Quantification of Pharmaceuticals, Personal Care Products, and Perfluoroalkyl Substances in Elliott Bay sediments (Seattle, Washington)

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

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Sandra Weakland
Valerie Partridge
Kathy Welch

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>Location</th>
<th>Authors</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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biota</th>
<th>Location</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sediments</th>
<th>Location</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface sediments (top 2-3cm)</td>
<td>Bellingham Bay, and Sound-wide</td>
<td>Long et al., 2013</td>
</tr>
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</table>

#### PFASs

<table>
<thead>
<tr>
<th>Water</th>
<th>Location</th>
<th>Authors</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>
</tbody>
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</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
Triclocarban (antibacterial)

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

**Concentration (ng/g dry wt)**

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

Triamterene (diuretic)
- **Triamterene** (diuretic)

- **Elliott Bay**
  - Detected
  - Concentration: 1.5, 1.0, 0.5, 0.0
  - Reported Limit Detected

- **B’ham Bay**
  - Detected
  - Concentration: 1.5, 1.0, 0.5, 0.0
  - Reported Limit

- **Long-Term Detects**: 16 of 30
  - Concentration/Report Limit: 1 - 5

- **Triamterene** detected at over half of stations up to 5x the Reporting Limit.

- **Localities**:
  - 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: 18 of 23, 7 rejects
  - Conc’n/RL: 1 - 24

**Map Highlights**

- Smith Cove
- Alki Beach
- West Waterway
- East Waterway
- Georgetown Reach

**Legend**

- 6.3 ng/g dry wt
- Diphenhydramine
Diphenhydramine (antihistamine)

- Detected at over half of stations
- Up to 24x the Reporting Limit

<table>
<thead>
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<td>Elliott Bay Detected</td>
</tr>
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<td>B’ham Bay Detected</td>
</tr>
<tr>
<td>Long-Term Detected</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
Perfluoroalkyl Substances

Perfluorooctanesulfonate (PFOS)

- Elliott Bay: Detected, Rpt Limit
- B’ham Bay: Detected (n = 1 of 30)
- Long-Term: Detected

Concentration (ng/g dry wt)

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