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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



PUGET SOUND ECOSYSTEM
MONITORING PROGRAM



DEPARTMENT OF
ECOLOGY
State of Washington

Maggie Dutch
Sandra Weakland
Valerie Partridge
Kathy Welch

Funding provided by...



Washington Department of Ecology
Marine Sediment Monitoring Team



Personal Care Products and Pharmaceuticals (PPCPs)

Perfluoroalkyl Substances (PFASs)

Sources

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

Non-stick, water repellent, stain-resistant chemicals; fire-fighting foams, roof treatments, ...

Pathway

POINT & non-point source

Point & NONPOINT source

Persistence

Continuous discharge to ecosystem

Persistent

Effects on aquatic biota

Increased mortality, reduced growth and reproduction, endocrine disruption...

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

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

PFASs

Water	Surface waters from rivers & lakes, WWTP effluent, fish tissue, osprey eggs	Various locations state-wide	Furl and Meredith, 2010
Biota			
Sediments	Surface sediments (top 2-3cm)	Bellingham Bay, and Sound-wide	Long et al., 2013

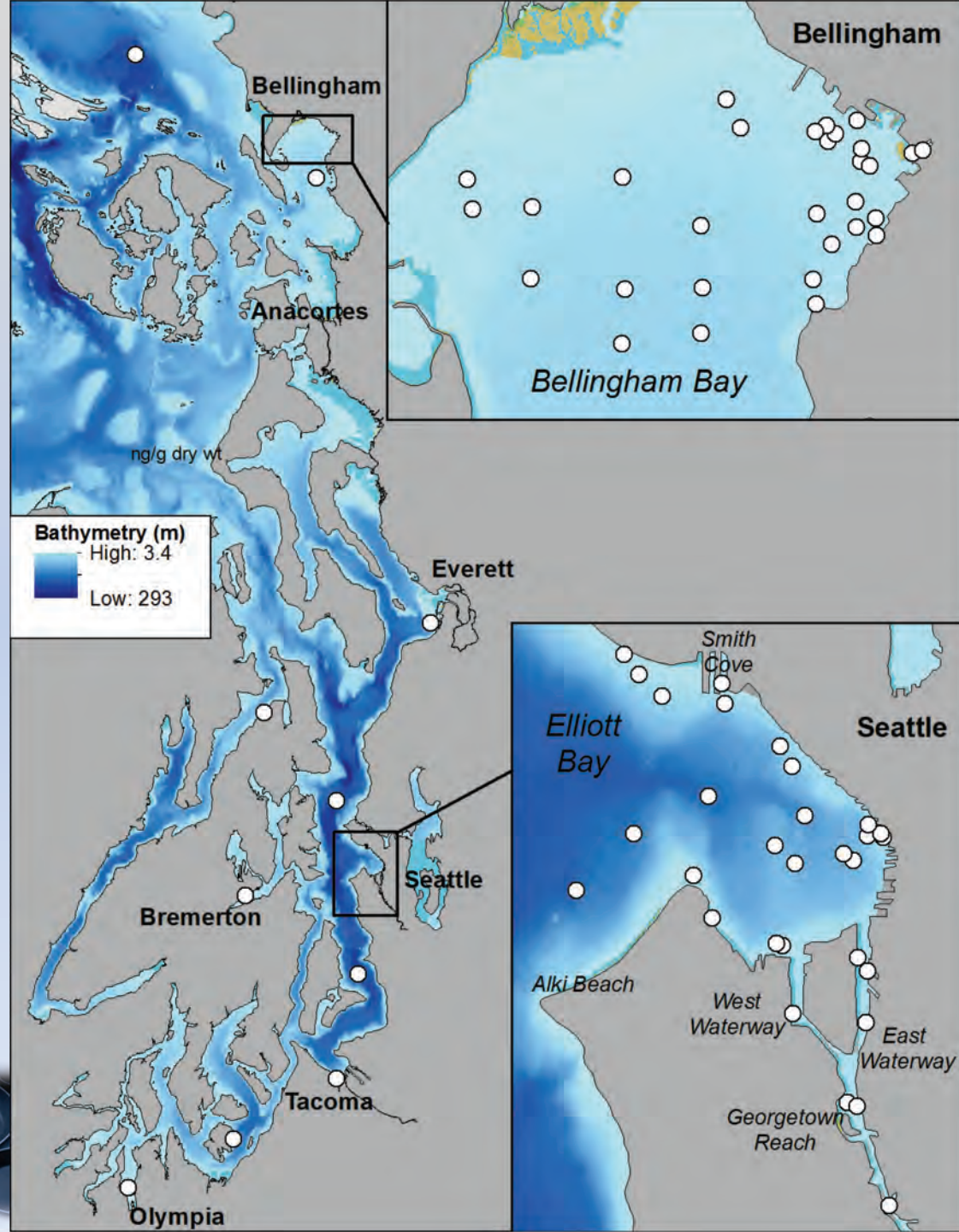


Sediment Quality Monitoring

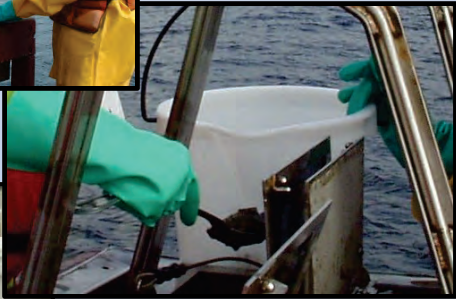


PUGET SOUND ECOSYSTEM
MONITORING PROGRAM

- **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:

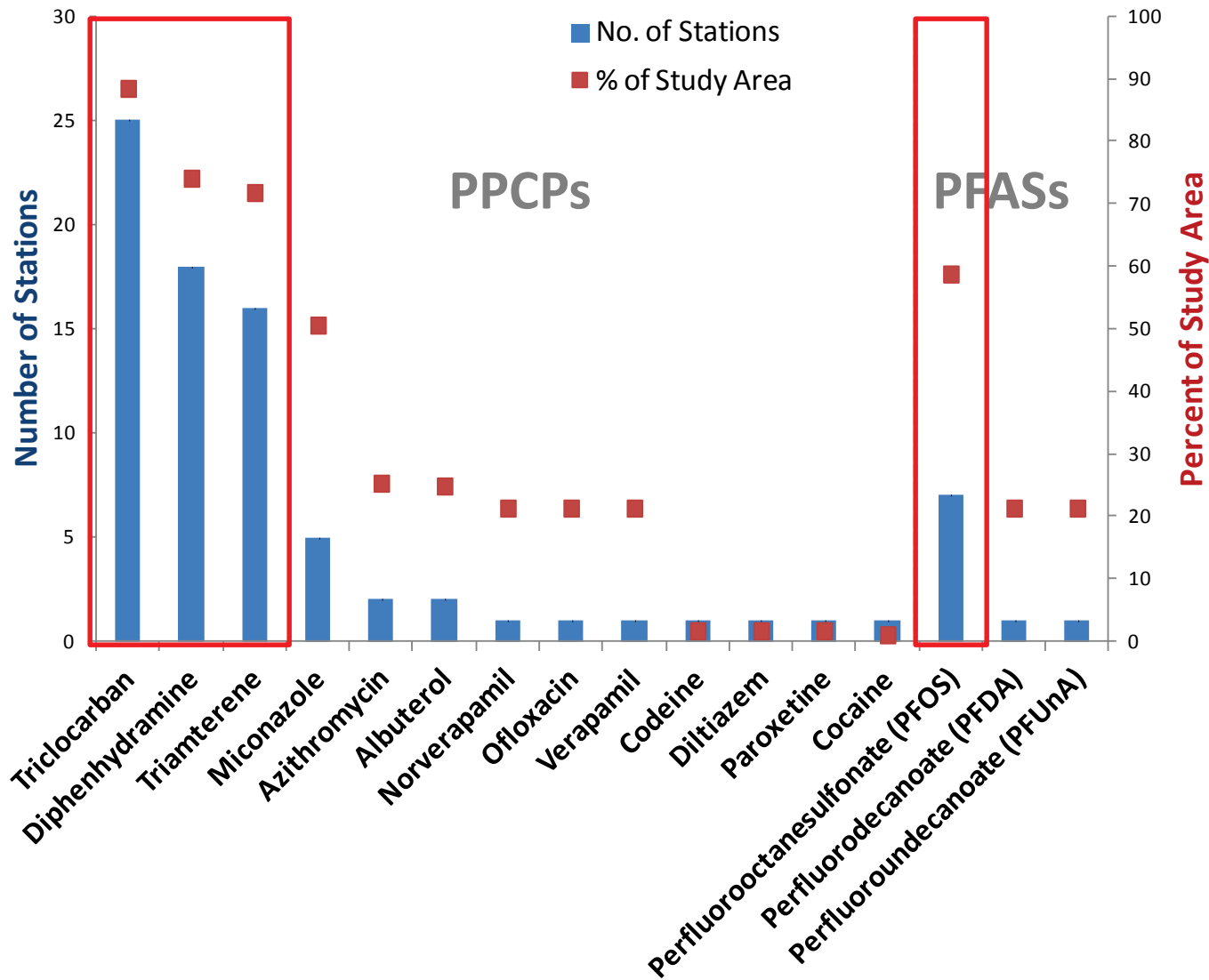
PPCPs

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

PFASs

- 390 results
- 6.9% results detected
- 3/13 PFASs detected

Incidence and Spatial Extent



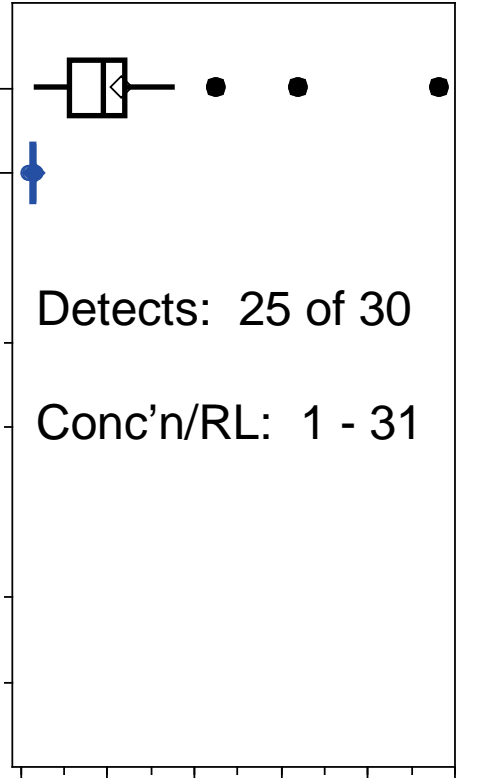


Triclocarban (antibacterial)

Elliott Bay

Detected

Rpt Limit

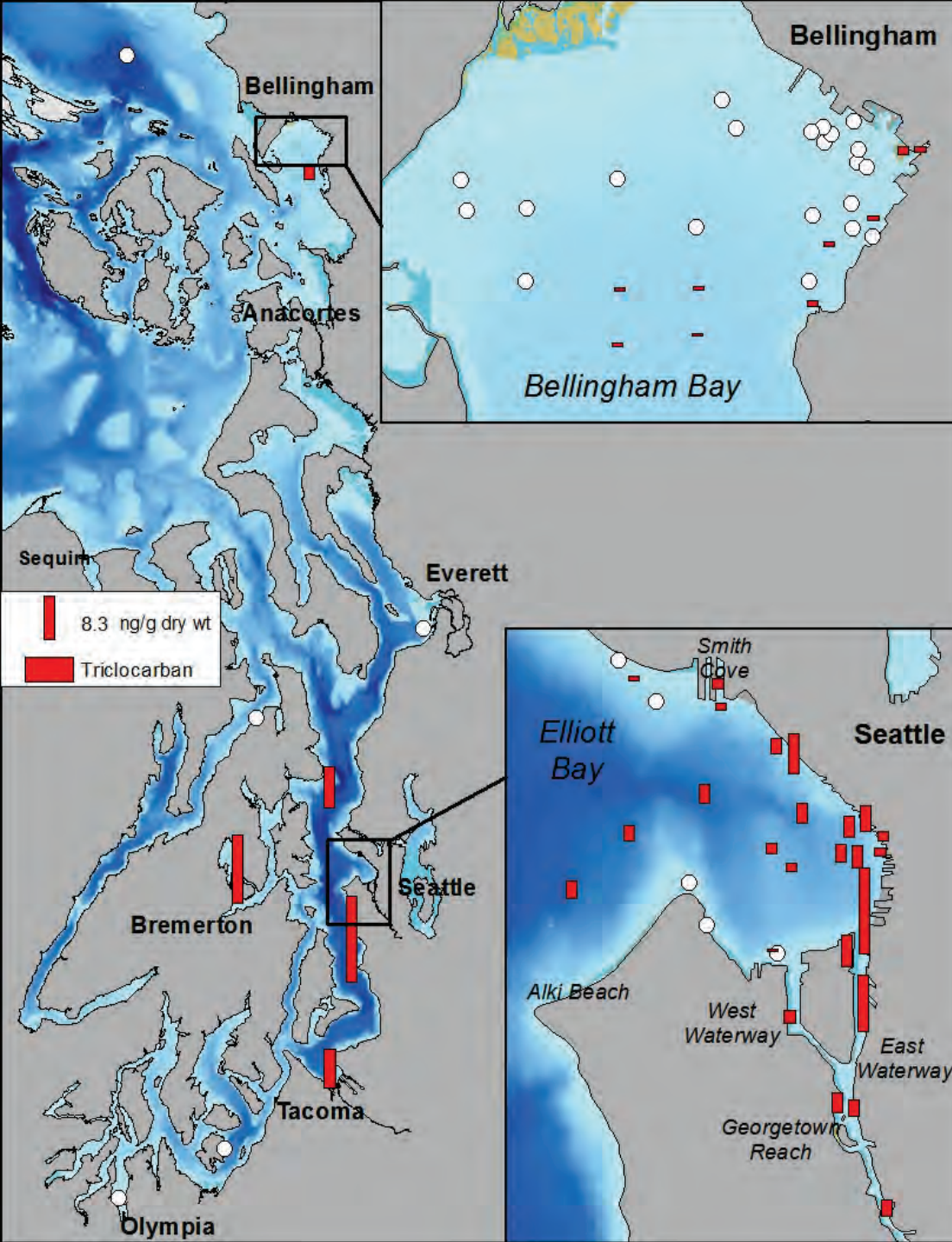


Detects: 25 of 30

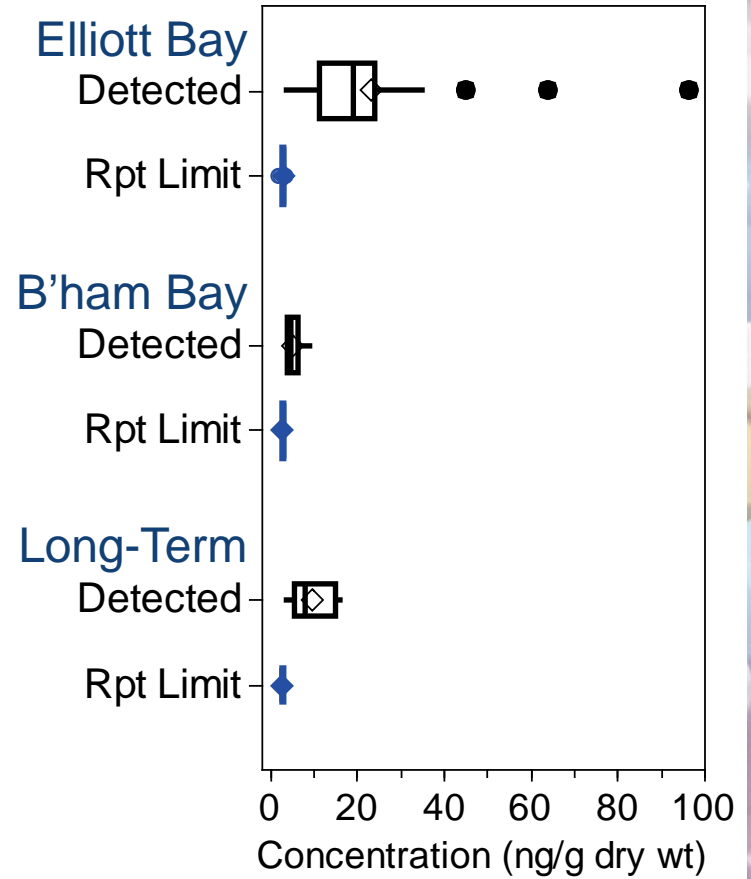
Conc'n/RL: 1 - 31

Concentration (ng/g dry wt)

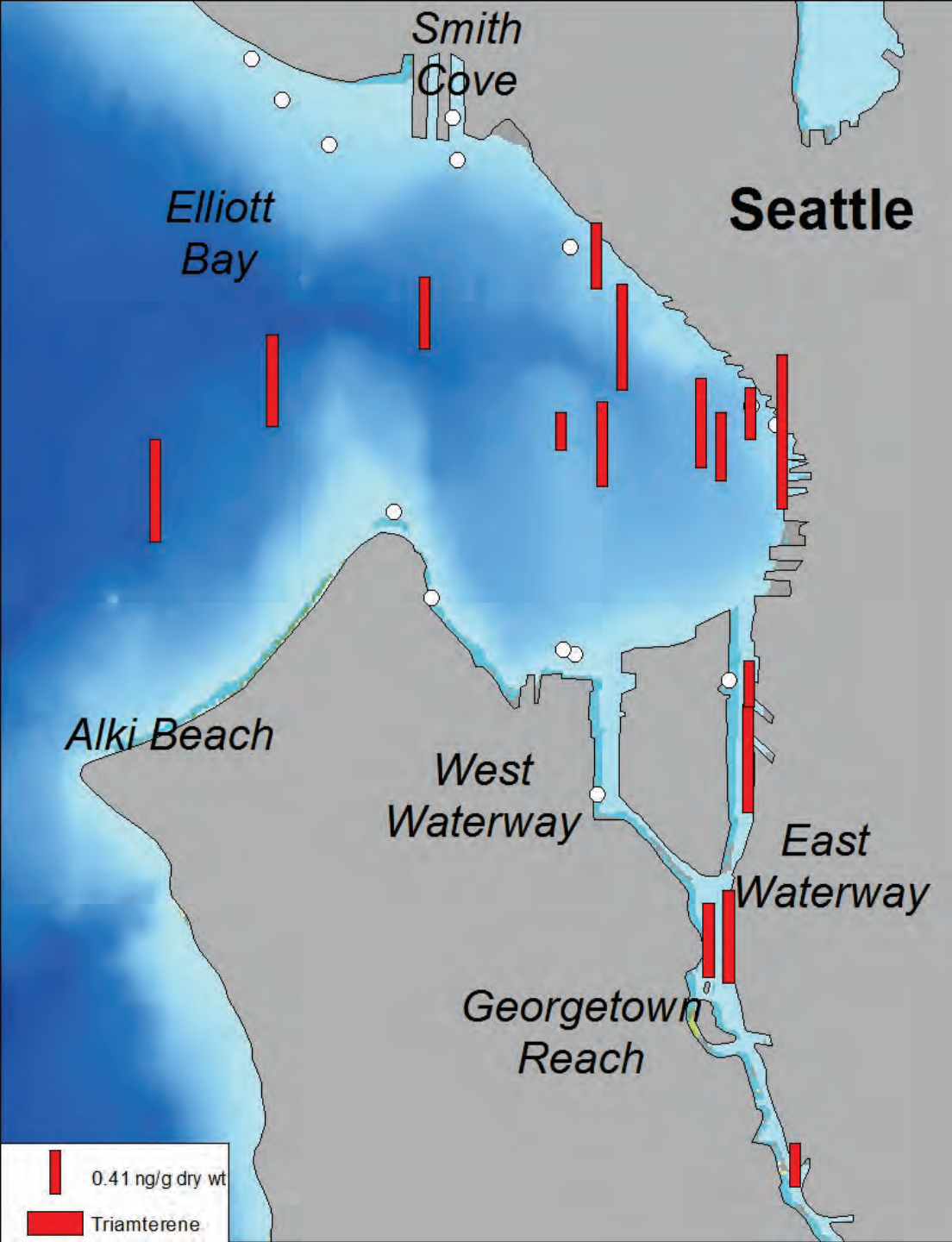
- Detected at most stations
- Highest values above Reporting Limit
- Waterways, shoreline, deep central



Triclocarban (antibacterial)



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

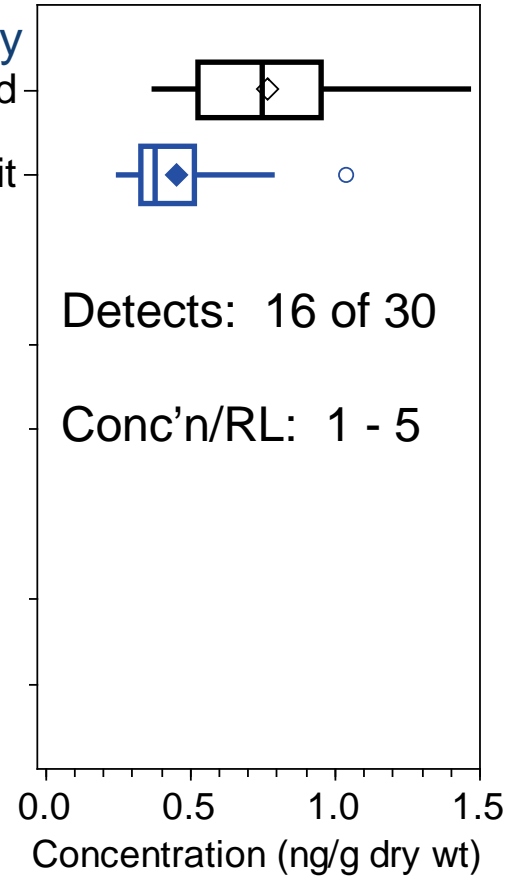


Triamterene (diuretic)

Elliott Bay

Detected

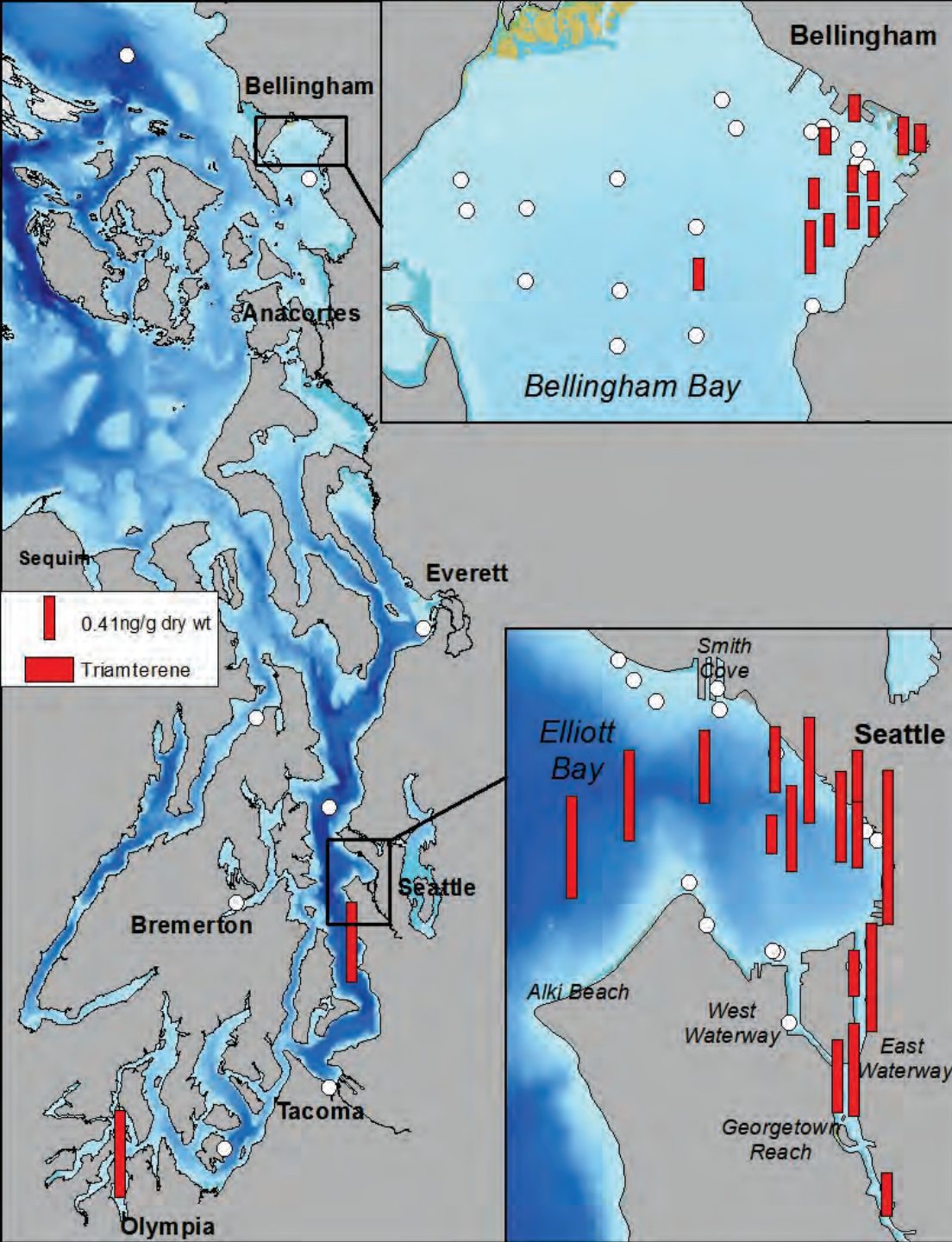
Rpt Limit



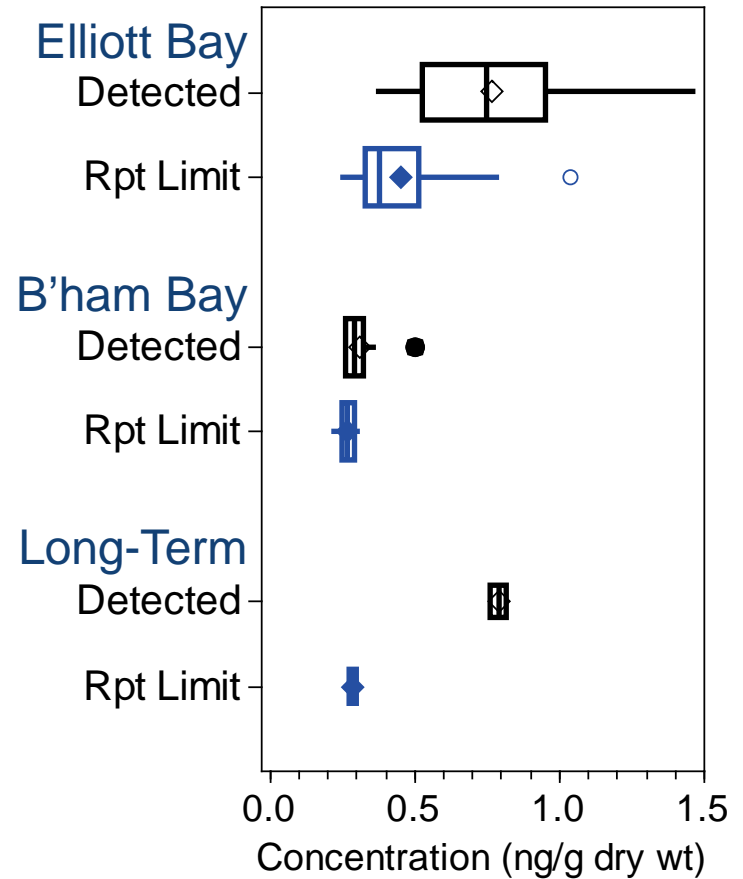
Detects: 16 of 30

Conc'n/RL: 1 - 5

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



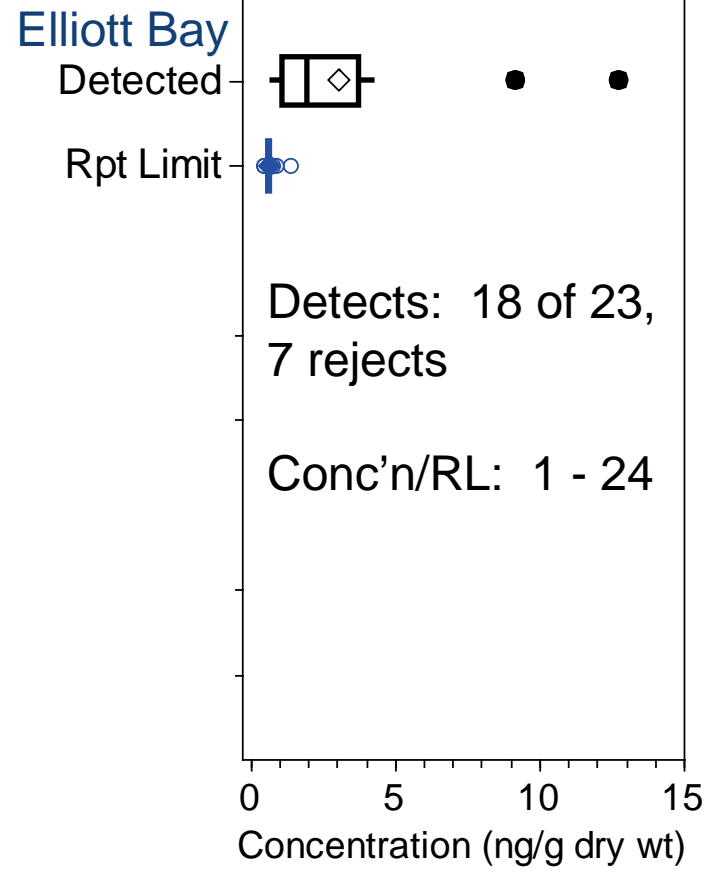
Triamterene (diuretic)



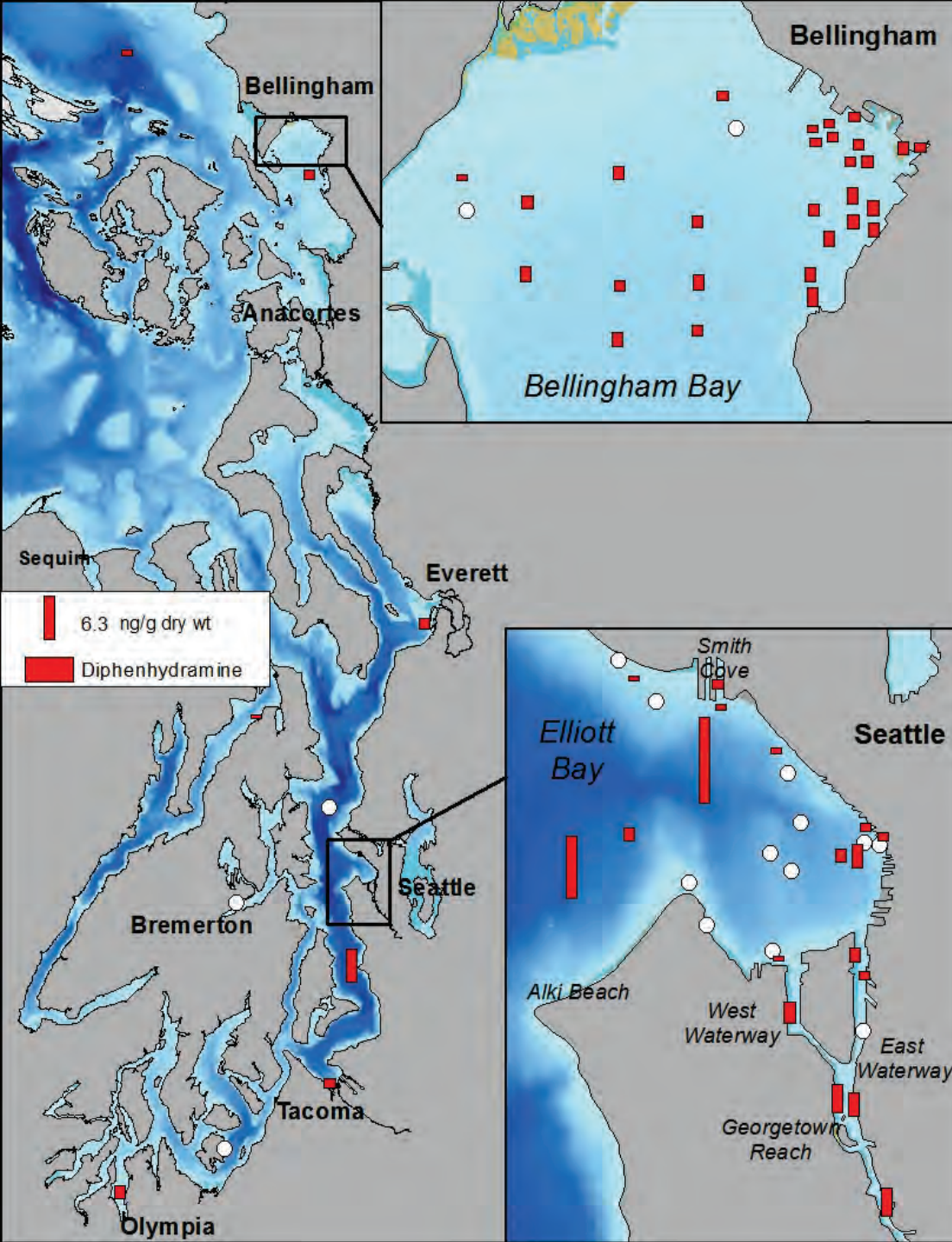
- Elliott Bay, Long-term > Bellingham Bay
- Bellingham Bay: e. shoreline, inner bay
- L-T: Budd Inlet, deep central



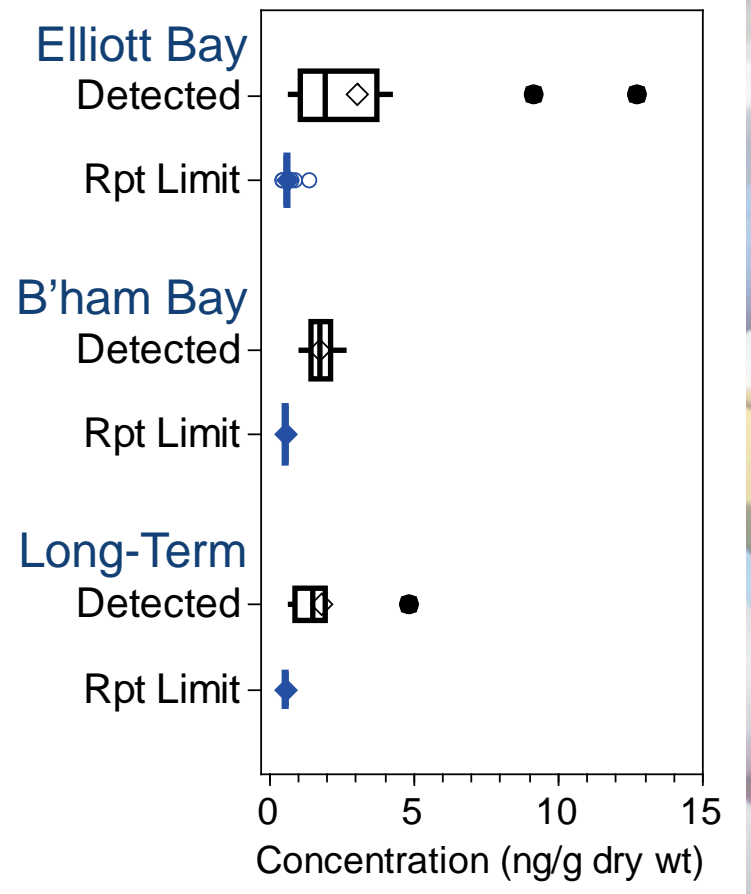
Diphenhydramine (antihistamine)



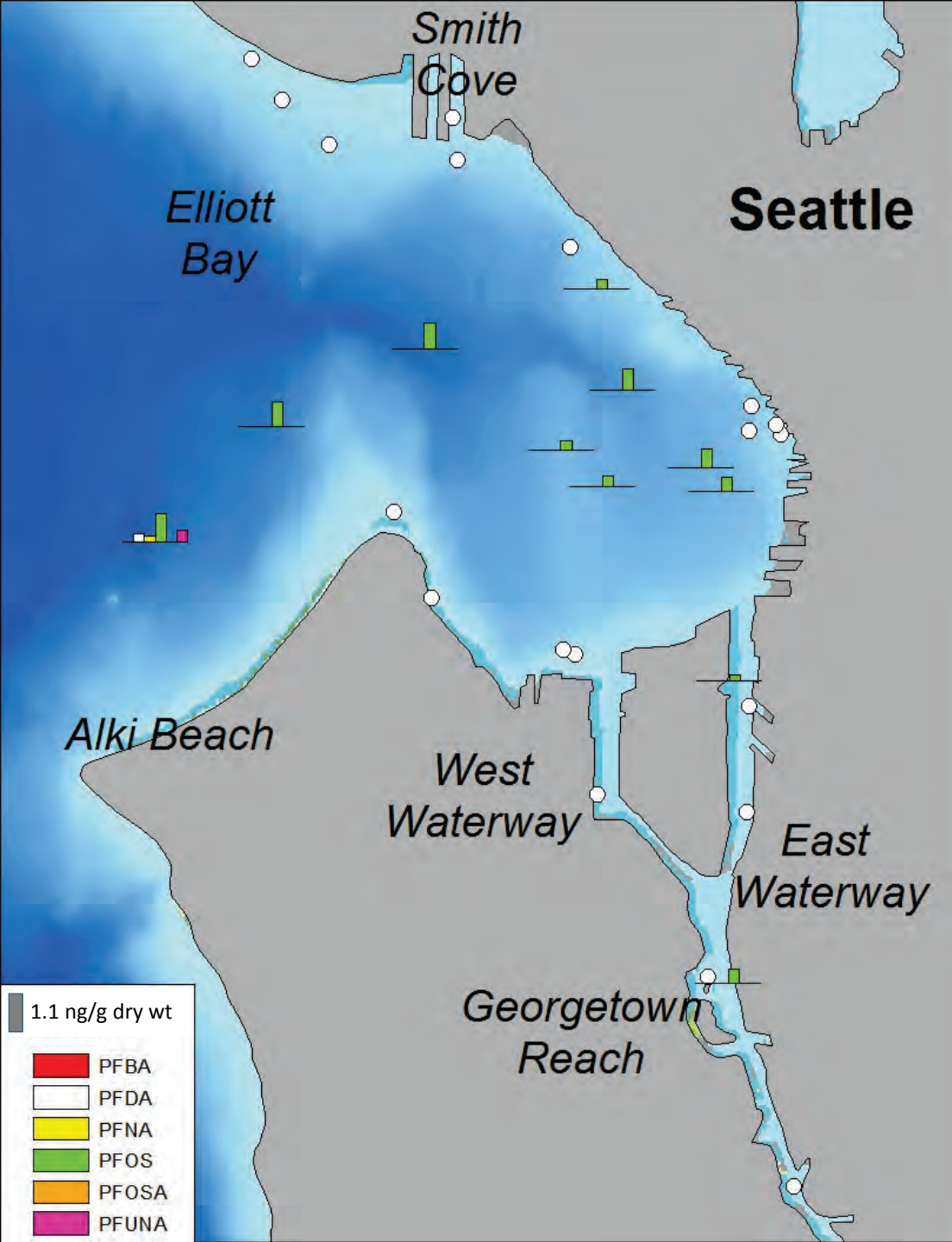
- Detected at over half of stations
- Up to 24x the Reporting Limit
- Waterways, shoreline, deep central



Diphenhydramine (antihistamine)



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

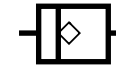


Perfluoroalkyl Substances

Perfluorooctanesulfonate (PFOS)

Elliott Bay

Detected



Rpt Limit

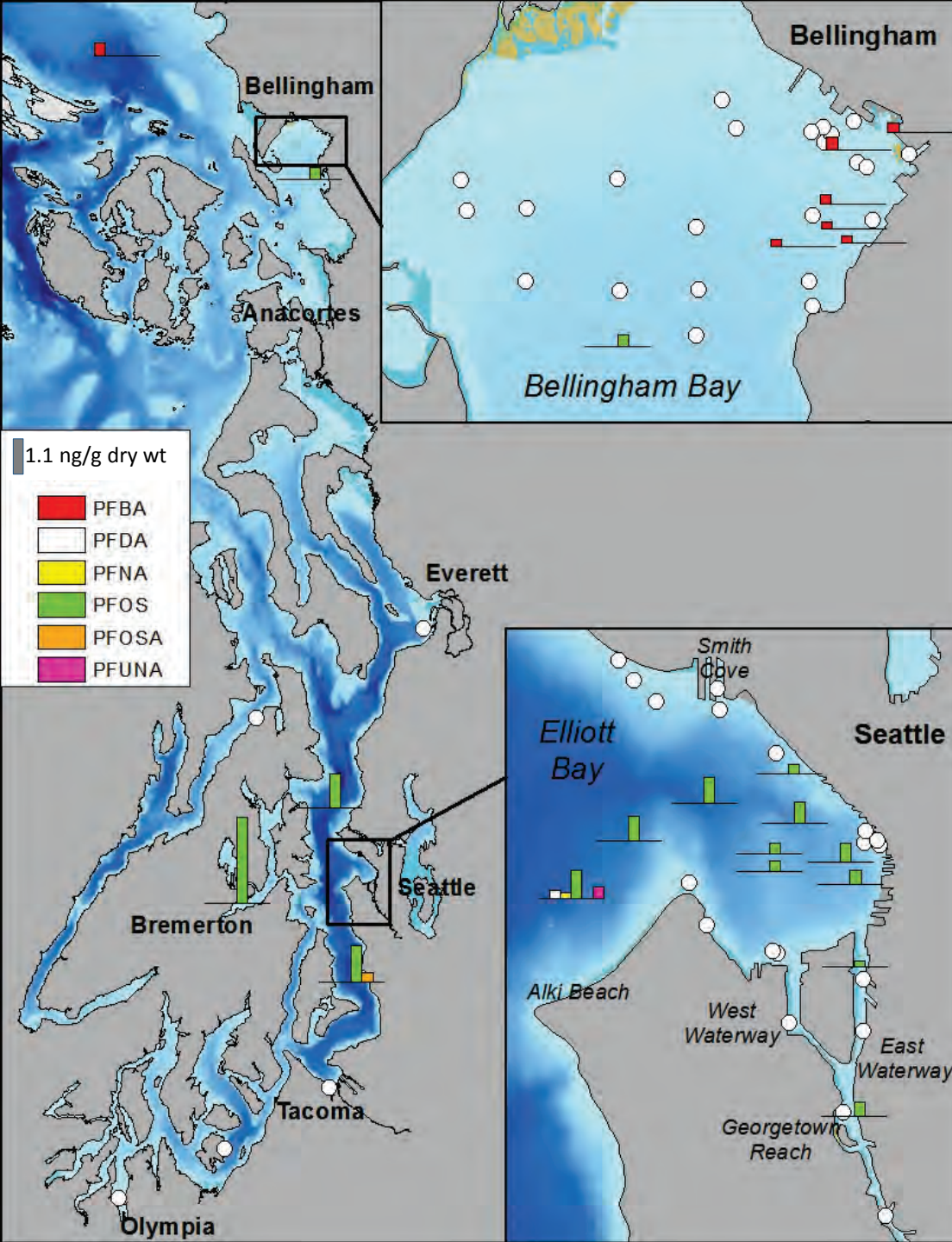


Detects: 11 of 30

Conc'n/RL: 0.5 - 2

0.0 0.5 1.0 1.5
Concentration (ng/g dry wt)

- 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

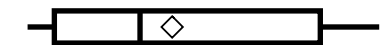
(n = 1 of 30)

Rpt Limit



Long-Term

Detected



Rpt Limit



0.0 0.5 1.0 1.5
Concentration (ng/g dry wt)

- 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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- **Wendy Eash-Loucks** – Elliott Bay outfall maps
King County Department of Natural Resources

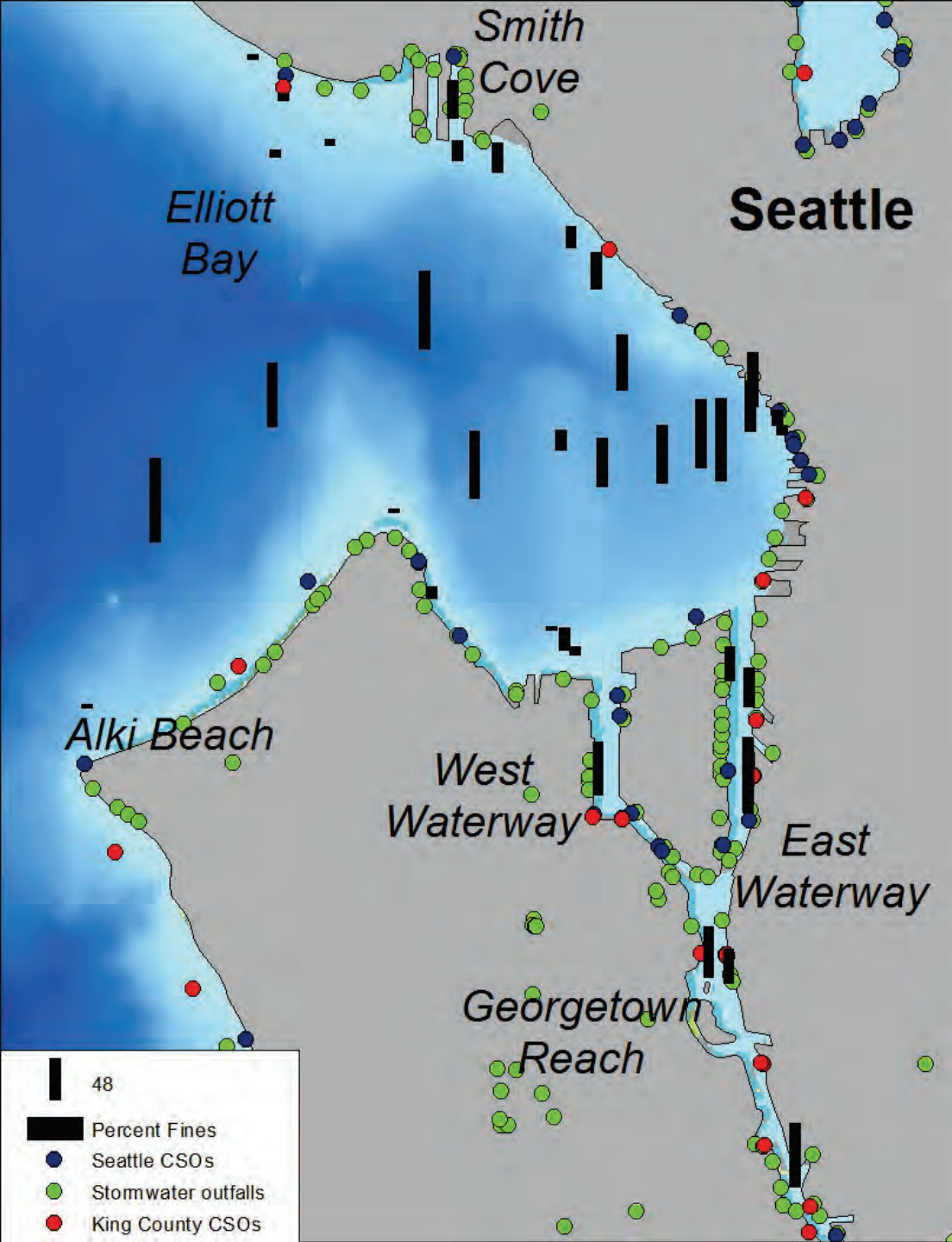


Further information:

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

