Per- and Polyfluoroalkyl Substances (PFAS) in Michigan Waters: Forever Chemicals or Whack-A-Mole?

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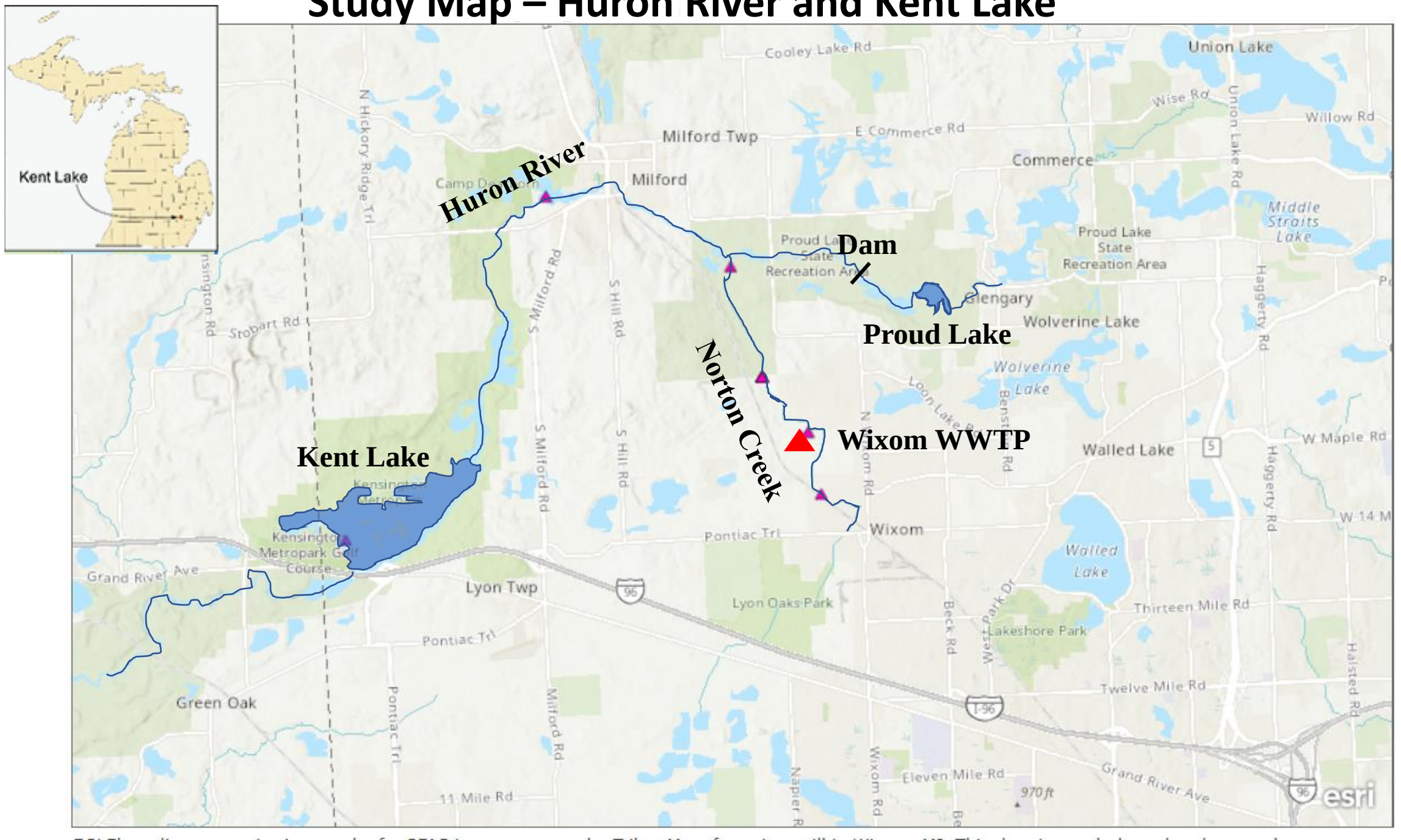
Introduction

- The story of PFAS contamination in the Huron River is a cautionary tale about understanding and controlling persistent toxic chemicals in the environment.
- GLEC carried out a field study of these contaminants in Kent Lake in 2021 for the Michigan Department of Environment, Great Lakes, and Energy (EGLE), Water Resources Division.
- I will present some highlights from that study.
- I will also provide a broader picture of PFAS contamination in Kent Lake and the Huron River.

Introduction to PFAS Chemistry

- PFAS: Per- and polyfluoroalkyl substances, a large class of man-made organic compounds, commonly referred to as "forever chemicals".
- They have been used in numerous industrial processes and consumer products for over 60 years. Examples: stain- and water-resistant fabrics and carpeting, cleaning products, paints and fire-fighting foams.
- PFAS compounds have different chemical, environmental and toxicological properties
- Many are persistent, some bioaccumulate in the environment, and several are toxic to mammals and/or birds in laboratory tests.
- Some can be degraded or transformed to other PFAS compounds
- Focus in this presentation is a single PFAS: perfluorooctane sulfonate (PFOS), which has been produced in large quantities and is of concern for human health effects

Study Map – Huron River and Kent Lake



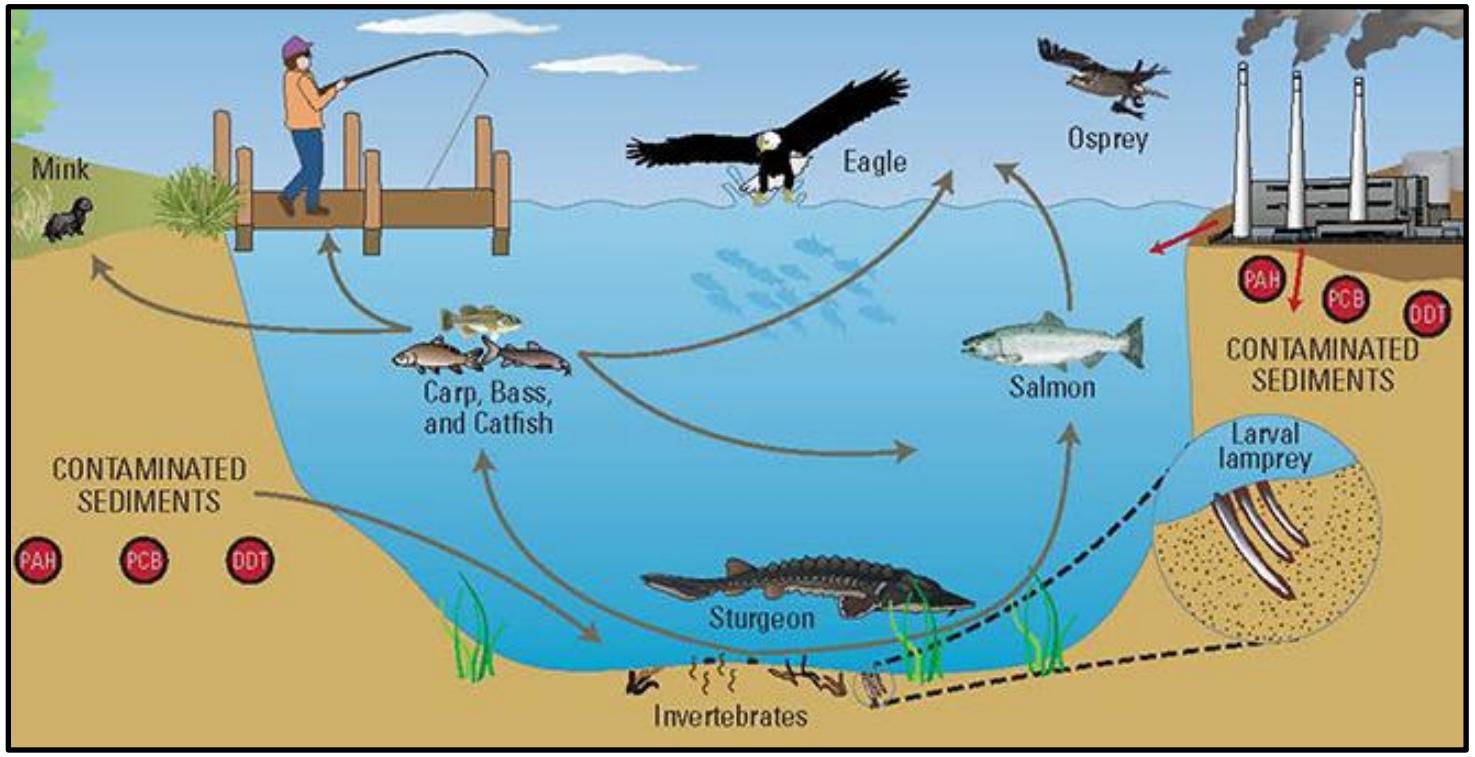
The story of PFOS/PFAS in the Huron River and Kent Lake

- In 2014 the city of Ann Arbor detected PFOS in a sample of drinking water, sourced from the Huron River.
- EGLE began sampling the river and its tributaries to identify sources of PFAS; nine surveys were conducted between July 2018 and September 2019.
- Water samples from 2 locations (Norton Creek and Willow Run) exceeded the Human Non-Cancer Value (HNV) for PFOS on more than one sampling date.
- Sampling and analysis of fish from throughout the Huron River identified high PFOS concentrations in Kent Lake.
- The PFOS concentrations were high enough to warrant a "Do Not Eat" fish advisory to cover Norton Creek and the Huron River downstream to the river mouth.
- Also in 2018, EGLE conducted a statewide assessment of PFAS in wastewater treatment plant (WWTP) effluent.
- Effluents from 3 of the 7 WWTPs in the Huron River watershed that had an Industrial Pretreatment Program (IPP) exceeded the HNV for PFOS:
  Ann Arbor, Brighton and Wixom.

What was the source of PFOS in Kent Lake and the Huron River?

- The Wixom WWTP effluent contained PFOS concentrations hundreds of times higher than the other WWTPs.
- The source of PFOS was traced to wastewater discharged to the sewer system from a metal plating facility.
- That facility added GAC adsorbers in October 2018 as a pretreatment process to remove PFAS from their wastewater.
- There was a 95% drop in PFOS concentrations in the WWTP effluent within 69 days following the addition of GAC treatment, and a 99% drop within one year.
- Treatment was very effective in controlling this major source of PFOS to Kent Lake and the Huron River.

But what about behavior of PFAS in the aquatic environment?



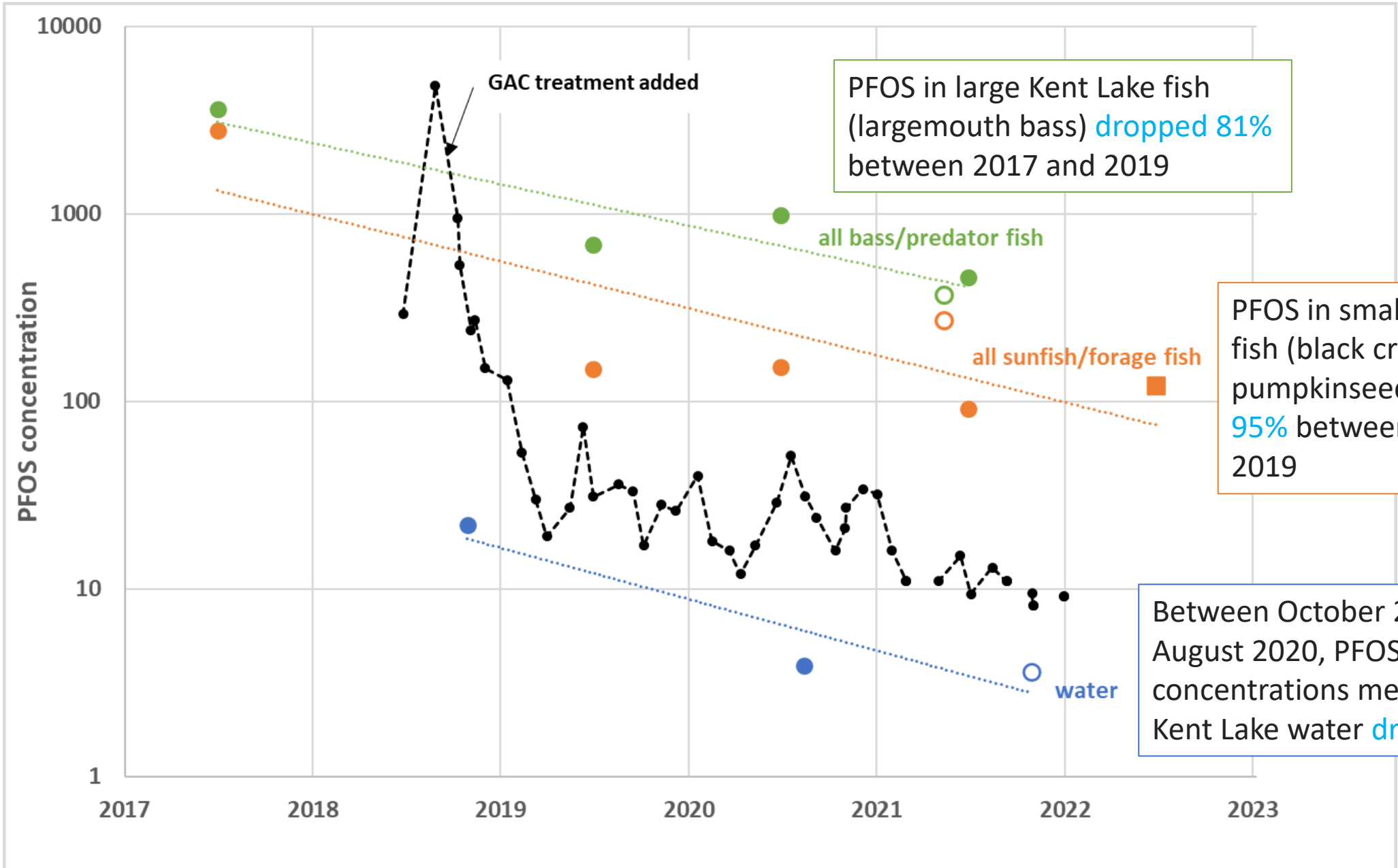
"Among the environmental media, the largest global reservoirs of PFASs are proposed to be oceans and sediment" (Ahrens et al., 2014. Review of PFAS…)

- What does this mean in the context of PFOS contamination in Kent Lake?
- Are sediments a sink or source of PFAS/PFOS to the environment?
- Can PFOS contamination in sediment pose a health risk to humans and wildlife?

GLEC field study in 2021 - sample collection and analysis

- Multiple sediment and water samples were collected in Kent Lake and an upstream reference lake during two events in fall of 2021.
- Surface water samples collected using a depth-integrated sampler.
- Sediment samples were collected using a Ponar sampler from three locations in each lake.
- Fish samples were collected in spring of 2021. Two predator fish and two prey fish samples were collected from each lake; each sample consisting of multiple individual fish.
- Benthic macroinvertebrate samples were collected in fall of 2021 as kick-net samples.
- Macroinvertebrates were sorted into major taxonomic groups (e.g., Odonata and Amphipoda).
- 35-36 PFAS compounds were analyzed in each sample.

PFOS concentrations (ppt) in WWTP effluent, water, and small and large fish

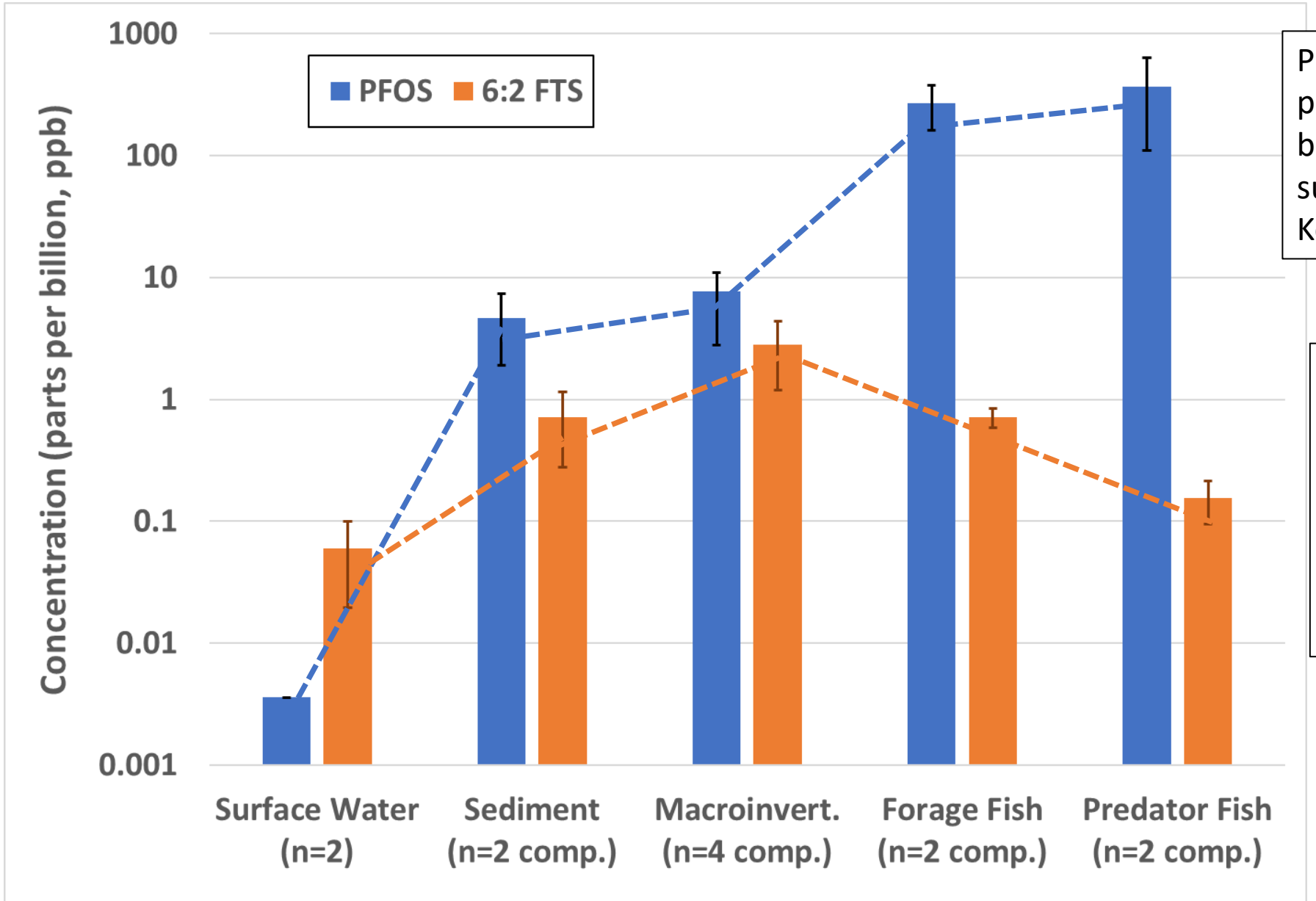


PFOS in large Kent Lake fish (largemouth bass) dropped 81% between 2017 and 2019

PFOS in small Kent Lake fish (black crappie & pumpkinseed) dropped 95% between 2017 and 2019

Between October 2018 and August 2020, PFOS concentrations measured in Kent Lake water dropped 82%

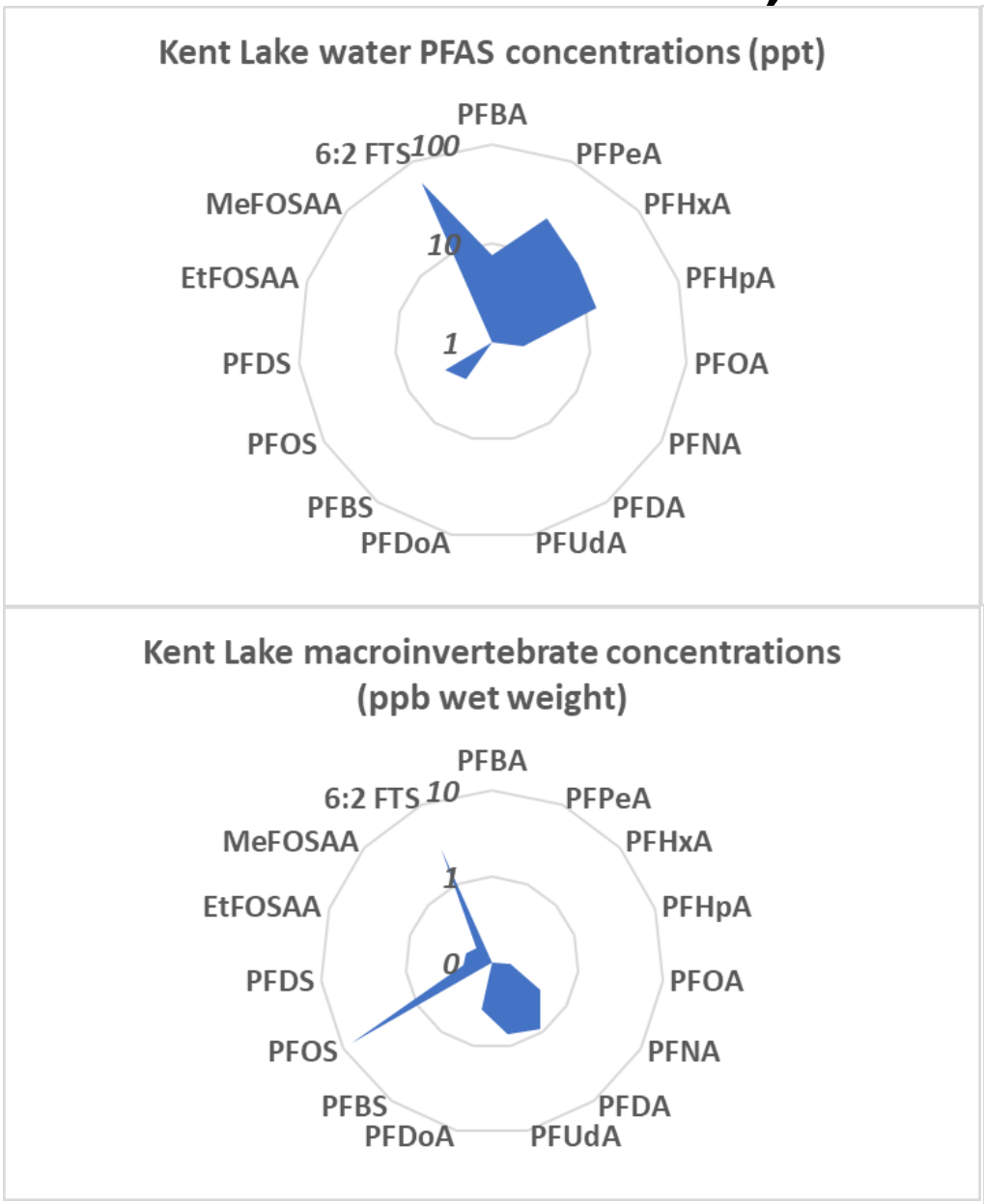
Results: partitioning and bioaccumulation of PFOS and 6:2 FTS

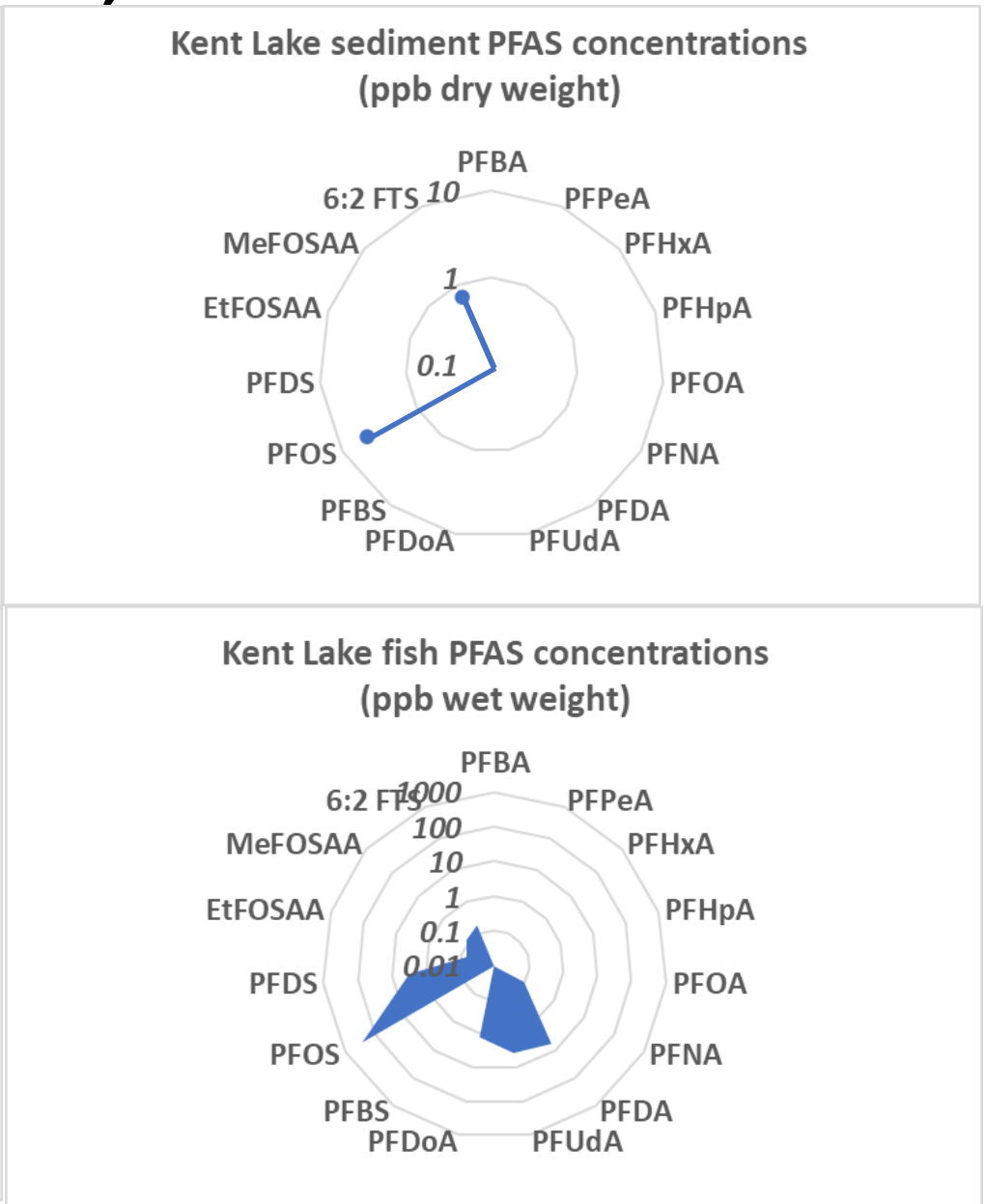


PFOS behaves as a persistent, bioaccumulative substance in Kent Lake.

6:2 FTS is a short-chain fluorotelomer that has mostly replaced PFOS in the chromium electroplating industry

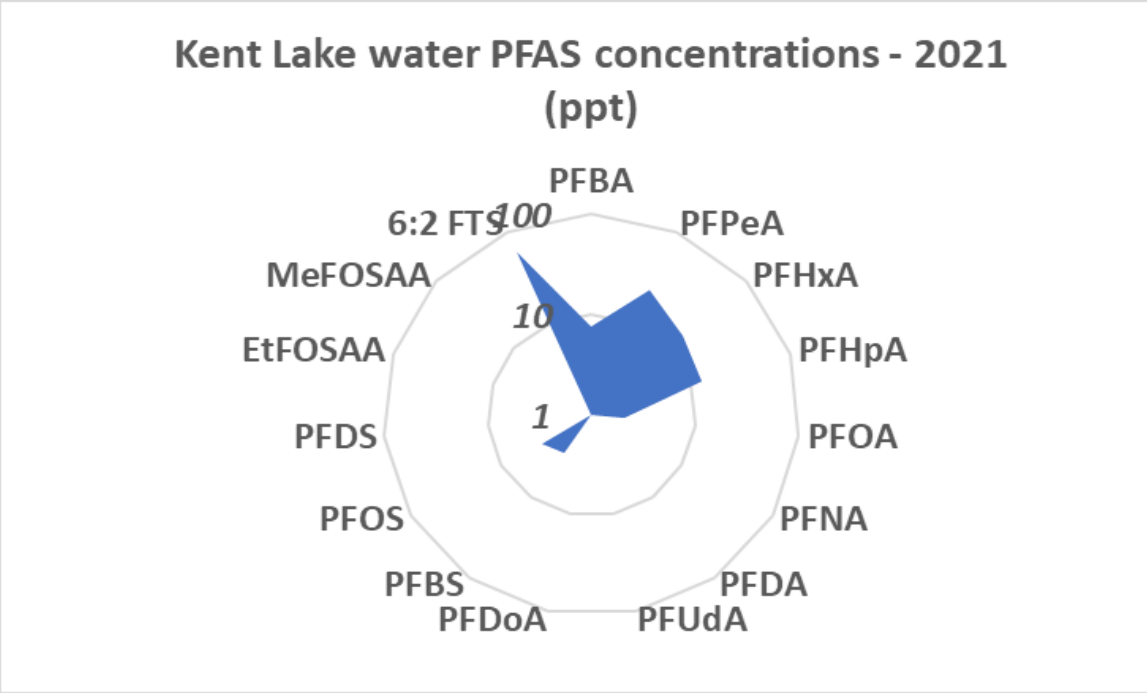
Comparison of concentrations of 15 PFAS compounds in Kent Lake water, sediment, fish and invertebrates

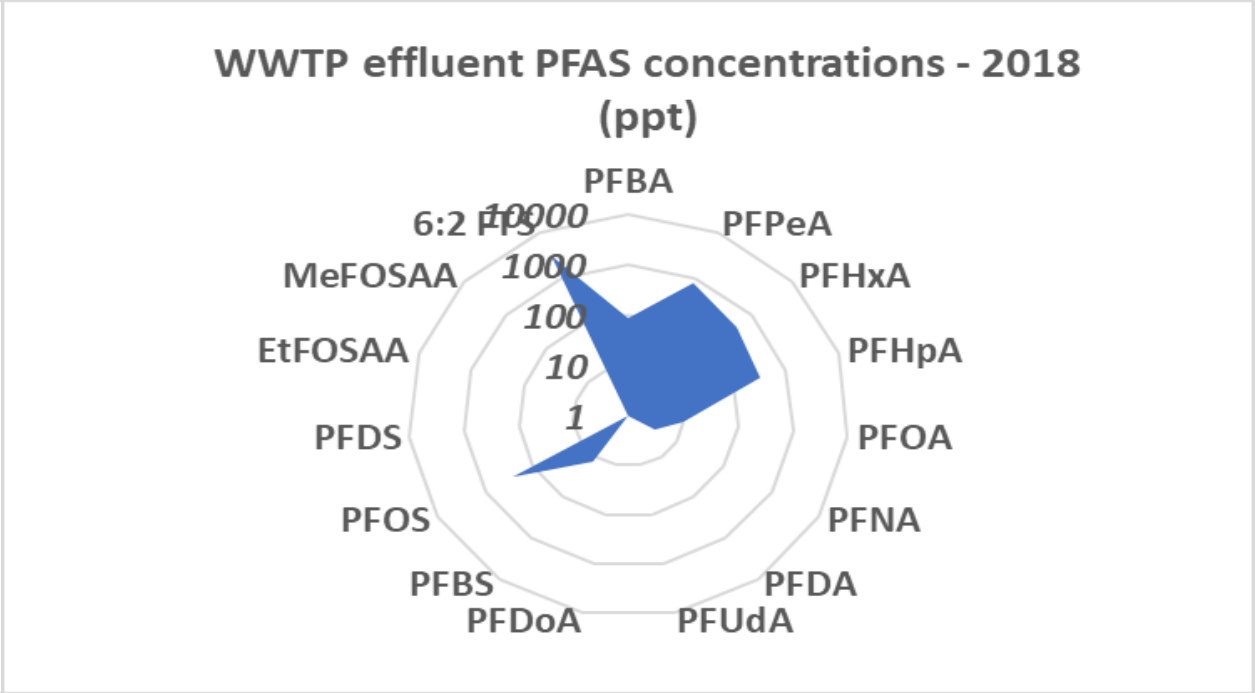




Comparison of PFAS Detected in Kent Lake with WWTP Discharge

- The 9 PFAS compounds detected in Kent Lake surface water were also measured in the WWTP effluent in 2018 (prior to installation of treatment at plating facility).





- Concentrations of these PFAS compounds in Kent Lake water and WWTP effluent are significantly correlated.
- This strongly suggests that the WWTP discharge was a major source of PFOS, 6:2 FTS and other PFAS to Kent Lake.

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From my perspective, PFAS are just the latest example of the challenge posed by persistent toxic chemicals released into the aquatic environment:

- Previous “forever chemicals” have included lead, mercury, plutonium, PAHs, DDT, dioxins/furans and PCBs.
- “Forever chemicals” can enter the environment via surprising pathways, often related to multiple uses and disposal methods.
- Most of these chemicals accumulate in sediments during disposal/release.
- Sediments can reintroducing contaminants to the ecosystem following controls (typically bans on production and or usage).
- I see numerous parallels between PFOS distribution and persistence in Kent Lake and the behavior of PCBs in similar aquatic ecosystems.

Thank you for your attention!

- We would like to acknowledge direction and finding of this project by Michigan Department of Environment, Great Lakes, and Energy (EGLE), Water Resources Division

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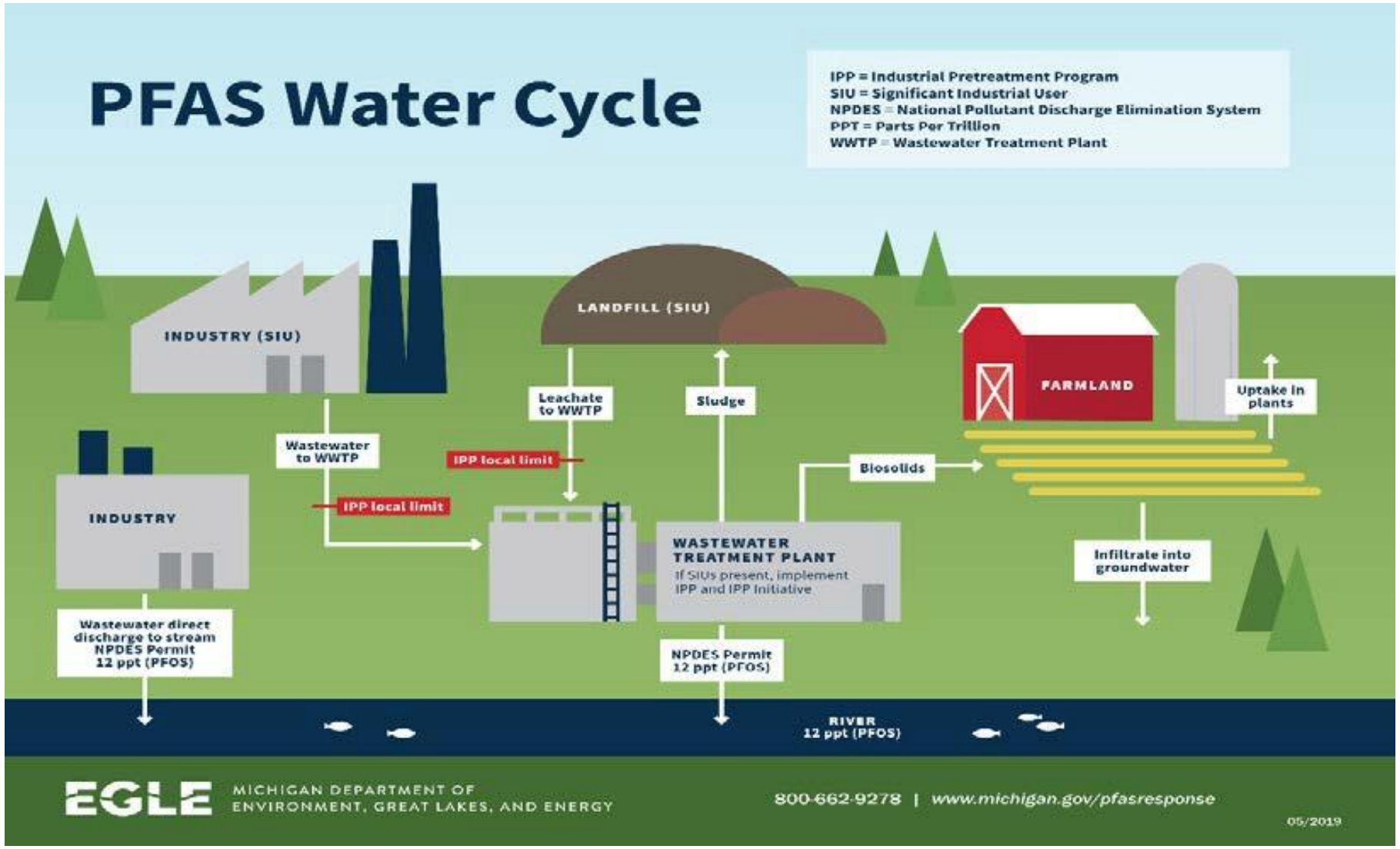
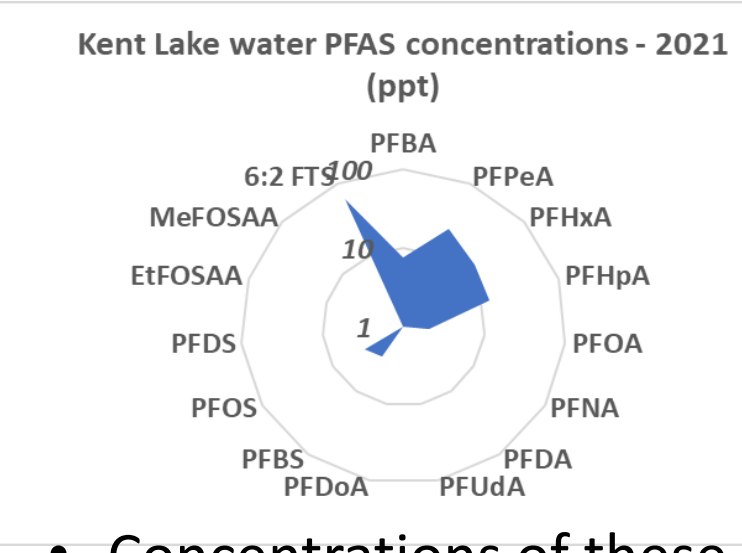
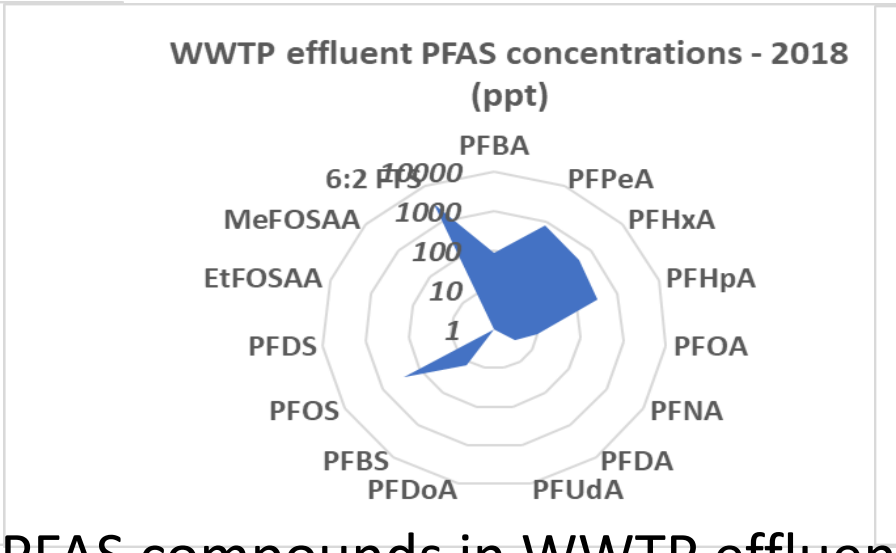


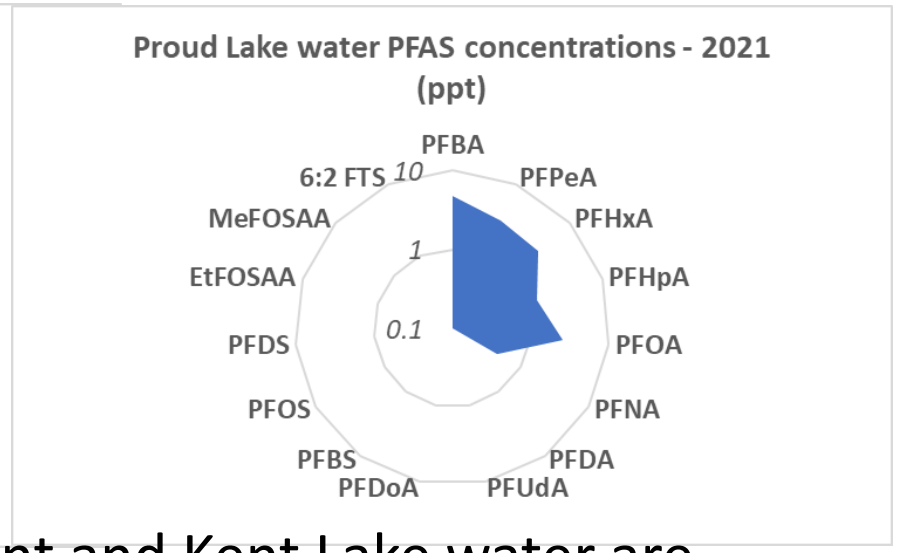
- Due to the widespread use of PFAS in many industries and consumer products, industrial discharges are expected to be the primary sources of PFAS to WWTPs.
- EGLE strategy for addressing PFAS has focused on identifying and addressing industrial discharges to WWTPs.

Comparison of PFAS Detected in Kent Lake with WWTP Discharge

- The 9 PFAS compounds detected in Kent Lake surface water were also measured in the WWTP effluent in 2018 (prior to installation of GAC treatment at plating facility).







- Concentrations of these PFAS compounds in WWTP effluent and Kent Lake water are significantly correlated, strongly suggests that the WWTP discharge was a major source of PFOS, 6:2 FTS and other PFAS to Kent Lake.
- Eight of the PFAS compounds measured in the Wixom WWTP effluent were also detected in Proud Lake water (albeit at much lower concentrations), but the concentrations were not significantly correlated concentrations of these PFAS compounds in the WWTP effluent
- PFAS compounds in Proud Lake, which does not receive discharge of Wixom WWTP effluent via flow from Norton Creek, most likely originate from other sources.

PFOS and 6:2 FTS usage by the metal plating industry

At the National level:

- Beginning in 1995, EPA recommended the use of PFOS as a fume suppressant in the chromium electroplating process.
- In 2012-2015, the U.S. metal plating industry transitioned away from PFOS to short-chain fluorotelomers - especially 6:2 FTS.

In Kent Lake:

- PFOS discharge continued after the industrial phase-out, and the source was only controlled by the addition of treatment.
- PFOS have persisted in Kent Lake sediment as well as biota, despite virtual elimination of the source via the Wixom WWTP.
- 6:2 FTS concentrations are quite high in Kent Lake water, suggesting continued usage and discharge.

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NEWS & INSIGHTS / NEWS RELEASES / 2023 / 08

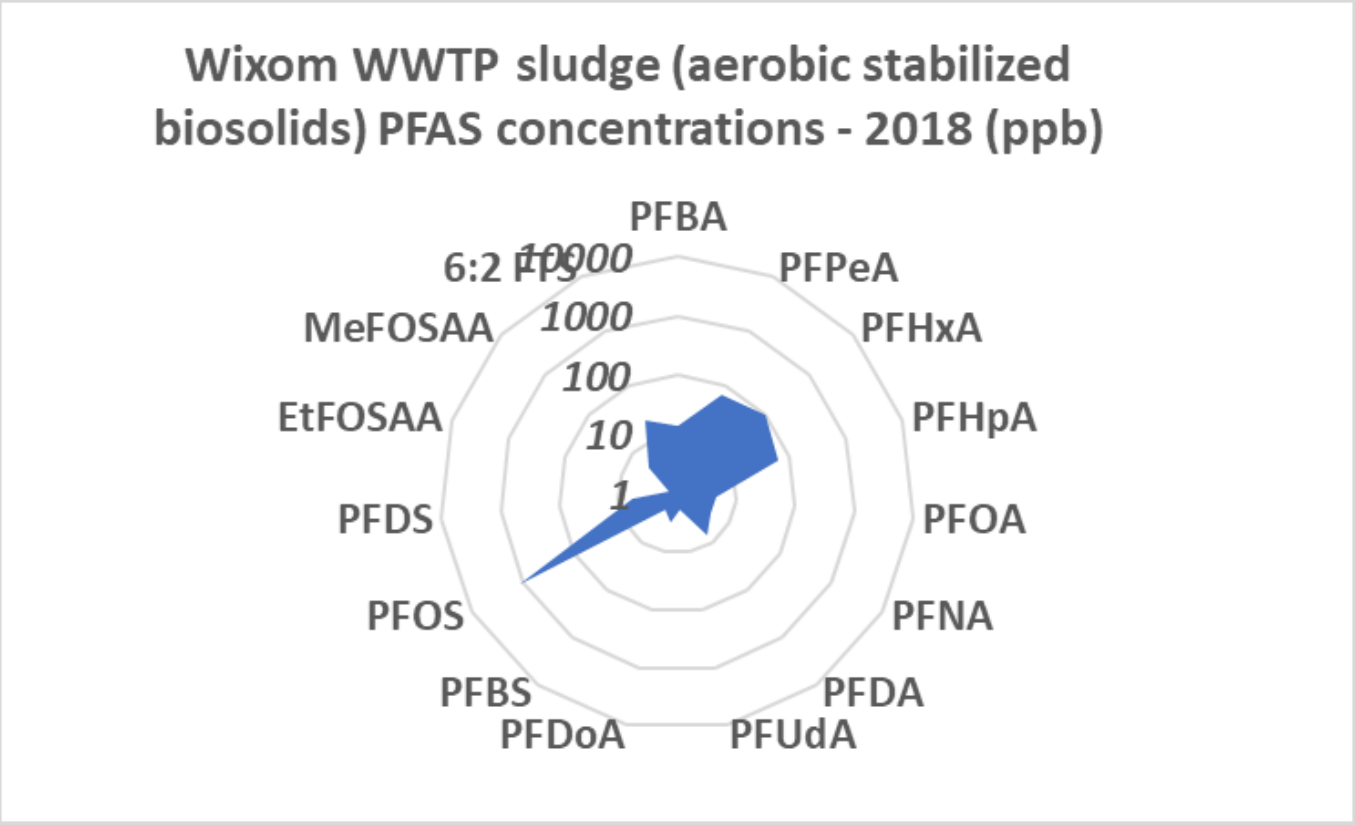
EWG updates PFAS map: Toxic 'forever chemicals' contaminate 3,186 locations in U.S.

328 locations are new

WASHINGTON – Today the Environmental Working Group updated its **interactive PFAS map** of sites contaminated with the **"forever chemicals"** known as PFAS to show **3,186 locations** in 50 states, the District of Columbia and two territories. **There are 328 newly confirmed locations with detections of PFAS.**

Biosolids – a second pathway of PFAS contamination

- WWTPs do remove some PFAS from wastewater
- These PFAS can end up in biosolids (solid wastewater residuals or “sludge”)



- Biosolids from Wixom WWTP were applied to farm fields as fertilizer from the late 1990s though 2015

How does Michigan currently manage PFOS in biosolids?

- **2021 Land application of biosolids containing PFAS interim strategy**
- **2022 Update to biosolids PFAS interim strategy**
- **Major Dischargers, Industrial Pretreatment Programs (IPPs) and Groundwater Discharge Permittees** that intend to land apply biosolids in Michigan shall collect and analyze a minimum of one representative biosolids sample for PFAS analysis in each year they intend to land apply, prior to the initial land application for the calendar year.
- **All other WWTPs** that intend to land apply biosolids in Michigan shall collect a minimum of one representative biosolids sample analyzed for PFAS prior to land application. Thereafter, upon permit reissuance, WWTPs shall collect one representative sample for PFAS prior to the initial land application that occurs within the permit cycle (every five years). WWTPs under this sampling frequency shall conduct the biosolids PFAS sampling in the same year they intend to land apply in order to have the most representative sample. Sampling frequency is subject to change if PFOS concentrations are 20 µg/kg or above.