May 2nd, 10:30 AM - 12:00 PM

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
Jill Brandenberger, Maggie Dutch, Joan Hardy, Andy James, Deb Lester, April Markiewicz, Dale Norton, Sandie O’Neill, Brian Penttila, Heather Trim, Irvin Schultz, James West, Kathleen Conn, and Alec Maule

This event is available at Western CEDAR: https://cedar.wwu.edu/ssec/2014ssec/Day3/64
Pharmaceuticals, Personal Care Products, & Perfluoroalkyl Substances in Elliott Bay and other Salish Sea Sediments

Maggie Dutch
Sandra Weakland
Valerie Partridge
Kathy Welch

Washington Department of Ecology
Marine Sediment Monitoring Team

Funding provided by...
<table>
<thead>
<tr>
<th>Sources</th>
<th>Personal Care Products and Pharmaceuticals (PPCPs)</th>
<th>Perfluoroalkyl Substances (PFASs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000s of Rx &amp; OTC drugs, nutritional supplements, shampoos, lotions, ...</td>
<td>Non-stick, water repellant, stain-resistant chemicals; fire-fighting foams, roof treatments, ...</td>
<td></td>
</tr>
<tr>
<td>Pathway</td>
<td>POINT &amp; non-point source</td>
<td>Point &amp; NONPOINT source</td>
</tr>
<tr>
<td>Persistence</td>
<td>Continuous discharge to ecosystem</td>
<td>Persistent</td>
</tr>
<tr>
<td>Effects on aquatic biota</td>
<td>Increased mortality, reduced growth and reproduction, endocrine disruption...</td>
<td>Bioaccumulative in fish, birds, mammals, and invertebrates; Effects not well known</td>
</tr>
</tbody>
</table>

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

### PPCPs

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

### PFASs

<table>
<thead>
<tr>
<th>Water</th>
<th>Sediments</th>
<th>Location</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface waters from rivers &amp; lakes, WWTP effluent, fish tissue, osprey eggs</td>
<td>Surface sediments (top 2-3cm)</td>
<td>Bellingham Bay, and Sound-wide</td>
<td>Long et al., 2013</td>
</tr>
<tr>
<td>Biota</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sediments</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</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
Sample Collection

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
- Detects: 25 of 30
- Conc’n/RL: 1 - 31

Concentration (ng/g dry wt)
Triclocarban (antibacterial)

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

Elliott Bay
- Detected
- Rpt Limit

B’ham Bay
- Detected
- Rpt Limit

Long-Term
- Detected
- Rpt Limit

- Elliott Bay > Bellingham Bay, Long-term
- Bellingham Bay: e. shoreline, so. central
- L-T: 3 urban bays, deep central
Triamterene (diuretic)

- Detected at over half of stations
- Up to 5x the Reporting Limit
- Waterways, central shoreline and deep

**Dectects:** 16 of 30

**Conc'n/RL:** 1 - 5

Concentration (ng/g dry wt)
Detected at over half of stations
- Up to 5x the Reporting Limit
- Waterways, central shoreline and deep
  - Elliott Bay, Long-term
  - Bellingham Bay: e. shoreline, inner bay
  - Long-Term Detects: 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
• Detected at over half of stations
• Up to 24x the Reporting Limit
• Waterways, shoreline, 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)

<table>
<thead>
<tr>
<th>Location</th>
<th>Detects</th>
<th>Conc’n/RL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elliott Bay</td>
<td>18</td>
<td>1 - 24</td>
</tr>
<tr>
<td>B’ham Bay</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Long-Term</td>
<td>18</td>
<td>1 - 24</td>
</tr>
</tbody>
</table>

- Elliott Bay=Bellingham Bay=Long-term
- Bellingham Bay: throughout
- L-T: urban, rural, & deep, central
Perfluorooctanesulfonate (PFOS)

- Detects: 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
Perfluorooctanesulfonate (PFOS)

**Elliott Bay**
- Detected
- Rpt Limit

**B’ham Bay**
- Detected
- Rpt Limit

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

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

Perfluoroalkyl Substances

- PFBA
- PFDA
- PFNA
- PFOS
- PFOSA
- PFUNA

Concentration (ng/g dry wt)

1.5 1.0 0.5 0.0

1.1 ng/g dry wt
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

Summary

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

- **EPA/National Estuary Program** – *funding*
- **Karin Feddersen** – data review/QA
  Ecology’s Manchester Environmental Lab
- **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