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

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

Maggie Dutch
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

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

## PPCPs

<table>
<thead>
<tr>
<th>Water Type</th>
<th>Sampling Location</th>
<th>Location</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effluent, wells, creeks</td>
<td>Sequim, WA</td>
<td>Johnson et al., 2004</td>
<td></td>
</tr>
<tr>
<td>Influent, effluent, biosolids in 4 WWTPs</td>
<td>Puget Sound</td>
<td>Lubliner et al., 2010</td>
<td></td>
</tr>
<tr>
<td>Surface and groundwater</td>
<td>Liberty Bay</td>
<td>Dougherty et al., 2010</td>
<td></td>
</tr>
<tr>
<td>Process and groundwater – reclaimed water TP</td>
<td>Various locations</td>
<td>Johnson and Marti, 2012</td>
<td></td>
</tr>
<tr>
<td>WWTP effluent, stormwater runoff</td>
<td>Columbia River</td>
<td>Morace, 2012</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Biota</th>
<th>Sampling Location</th>
<th>Location</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitellogenin in male English sole</td>
<td>Elliott Bay</td>
<td>Johnson et al., 2008</td>
<td></td>
</tr>
<tr>
<td>Endocrine disrupting chemicals in fish bile</td>
<td>Puget Sound</td>
<td>da Silva et al., 2013</td>
<td></td>
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</tbody>
</table>

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

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<th>Sampling Location</th>
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</tr>
</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>
<td></td>
</tr>
</tbody>
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</table>
Sediment Quality Monitoring

**PUGET SOUND ECOSYSTEM MONITORING PROGRAM**

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

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

- 0 20 40 60 80 100
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

Concentration (ng/g dry wt)

- 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

Concentration (ng/g dry wt)

0.0 0.5 1.0 1.5

Elliott Bay
Detected

B’ham Bay
Detected

Long-Term
Detected

Rpt Limit

0.41 ng/g dry wt

Triamterene

0.15

1.0

Detected at over half of stations

Up to 5x the Reporting Limit

Waterways, central shoreline and deep Elliott Bay

B’ham Bay

Long-Term Detects: 16 of 30

Conc’n/RL: 1 - 5

Triamterene
(diuretic)
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
  - Rpt Limit
  - Detects: 18 of 23, 7 rejects
  - Conc’n/RL: 1 - 24

**Map of Seattle**
- Elliott Bay
- Smith Cove
- Alki Beach
- Smith Cove
- Georgetown Reach
- West Waterway
- East Waterway
- Smith Cove
Diphenhydramine (antihistamine)

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

<table>
<thead>
<tr>
<th>Concentration (ng/g dry wt)</th>
</tr>
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<tbody>
<tr>
<td>Elliott Bay</td>
</tr>
<tr>
<td>B'ham 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
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 (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*
- **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