
 - USA accounts for 25 %
 - Other countries 25 % (27)



- Neonicotinoids *imidacloprid*, *clothianidin*, and *thiamethoxam*
 - Most widely used insecticide class in the world as of 2019 (25)
 - Seed treatment as prophylactic (25)
 - Negatively affect aquatic microorganism communities with as few as 1-15ppb (22)

Industrial Chemicals

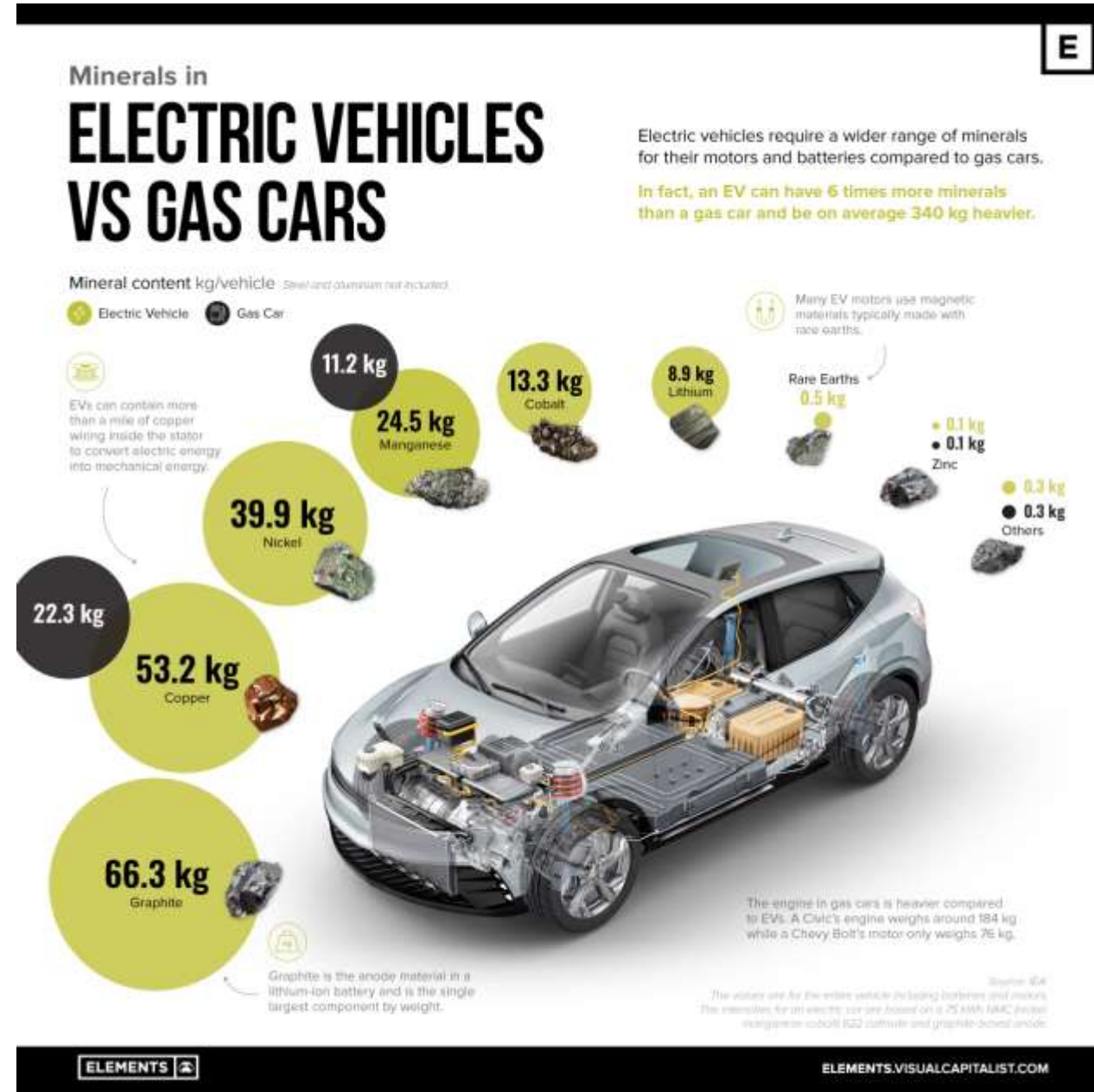
- Bisphenol A (BPA)
 - Still used in many plastics' production
 - Plastic bottles, food storage containers, canned food cans, receipt paper, **PVC**
 - Found in humans' urine
 - Has been linked to human health problems:
 - ADHD, anxiety, depression, early puberty in girls, diabetes, obesity, and heart disease. (9)



Photo credit: <https://blog.bottlestore.com/follow-up-which-plastic-bottles-are-bpa-free/>

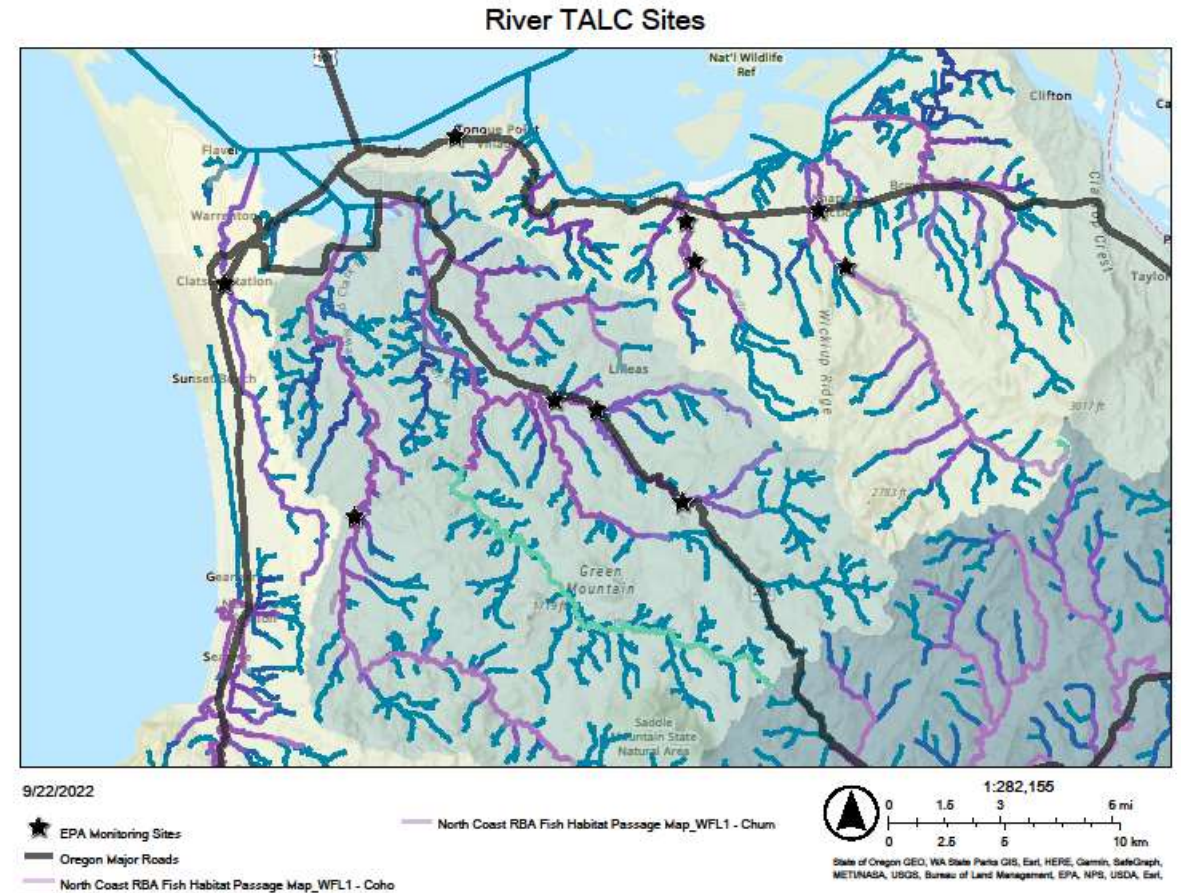
Benzothiazoles: anti-corrosion agents

- Added to copper, rubber, and other materials to slow breakdown; also cleaning detergents
- Produced en-masse
- Environmentally present worldwide
- Chemical structure keeps them persistent
- Inhibit production of RNA, proteins, and enzymes (8)



Potential Mitigations

- Mapping areas where mitigation is needed
- Bioswales/vegetated strips
 - Similar performance to filtration systems—removal of 85% of suspended solids (29)
- Permeable pavement
- Infiltration trenches
- Tire manufacturing practices??



NCWA: What we do and how you can help!



- **Riparian planting***
 - Canyon Creek
 - Blackberry Bog
- **Temperature/Turbidity monitoring***
 - 24 sites throughout our service area
- **Roadway Runoff Testing***
 - River TALC
- Nature Matters
 - Last Thursday each month at the Fort George Lovell Taproom
- **Mapping***
 - Past, current, and future projects
- ***Volunteer Opportunities***

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