Contaminants of Emerging Concern and Ecosystem Management in Puget Sound

Andy James

University of Washington Tacoma

Center for Urban Waters

University of Washington Tacoma at Center for Urban Waters

Photo credit: Cody Char

<u>Water Quality Research</u>

- Investigate the occurrence, treatment, and effects of Contaminants of Emerging Concern
- Improving methods for bacteria source tracking
- Stormwater treatment and impacts

<u>Ecosystem Modeling</u>

- Food web interactions
- Habitat (aquatic resources) requirements and status

<u>Ecosystem Recovery and Adaptive Management</u>

- Evaluating the effectiveness of restoration/recovery/protection programs and activities
- Improved science communication

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Investigating the occurrence of Contaminants of Emerging Concern

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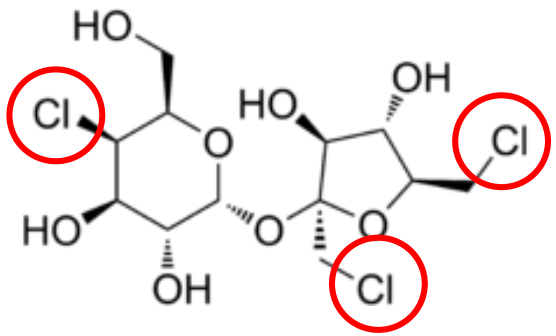
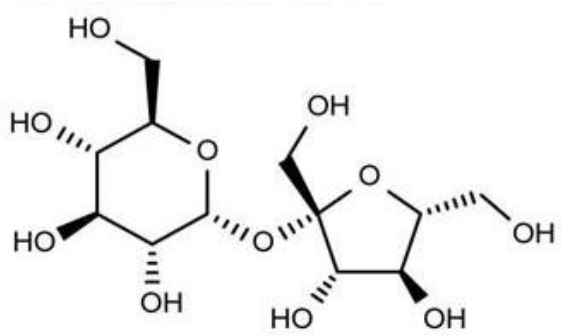
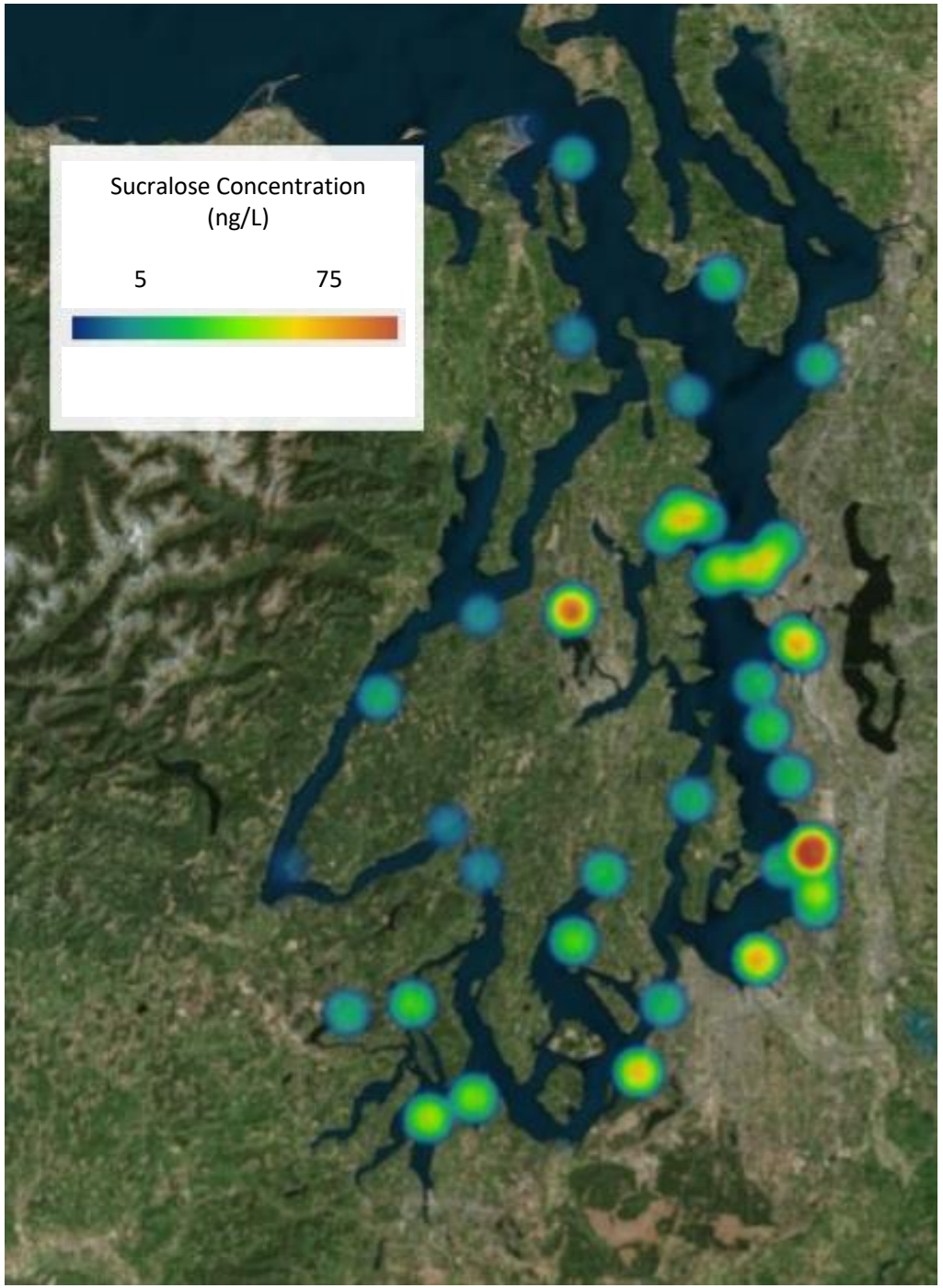
Sucralose



Sucralose

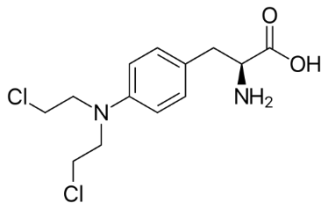


Sucrose



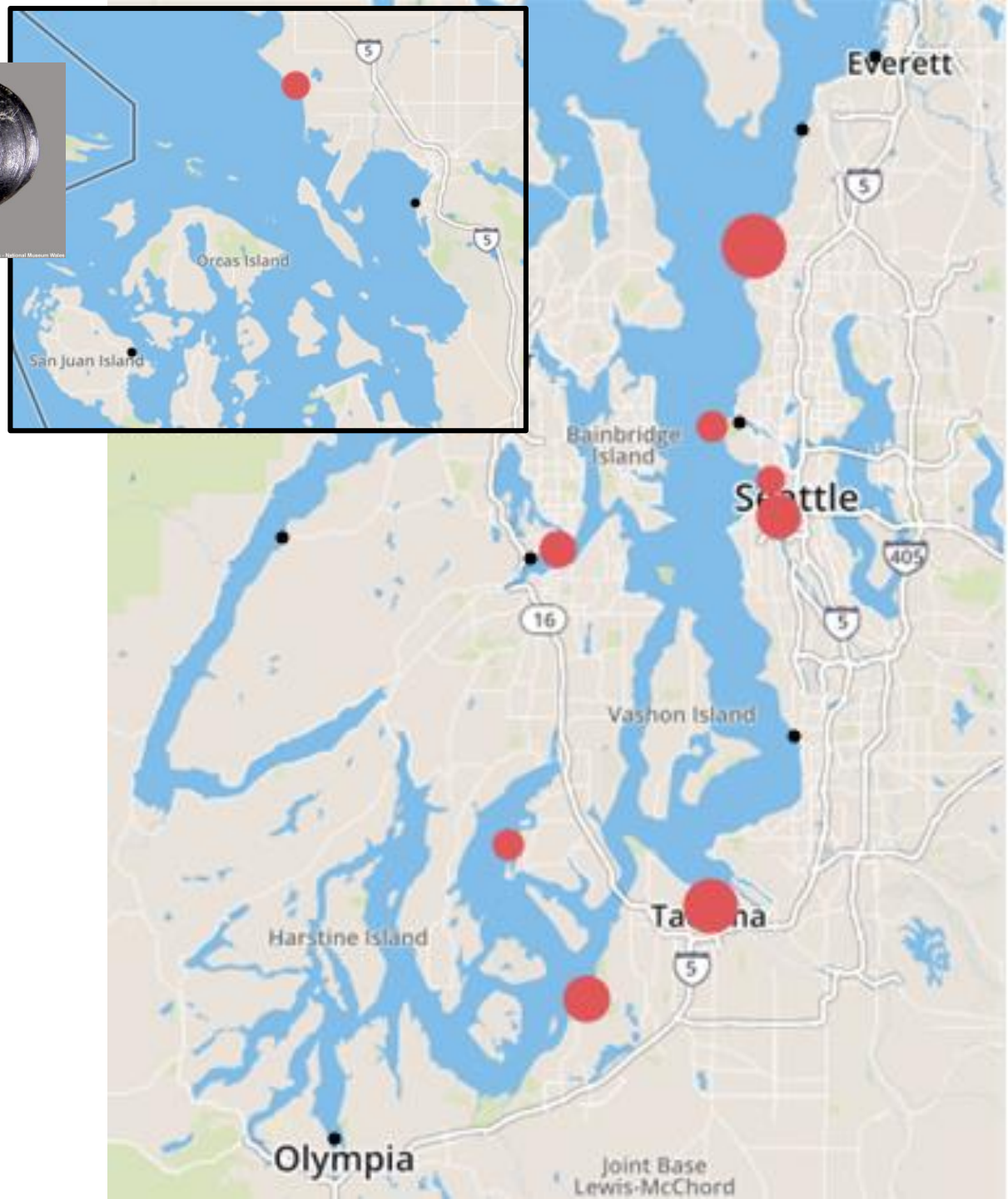
Justin Miller-Schulze, 2015

Melphalan
(chemotherapy drug)



Carcinogen due to DNA interactions

Shown to induce heritable deletions and mutations in male germ cells (mice)



Values in ng/g (wet weight)

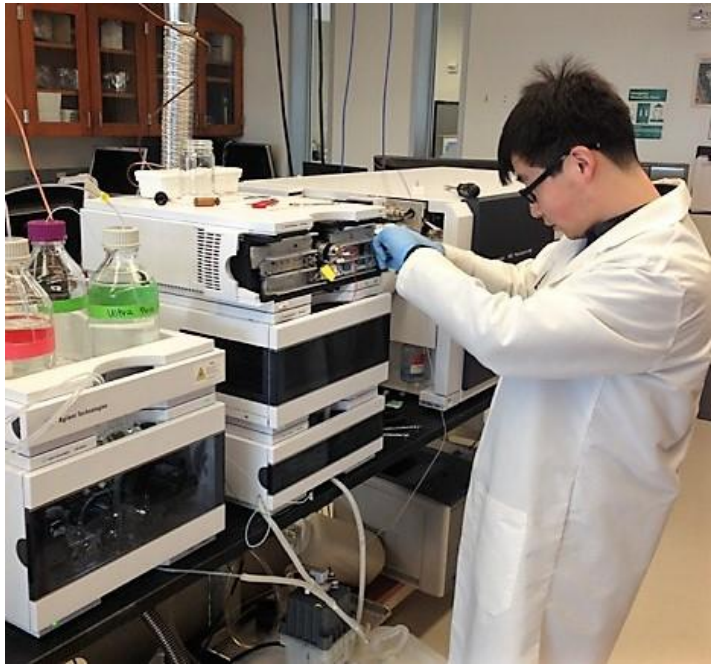
Contaminants of Emerging Concern

- Wide range of chemicals in water and biota
- Some of them appear to be at levels of environmental concern

- Expand the scope of the investigation

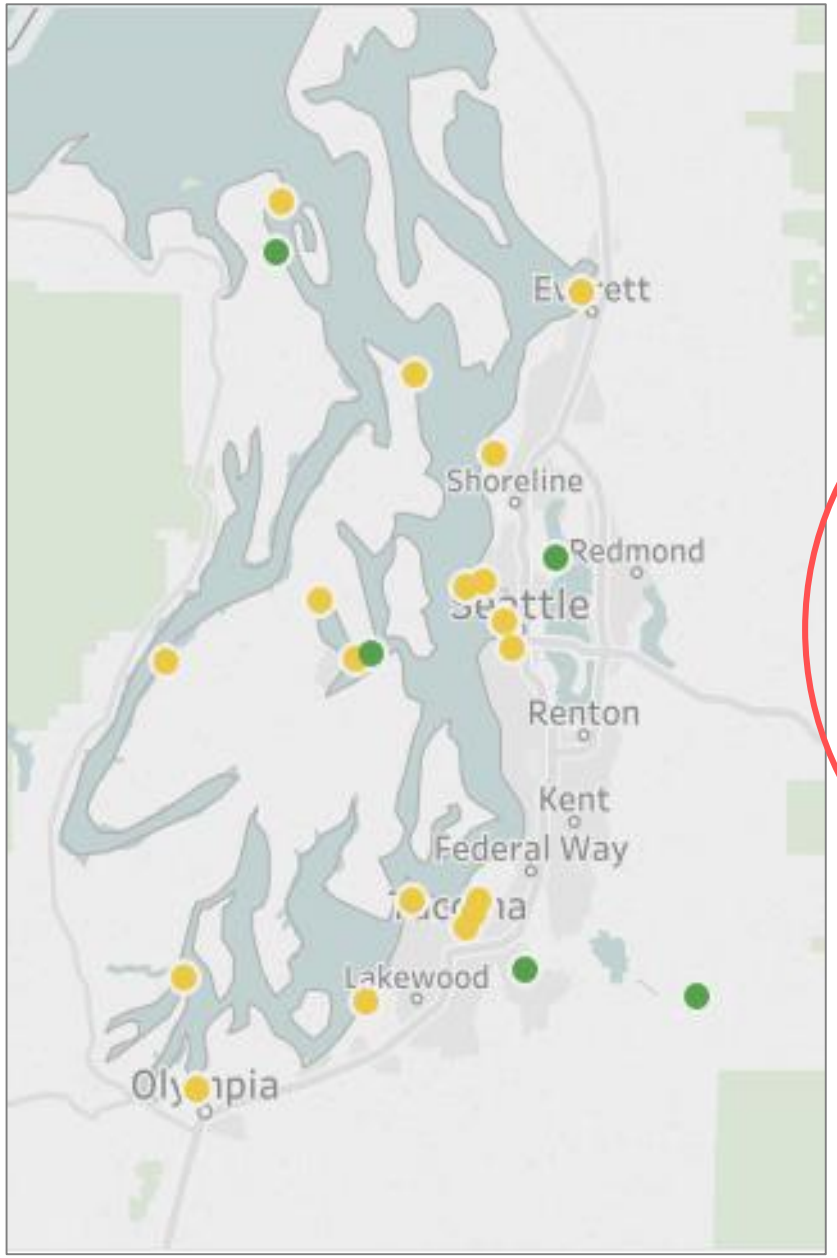
High resolution mass spectrometry

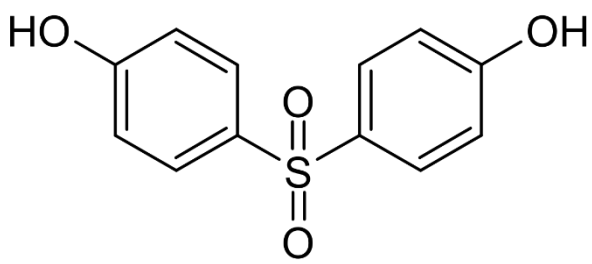
- Allows the acquisition of large amounts of chemical information in a given sample
- Increases capability of compound identification
- Post-processing and analysis → identification of patterns and fingerprints



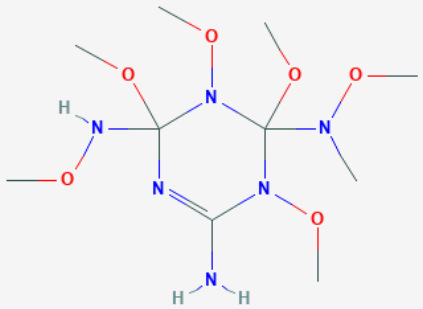
LC-MSMS/QToF

Characterizing Occurrence of CECs in Puget Sound

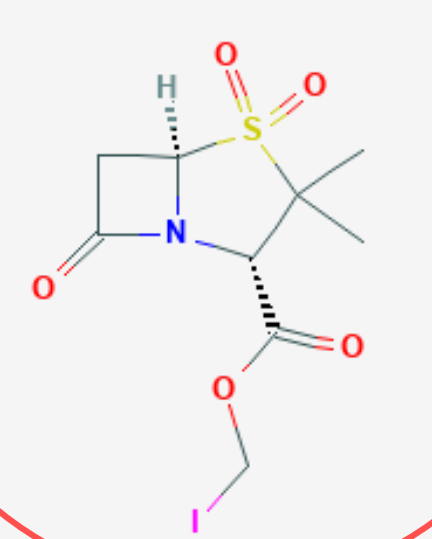




Bisphenol S



Hexa(methoxy) methyl melamine



Iodomethyl sulbactam

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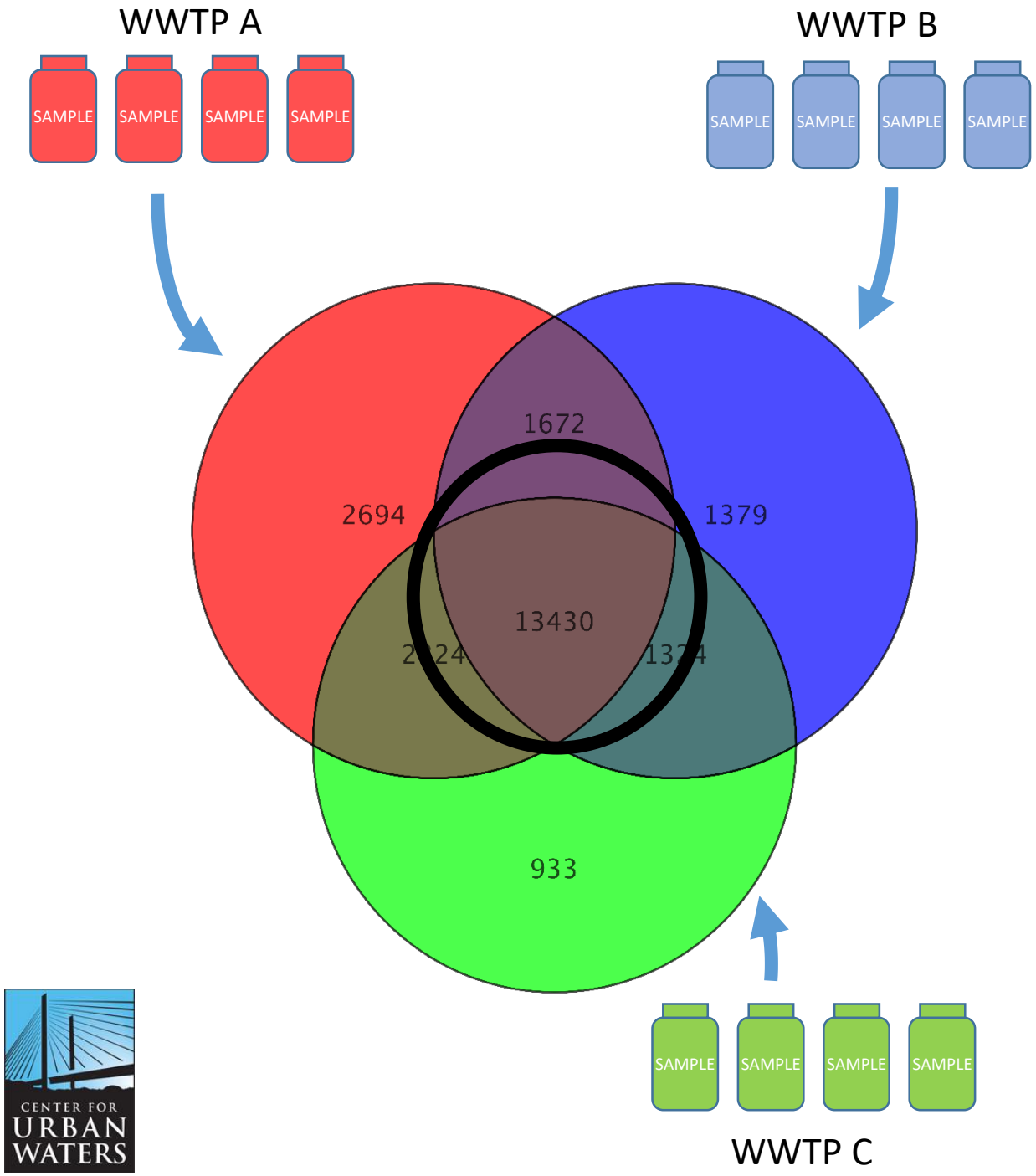


Source Fingerprinting

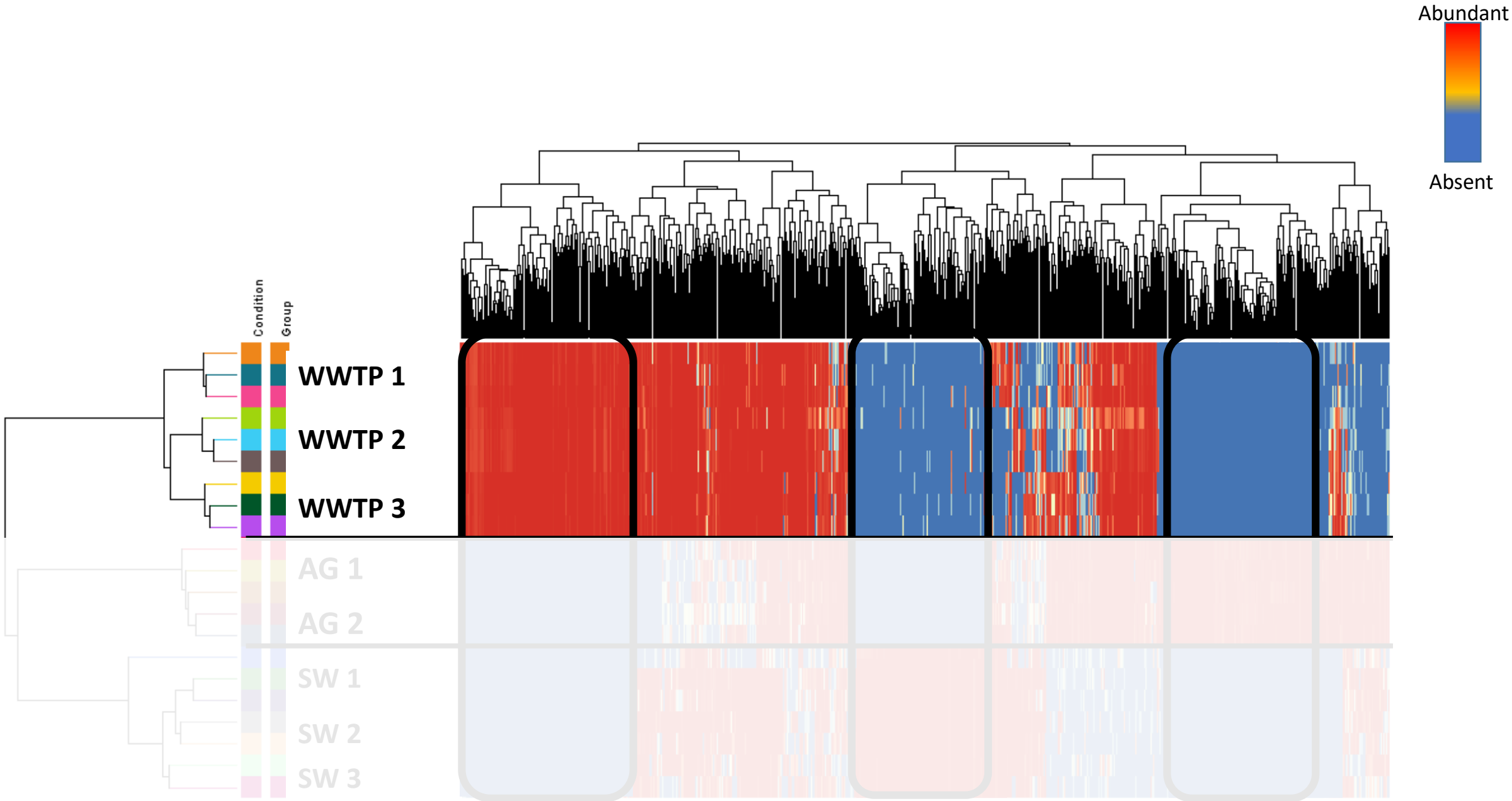
Identify suites of compounds that are unique to, and consistently found in, a given source

- WWTP effluent
- Stormwater
- "Synthetic" OSS effluent
- Boat waste and additives
- Components – Tire leachate

Supports evaluation of spatial and temporal occurrence from various sources

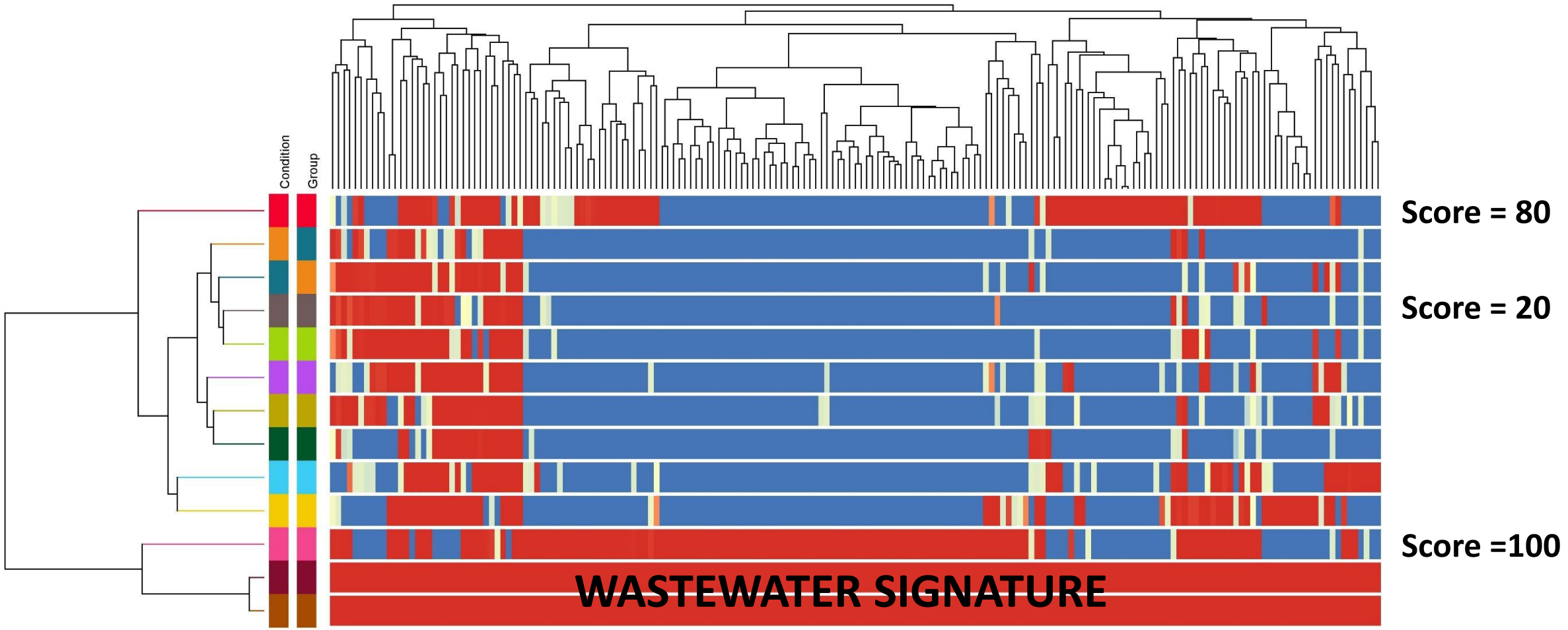
Supports evaluation of exposures

Source Fingerprinting – wastewater, stormwater, and agricultural runoff



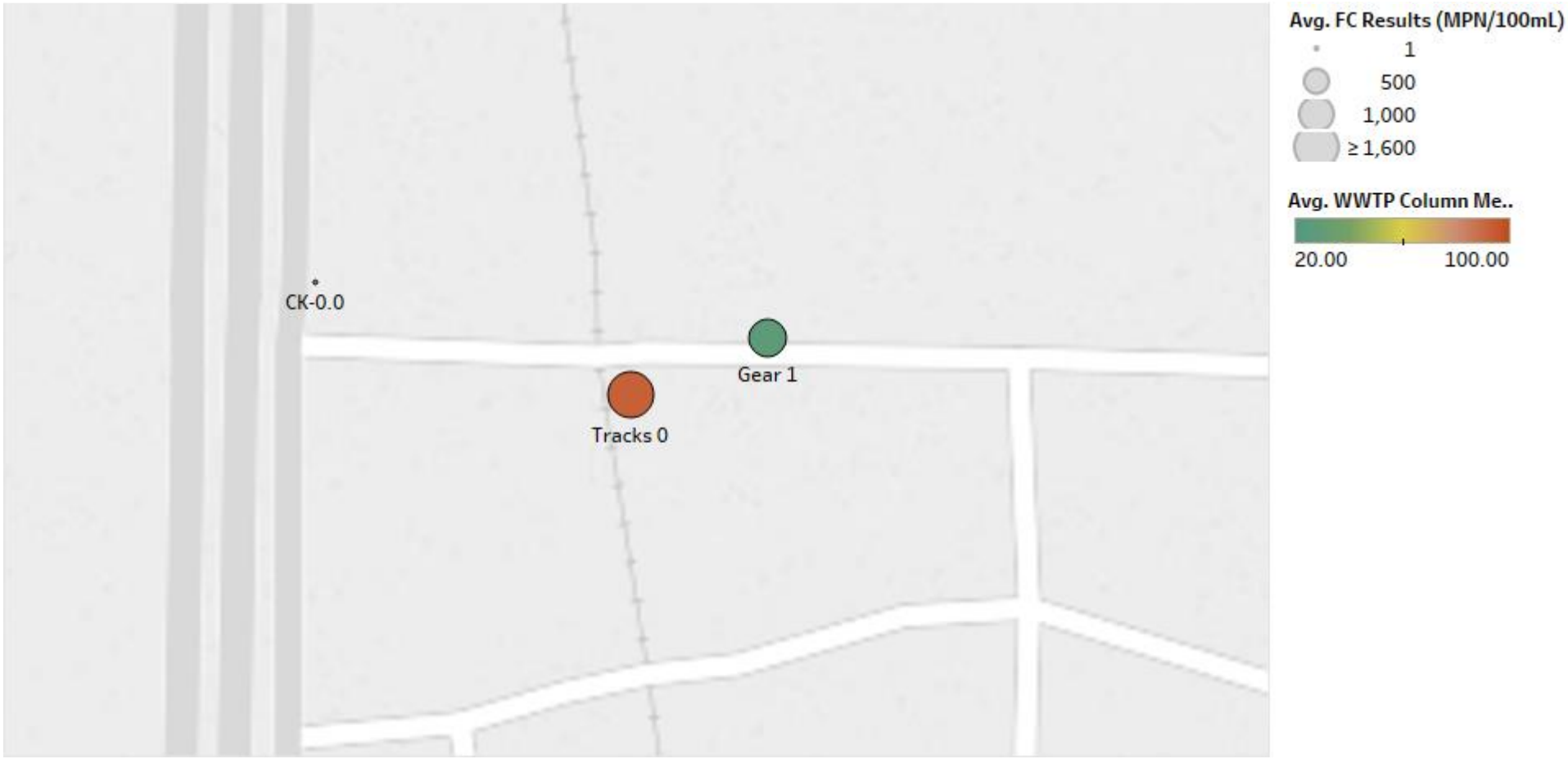
Compare Wastewater Signature to Field Samples

- Add up relative abundance measurement for all compounds in all samples to create relative impact score



Examples

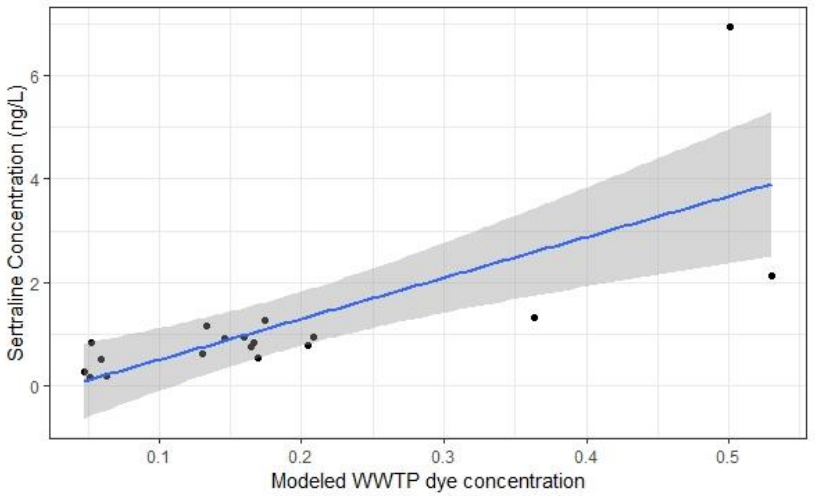
- FC > 1000 at two sites
- Wastewater signature suggest different sources
- Cross check with occurrence of use-specific chemicals



Utilization of Salish Sea hydrodynamic model to evaluate transport and exposure

WWTP Effluent

- Measured contaminants/signatures to truth model output
- Use output to predict spatial and temporal variations in exposures



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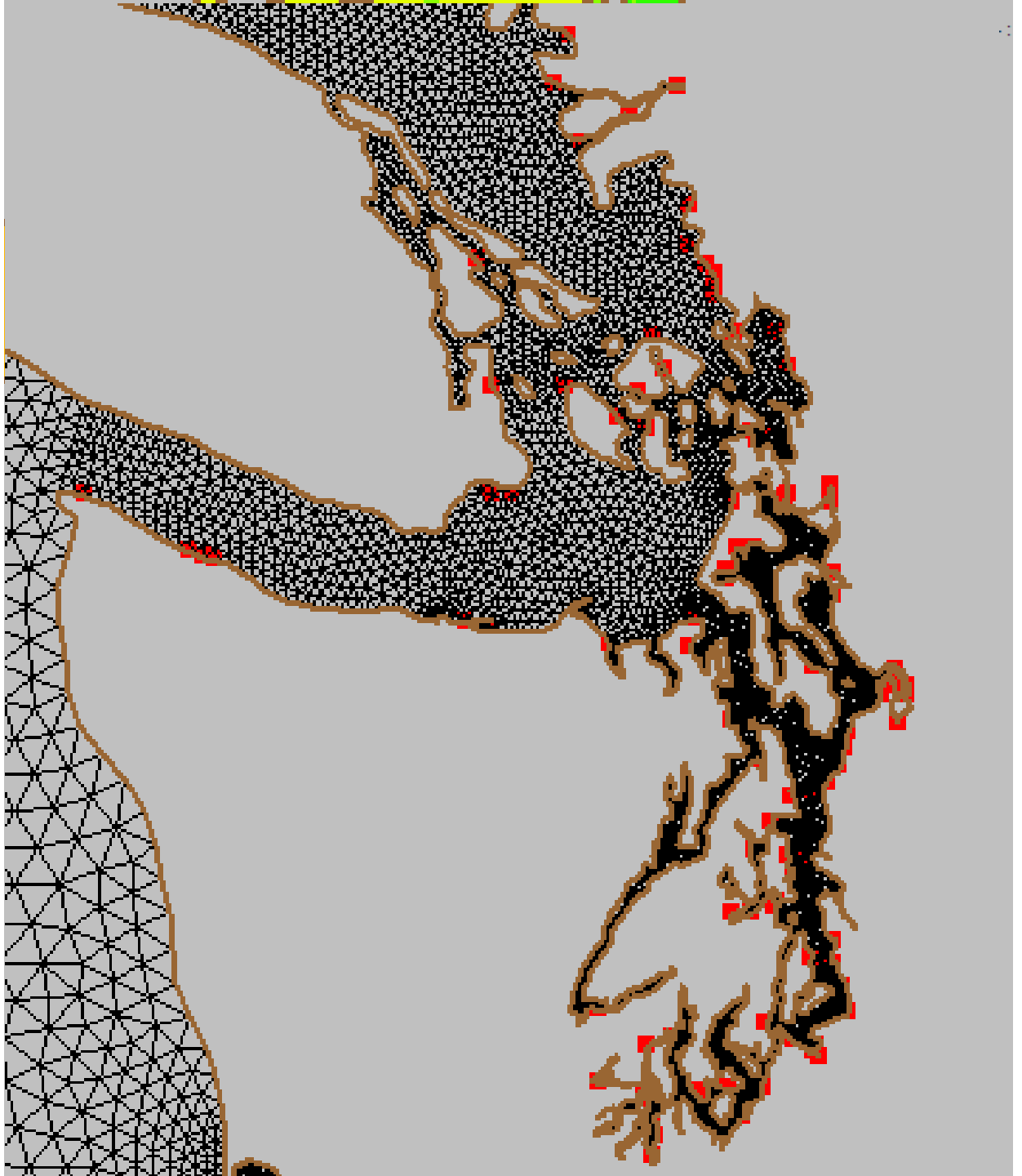
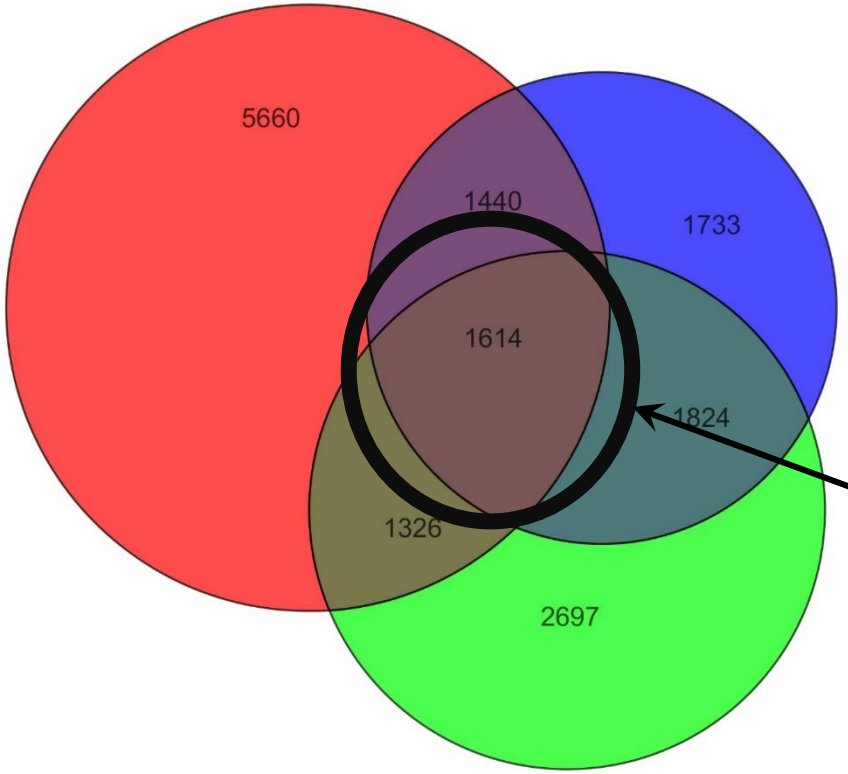


ENDOCRINE DISRUPTION A

SAMPLE SAMPLE SAMPLE SAMPLE

ENDOCRINE DISRUPTION B

SAMPLE SAMPLE SAMPLE SAMPLE



SAMPLE SAMPLE SAMPLE SAMPLE

ENDOCRINE DISRUPTION C

Investigate and Identify chemicals that are associated with **biological impacts**

- Endocrine disruption (e.g. vitellogenin in fish)
- Biomarker response
- PreSpawn Coho Mortality

Candidate chemicals

Source fingerprints
HRMS compound identification

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Prioritization of Contaminants of Emerging Concern

Regional working group

- UW, WSU, WWU, Washington Department of Fish and Wildlife, Washington State Department of Ecology, King County, etc.
- Risk based approach based on EU NORMAN framework through collaborative partnership
- Aligns with outcomes/recommendations from regional ecosystem management programs
  - National Estuary Program
  - Governor's Southern Resident Killer Whale task force
  - New regulation via Washington State Department of Ecology
  - Columbia River Toxics Reduction Working Group

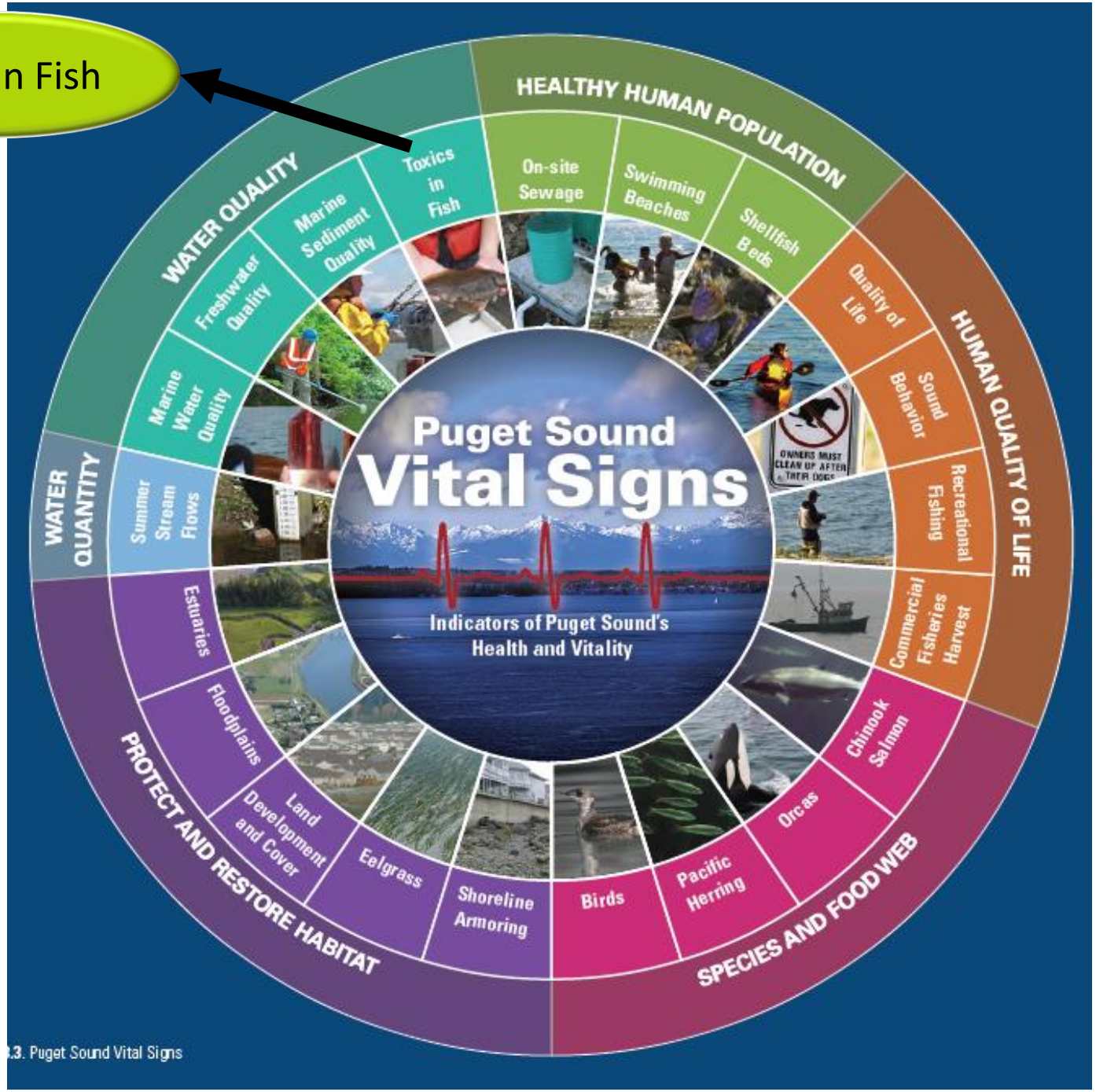
Framework for Ecosystem Recovery and Management under National Estuary Program

Toxics in Fish

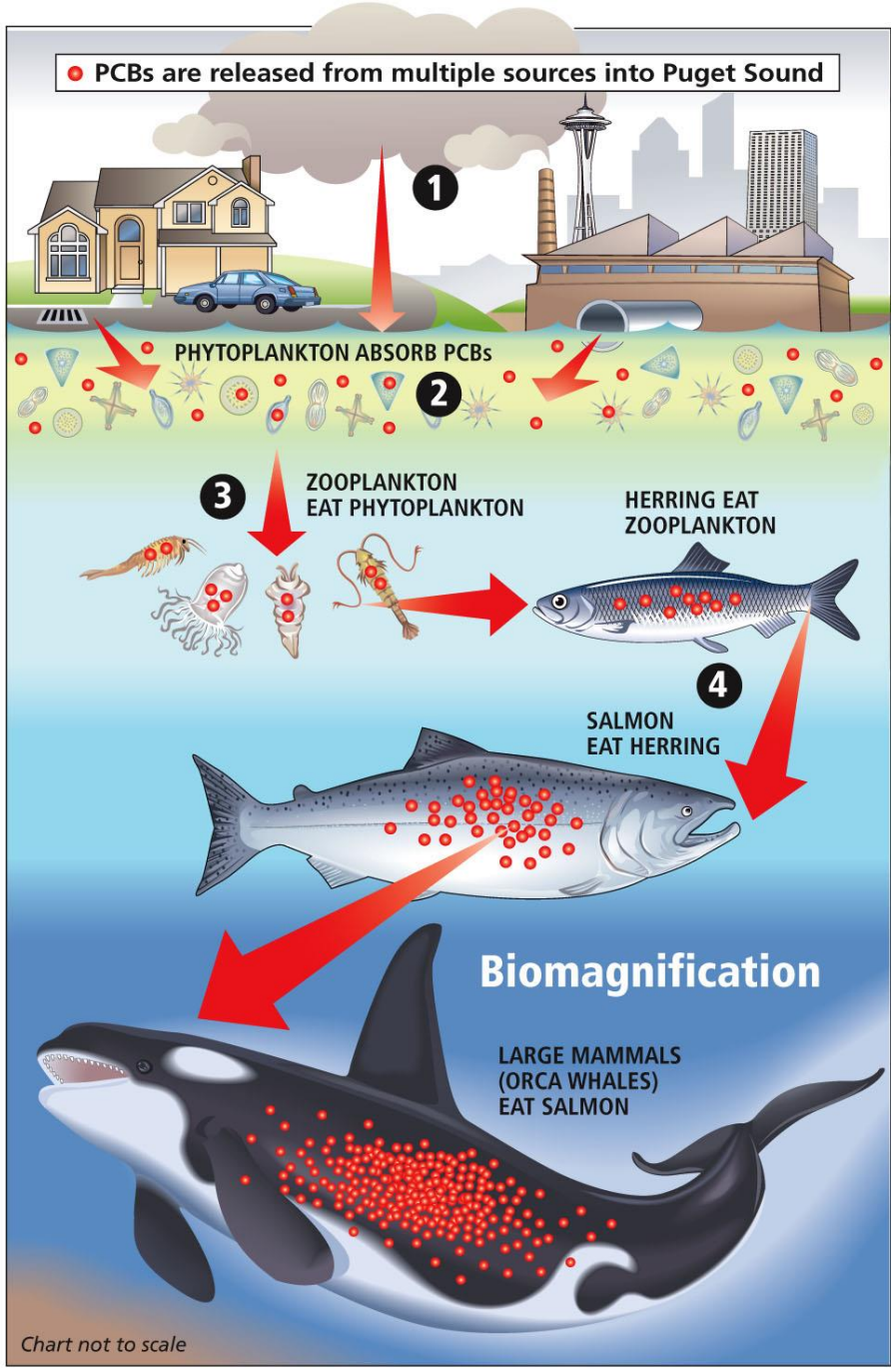
Puget Sound: Vital Signs linked to **Ecosystem Components**

Develop recovery plans focusing on a suite of ecosystem indicators and targets

Toxics in Fish
Fish populations not harmed by toxics contaminants and fish safe for consumption by predators and humans



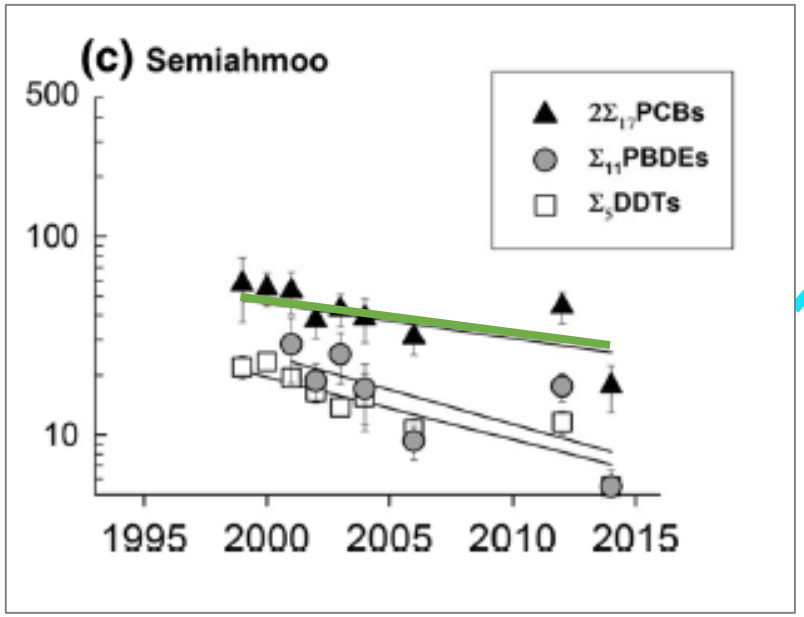
3. Puget Sound Vital Signs

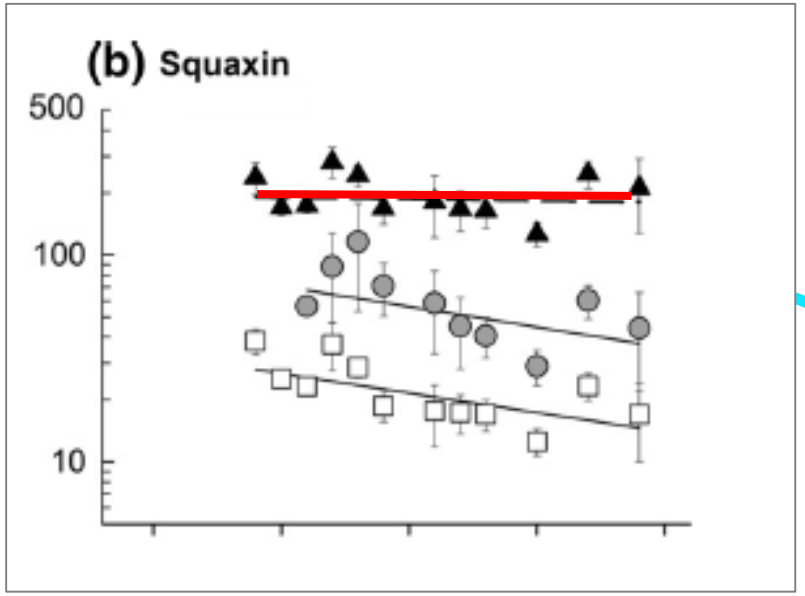


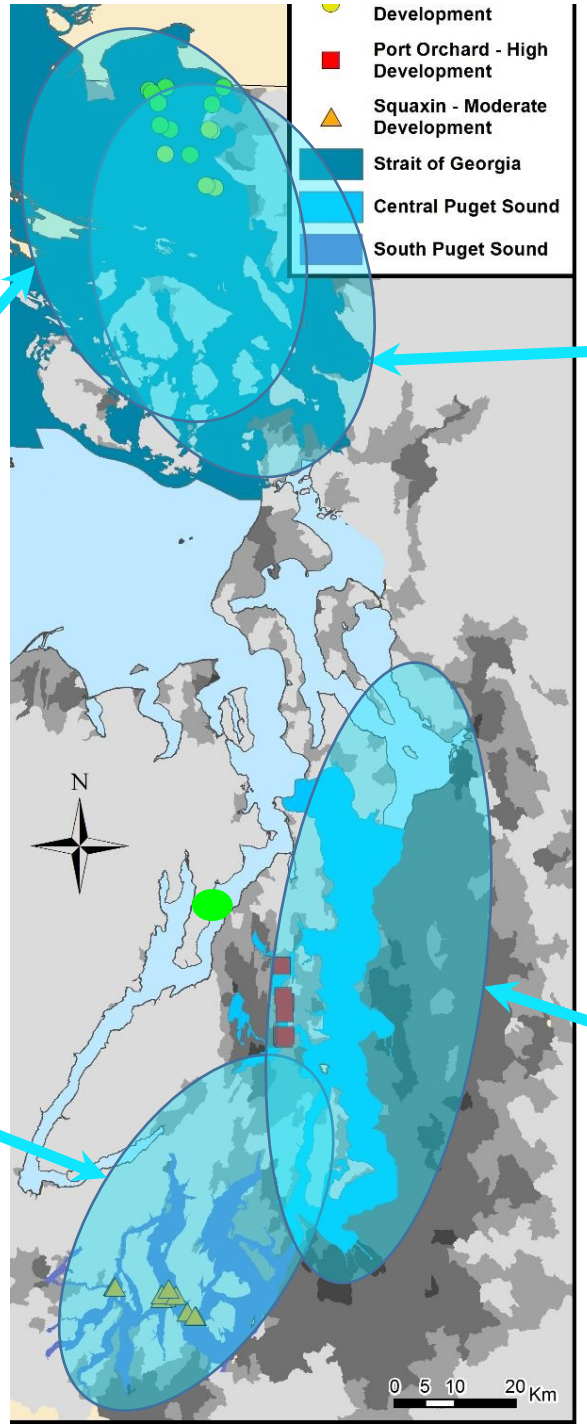
Source: Seattle Post-Intelligencer “The Zone” thezone@seattlepi.com

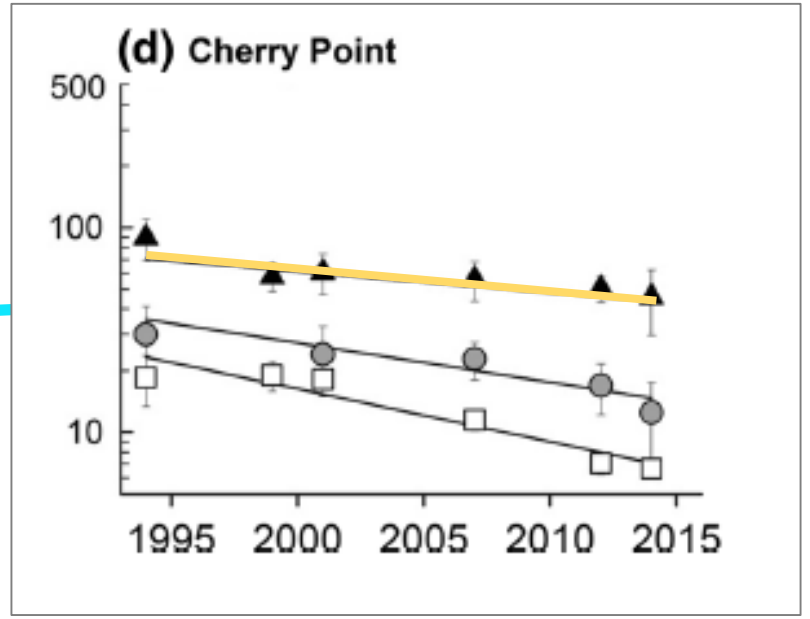
Herring (pelagic food web)

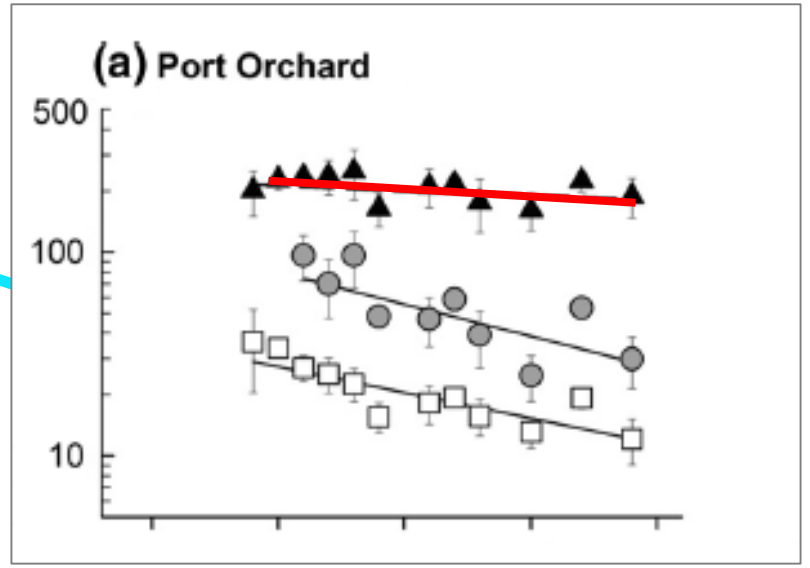
PCBs in Herring











West et al, 2017

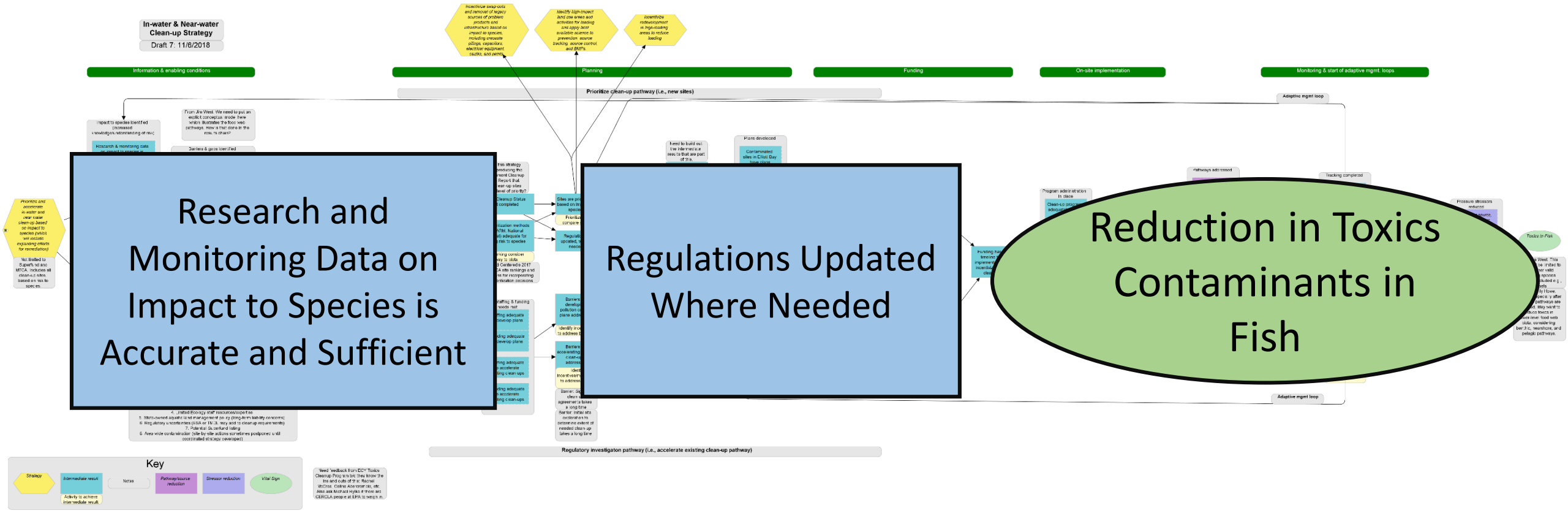
Toxics in Fish Implementation Strategy

Regional Open Standards-based process

- Compile state of knowledge
- Identify causes, barriers (including gaps in information), and opportunities for recovery with group of regional experts
- Identify conceptual models (Results Chains)
- Identify strategies, approaches, and actions (including research and monitoring)

Toxics in Fish Implementation Strategy

Strategy: In-water and Near-water Clean Ups



Toxics in Fish Implementation Strategy

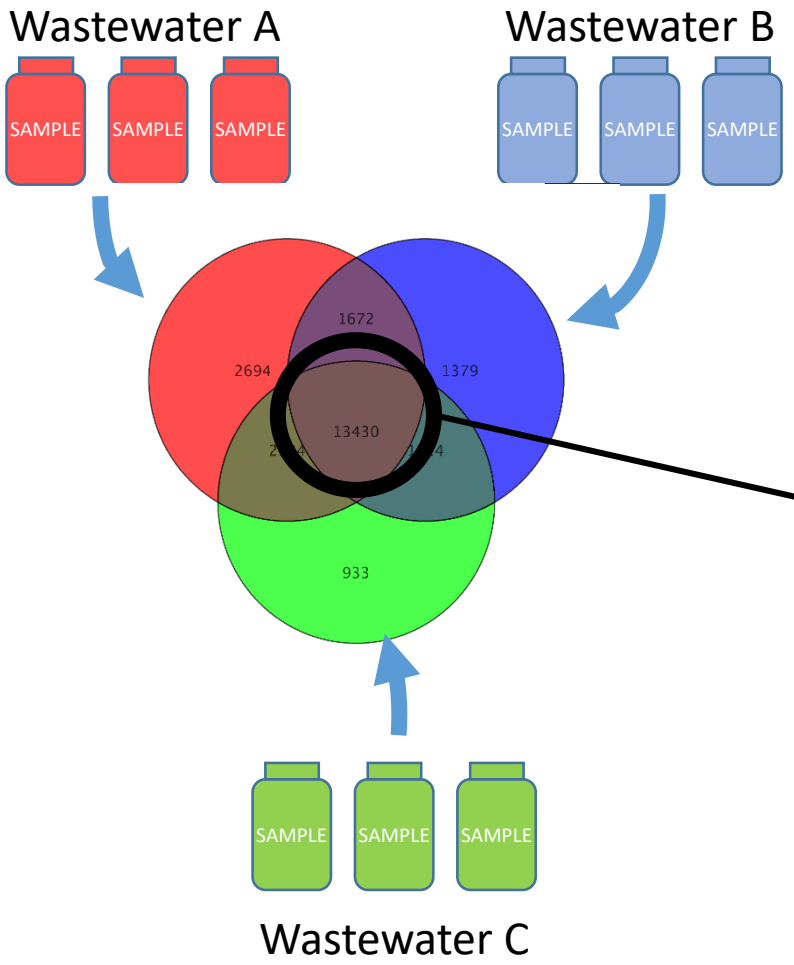
Benefits –

- Potential to focus and prioritize investments
- Potential to build regional support for ecosystem management projects
- Identify and Prioritize Research and Monitoring Gaps

Challenges –

- Managing group of experts from broad sectors to focus on specific environmental issue is difficult
- Often not clear or consistent messages from group
- Participants have varying areas of expertise
- A lot of time is required to provide Best Available Science

Thank You



- Identify chemicals that are present in multiple replicates for multiple events (minus process blanks)
- Compare those to field samples

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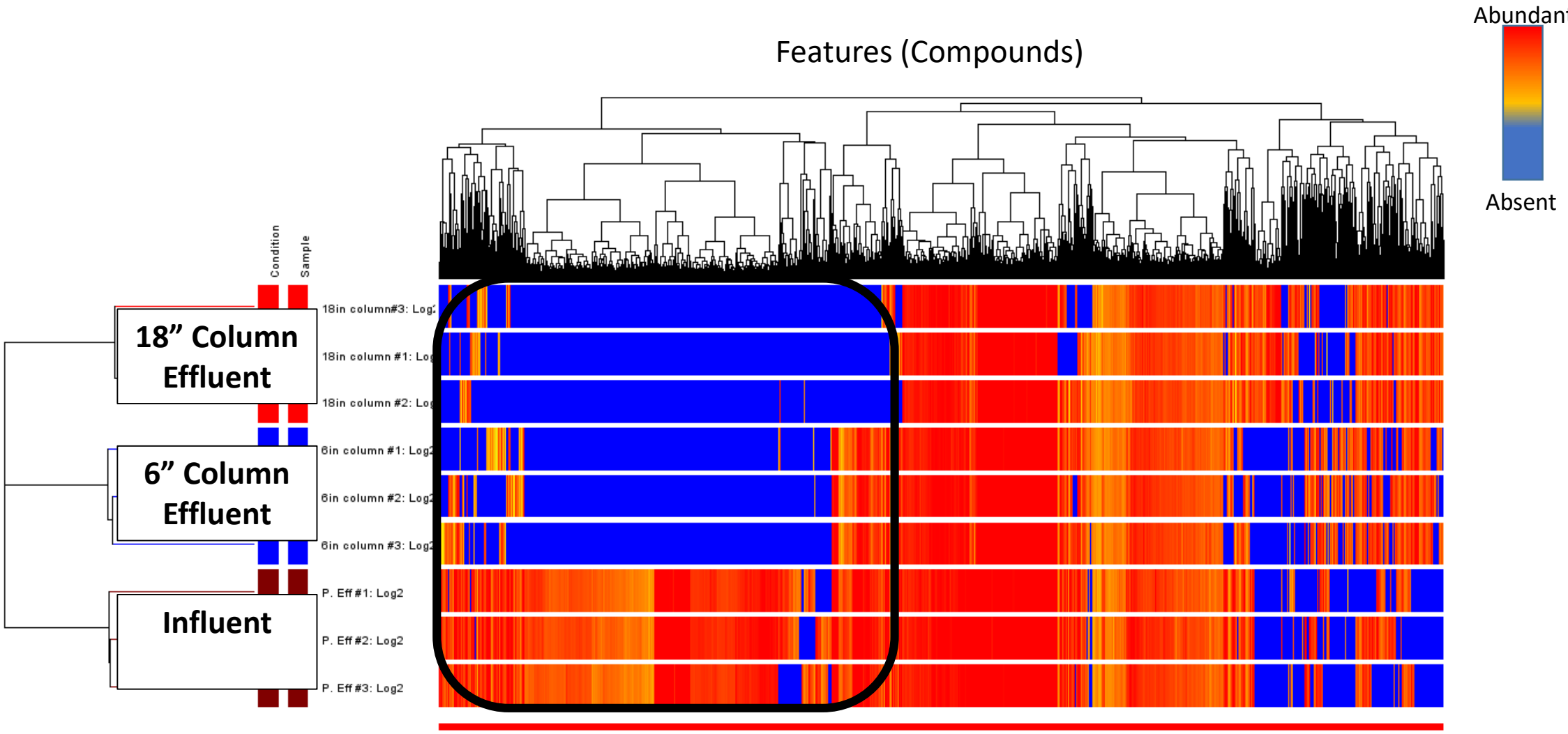
Evaluation of Treatment System Performance
Removal of Trace Organic Contaminants through Soil Columns

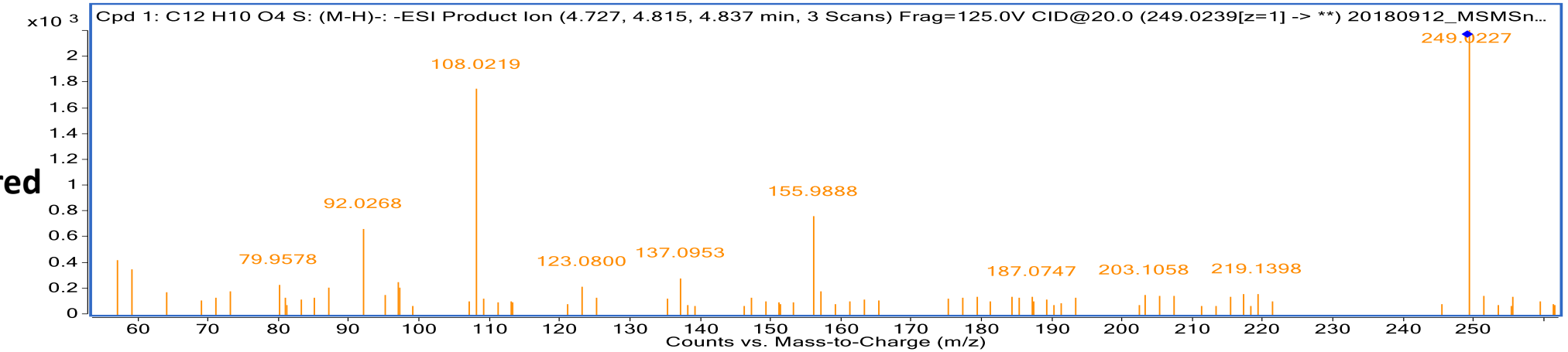


Bisphenol S (S2a)

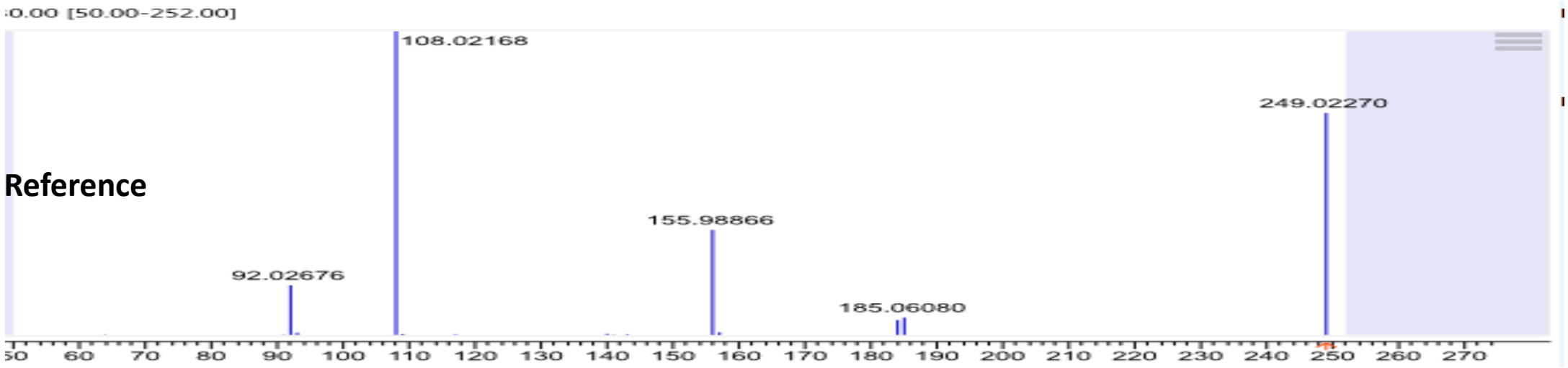
Compound identification

- Retention time
- Accurate mass of parent compound
- Fragment mass and fragment patterns

Measured

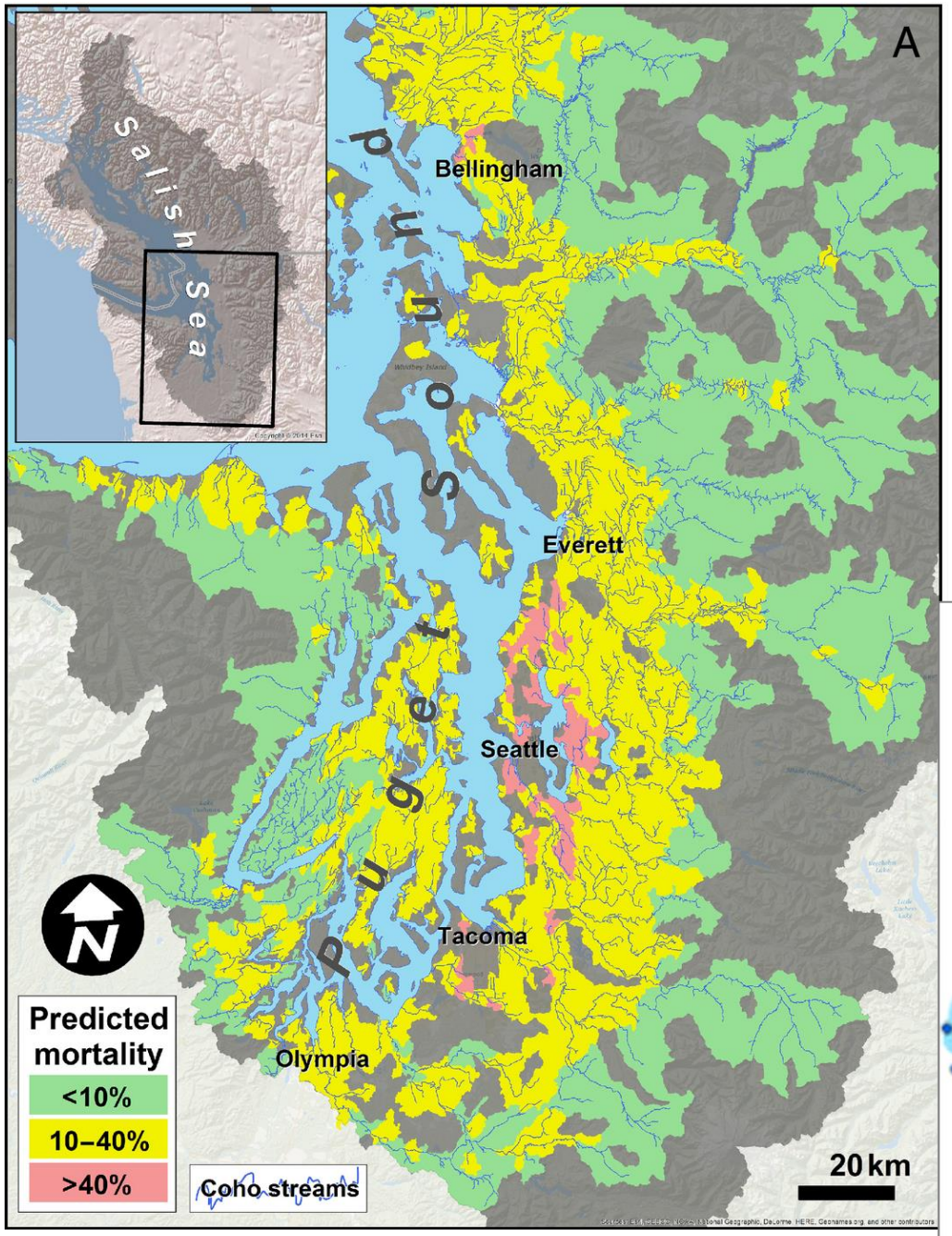


Database Reference



Salish Sea Model Development

- Utilize land use characterization and existing runoff predictions to incorporate stormwater inputs
- Develop “toxics module” to allow incorporation of fate and transformation considerations



Feist et al. Ecological Applications. 2017.