Great Lakes Fish Monitoring and Surveillance Program and its implications for the watershed

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CAARES Center for Air and Aquatic Resources Engineering and Science

CAARES

CAARES is a state-of-the-art research facility specializing in environmental engineering and sciences. CAARES houses numerous analytical instrumentation and expert personnel that enable us to be a leader in the field of environmental contaminant analysis.



CAARES







- CAARES operates as a research facility and a core analytical facility serving both internal and external clients.
- Primary focus is on the analysis of organic contaminants in the environment including PFAS, PCBs, Dioxins, PBDEs and OCPs.
- Analysis conducted using state-of-the-art LC-MS and GC-MS techniques.

The Great Lakes Fish Monitoring and Surveillance Program (GLFMSP)

- The Great Lakes Fish Monitoring Program started in the late 1970s by the US-EPA.
- In 2004 (moved to Clarkson) morphed to the Great Lakes Fish Monitoring and Surveillance Program (include legacy and emerging contaminants).
- Data generated is used by other agencies, Great Lakes states and Tribes, NGOs and other researchers.







Historical Impacts on the Great Lakes





The Cuyahoga River (Ohio) carrying loads of sewage and chemicals to Lake Erie.

The Cuyahoga River Fires





The river caught on fire at least 12 times. The last fire in 1969 led to the establishment of the US EPA.

https://www.smithsonianmag.com/history/cuyahoga-river-caught-fire-least-dozen-times-no-one-cared-until-1969-180972444/

Historical Impacts on the Great Lakes



Paper pulp waste being released into Lake Erie.

Historical Impacts on the Great Lakes



Impact of steel mills and refineries on Lake Michigan

Gross contamination is easy to spot



What about trace level contamination?



EPAs drinking water threshold for selected organic contaminants

Compound	Threshold
Toluene	1 mg/L (1 PPM)
Benzene	5 ug/L (5 PPB)
Lindane	2 ug/L (2 PPB)
Hexachlorobenzene	1 ug/L (1 PPB)
PCBs	500 ng/L (500 PPT)
BaP	200 ng /L (200 PPT)
PFOA and PFOS	70ng/L (70 PPT)

https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#Organic

Trace Level Contamination



Olympic-size swimming pool holds 2 500 000 L of water



Contaminate with 2.5 L (1 PPM)



Contaminate with 2.5 mL (1PPB)

Trace Level Contamination



Trace Level Contaminant Analysis

Challenges:

- \checkmark Sample preparation \rightarrow Need to concentrate samples due to low concentrations (low ppt level).
- \checkmark Require highly sensitive instrumentation for detection \rightarrow Chromatography-Mass Spectrometry systems.
- ✓ Require highly skilled Technicians/Scientist to perform the analysis.

Trace Level Contaminant Analysis

Challenges:

 \checkmark Sample preparation \rightarrow Need to concentrate samples due to low concentrations (low ppt level).



1000-fold concentration step

Automated SPE unit



Cost of equipment \$50,000-\$100,000 Process about 10 samples a day Per sample cost is \$75

Liquid Chromatography-Mass Spectrometry (LC-MS) System



- Cost of equipment \$350,000-\$500,000
- Analyze 100 samples per day.
- Per sample cost for PFAS analysis ranges from \$150-\$300.
- Turn around time for data is typically 2 weeks.

PFAS in the Great Lakes Fish (2005-2015)

Temporal and Spatial trends are monitored for a wide range of contaminants that are present in the Great Lakes.



Targeted vs Non-Targeted Analysis

Targeted analysis is a search for a known compound.







Targeted vs Non-Targeted Analysis

Non-targeted analysis allows you to have a comprehensive look at a sample and then you decide what is important and what is not (surveillance).



How do you identify contaminants in a complex matrix?





Non-Targeted Analysis

CAARES is one of the leaders of non-targeted analysis (NTA) for the detection and identification of novel contaminants using state-of-the-art systems such as GCxGC-HRMS.



Non-Targeted Analysis

Analysis carried out on a GCxGC-HR TOF MS (LECO Pegasus GC-HRT⁺).

- Cost of equipment \$600,000-\$700,000
- Analyze 5-10 samples per day
- Per sample cost for analysis ranges from \$1200-1500
- Turn around time for data typically 2-3 weeks (may take 1-2 months).



Non-Targeted Analysis

CAARES is one of the leaders of non-targeted analysis (NTA) for the detection and identification of novel contaminants using state-of-the-art systems such as GCxGC-HRMS.



Thank you!

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