

# **Analysis of Homolog Distributions to Better Understand Nature of Loads**

SRRTTF Data Synthesis  
Workshop

May 30, 2019

# Objective

- Compare homolog patterns to gain understanding of the nature of the load
  - Source mechanisms
    - Atmospheric deposition, Lake Coeur d'Alene
  - In-river response
- Won't provide definitive answers, but will provide data for “weight of evidence” approach

## Example Outcomes

- If homolog patterns vary seasonally at a given location
  - Would lend support to the theory that loads vary seasonally
- If homolog patterns in atmospheric deposition are different than those in Lake Coeur d'Alene
  - Would lend support to the theory something other than atmospheric deposition is driving PCBs in the lake

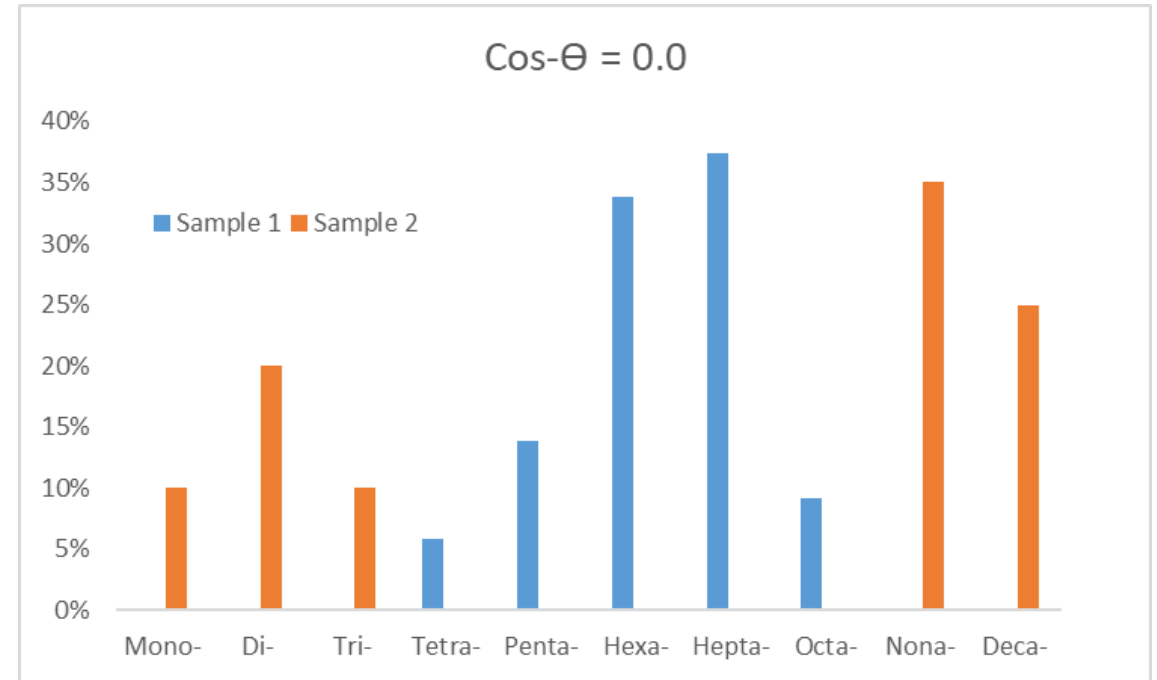
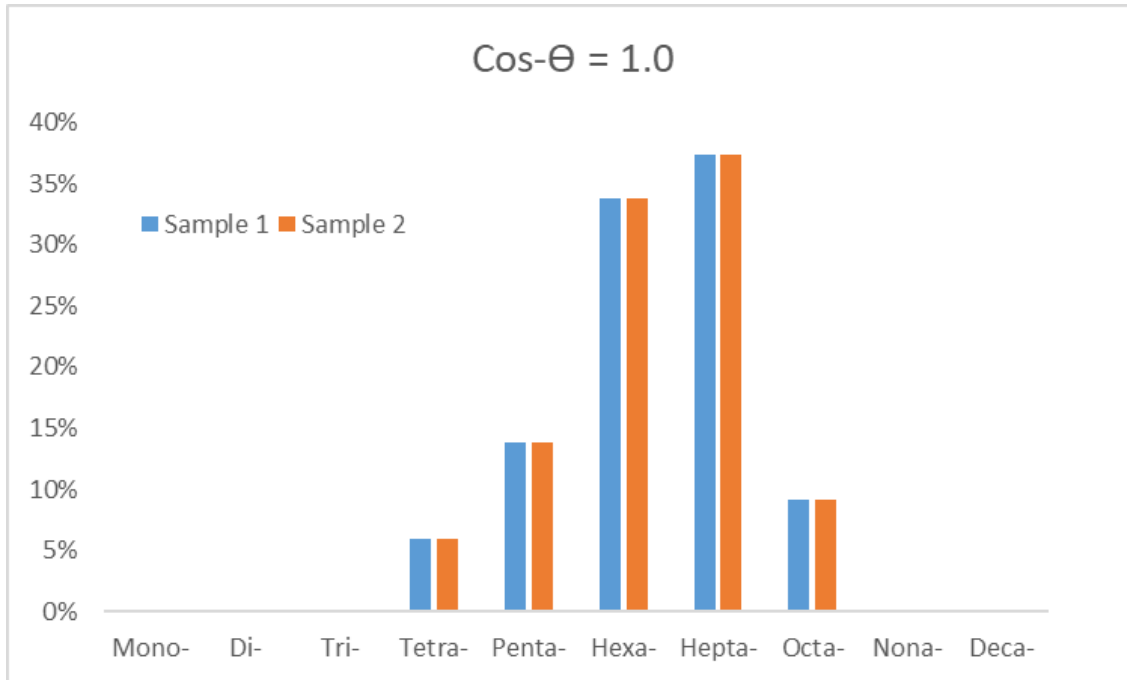
# Measuring Similarity

- Calculated using cosine theta ( $\cos\theta$ ) method
  - Quantitative method for assessing similarity between matrices (e.g. homolog patterns)
- Theory
  - Given two vectors of attributes, A and B, the cosine similarity is represented as:

$$\text{similarity} = \cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\| \|\mathbf{B}\|} = \frac{\sum_{i=1}^n A_i B_i}{\sqrt{\sum_{i=1}^n A_i^2} \sqrt{\sum_{i=1}^n B_i^2}},$$

# Measuring Similarity

- $\text{Cos-}\theta$  is analogous to a correlation coefficient
  - Exact comparison,  $\text{cos-}\theta = 1$
  - Completely different patterns,  $\text{cos-}\theta = 0$



# Similarity Analyses Conducted

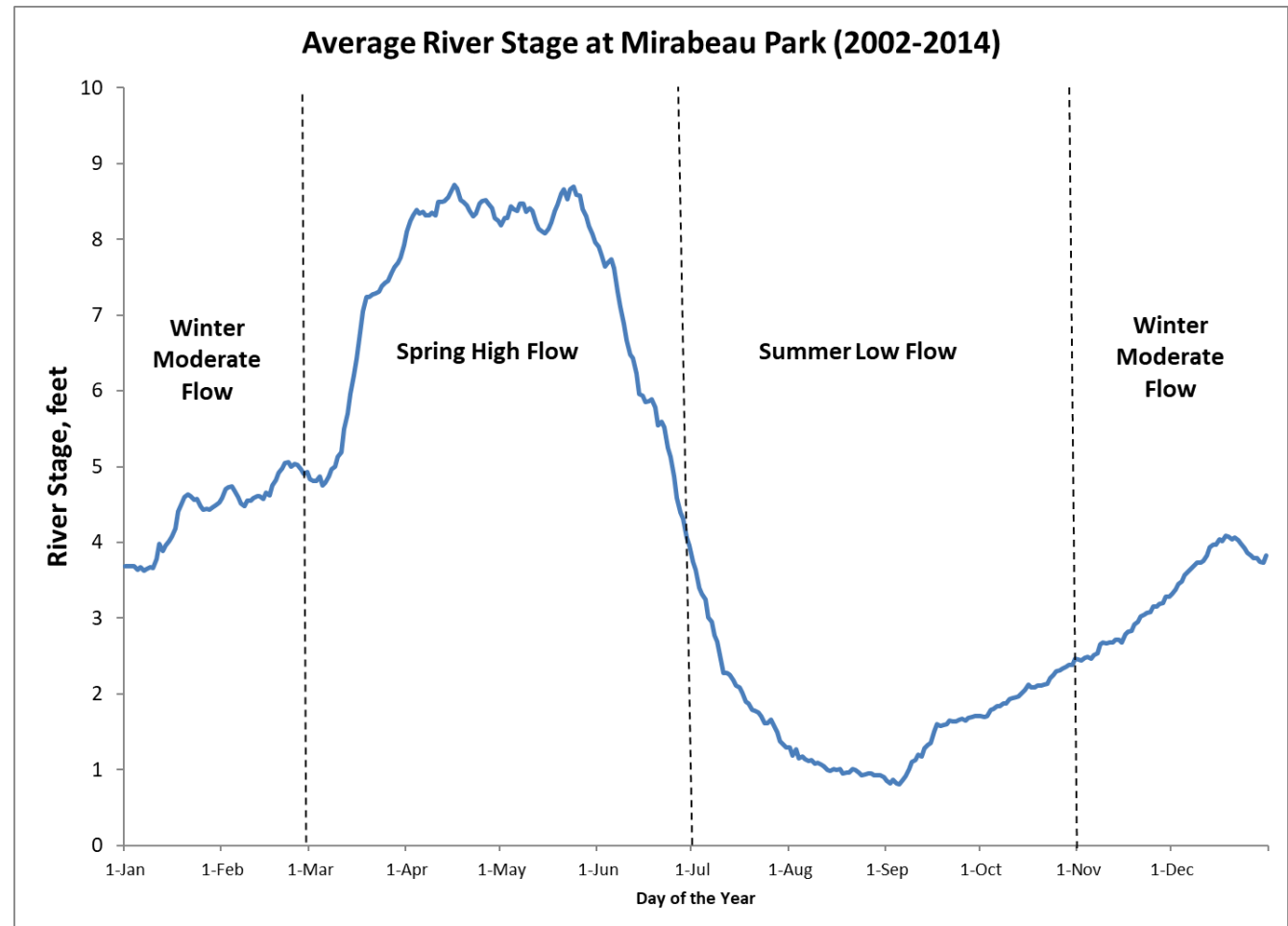
- Lake Coeur d'Alene seasonality
  - Does the nature of the load entering the river from Lake CdA vary seasonally?
- Atmospheric deposition
  - How do deposition patterns compare to patterns in delivery mechanisms?
- In-river seasonality
  - Does the nature of concentrations in the river vary seasonally?

# Lake Coeur d'Alene Seasonality

- Assess seasonal variability of homolog distributions entering the river from Lake Coeur d'Alene
  - Different patterns by season may imply seasonally-varying loading sources

# Lake CdA Seasonality: Approach

- Calculate similarity of homolog distributions for three different seasonal periods
  - Spring high flow
  - Summer low flow
  - Winter moderate flow





# Lake CdA Seasonality: Available Data

- 2014 Confidence testing
  - 9 samples May 23, 2014
- 2014 Synoptic survey
  - 7 samples August 12-23, 2014
- 2016 Monthly monitoring
  - One sample each in March, April, May, October, November, December\*

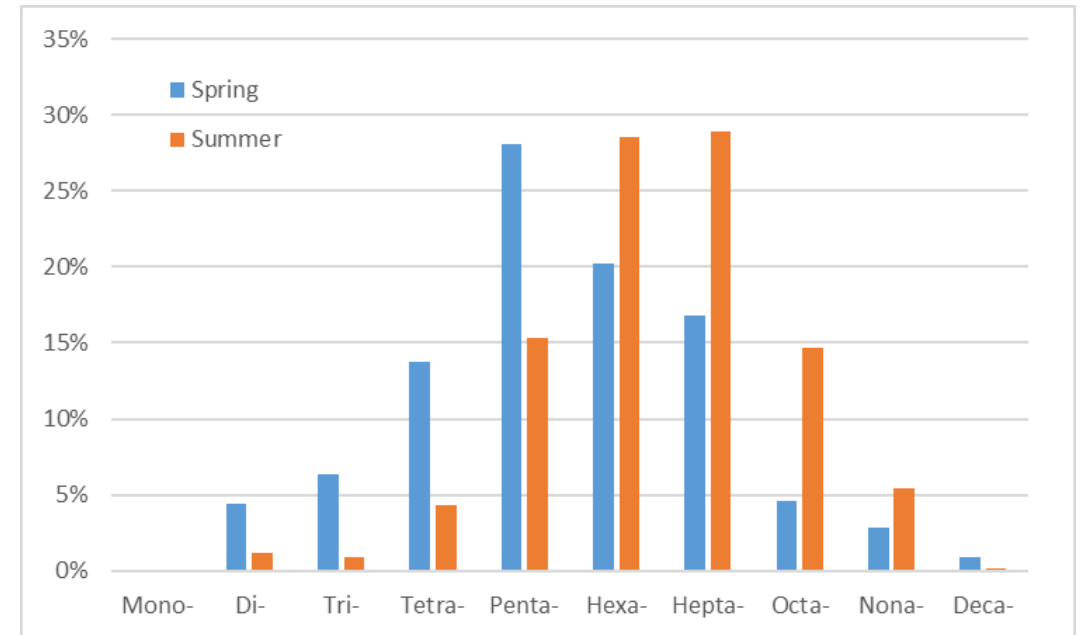
\*excluded due to blank contamination



# Lake CdA Seasonality: Results

- Cos- $\theta$  correlations by season

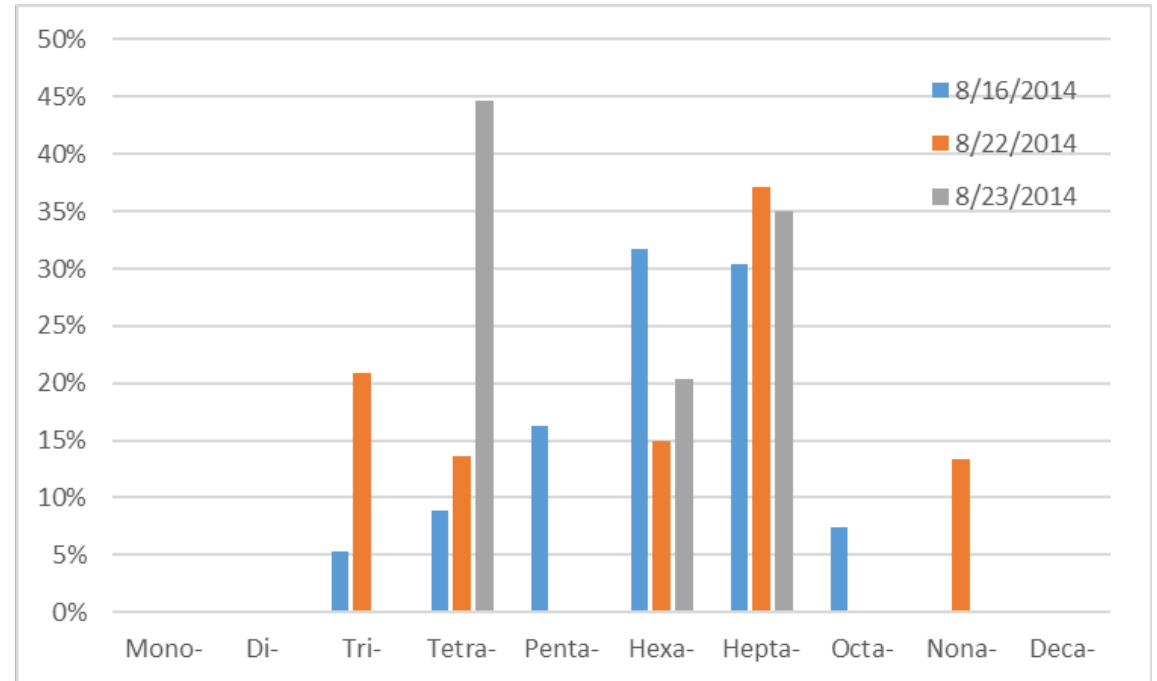
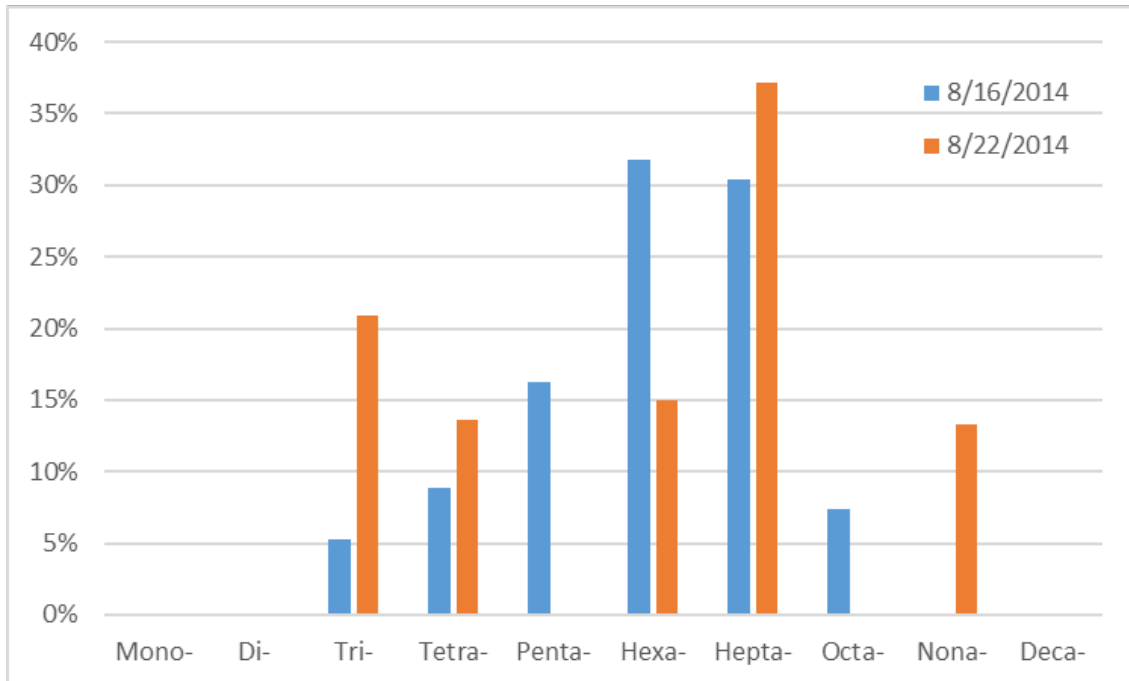
	Spring	Summer	Winter
Spring	1.00		
Summer	0.85	1.00	
Winter	*	*	*



\*Only sample available from winter season had excessive blank contamination

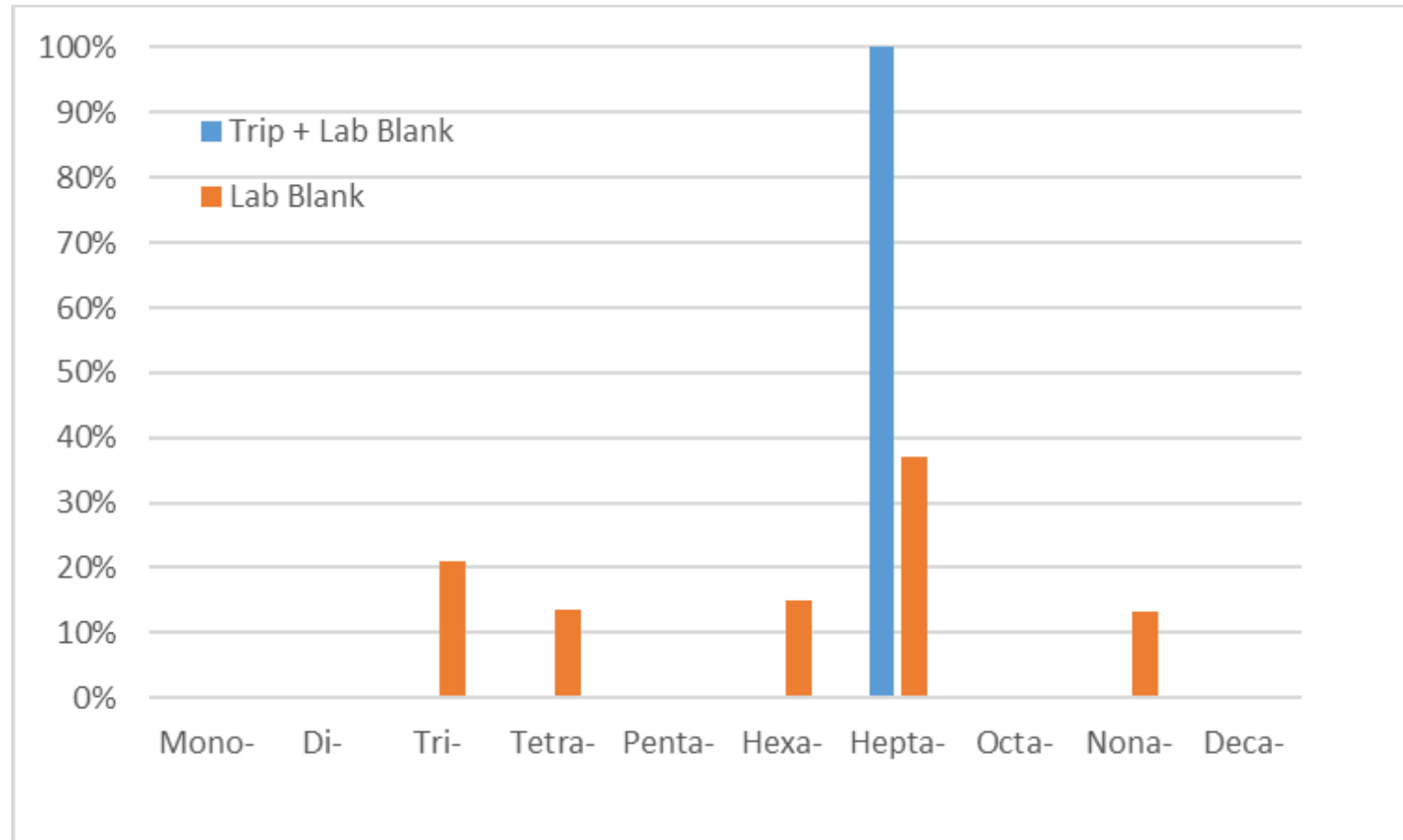
# Lake CdA Data Usability

- High variability in patterns among samples in a given season
  - $\text{Cos-}\theta=0.69$  among samples within a season



# Lake CdA Data Usability

- High variability in patterns depending on blank correction method used



# Lake CdA Seasonality: Conclusions

- We can't say anything with reasonable certainty about seasonality of Lake CdA homolog patterns
- Did we learn anything?
  - There is a limit to what we can say about patterns when ambient concentrations are that low
  - We could potentially glean more information using a less severe blank correction method
- Will additional monitoring help?
  - Not likely, until analytical methods improve

# Similarity Analyses Conducted

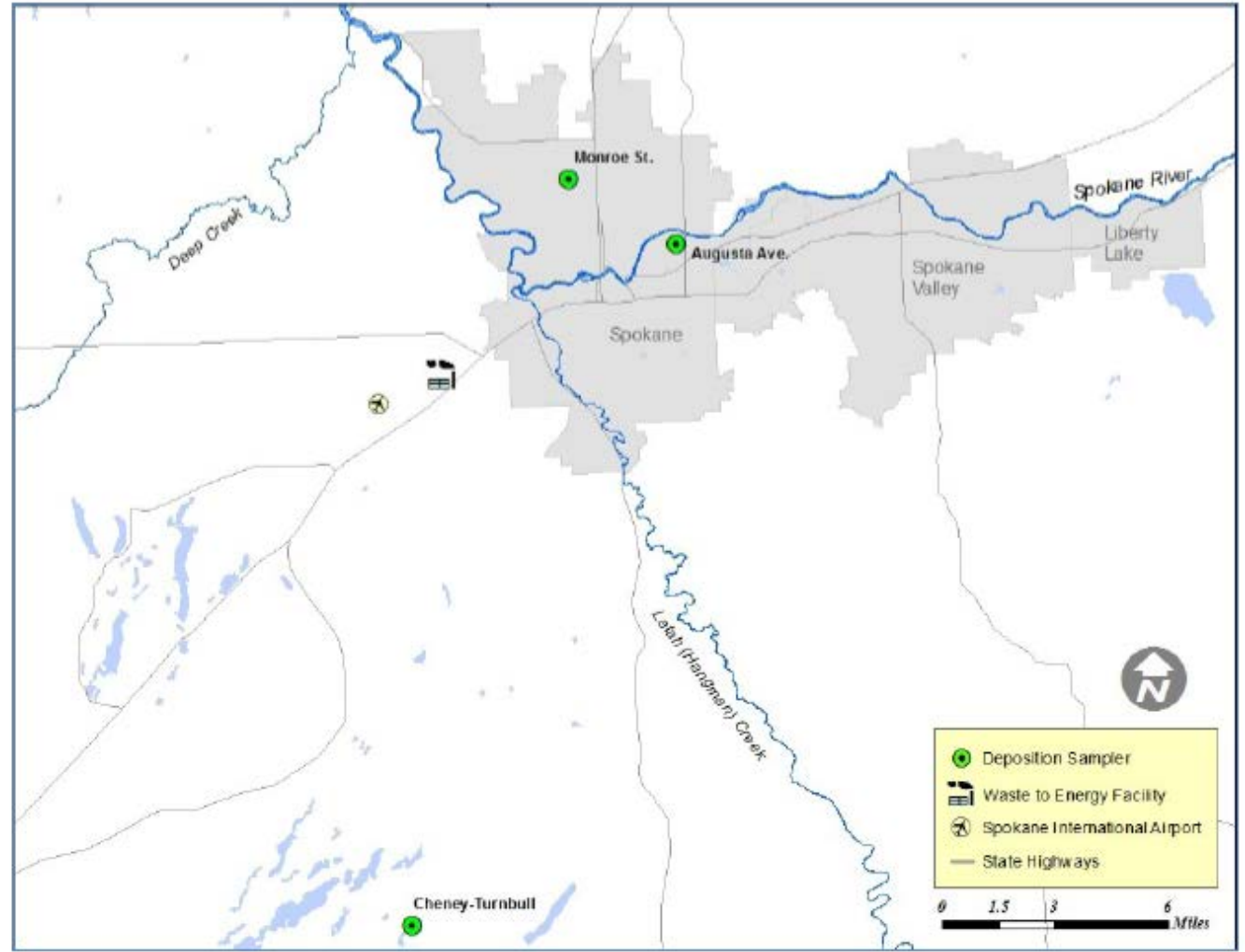
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  - Does the nature of the loading from Lake CdA to the river vary seasonally?
- Atmospheric deposition
  - How do deposition patterns compare to delivery mechanisms?
- In-river seasonality
  - Does the nature of concentration in the river vary seasonally?

# Atmospheric Deposition Correlations

- How do homolog patterns in atmospheric deposition compare to patterns in delivery mechanisms?
- Deposition
  - 2014 EAP atmospheric deposition study
- Delivery mechanisms
  - Groundwater up-gradient of Kaiser
  - City of Spokane stormwater
  - Lake Coeur d'Alene

# Atmospheric Deposition: Available Data

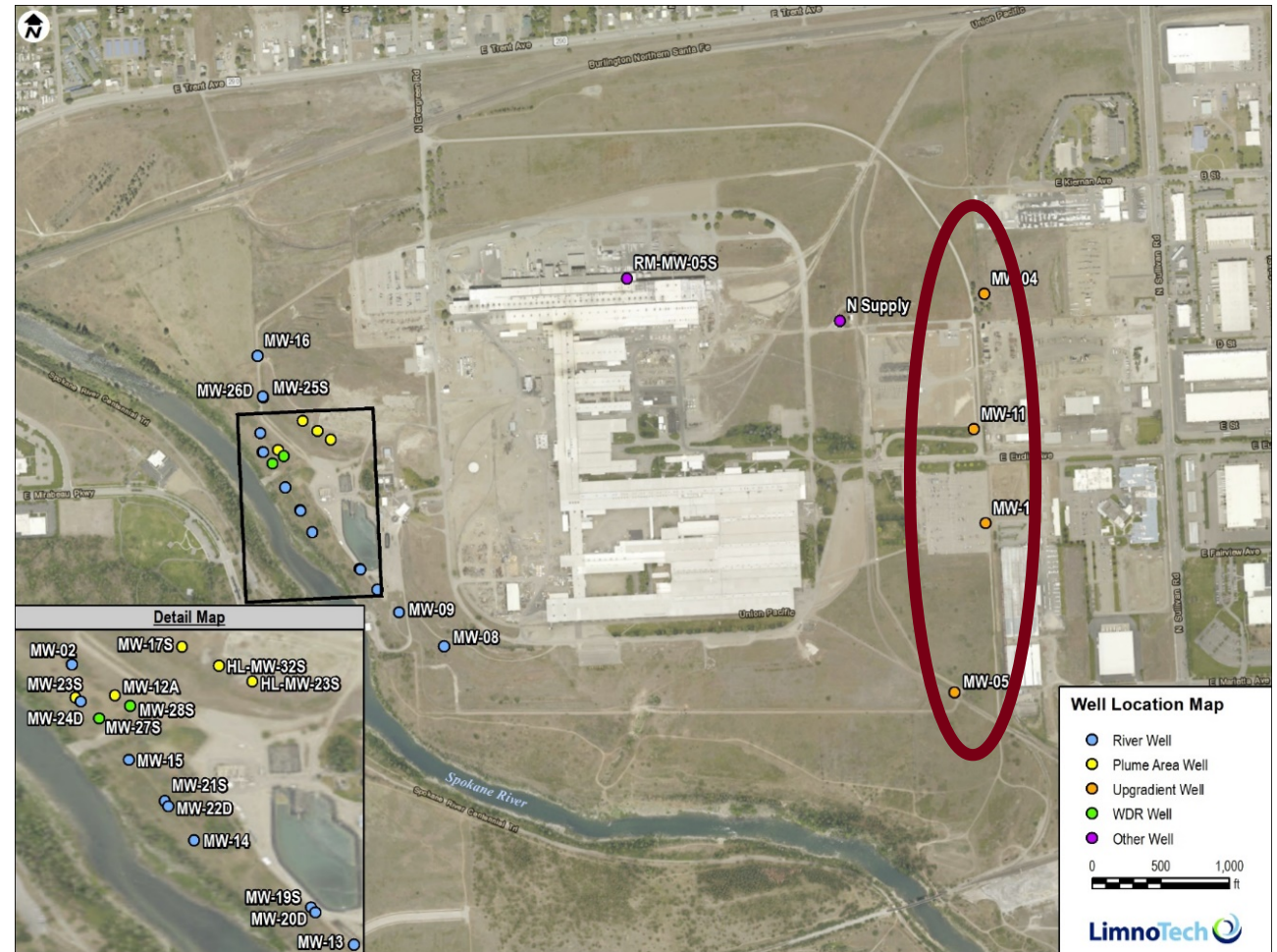
- Four quarterly samples over 2016-2017
- Three sites
  - Augusta: urban-commercial
  - Monroe: urban-residential
  - Turnbull NWR: background
- Pilot study
  - Variability in field replicates





# Atmospheric Deposition: Groundwater Data

- 77 samples from four wells up-gradient of Kaiser



# Atmospheric Deposition: Stormwater Data

- Six samples from Cochran basin for four quarterly monitoring events in 2016-2017



# Atmospheric Deposition Correlation Results

	Cos- $\theta$		
	Augusta	Monroe	Turnbull
Lake CdA	*	*	*
Up-gradient Groundwater	0.93	0.72	0.51
Stormwater	0.91	0.66	0.38

- Lake Coeur d'Alene excluded due to low concentrations
- Monroe and Turnbull sites do not match either stormwater or up-gradient groundwater
- Better correlation with Augusta site

# Atmospheric Deposition: Conclusions

- Ecology atmospheric deposition study was a pilot project, so available data should be used cautiously
- Poor correlation exists between deposition patterns at Monroe/ Turnbull sites and delivery mechanisms
- Will more data help?
  - Yes, but probably best left to Ecology
  - Too complex a topic for the Task Force to lead



# Similarity Analyses Conducted

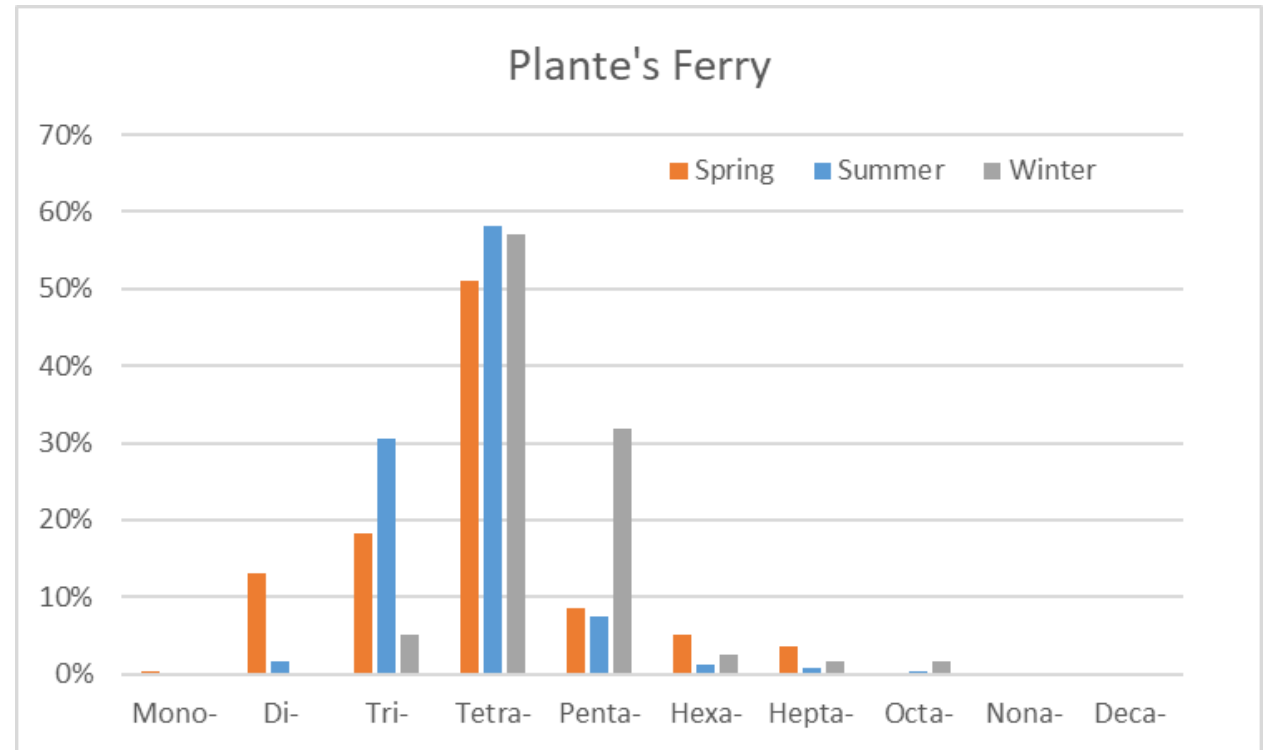
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# In-River Seasonality: Data Considered

- Focus on stations sampled for all synoptic surveys, plus monthly
  - Plante's Ferry
    - 3 Spring samples
    - 15 Summer samples
    - 1 winter sample
  - Spokane USGS gage
    - 5 Spring samples
    - 14 Summer samples
    - 1 winter sample

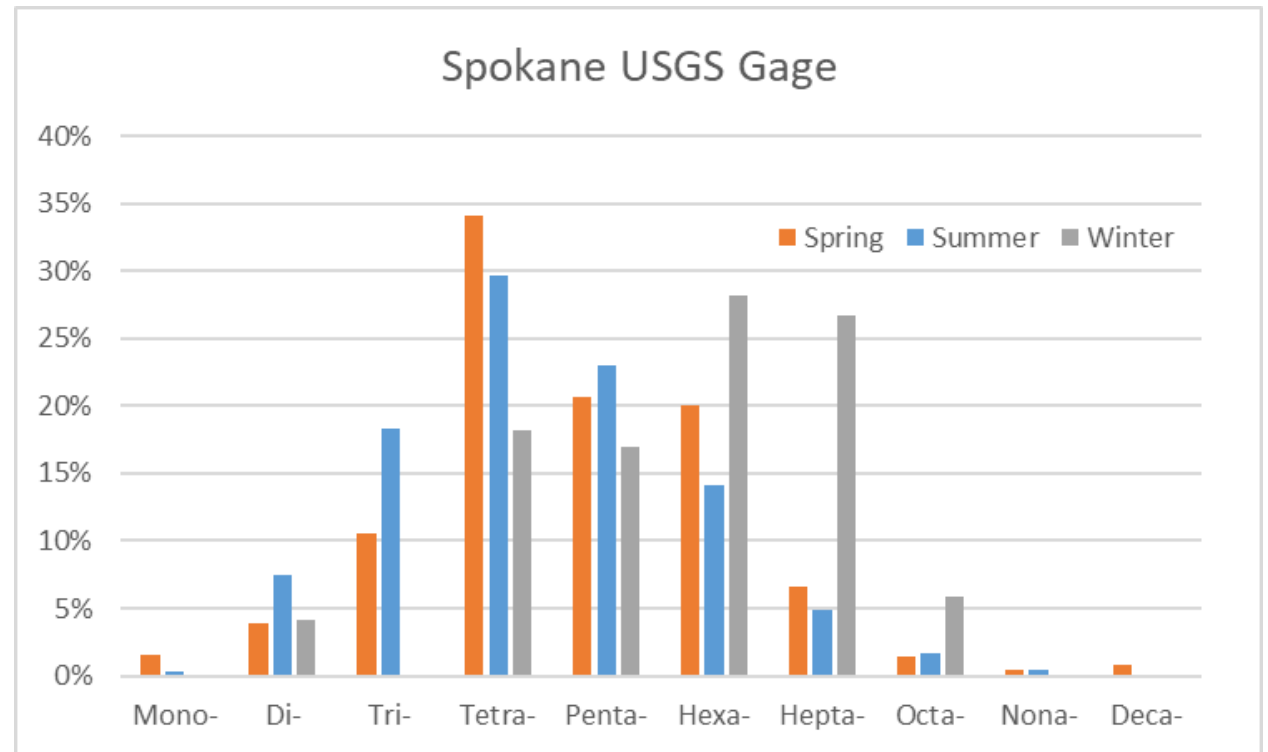
# Plante's Ferry Analysis

- Very high similarity between spring and summer
  - $\text{Cos-}\theta=0.964$
- Lower similarity between winter and other seasons
  - Summer-winter  $\text{Cos-}\theta=0.857$
  - Spring-winter  $\text{Cos-}\theta=0.887$
  - Single winter sample



# USGS Gage Analysis

- High similarity between spring and summer
  - $\text{Cos-}\theta=0.968$
- Lesser similarity between winter and other seasons
  - Summer-winter  $\text{Cos-}\theta=0.71$
  - Spring-winter  $\text{Cos-}\theta=0.80$
  - Single winter sample





## In-River Seasonality: Conclusions

- Not seeing a marked difference in spring vs. summer homolog patterns at Plante's Ferry and USGS gage
  - No strong evidence of seasonally varying loads
- Insufficient data to say anything about winter flow
- Will additional monitoring help?
  - Yes, if we want to rigorously assess seasonality