Delaware River Basin Commission

A Review of Analytical Methods for PCB Trackdown Efforts

Toxic Contaminants Workgroup Meeting

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Delaware River Basin Commission

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Outline

- PCBs structure and nomenclature
- PCB TMDL background
- Goal of PCB Trackback
- Selection of appropriate methods
- Examples using different methods

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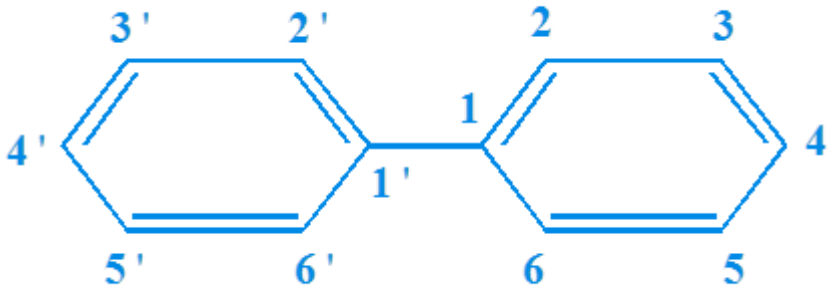

PCB Chemistry

- Polychlorinated biphenyls (PCBs) are man-made organic chemicals with a biphenyl base structure and 209 possible chlorine substitution patterns.
- Terminology: Aroclors, congeners, homologs.
- Properties: Hydrophobic, accumulate in sediments and tissues (fish tissue contamination is driver for PCB TMDL)
- Carcinogenic, and non-carcinogenic

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PCB TMDL Elements

- Implementation of the PCB TMDL required:
  - Monitoring effluent using a sensitive analytical method (Method 1668A) for all 209 congeners.
  - Develop and implement a Pollutant Minimization Plan (PMP) to identify and reduce sources of PCBs.

PMP Goals:
Trackback sources of PCBs

- Develop sampling and analytical plan
  - Identify sampling locations
  - Grab vs composite
  - Dry and/or wet weather samples
- Select a method which is sufficiently sensitive to provide the PCB information need to calculate PCB mass:
  - PCB Conc. X Flow= PCB mass

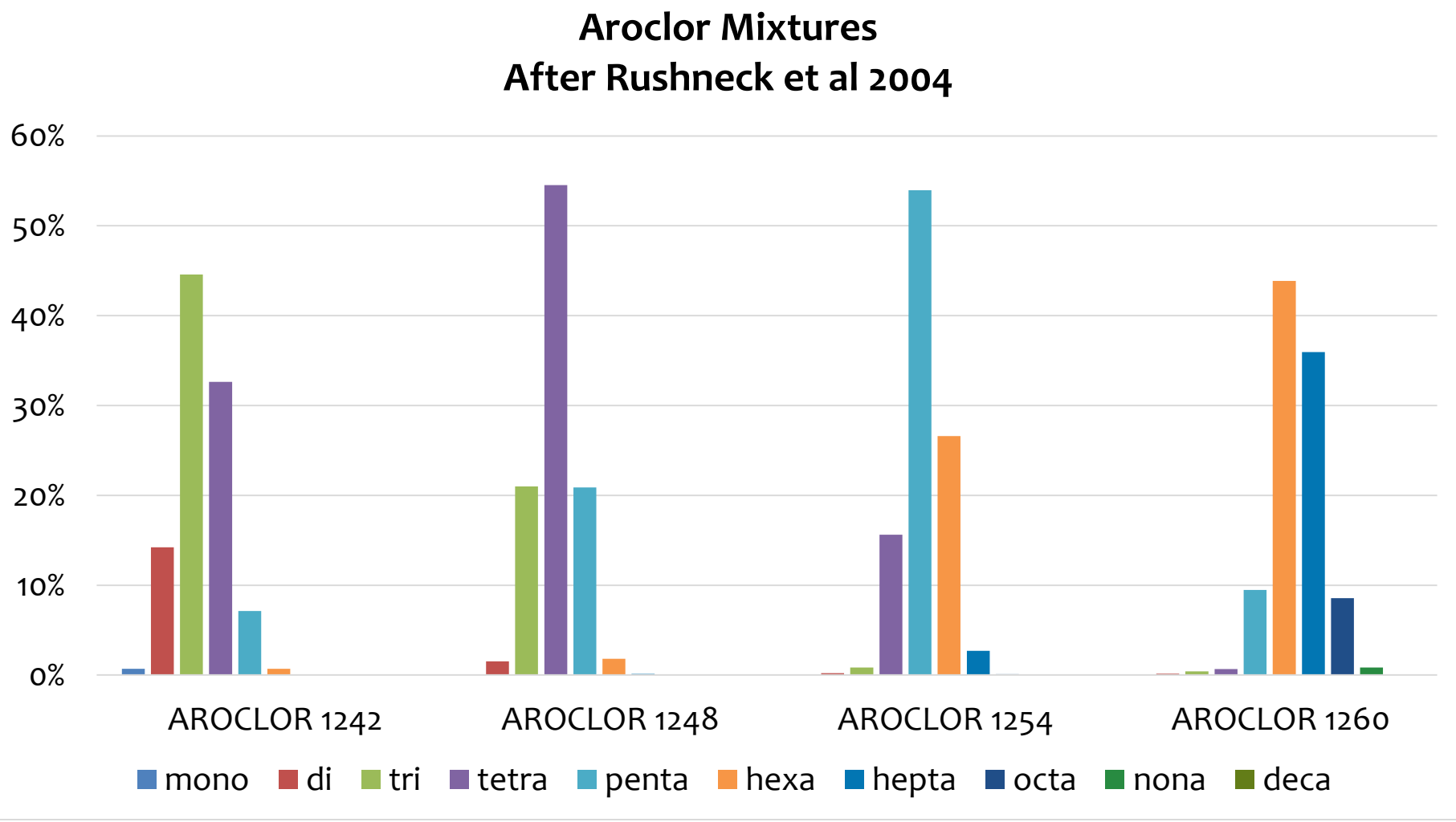
Selecting Sufficiently Sensitive Method

- Understand your existing data
  - What samples have been collected and where (maps help)
  - Summarize analytical results and identify methods used
  - Use data to identify potential sources
  - Select appropriate method for additional trackback efforts to meet Data Quality Objectives (DQOs)

PCB Methods

Method/Cost	Advantages	Disadvantages
608 *Gas Chromatograph (GC) $150-200*	Cheap	High detection limits (ppb) (uses unweathered commercial Aroclor mixtures as standards, does not detect congeners)
8082a *GC, Electron Capture Device (ECD) $300-400*	Identifies Aroclors and selected congeners	Limited results for congeners, high detection limits (ppb)
680 *(High Resolution GC/ Low Resolution Mass Spectrometry (HRGC/LRMS) $250-300*	Reports homologs and all 209 congeners (can detect weathered congeners)	Detection limits (sub-ppb) but depending on expected concentrations may yield ND results
Trackback (HRGC/HRMS) *Similar to 1668A ~$350*	Reports homologs by summing congeners	Detection limits similar to 1668A

PCB Contribution by Homolog for Selected Aroclors



Analytical Method 608

Method 608 Chromatogram

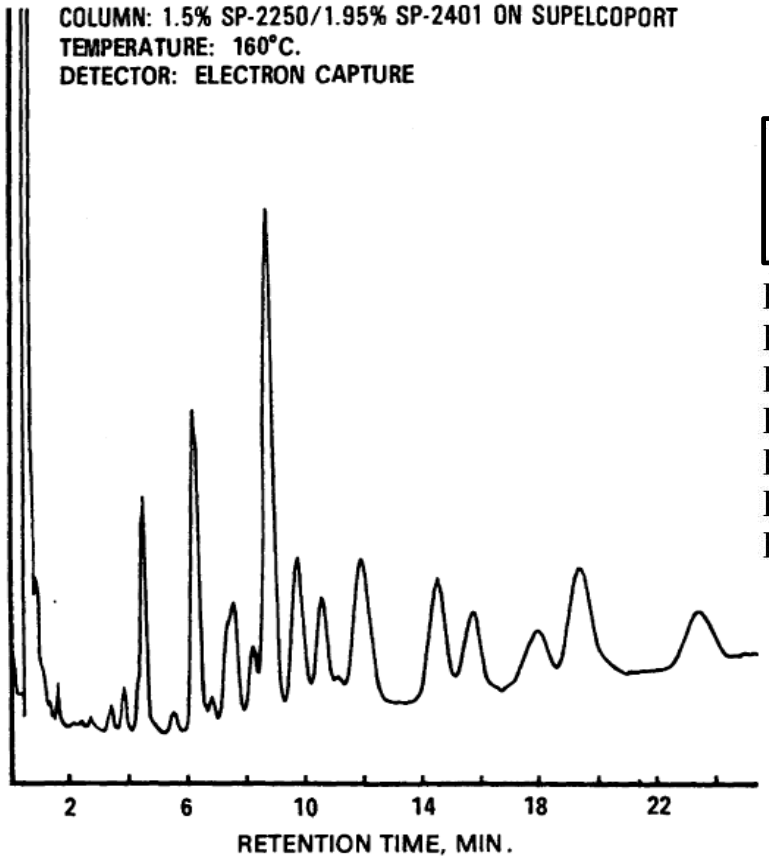


Figure 7. Gas chromatogram of PCB-1242.

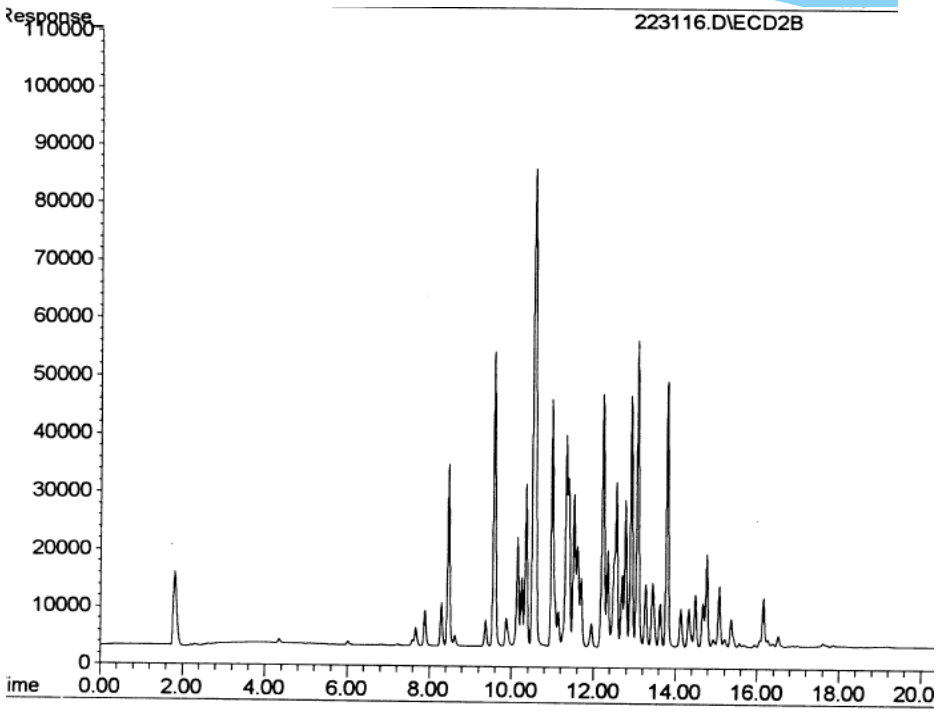
Method 608 Detection Limits
Aroclor 1242=65 ppb or 65,000 pg/L

Parameter	Method detection limit (µg/L)
PCB-1016	nd
PCB-1221	nd
PCB-1232	nd
PCB-1242	0.065
PCB-1248	nd
PCB-1254	nd
PCB-1260	nd

Entire pattern must match for positive ID
No information regarding congeners or homologs, just one value

Analytical Method 8082a

Method 8082a Chromatogram



Compound	CAS Registry No.[a]	IUPAC #
Aroclor 1016	12674-11-2	-
Aroclor 1221	11104-28-2	-
Aroclor 1232	11141-16-5	-
Aroclor 1242	53469-21-9	-
Aroclor 1248	12672-29-6	-
Aroclor 1254	11097-69-1	-
Aroclor 1260	11096-82-5	-
2-Chlorobiphenyl	2051-60-7	1
2,3-Dichlorobiphenyl	16605-91-7	5
2,2',5-Trichlorobiphenyl	37680-65-2	18
2,4',5-Trichlorobiphenyl	16606-02-3	31
2,2',3,5'-Tetrachlorobiphenyl	41464-39-5	44
2,2',5,5'-Tetrachlorobiphenyl	35693-99-3	52
2,3',4,4'-Tetrachlorobiphenyl	32598-10-0	66
2,2',3,4,5'-Pentachlorobiphenyl	38380-02-8	87
2,2',4,5,5'-Pentachlorobiphenyl	37680-73-2	101
2,3,3',4',6-Pentachlorobiphenyl	38380-03-9	110
2,2',3,4,4',5'-Hexachlorobiphenyl	35065-28-2	138
2,2',3,4,5,5'-Hexachlorobiphenyl	52712-04-6	141
2,2',3,5,5',6-Hexachlorobiphenyl	52663-63-5	151
2,2',4,4',5,5'-Hexachlorobiphenyl	35065-27-1	153
2,2',3,3',4,4',5-Heptachlorobiphenyl	35065-30-6	170
2,2',3,4,4',5,5'-Heptachlorobiphenyl	35065-29-3	180
2,2',3,4,4',5',6-Heptachlorobiphenyl	52663-69-1	183
2,2',3,4',5,5',6-Heptachlorobiphenyl	52663-68-0	187
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	40186-72-9	206

Chemical Abstract Service Registry No.

Aroclor and congener reporting limits on the order of 5 ppb or 5,000 p/L per congener or Aroclor

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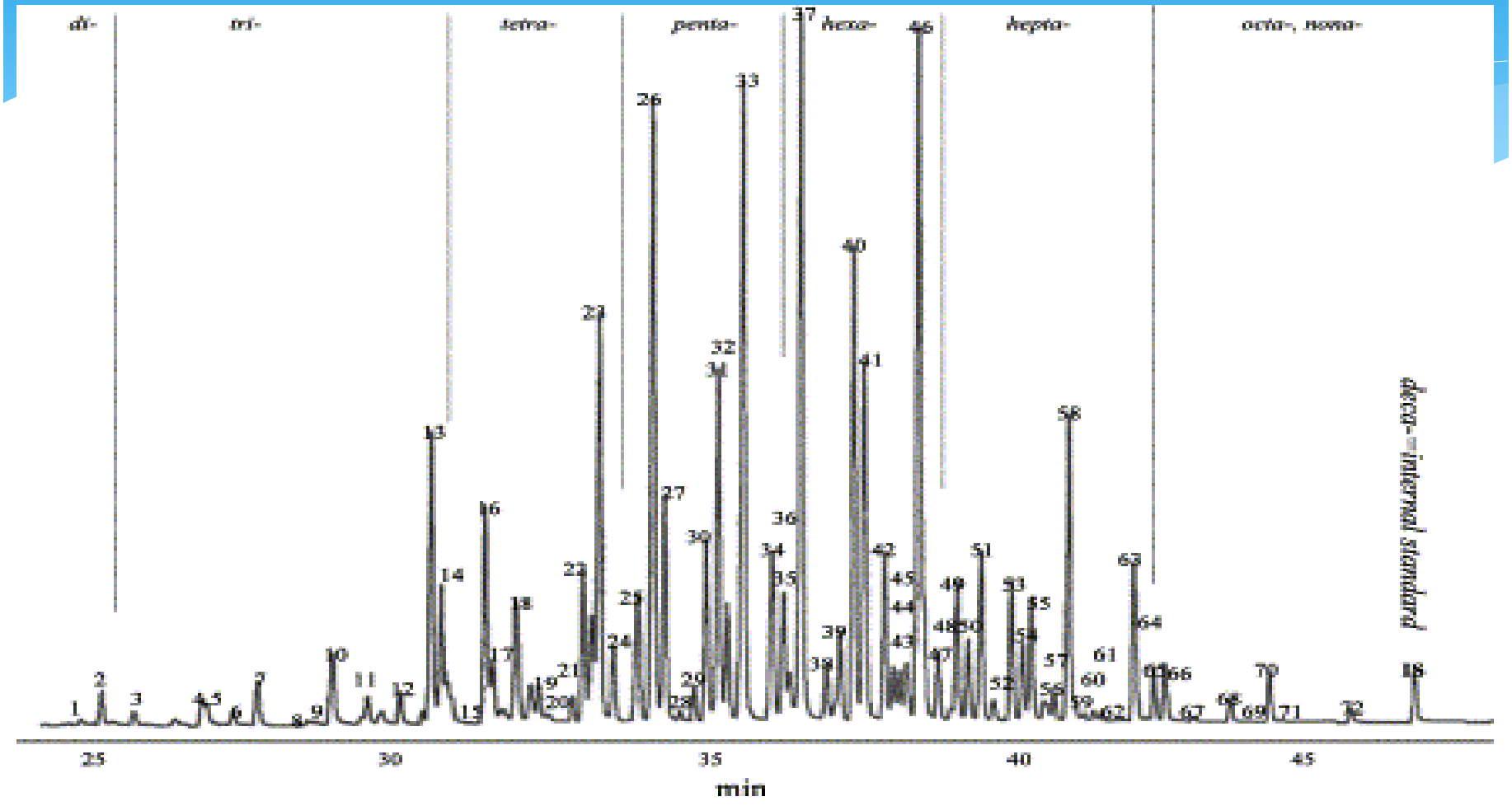
Analytical Method 680

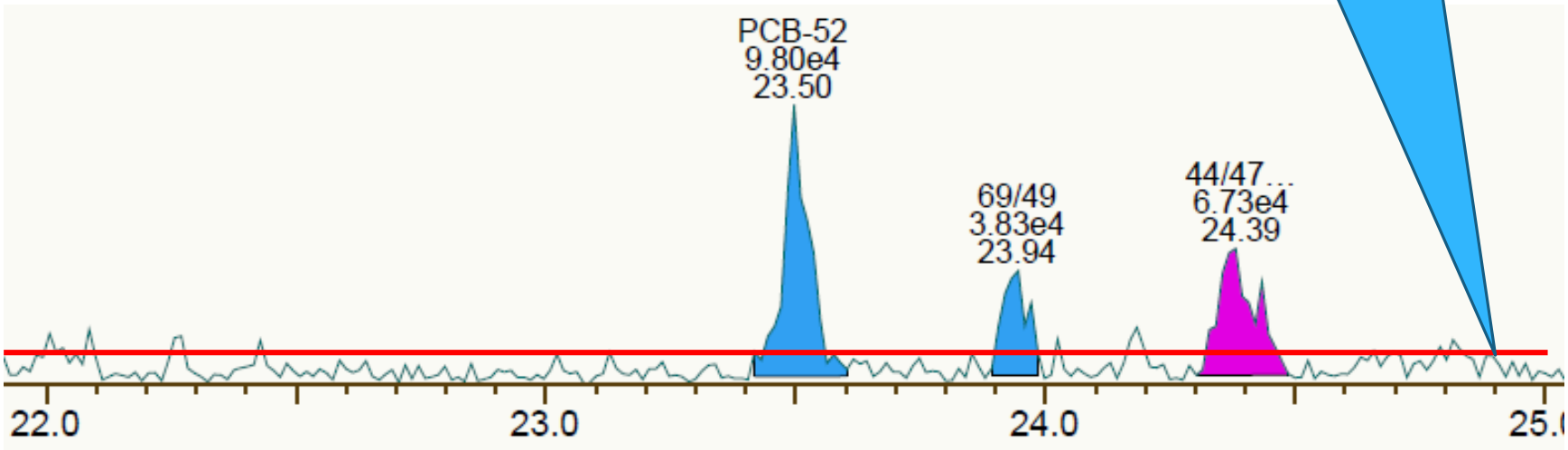


All 209 congeners reported

Typical Detection Limits range from 0.5 to 5.0 ppb or 500-5,000 pg/L

Trackback Analytical Method Developed by Pace

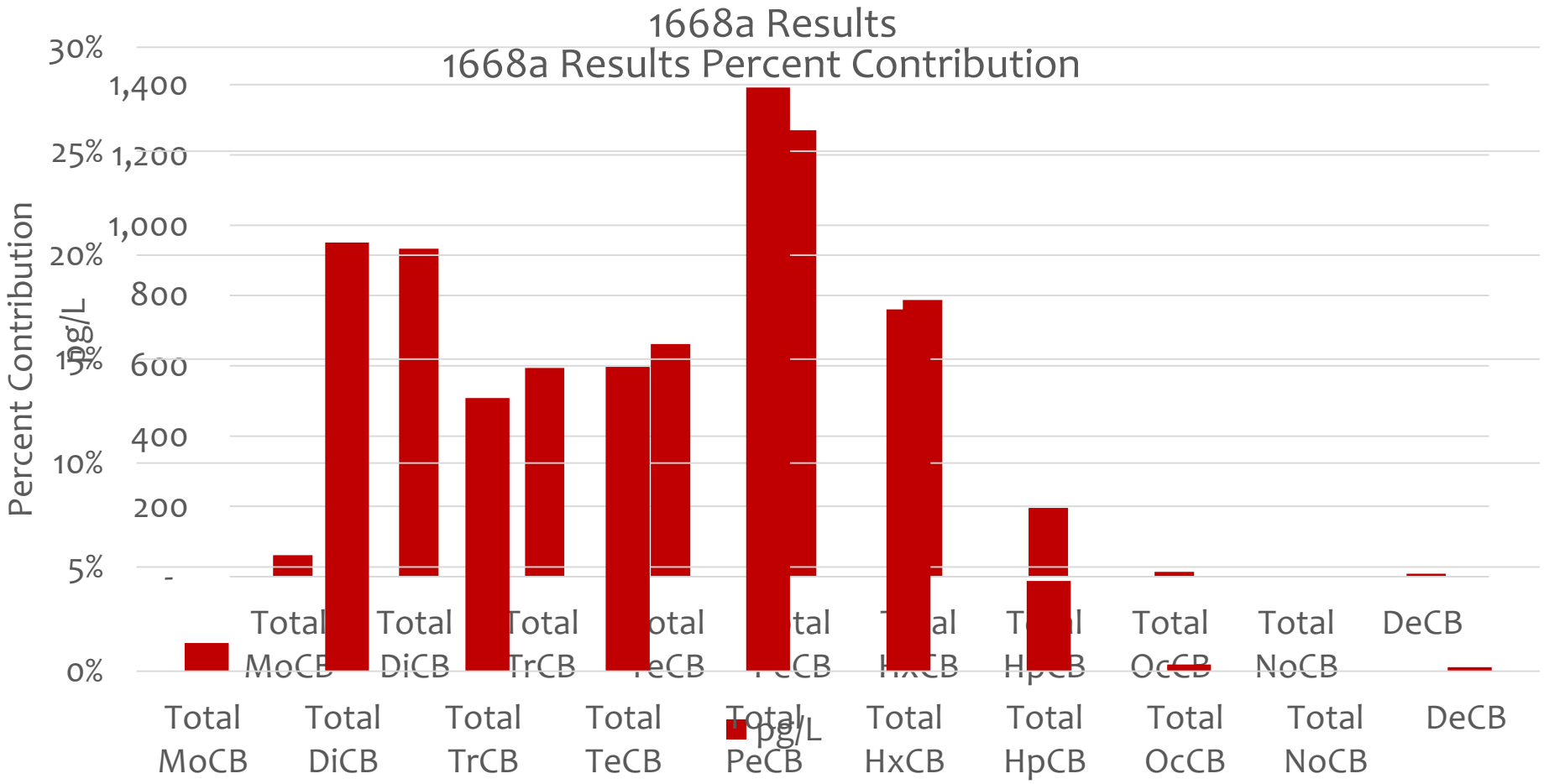
Example Chromatogram



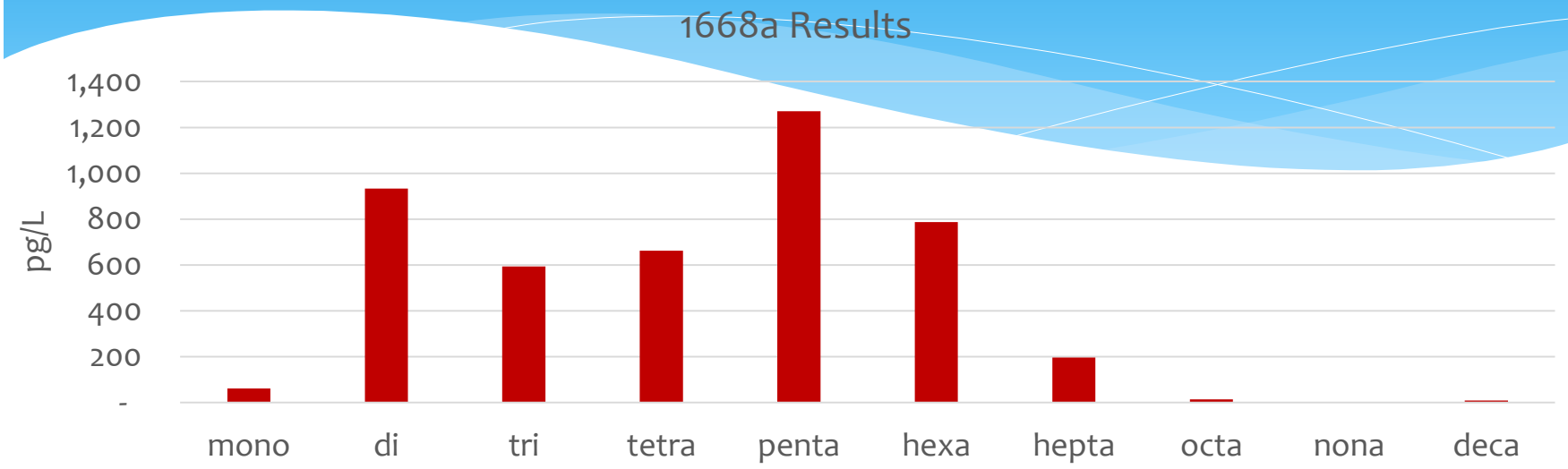
units pg/L	1st Quartile	Median	3rd Quartile
MDL	28.78	36.74	50.47

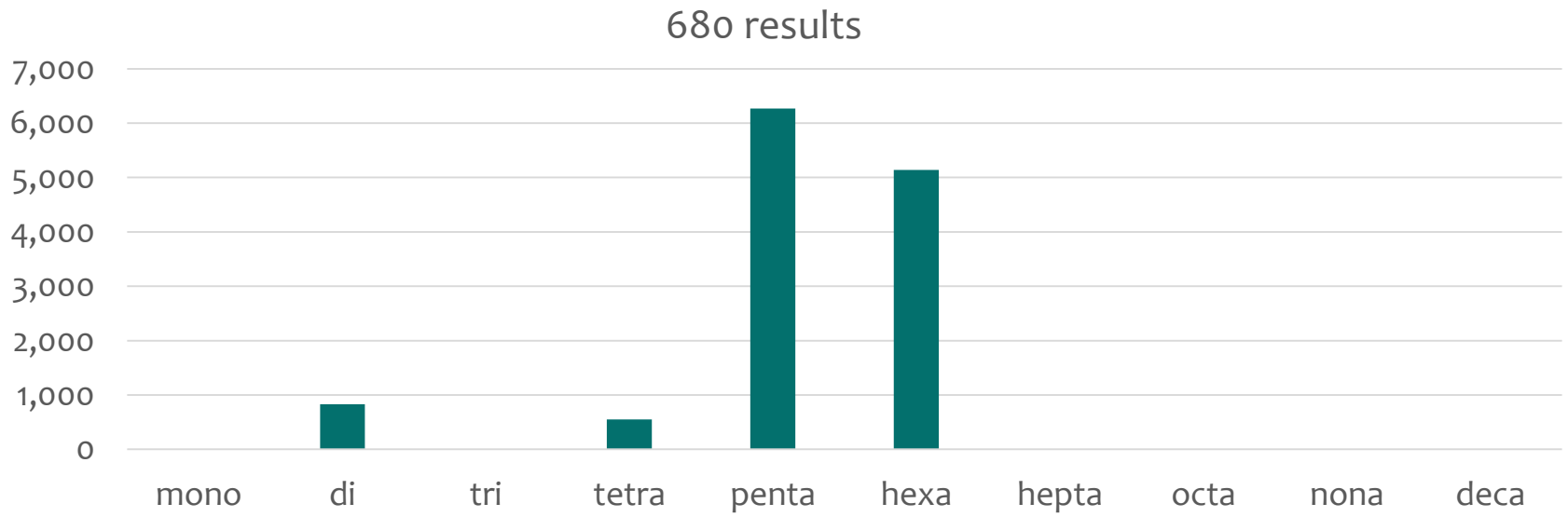
Trackdown Results using 1668a

- 1668A results = tPCBs =4,526 pg/L

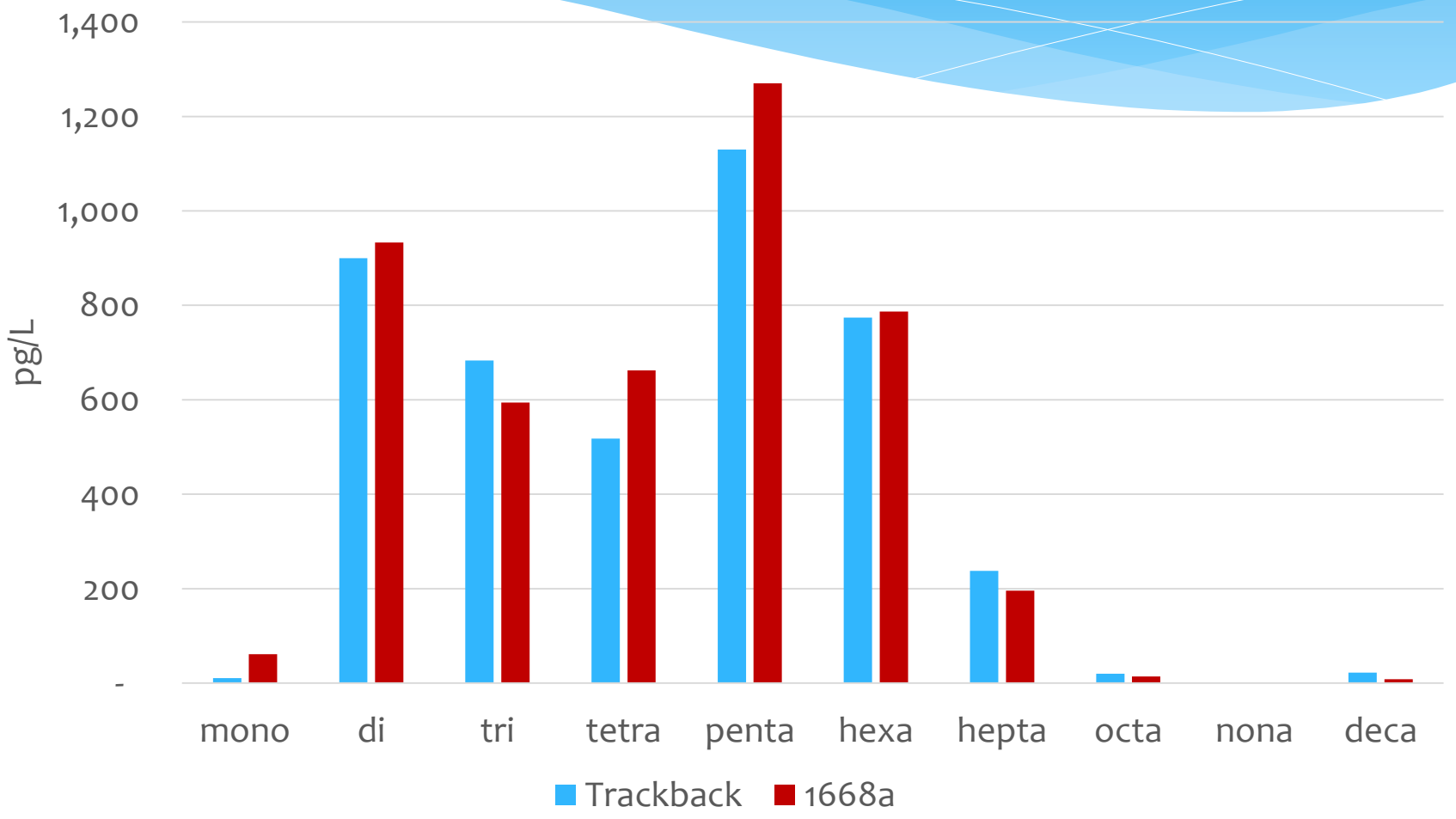


1668a vs 680


1668a Results
pg/L
1,400
1,200
1,000
800
600
400
200
-
mono
di
tri
tetra
penta
hexa
hepta
octa
nona
deca


680 results
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
mono
di
tri
tetra
penta
hexa
hepta
octa
nona
deca

1668a vs Trackback Yields Similar total and Homolog Concentrations



Conclusion

- Understand your existing data
  - Where it was collected and how was it analyzed
- Use this information to plan future trackdown sampling events
- Select a method which will meet study objectives
- Include flow estimates at locations where samples are collected
- Develop a data management scheme