

RECONNAISSANCE INVESTIGATION OF EMERGING CONTAMINANTS IN WASTEWATER-TREATMENT-PLANT EFFLUENT AND STORMWATER RUNOFF IN THE COLUMBIA RIVER BASIN

Jennifer Morace
USGS Oregon Water Science Center

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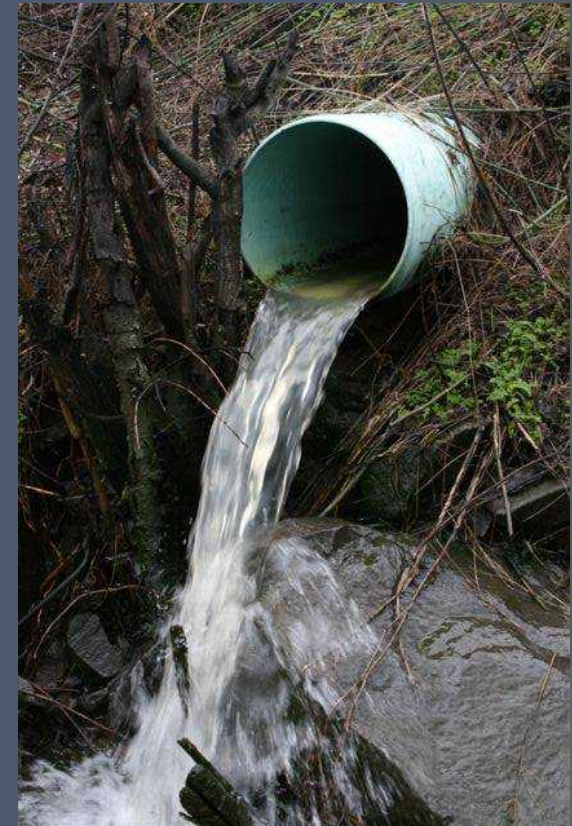
Report available at
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Columbia River Inputs Study

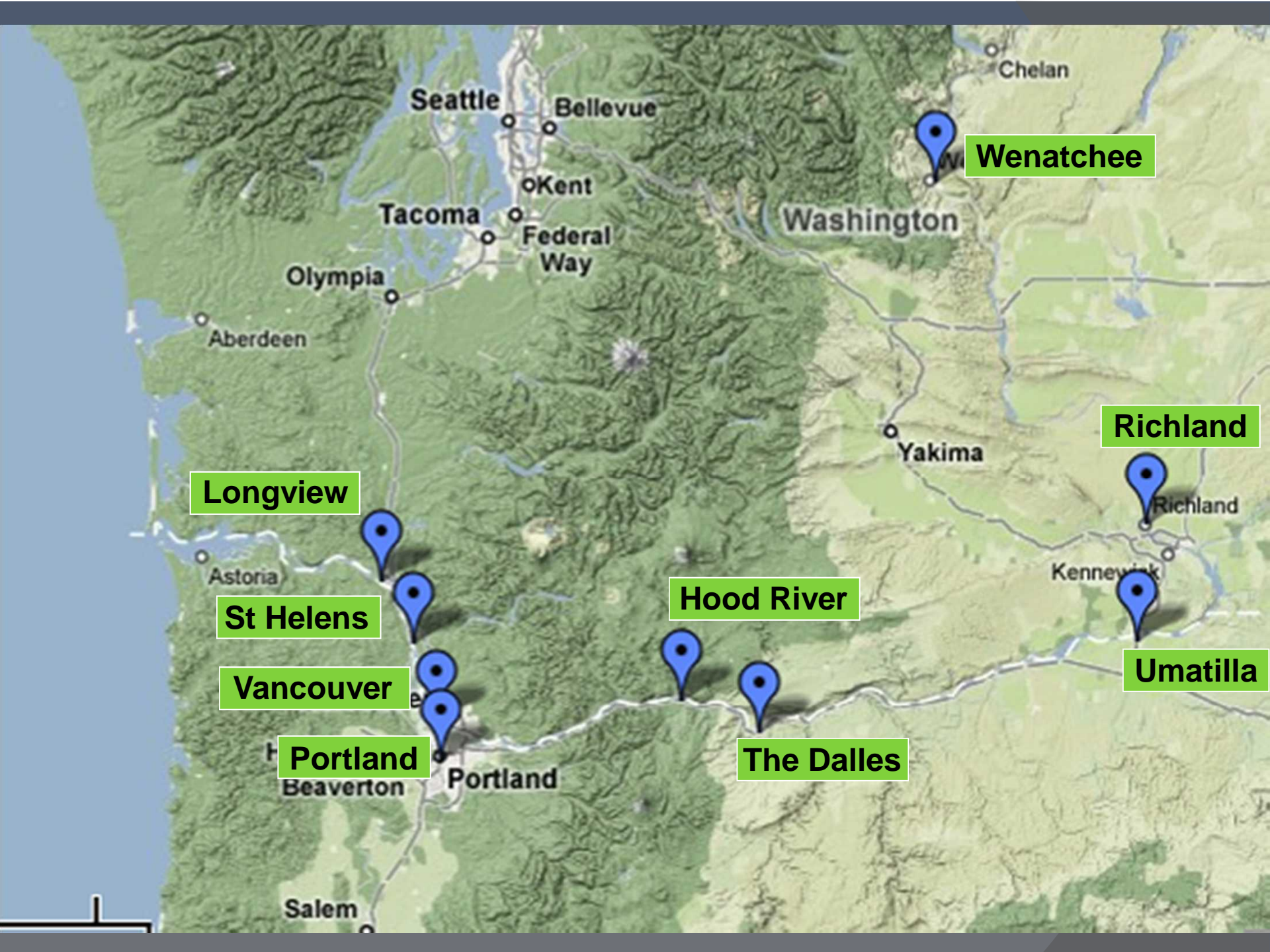
- Characterize pathways contributing directly to the Columbia River



- WWTP effluent



- Stormwater runoff



Wenatchee

Richland

Umatilla

The Dalles

Hood River

Vancouver

St Helens

Longview

Portland

Portland

Beaverton

Seattle

Bellevue

Kent

Tacoma

Federal Way

Olympia

Aberdeen

Astoria

Salem

Washington

Chelan

Yakima

Kennewick

Richland

City and WWTP characteristics

City	Annual precip, inches	Population	Columbia River Mile	Design flow, mgd	Plant Description
Wenatchee	9	27,856	466.6	7.1	Activated sludge; secondary treatment; ultraviolet (UV) disinfection
Richland	7	38,708	337.1	11.4	Activated sludge; secondary clarification; chlorine disinfection
Umatilla	8	4,978	289	0.92	Oxidation ditch; UV disinfection
The Dalles	14	12,156	189.5	4.15	Activated sludge; UV disinfection
Hood River	32	5,831	165	2	Activated sludge; UV disinfection
Portland	37	529,121	105.5	72	Activated sludge; secondary clarification; chlorine disinfection
Vancouver	42	143,560	105	28	Industrial pretreatment lagoon; secondary activated sludge; UV disinfection
St Helens	46	10,019	86.9	45	Combined municipal and kraft mill aerated stabilization basin
Longview	48	34,660	67.5	26	Activated sludge; secondary clarification; chlorine disinfection

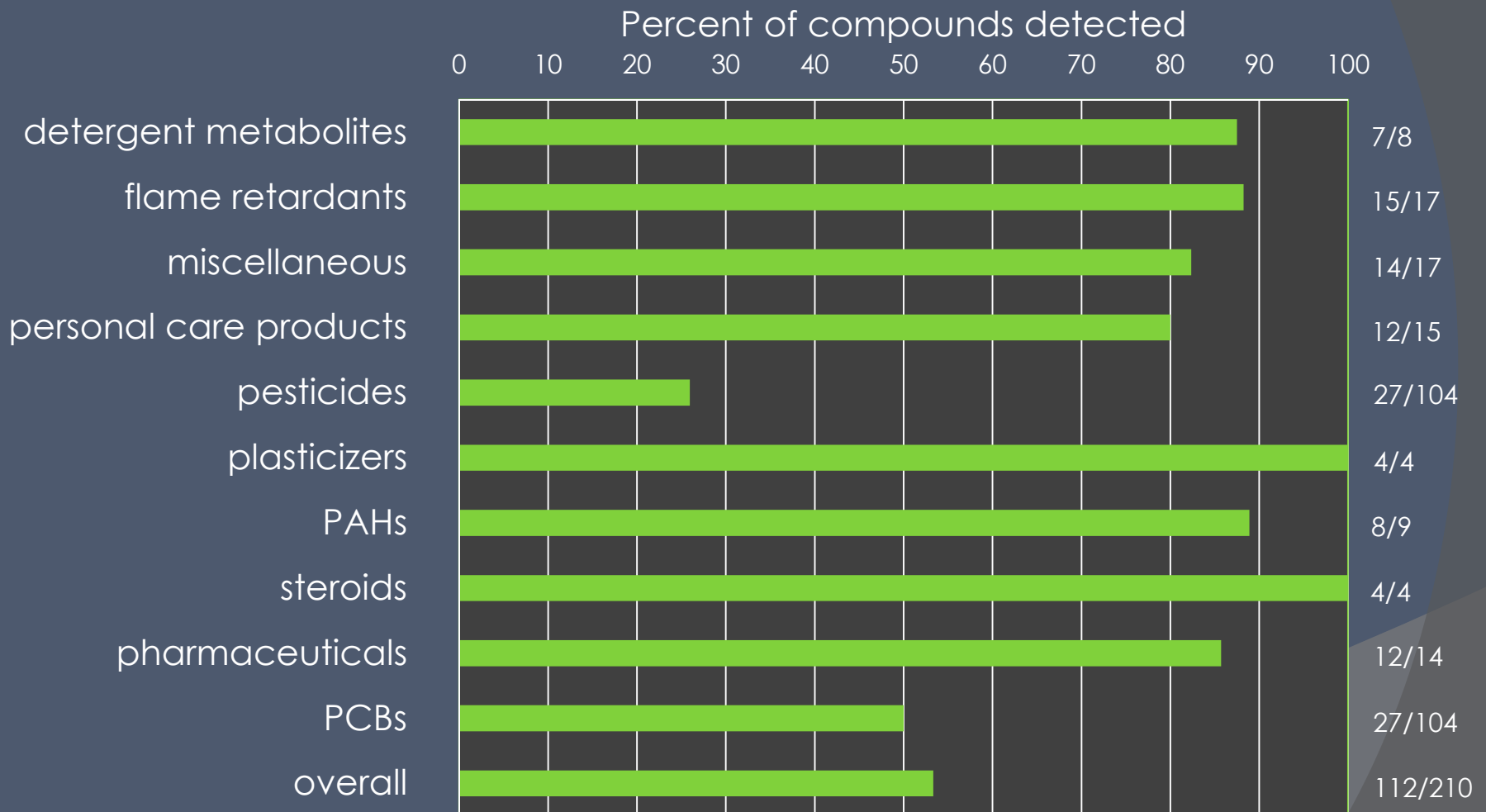
Contaminants analyzed in WWTP effluent

- Pharmaceuticals
- Anthropogenic-indicator compounds
- PCBs
- PBDEs
- PAHs
- Currently used pesticides
- Mercury
- Estrogenicity



Hood River Wastewater Treatment Plant

Contaminants measured in WWTP effluents



Percent of detection at each WWTP sampled

	Total # analyzed	Wenatchee	Richland	Umatilla	The Dalles	Hood River	Vancouver	Portland (am)	Portland (noon)	Portland (pm)	St. Helens	Longview
plasticizers	4	100	25	50	50	25	50	25	75	50	100	100
steroids	4	100	75	100	75	75	75	75	75	75	100	100
detergent metabolites	8	50	0	38	50	50	38	63	63	63	63	63
pharmaceuticals	14	43	29	36	36	43	43	36	43	43	50	57
personal care products	15	60	47	33	47	53	40	47	53	47	53	80
PAHs	9	0	0	11	11	0	0	11	11	11	22	44
flame retardants	17	82	76	76	82	82	82	82	82	82	82	65
miscellaneous	17	47	29	24	35	24	24	35	35	47	35	53
PCBs	18	44	0	0	0	0	0	0	0	0	6	11
pesticides	104	12	18	12	15	13	16	9	13	9	13	15
overall	210	37	25	28	33	29	30	29	32	30	33	40

Compounds found at all WWTPs

maximum concentrations shown in micrograms per liter

- Tri(2-chloroethyl)phosphate – 0.65
- Tri(dichloroisopropyl)phosphate – 0.69
- Benzophenone – 0.28
- 1,4-Dichlorobenzene – 0.88
- HHCb – 2.5
- Cholesterol – E 6.3
- 3-*beta*-Coprostanol – E 5.8
- *beta*-Sitosterol – E 3.2
- Carbamazepine – 0.12
- Diphenhydramine – 0.11

WWTP effluent – PCBS, PBDEs, DDTs

- PBDEs detected at all cities
 - 9 congeners analyzed
 - PBDE-47, PBDE-99, PBDE-100 at highest concentrations
 - Richland and Portland highest
 - Higher later in the day (2 to 4 x morning concentrations)
- PCBs primarily at Wenatchee
- No DDTs detected



Case Study: Nonylphenol compounds

- Nonionic detergent metabolites
- Known endocrine disruptors
- Toxic to aquatic life (reproductive effects)
- Resistant to natural degradation
- Presence in WWTP effluent as a breakdown product from surfactants and detergents



Nonylphenol compounds

Sum of *para*-, NP1EO, NP2EO, OP1EO, OP2EO

Median concentrations:

- Portland 22 µg/L
- All other cities 3.6 µg/L

Freshwater aquatic-life criteria

- Acute (1-hour ave.) criterion: 28 µg/L
- Chronic (4-day ave.) criterion: 6.6 µg/L

Banned by European Union – hazard to human and environmental safety

WWTPs	Sum (µg/L)
Wenatchee (2008)	3.0
Wenatchee (2009)	2.1
Richland	4.3
Umatilla	--
The Dalles	6.5
Hood River	3.6
Portland am	23
Portland noon	22
Portland pm	16
Vancouver	1.5
St Helens	4.9
Longview	3.7

Loadings to the Columbia

- Nonylphenol compounds in Portland
 - 49 mgd from WWTP
 - Median concentration of 22 $\mu\text{g}/\text{L}$
 - 4,100 g/day of nonylphenols
 - 9 pounds/day
- Could lead to Columbia concentration of 0.02 $\mu\text{g}/\text{L}$

Detection limit is 0.2 $\mu\text{g}/\text{L}$

Implications for sampling

- Most compounds would not be quantifiable in the main stem using conventional methods
- Emphasizes the utility of passive sampling
 - Concentrates compounds, therefore lower detection limits
 - Time-integrated sample



Oregon Senate Bill (SB) 737

- Developed a list of priority persistent bioaccumulative toxics that have a documented effect on human health, wildlife and aquatic life
- Final P³ List identified 118 toxic pollutants that either persist in the environment or accumulate in animals
- Developed “plan initiation” levels for all compounds on the P³ list
- Effluent samples collected at 52 largest municipal wastewater plants
 - July 1- August 30, 2010
 - November 1 - December 15, 2010
- Requires these 52 WWTPs to develop plans by 2011 for reducing priority persistent pollutants through pollution prevention and toxics reduction for those compounds detected above “plan initiation” levels

SB737 Compounds

- 118 persistent pollutants on SB 737 list
- 63 were not analyzed in this study
- 13 were only analyzed in stormwater-runoff samples
- 42 pollutants analyzed in wastewater
 - 27 were detected
 - Only 4 were measured at least once at a level greater than the assigned plan initiation level

SB737 compounds detected greater than initiation levels



Chemical name	Initiation level	Number of WWTPs with detections	Number of WWTPs with detections > initiation level	Range of detections (micrograms per liter)	WWTPs with detections
Cholesterol	0.06	9	9	Present - E 6.3	All WWTPs sampled
Coprostanol	0.04	9	9	Present - E 5.8	All WWTPs sampled
Anthracene	0.01	1	1	Present	St. Helens
Fluoranthene	0.04	1	1	E 0.11	Wenatchee

Contaminants analyzed in Stormwater Runoff

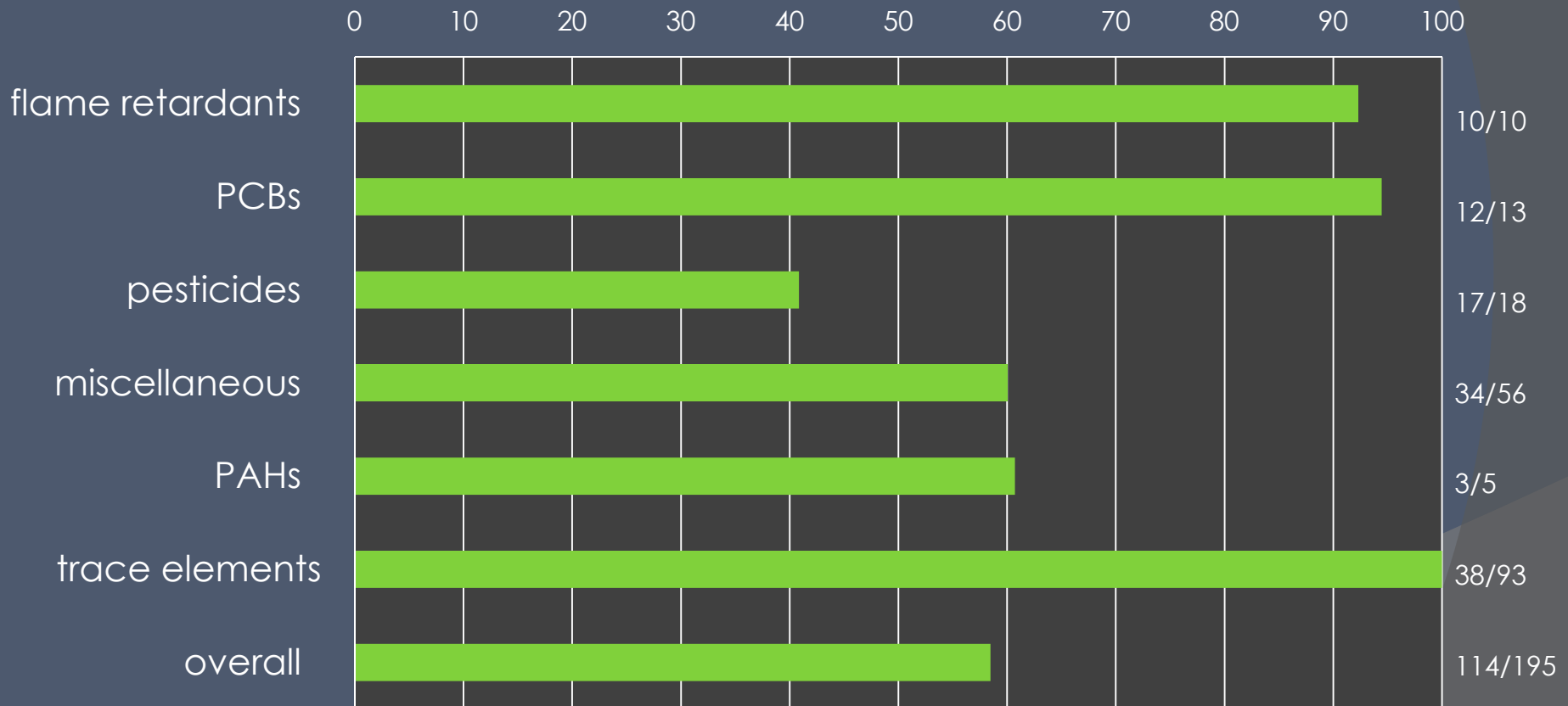
- Currently used pesticides
- PCBs
- PBDEs
- PAHs
- Mercury
- Metals and trace elements
- Oil and grease



Willamette River in Portland at Marquam Bridge

Contaminants measured in stormwater runoff

Percent of compounds detected



Comparison to water-quality criteria

Analyte	Range detected in this study (micrograms per liter)	Wenatchee	Umatilla	The Dalles	Col Slough	Vancouver1	Vancouver2	Portland	Willamette1	Will2 - Dec	Will2 - May	Willamette3	Willamette4
Cadmium	E 0.01 - 0.6									X	X		
Copper	E 0.68 - 11	X	X	X	X	X	X	X	X	X			
Lead	0.03 - 12						X			X	X		
Mercury	0.0021 - 0.23						X			X	X	X	X
Zinc	4.5 - 100	X						X	X				X

Lessons learned

- The actions of society have an effect on the ecosystem.
- What goes down the drain reaches the river and the biota that rely on it. Not everything is cleaned up by the WWTP.
- We need more information on toxicity of these contaminants to truly know the effects on the ecosystem.
- Implications for the foodweb need to be examined.





Jack Ohman, *The Oregonian*, May 2007

Questions?

Jennifer Morace
 jlmorace@usgs.gov
 503.251.3229



NEDC Northwest Environmental Defense Center

