LimnoTech
Water Environment | Scientists Engineers

Comparison of Homolog-Patterns for Groundwater Well Data and Suspected Loads

SRRTTF TTWG Meeting

Dave Dilks and Tim Towey

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Summary

- Task Description
  - Compile and assess all relevant groundwater PCB data
  - Compare homolog patterns from suspected groundwater sources to homolog patterns observed in groundwater wells
- Correlations found between three well areas and observed river loads
  - Wells up-gradient of Kaiser → Barker-Mirabeau loading pattern
  - Kaiser wells → Mirabeau-Trent and Barker-Trent loading pattern
  - GE wells → Trent-Greene loading pattern
- Not a definitive conclusion of contribution, but strong evidence

Compile Groundwater Data

- Method 1668 only
- Data sources identified
  - Historical data available in Ecology's EIM
  - Recent data collected jointly by Ecology and Spokane County
  - Data collected as part of the Upriver Dam remedial activities
  - Data collected by Ecology from the GE site
  - Data collected by Kaiser on their facility and up-gradient from it

Groundwater Data Assessment

- Screen for sites where PCB concentrations are high enough to cause an increase in river concentrations
- Three sites identified
  - Up-gradient from the Kaiser facility
  - Kaiser site
  - GE site

Fingerprinting: Cosine Theta Method

- Quantitative method for assessing similarity between homolog patterns
  - Different than positive matrix factorization, which is used to “un-mix” environmental samples into the original source contributions
  - Recommended as the most intuitive metric for pattern comparison

Fingerprinting: Cosine Theta Method

- Cos-θ parameter is similar to a correlation coefficient
  - Ranges from 0 to 1
- Example values
  - Comparing Aroclor 1242 to Aroclor 1260: 0.06
  - Comparing Aroclor 1242 to Aroclor 1248: 0.77

Fingerprinting Results

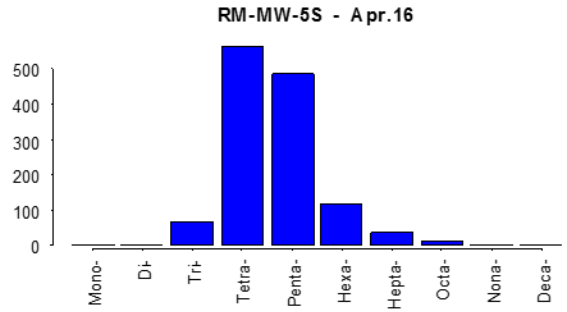
- Multiple wells per site, often multiple samples per well
- Cos-θ parameter calculated using both mean and maximum of well data

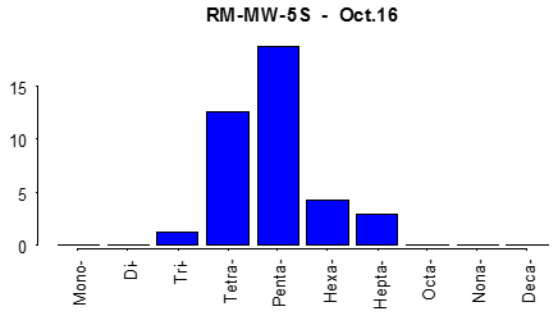
Well Group Location	River Reach	cos-θ (mean of well samples)	cos-θ (max of well samples)
Up-gradient of Kaiser	Barker – Mirabeau (2015)	**0.69**	**0.73**
Kaiser Site	Barker – Trent (2014)	**0.96**	**0.94**
Kaiser Site	Barker – Mirabeau (2015)	0.13	0.07
Kaiser Site	Mirabeau – Trent (2015)	**0.98**	**0.97**
GE Site	Trent – Greene (2014)	**0.94**	**0.94**
GE Site	Trent – Greene (2015)	**0.81**	**0.78**

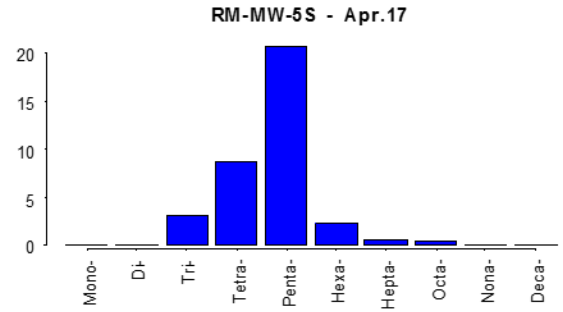
Results Should Be Considered Evidence, not Definitive Proof

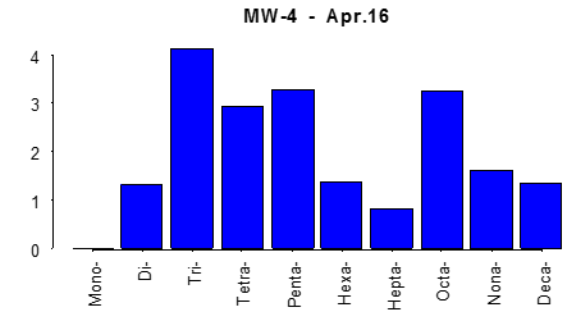
- Correlation does not necessarily mean causation
- Variability in patterns exists among wells at the same site
- Uncertainty exists in estimated loading pattern
  - Barker to Mirabeau and Trent to Greene results are sensitive to certain assumptions

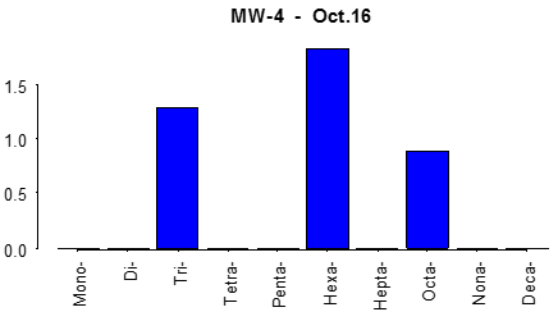
Variability in Well Patterns

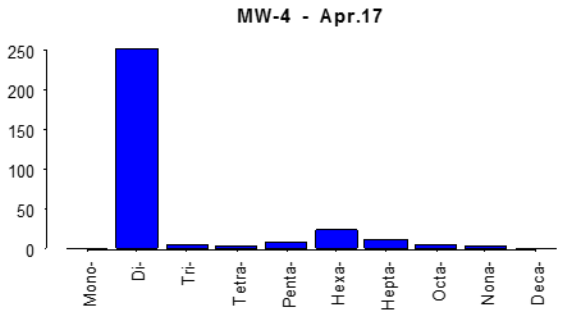


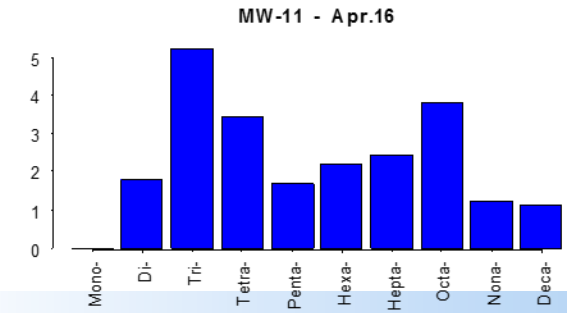


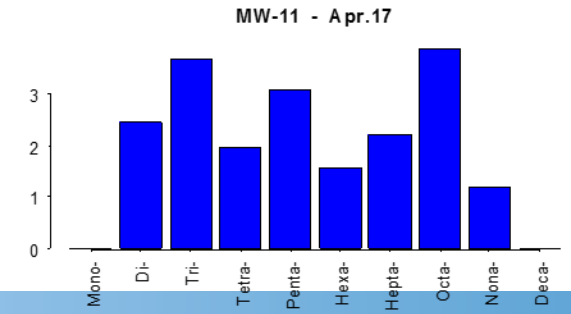












Results are Sensitive to Certain Assumptions

- Barker to Mirabeau
  - Calculated load is driven by a single river sample
    - One sample out of six had high concentration
  - Adjustment of potentially anomalous hexachloro homolog result would improve correlation
- Trent to Greene
  - Mass balance calculated negative loads for lighter homologs in 2014 and 2015

Conclusions

- Correlation seen between patterns for three well areas and estimated loads to river
  - Wells up-gradient of Kaiser generally match Barker-Mirabeau load
  - Kaiser wells match Mirabeau-Trent, Barker-Trent load
  - GE wells match Trent-Greene load
- Not a definitive conclusion of contribution
  - Correlation does not necessarily mean causation
  - Variability in patterns among wells at the same site
  - Uncertainty in estimated loading pattern
- Should be considered as strong evidence of contribution