Approaches to Quantifying Sources of Chemical Pollutants to Puget Sound

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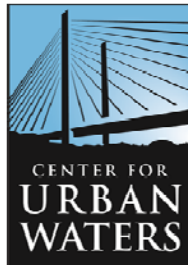

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Question for Today

Do we have the technology and scientific understanding to quantify both the absolute and relative magnitudes of pollutant sources to surface waters?

Why is this important?

Total Maximum Daily Load (TMDL) is a major tool used to implement the Clean Water Act

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Outline for Today

- Brief review of approach to non-point source pollution management via TMDLs
- Discussion of approaches to quantify pollutant loads
- Example of an under-utilized approach with great promise
- Conclusions

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Total Maximum Daily Loads

Section 303(d) of the Clean Water Act

- EPA published final rule implementing 303(d) on July 13, 2000, driven by a series of successful citizen's suits
- A water quality based approach to pollution abatement (rather than end of pipe limits)
- Focuses on non-point source pollution

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U.S. EPA Total Maximum Daily Load Program

- Designate *beneficial uses* for Nation's waters
  - Fishing
  - Swimming
- Develop *water quality criteria* to protect beneficial uses (e.g., dissolved oxygen to protect fish; bacteria to allow swimming)
- Analyze *monitoring data* relative to water quality criteria
- Where standards are not met, water body is placed on the *Impaired Waters List*.

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U.S. EPA Total Maximum Daily Load Program

- Authorizing Federal Legislation: Clean Water Act Section 303
  - For water bodies on the Impaired List, conduct further assessment of *pollutant loadings* and ambient conditions
  - Complete pollutant load allocation formula
  - Complete and implement restoration strategy
  - Monitor changes in water quality
  - Remove water body from Impaired List based on monitoring results

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Estimating Pollutant Loads

Requirement: For each *impairing substance*, must derive a numerical objective (water quality criteria). For example:

- The PCB concentration in sediment must be lower than that which would result in a fish tissue consumption advisory
- Dissolved oxygen concentrations must exceed 4 mg/L during critical fish spawning times

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Estimating Pollutant Loads

Requirement: One or more models that relate the maximum allowed pollutant concentration to the total external pollutant loading.

e.g., What is the maximum amount of copper that may be discharged into a river without exceeding the numeric water quality criteria?

Concentration = *f*(Loading)

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TMDL Formula

TMDL = LA(s) + WLA(s) + Margin of Safety + Reserve Capacity

LA = load allocation from nonpoint sources (kg/year)

- runoff
- release from contaminated sediment
- atmospheric deposition
- agricultural runoff
- on-site septic systems
- shipping and other transportation
- others

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TMDL Formula

TMDL = LA(s) + WLA(s) + Margin of Safety + Reserve Capacity

WLA = waste load allocations from point sources (kg/year)

- industrial discharges
- wastewater treatment plants

Margin of Safety = to account for potential scientific error

Reserve Capacity = set aside for future development

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Problem: Determining the relative importance of source types

- Approach #1 Determine the magnitude of each individual source
  - Expensive and time-consuming
  - Site specific (little collective wisdom)
  - Difficult for 'ambiguous' sources (such as many non-point sources)

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Problem: Determining the relative importance of source types

- Approach #2 Characterize ambient chemical 'fingerprint' in receiving waters and 'back out' sources

Receptors → Source Types


→

+

+ …

Requires:

1. Ambient measurements
2. Distinctive 'tracer' chemicals
3. Multivariate statistics
4. Minimal (or known) environmental chemistry

Good tool for relative importance of source types

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Problem: Determining the relative importance of source types

- Approach #2 Characterize ambient chemical 'fingerprint' in receiving waters and 'back out' sources
  - Well established in air quality studies
  - Requires some non-traditional analytical chemistry
    - Tracer compounds
    - Lower reporting limits
  - Admittedly indirect

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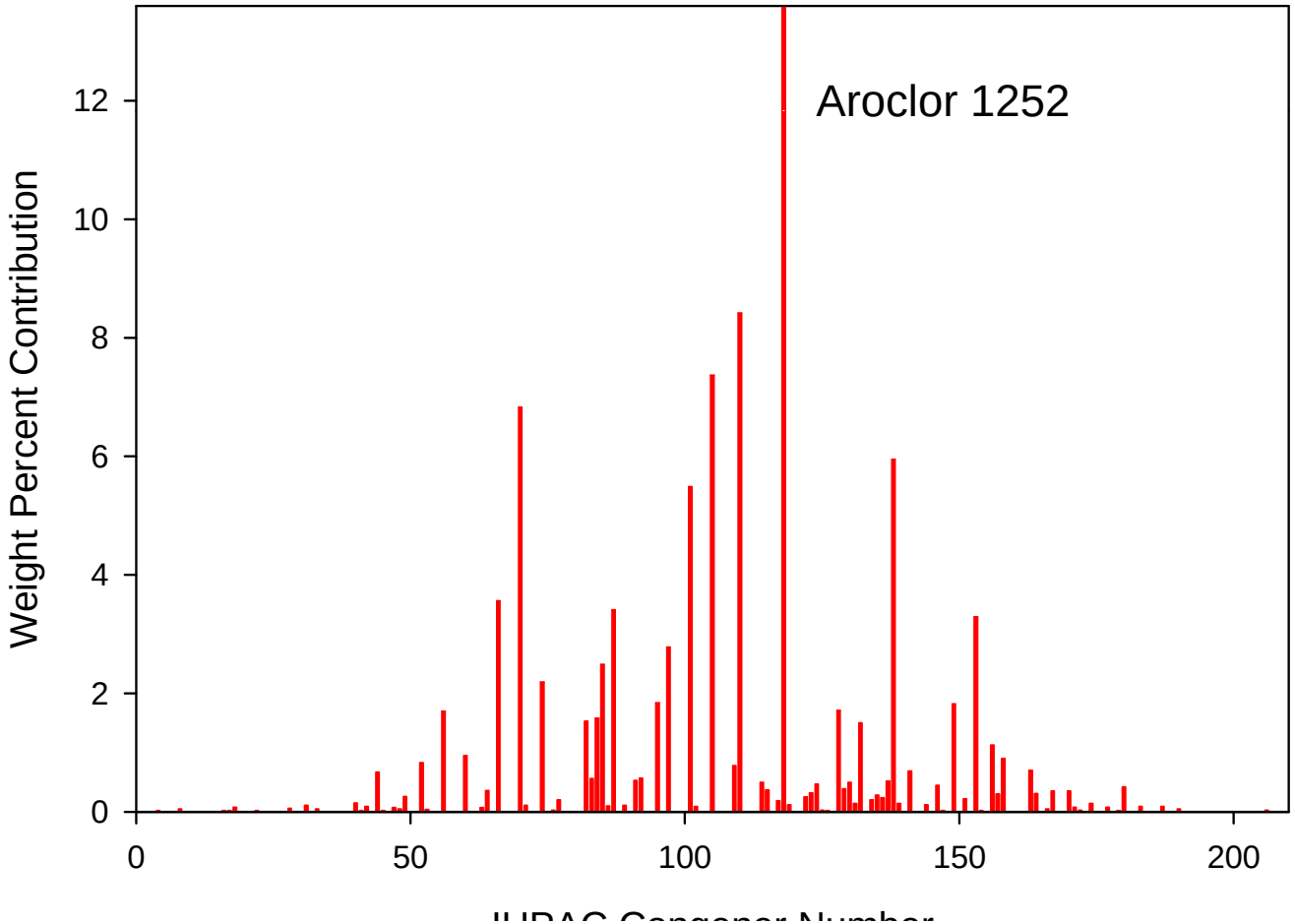
Example:
Sources of PCBs to Chesapeake Bay Fish



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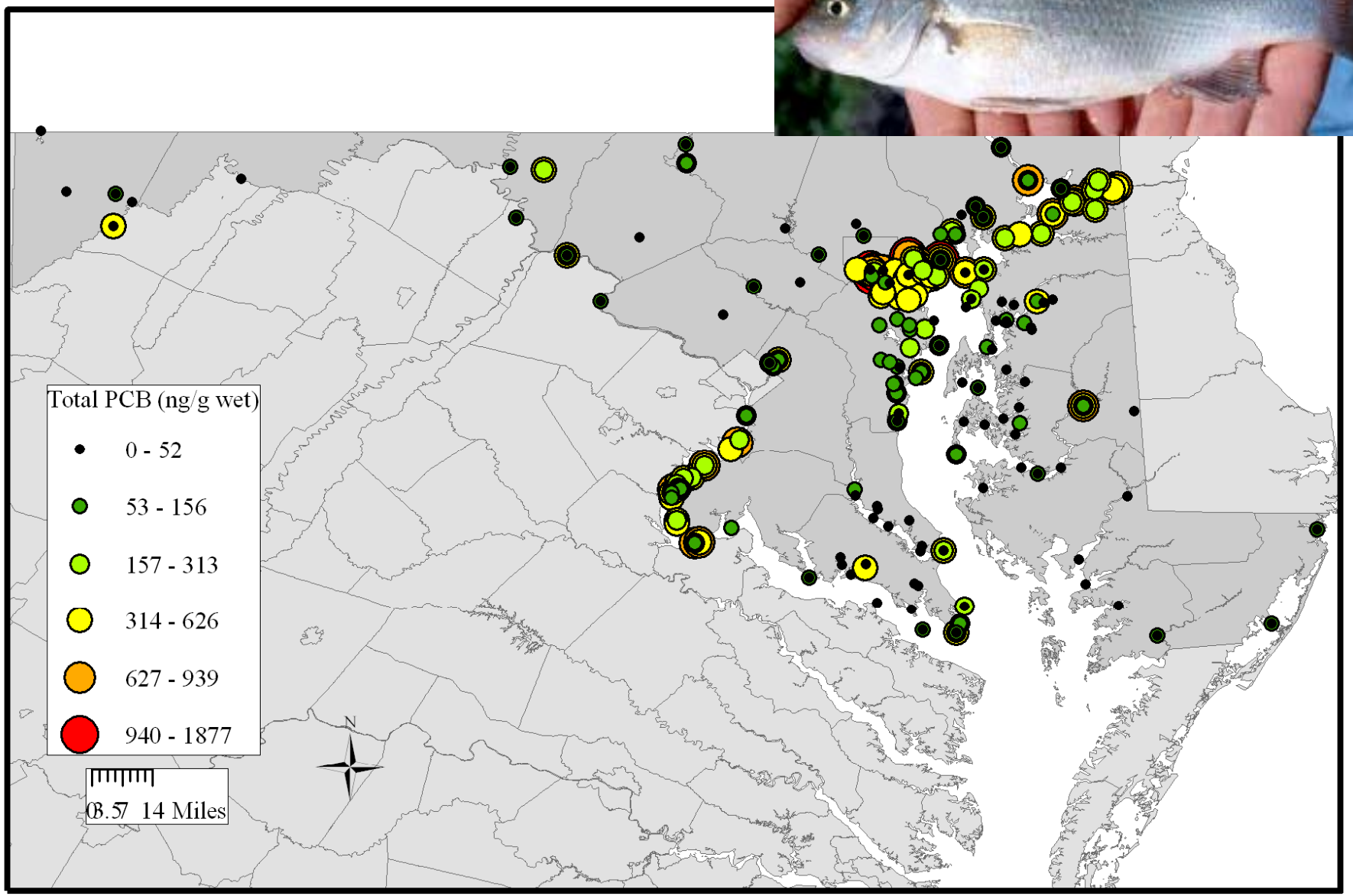
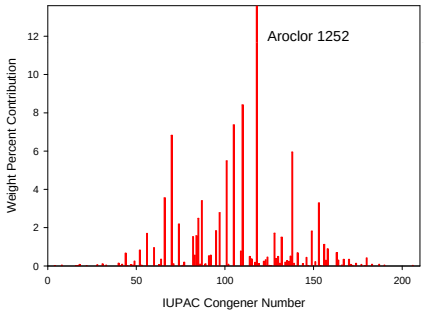
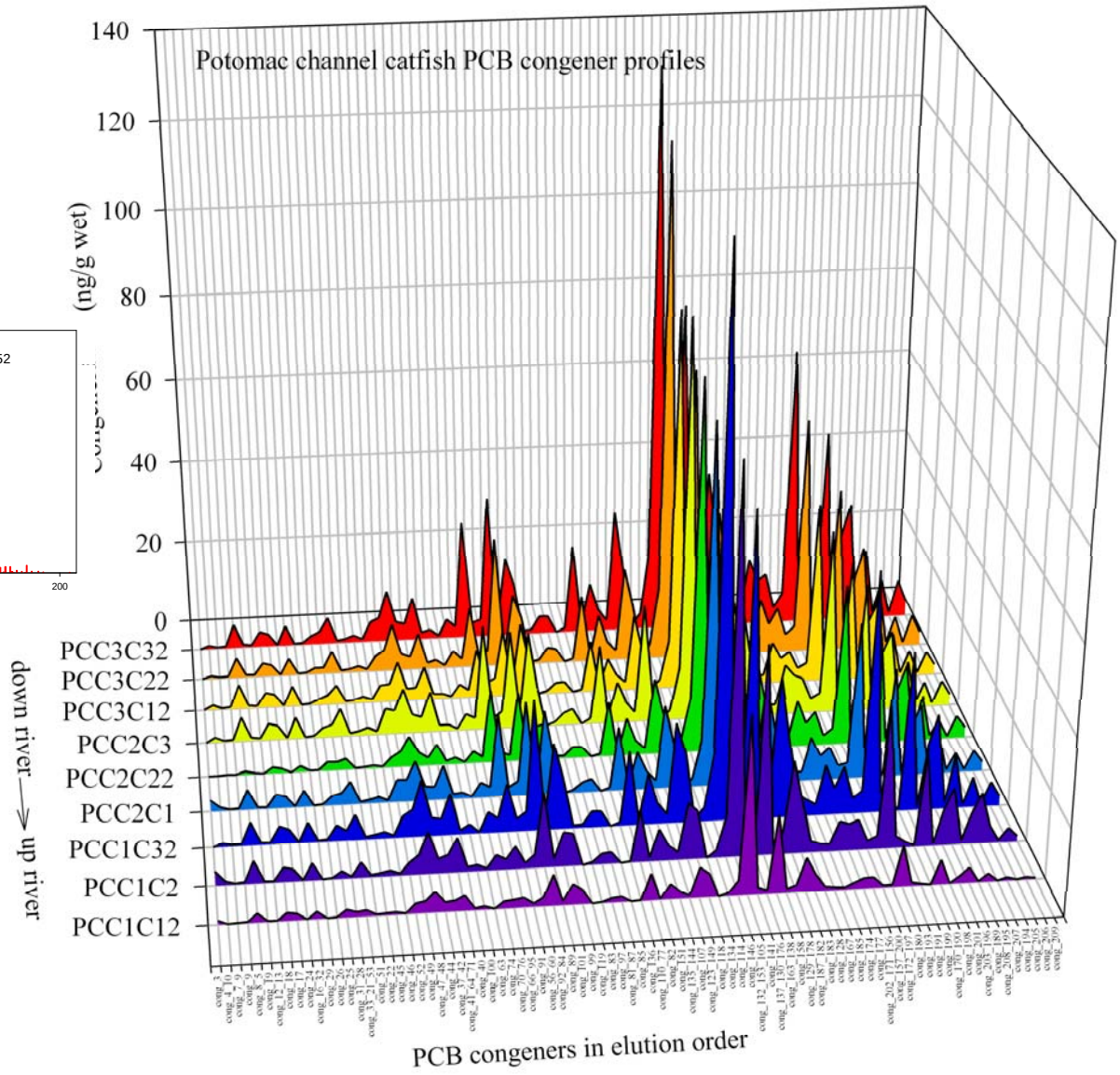
Total PCBs in White Perch



Potomac River Channel Catfish PCB Fingerprints





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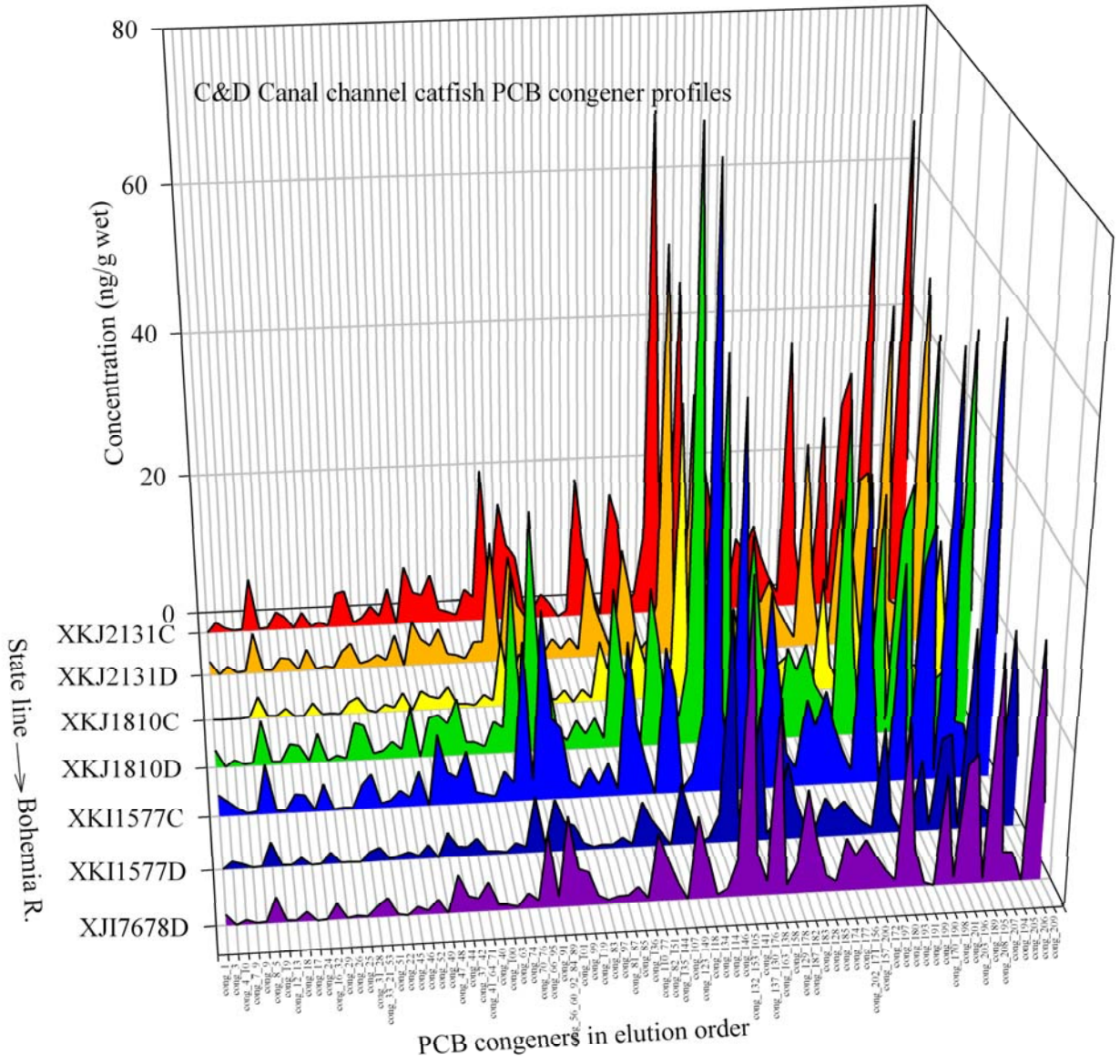
C&D Canal Channel Catfish PCB Fingerprints



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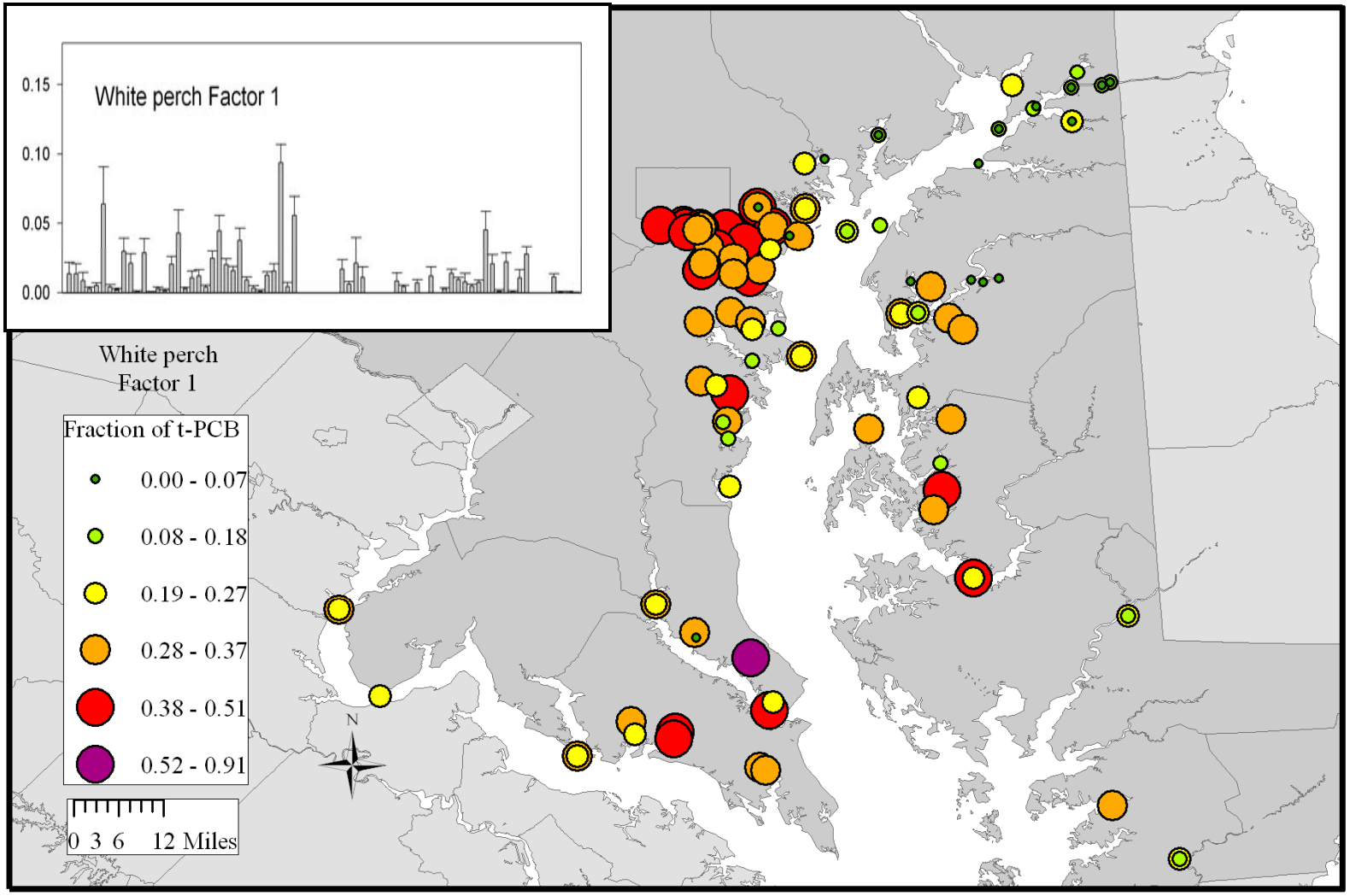
Teasing apart PCB sources: Urban signature



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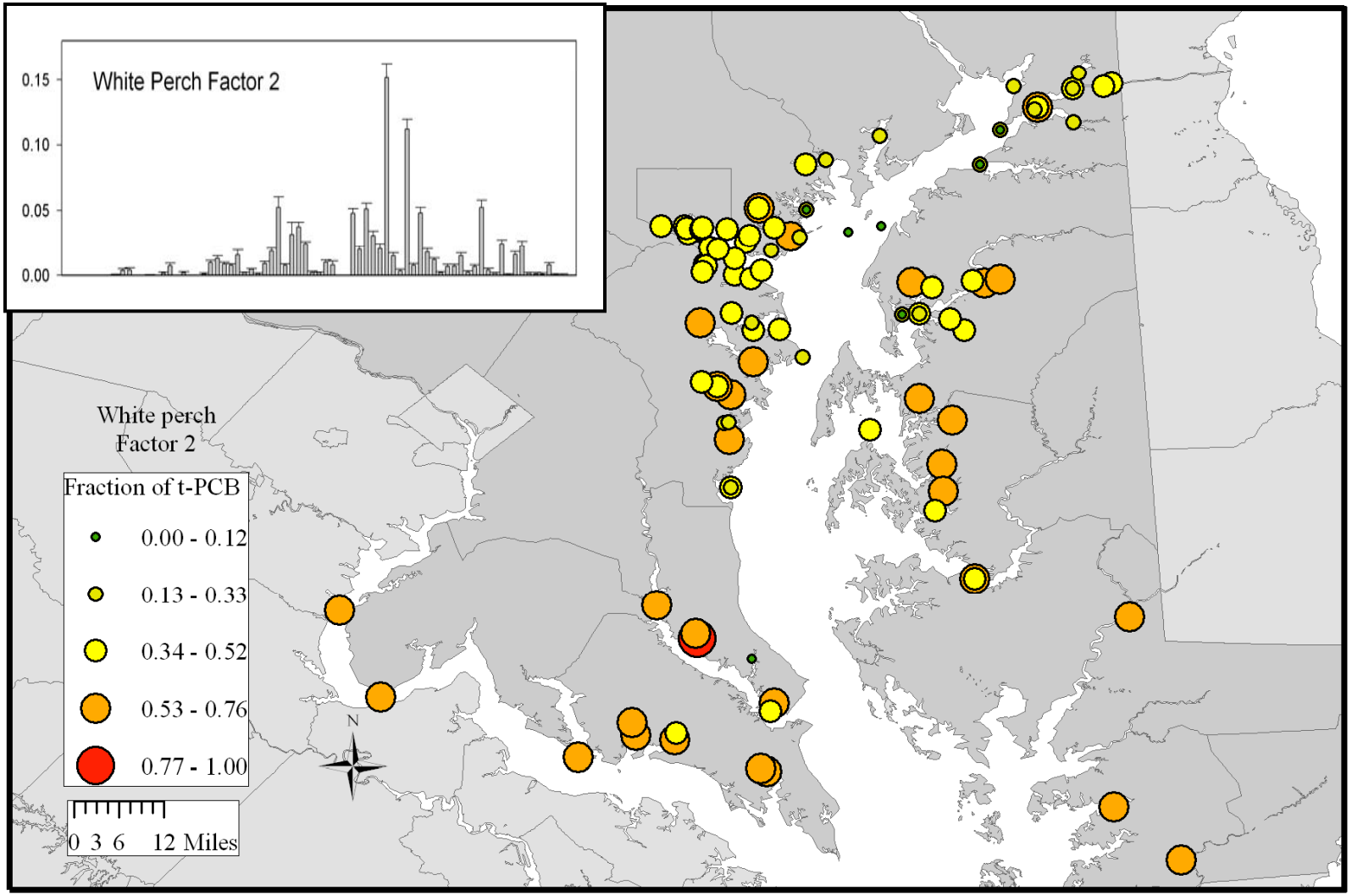
Teasing apart PCB sources: Regional background



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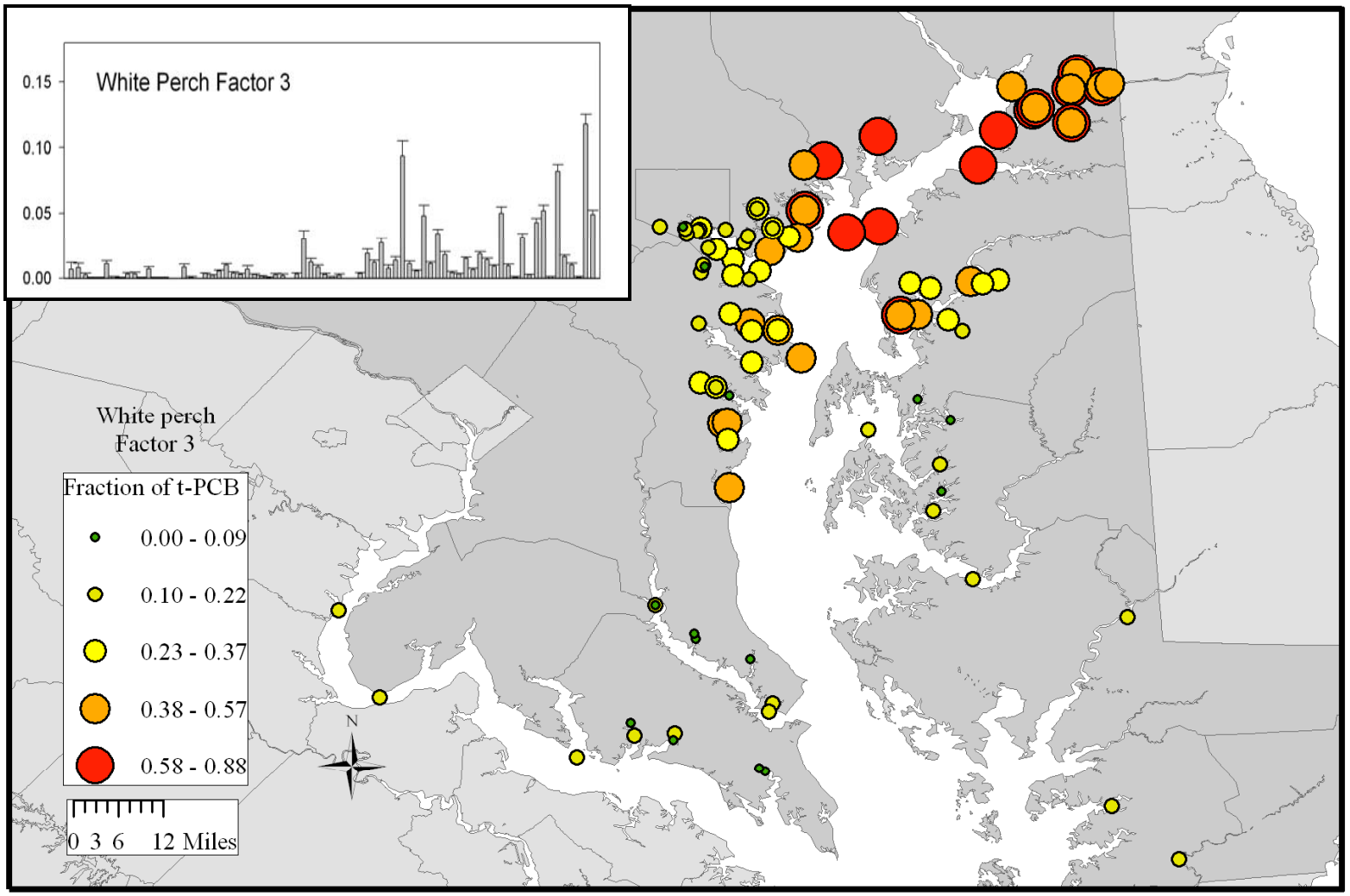
Teasing apart PCB sources: A new PCB source!



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Improving Pollutant Source Characterization in Puget Sound

- Current sampling and analytical plans are 90% of the way towards generating necessary information
  - Expand analyte list to 'tracer' compounds
  - Improve analytical reporting limits
- Multivariate statistical techniques exist, are generally robust, and are routinely used by U.S. EPA in air quality studies
- Significant opportunity to develop higher quality information at comparable cost and efforts.

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