Evaluating a Prioritization Framework for Monitoring Chemicals of Emerging Concern in the Salish Sea Based on Lessons Learned from Western States Programs

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Speaker
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Pharmaceuticals, Personal Care Products, & Perfluoroalkyl Substances in Elliott Bay and other Salish Sea Sediments

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Washington Department of Ecology
Marine Sediment Monitoring Team

Funding provided by...
## Personal Care Products and Pharmaceuticals (PPCPs)

**Sources**
- 1000s of Rx & OTC drugs, nutritional supplements, shampoos, lotions, ...

**Pathway**
- POINT & non-point source

**Persistence**
- Continuous discharge to ecosystem

**Effects on aquatic biota**
- Increased mortality, reduced growth and reproduction, endocrine disruption...

## Perfluoroalkyl Substances (PFASs)

**Sources**
- Non-stick, water repellant, stain-resistant chemicals; fire-fighting foams, roof treatments, ...

**Pathway**
- Point & NONPOINT source

**Persistence**
- Persistent

**Effects on aquatic biota**
- Bioaccumulative in fish, birds, mammals, and invertebrates; Effects not well known

**Recognized worldwide as Contaminants of Emerging Concern**
### PPCPs/PFASs Monitoring in WA Waters

#### PPCPs

<table>
<thead>
<tr>
<th>Water</th>
<th>Site/Region</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effluent, wells, creeks</td>
<td>Sequim, WA</td>
<td>Johnson et al., 2004</td>
</tr>
<tr>
<td>Influent, effluent, biosolids in 4 WWTPs</td>
<td>Puget Sound</td>
<td>Lubliner et al., 2010</td>
</tr>
<tr>
<td>Surface and groundwater</td>
<td>Liberty Bay</td>
<td>Dougherty et al., 2010</td>
</tr>
<tr>
<td>Process and groundwater – reclaimed water TP</td>
<td>Various locations</td>
<td>Johnson and Marti, 2012</td>
</tr>
<tr>
<td>WWTP effluent, stormwater runoff</td>
<td>Columbia River</td>
<td>Morace, 2012</td>
</tr>
<tr>
<td>Biota</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitellogenin in male English sole</td>
<td>Elliott Bay</td>
<td>Johnson et al., 2008</td>
</tr>
<tr>
<td>Endocrine disrupting chemicals in fish bile</td>
<td>Puget Sound</td>
<td>da Silva et al., 2013</td>
</tr>
<tr>
<td>Sediments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface sediments (top 2-3cm)</td>
<td>Bellingham Bay, and Sound-wide</td>
<td>Long et al., 2013</td>
</tr>
</tbody>
</table>

#### PFASs

<table>
<thead>
<tr>
<th>Water</th>
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</thead>
<tbody>
<tr>
<td>Surface waters from rivers &amp; lakes, WWTP effluent, fish tissue, osprey eggs</td>
<td>Various locations state-wide</td>
<td>Furl and Meredith, 2010</td>
</tr>
<tr>
<td>Biota</td>
<td></td>
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</table>
Sediment Quality Monitoring

• **Status & Trends** monitoring at long-term, 8 regions, 6 bays:
  - Chemistry, Toxicity, Benthos

• **Focus on 119 PPCPs/13 PFASs**
  - 30 Elliott Bay (2013)
  - 30 Bellingham Bay (2010)
  - 10 long-term stations (2010)

• **Goal/Objectives**
  - Measure concentrations
  - Establish baseline data set
  - Record distribution
  - Compare between locations
Top 2-3 cm of sediment collected with double vanVeen grab sampler

Sample Analyses

- **119 PPCPs (5 lists)**
  - AXYS MLA-075/EPA1694
  - RLs: 1-1,000 ng/g dry wt
- **13 PFASs**
  - AXYS Method MLA-041
  - RLs: 0.1-0.2 ng/g dry wt
- **HPLC/ESI-MS/MS**
  - High performance liquid chromatography
  - triple quadrupole mass spectrometer
  - positive and negative electrospray ionization modes
Elliott Bay Results:

**PPCPs**
- 3570 results
- 4.5% results detected
- 13/119 PPCPs detected

**PFASs**
- 390 results
- 6.9% results detected
- 3/13 PFASs detected
Triclocarban (antibacterial)

- Detected at most stations
- Highest values above Reporting Limit
- Waterways, shoreline, deep central

Elliott Bay

Long-Term Detect: 25 of 30
Conc’n/RL: 1 - 31
Triclocarban (antibacterial)

- Detected at most stations
- Highest values above Reporting Limit
- Waterways, shoreline, deep central

Chart showing concentrations:
- Elliott Bay: Detected
- B'ham Bay: Detected
- Long-Term: Detected
- Concentration (ng/g dry wt)

- Elliott Bay > Bellingham Bay, Long-term
- Bellingham Bay: e. shoreline, so. central
- L-T: 3 urban bays, deep central
• Detected at over half of stations
• Up to 5x the Reporting Limit
• Waterways, central shoreline and deep

Triamterene
(diuretic)

Concentration (ng/g dry wt)

Dectes: 16 of 30
Conc’n/RL: 1 - 5
Triamterene (diuretic)

- Elliott Bay, Long-term > Bellingham Bay
- Bellingham Bay: e. shoreline, inner bay
- L-T: Budd Inlet, deep central
Diphenhydramine (antihistamine)

- Detected at over half of stations
- Up to 24x the Reporting Limit
- Waterways, shoreline, deep central

### Concentration (ng/g dry wt)

- Elliott Bay: Detected
- Concentration range: 1 - 24

**Graph:**
- Detects: 18 of 23, 7 rejects
- Concentration (ng/g dry wt): 0 - 15
Diphenhydramine (antihistamine)

- Detected at over half of stations
- Up to 24x the Reporting Limit
- Waterways, shoreline, deep central

<table>
<thead>
<tr>
<th>Concentration (ng/g dry wt)</th>
</tr>
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<tbody>
<tr>
<td>Elliott Bay</td>
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<tr>
<td>Bellingham Bay</td>
</tr>
<tr>
<td>Long-Term</td>
</tr>
</tbody>
</table>

- *Elliott Bay=Bellingham Bay=Long-term*
- *Bellingham Bay: throughout*
- *L-T: urban, rural, & deep, central*
Perfluoroalkyl Substances

Perfluorooctanesulfonate (PFOS)

- Elliott Bay Detected
- Rpt Limit

Dectes: 11 of 30
Conc’n/RL: 0.5 - 2

- PFOS - Detected at a third of stations
- Up to 2x the Reporting Limit
- Duwamish, central and deep

1.1 ng/g dry wt
Perfluorooctanesulfonate (PFOS)

- **Elliott Bay**
  - Detected
  - Rpt Limit

- **B’ham Bay**
  - Detected
  - Rpt Limit
  - (n = 1 of 30)

- **Long-Term**
  - Detected
  - Rpt Limit

- Long-Term > Elliott Bay
- L-T: PFOS – deep, Sinclair Inl., Bell. Bay
- PFBA: E. Bellingham Bay, Str. Georgia
Summary

• Baseline established
• Limited PPCPs/PFASs detected – 4 common
• Concentrations near Reporting Limits, some higher
• Similarities/Differences in chemical signature of bays

Recommendations

• Establish baseline for all 6 PSEMP urban bays
• Couple chemical quantification with biological end-point analyses
• Prioritize limited CEC suite for future Salish Sea monitoring
Thank you to...

- **EPA/National Estuary Program** – *funding*
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- **Georgina Brooks, Richard Grace, lab staff**
  AXYS Analytical Services, Ltd.
- **Wendy Eash-Loucks** – Elliott Bay outfall maps
  King County Department of Natural Resources

Further information:

Marine Sediment Monitoring Team website:
http://www.ecy.wa.gov/programs/eap/sediment
Elliott Bay
(sources/sinks)

- 30 stations
- Seattle CSOs
- King County CSOs
- Stormwater outfalls
- Percent fines