PFAS In Chautauqua County Lakes

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Introduction

Per- and polyfluoroalkyl substances or PFAS are a family of thousands of synthetic compounds widely used for the past eighty years in a host of industrial, commercial and everyday applications. They are persistent and are found everywhere at low levels but can be found at high levels in certain locations throughout the world. Their toxicity and distribution are a matter of much concern. Several states and the USEPA have started to regulate select PFAS chemicals including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) and there has been a frenzy of PFAS sampling across the country over the past few years. Now most public drinking water supplies in New York must sample for PFAS, which has uncovered problems across the state including some in Chautauqua County. To get an idea of what's happening in our own lakes and waterways, the Chautauqua–Conewango Consortium, A Waterkeeper Alliance Affiliate (Consortium) participated in a nationwide PFAS survey by sampling the Chadakoin River. Using a relatively inexpensive method developed by Cyclopure, Inc. they collected two samples from the river in 2022 and found they contained PFAS. A third sample from a large pond with an undeveloped watershed contained no PFAS. To better understand the prevalence of PFAS in our lakes, Consortium volunteers sampled the outlets of Bear, Cassadaga, Chautauqua and Findley lakes. This report provides the results from those samples and examines the quality of the Cyclopure method by comparing those results to data from commercial labs. It also reviews current PFAS water quality standards, issues and concerns about PFAS in animals.

Background

Per- and polyfluoroalkyl substances (PFAS) have unique properties as repellants and surfactants and are often used as coatings that make things slippery, which has made them useful for numerous everyday applications including cleaning products, food packaging, clothing, furniture and more, along with a tremendous number of industrial applications (Figure 1). They also have a high heat capacity and have been used in firefighting foams for extinguishing flammable liquids. Because of their wide use and the fact that they break down extremely slowly, they build up over time and are present in low levels throughout the environment including in water, soil, air and precipitation and are even found in the bloodstream of animals and in fish. In short, they are everywhere and are often referred to as "forever chemicals" because they are so persistent in our environment.

As the name Per- and polyfluoroalkyl substances may imply, their individual compounds have long, complicated names that are hard to pronounce. For this reason, and to make this report a little easier to read, their abbreviated acronyms are used. The full names of those substances discussed are as follows in order of their mention:

PFOA = perfluorooctanoic acid,
PFOS = perfluorooctane sulfonate,
PFHxA = perfluorohexanoic acid,
PFNA = perfluorononanoic acid,
PFBA = perfluorobutanoic acid,
PFHxS = perfluorohexanesulfonic acid, and
HFPO-DA = hexafluoropropylene oxide dimer acid. (HFPO-DA is a main component in GenX which is the tradename for a chemical created by the Chemorus company used as a replacement for PFOA).

Figure 1: *Examples of products that contain PFAS. From Riverside, CA Public Utilities[1].*

Human health effects from PFAS exposure are currently being studied. Because there are so many compounds, there is little known about health effects except for those with the most widespread use including PFOA and PFOS. These may cause developmental delays in children, an increased risk of certain cancers and affect the immune and hormone systems[2]. For this reason, PFOA and PFOS have been phased out of production and EPA has designated them "hazardous substances[3]." Many other PFAS compounds are still in use. Others that are being studied and which are discussed in this report include PFNA, PFBA and PFHxA, which have been shown to cause similar health affects as PFOA and PFOS in lab animals[2]. The NYSDOH started regulating PFOA and PFOS in 2020 following issues in Hoosick Falls and has established a maximum allowable level of 10 parts per trillion (ppt) for them in drinking water[4]. One part per trillion is an extremely minute quantity which is equivalent to 1 cent in 10 billion dollars. Previously, the smallest quantity of contaminants regulated in drinking water were in parts per billion; 1 ppb is a thousand times bigger than 1 ppt. In April this year EPA established maximum allowable levels for PFOA and PFOS in drinking water of 4 ppt and set a limit of 10 ppt for PFNA, PFBA, PFHxS and HFPO-DA all starting in 2029[5]. Furthermore, the DEC issued "ambient water quality guidance values" for human health for PFOA of 6.7 ppt and for PFOS of 2.7 ppt; they also issued chronic and acute guidance values for aquatic life for PFOS in fresh and salt water[6].

Groundwater and surface water contamination from PFAS is of great concern nationally and locally, which has sparked a frenzy of water quality sampling across the country. In New York, state-wide sampling of public water supplies started in 2020 and sampling private wells around landfills and other known sources of PFAS started earlier. Other states have followed suit. In 2021, the Ohio River Valley Water Sanitation Commission (ORSANCO) sampled the entire 981 miles of the Ohio River at random locations for PFAS and found low levels of PFAS in every sample (Figure 2)[7].

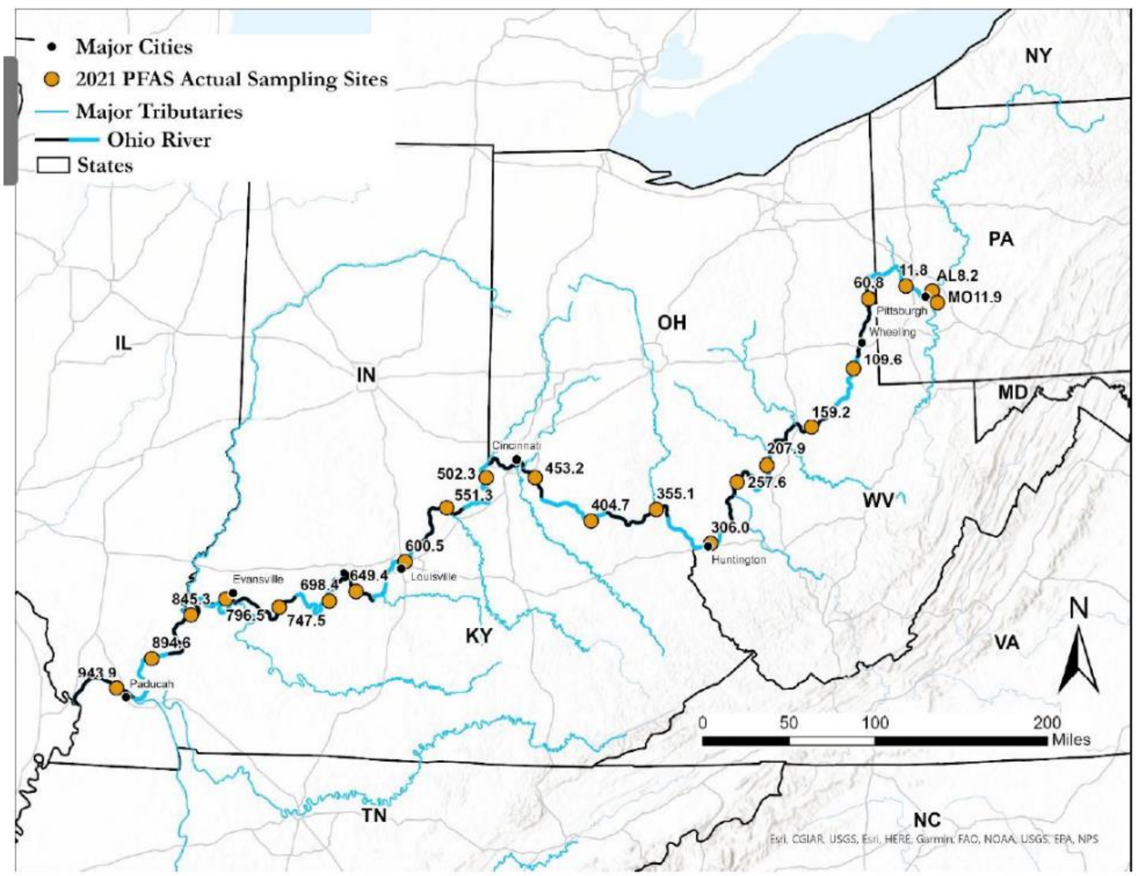

***Figure 2**: Map showing ORSANCO PFAS sampling locations along the Ohio River[7].*

Chautauqua County has seen its share of PFAS impacts to groundwater quality. Most notably, the Village of Mayville detected high levels of PFNA in its wells in 2020[8], forcing them to spend over a million dollars on water supply improvements and treatment to make the water safe to drink. Bemus Point Elementary School found itself in the same boat shortly after, which cost them nearly half a million dollars to install treatment, even though PFNA is not currently regulated in drinking water. The cause of both were linked to firefighting foam. It should be noted that the County Health Department tested private wells in both areas and found no PFAS contamination, indicating these were very localized problems. Other sources of PFAS that can pollute water include landfills, hazardous waste sites, sewage treatment plants, airports, certain industries and even septic systems[9]. A mobile home park in Busti was found to exceed PFAS drinking water standards forcing them to make changes to their water system, but no obvious source was identified, and the Army reserve center in Gerry found low levels in their drinking water well. These are only a few that were identified by mandatory drinking water monitoring, there are likely more water wells with problems where no such monitoring is required.

PFAS Monitoring of Local Waterways

In 2022 Waterkeeper Alliance, a network of more than 350 local watershed-based groups across the country, partnered with Cyclopure, a private company that developed a low-cost water test for PFAS, to sample 114 watersheds (Figure 3)[10]. Locally, Consortium volunteers collected samples from waterways up- and downstream of potential PFAS sources such as landfills and industrial sites. While Cyclopure's method tests for 55 PFAS compounds, Waterkeeper Alliance focused on four – PFOA, PFOS, PFBS and HFPO-DA chemicals. Of the 228 surface water samples analyzed, 169 contained measurable levels of one or more of these compounds.

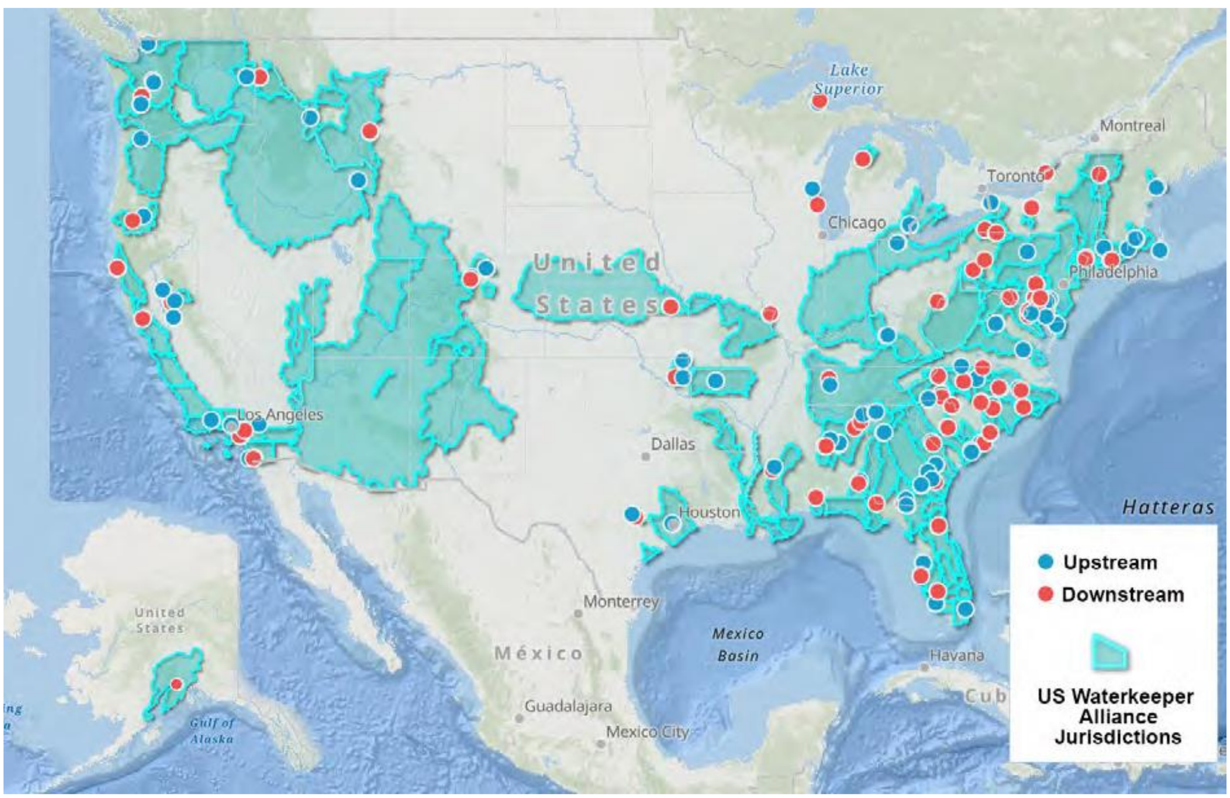

***Figure 3**: Map showing Waterkeeper Alliance's PFAS sample locations in the US[10].*

The Consortium collected samples from the Chadakoin River up- and downstream of the Taylor Firefighting Training Center in Jamestown that contained low levels of PFAS. This sparked an effort to use the Waterkeeper/Cyclopure method to collect samples from the outlet of Chautauqua County's four inland lakes – Bear, Cassadaga, Chautauqua and Findley. In doing so we also wanted to validate the Cyclopure results by collecting quality control samples. Cycolpure has conducted several quality control studies on their method, but we were compelled to conduct our own to ensure the results from this low-cost method were reliable for our application.

Results and Discussion

The first PFAS samples were collected from the Chadakoin River on June 13, 2022 by Consortium volunteers near the Taylor Firefighting Training Center (Photo 1). Of the 55 PFAS chemicals tested by Cyclopure shown in Table 1, PFOA, PFOS and PFHxA were detected at levels between 1.0 and 2.0 ppt in both the upstream and downstream samples. On September 11, 2023 a sample was collected from the Chadakoin River at the McCrea Point boat launch, located upstream of the Taylor Firefighting Training Center and close to the Chautauqua Lake outlet (Photo 2). This sample location was used in previous Chautauqua Lake studies to represent the lake outlet. PFOA, PFOS and PFHxA were also detected in this sample at levels between 1.0 and 1.5 ppt. Results are shown in Table 2.

Photos 1&2: *Consortium volunteers collecting PFAS samples. Left - Jan Bowman at the Chadakoin River on 6/13/2022; right – Willaim Boria at McCrea Point on 9/11/2023 (not pictured but assisting at both sites is Jane Conroe).*

Table 1: The 55 PFAS compounds analyzed by Cyclopure method (table provided by Cyclopure). Also shown in table are the PFAS compounds analyzed by two private labs discussed later in this report. 1-indicates compound analyzed by Eurofins lab, 2-indicates compound analyzed by ALS lab.

CYCLOPURE

Appendix.

PFAS detected by Cyclopure analytical methods.

Compound	Abbreviation	CAS#	EPA 1633
Perfluorobutanoic Acid 1	PFBA	375-22-4	Y
Perfluoropentanoic Acid 1	PFPeA	2706-90-3	Y
Perfluorohexanoic Acid 1, 2	PFHxA	307-24-4	Y
Perfluoroheptanoic Acid 1, 2	PFHpA	375-85-9	Y
Perfluorooctanoic Acid 1, 2	PFOA	335-67-1	Y
Perfluorononanoic Acid 1, 2	PFNA	375-95-1	Y
Perfluorodecanoic Acid 1, 2	PFDA	335-76-2	Y
Perfluoroundecanoic Acid 1, 2	PFUnA	2058-94-8	Y
Perfluorododecanoic Acid 1, 2	PFDoA	307-55-1	Y
Perfluorotridecanoic Acid 1, 2	PFTrDA	72629-94-8	Y
Perfluorotetradecanoic Acid 1, 2	PFTeA	376-06-7	Y
Perfluoropropane Sulfonic Acid	PFPrS	423-41-6	
Perfluorobutane Sulfonic Acid 1, 2	PFBS	375-73-5	Y
Perfluoropentane Sulfonic Acid	PFPeS	2706-91-4	Y
Perfluorohexane Sulfonic Acid 1, 2	PFHxS	355-46-4	Y
Perfluoroheptane Sulfonic Acid	PFHpS	375-92-8	Y
Perfluorooctane Sulfonic Acid 1, 2	PFOS	1763-23-1	Y
Perfluorononane Sulfonic Acid	PFNS	474511-07-4	Y
Perfluorodecane Sulfonic Acid	PFDS	335-77-3	Y
Perfluorododecane Sulfonic Acid	PFDoS	79780-39-5	Y
4:2 Fluorotelomer Sulfonate	4:2 FTS	414911-30-1	Y
6:2 Fluorotelomer Sulfonate	6:2 FTS	425670-75-3	Y
8:2 Fluorotelomer Sulfonate	8:2 FTS	481071-78-7	Y
10:2 Fluorotelomer Sulfonate	10:2 FTS	120226-60-0	
Perfluorobutane Sulfonamide	FBSA	30334-69-1	
N-Methylperfluorobutanesulfonamide	MeFBSA	68298-12-4	
Perfluorohexane Sulfonamide	FHxSA	41997-13-1	
Perfluorooctane Sulfonamide	PFOSA	754-91-6	Y
Perfluorodecane Sulfonamide	FDSA	N/A	
N-Ethylperfluorooctane-1-Sulfonamide	NEtFOSA	4151-50-2	Y
N-Methylperfluorooctane-1-Sulfonamide	NMeFOSA	31506-32-8	Y
Perfluorooctane Sulfonamido Acetic Acid	FOSAA	2806-24-8	
N-Ethyl Perfluorooctane Sulfonamido Acetic Acid	NEtFOSAA	2991-50-6	Y
N-Methyl Perfluorooctane Sulfonamido Acetic Acid 1	NMeFOSAA	2355-31-9	Y
N-methyl perfluorooctanesulfonamidoethanol 2	NMeFOSE	24448-09-7	Y
N-ethyl perfluorooctanesulfonamidoethanol 1, 2	NEtFOSE	1691-99-2	Y
Hexafluoropropylene Oxide Dimer Acid 1, 2	HFPO-DA	13252-13-6	Y
4,8-Dioxa-3H-Perfluorononanoate 1, 2	ADONA	919005-14-4	Y
Perfluoro-3-Methoxypropanoic Acid	PFMPA	377-73-1	Y
Perfluoro-4-Methoxybutanoic Acid	PFMBA	863090-89-5	Y
Perfluoro-3,6-Dioxaheptanoic Acid	NFDHA	151772-58-6	Y
9-Chlorohexadecafluoro-3-Oxanone-1-Sulfonic Acid 1, 2	9Cl-PF3ONS	756426-58-1	Y
11-Chloroeicosafluoro-3-Oxanonane-1-Sulfonic Acid 1, 2	11CL-PF3OUdS	763051-92-9	Y
Perfluoro(2-ethoxyethane) Sulfonic acid	PFEESA	113507-82-7	Y
Perfluoro-4-ethylcyclohexane Sulfonic Acid	PFECHS	646-83-3	
8-Chloroperfluoro-1-Octanesulfonic Acid	8Cl-PFOS	777011-38-8	
3-Perfluoropropyl Propanoic Acid	3:3FTCA	356-02-5	Y
2h,2h,3h,3h-Perfluorooctanoic Acid	5:3FTCA	914637-49-3	Y
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	Y
2H-Perfluoro-2-dodecenoic acid	FDUEA	70887-94-4	
2H-perfluoro-2-decenoic acid	FOUEA	70887-84-2	
Bis(perfluorohexyl)phosphinic acid	6:6PFPi	40143-77-9	
(Heptadecafluorooctyl)(tridecafluorohexyl) Phosphinic Acid	6:8PFPi	610800-34-5	
Bis(perfluorooctyl)phosphinic acid	8:8PFPi	40143-79-1	
N-(3-dimethylaminopropan-1-yl) perfluoro-1-hexanesulfonamide	N-AP-FHxSA	50598-28-2	

On September 11, 2023 samples were also collected from the outlets to Bear, Cassadaga and Findley lakes at the following locations:

Bear Lake – from the end of the dock owned by Patsy Lindell at the end of Muskie Point Road,
Cassadaga Lakes – on the south side of the Maple Avenue bridge from the east bank,
Findley Lake – from the end of the kayak launch at the DEC public access point off Route 430.

Results from these samples detected none of the 55 PFAS chemicals tested. A sample was also collected on April 20, 2023 from the Jamestown Audubon Community Nature Center's Big Pond outlet that detected no PFAS compounds.

The PFAS chemicals detected in the Chadakoin River and Chautauqua Lake outlet samples are low and do not cause any reason for alarm at this time. They are well below the current NYSDOH's PFOA and PFOS standard for drinking water of 10 ppt and the EPA's proposed standard of 4 ppt set to take effect in 2029. However, PFOS does hover around one-half of DEC's ambient water quality guidance value for human health of 2.7 ppt. As DEC explained in a press release[6], "The new Guidance Values are below DOH's MCLs for PFOA, PFOS…. to provide an extra margin of safety against the potential build-up of these contaminants to levels approaching or exceeding the MCLs."

Table 2: *PFAS results from Chadakoin River and Chautauqua Lake Outlet.*

Compound Name	**Acronym**	**PFAS Concentration (ppt)**	
		6/13/2022 Chadakoin R	**9/11/2023 Chaut L Outlet**
Perfluorooctanoic Acid	PFOA	1.7	1.3
Perfluorooctane Sulfonic Acid	PFOS	1.8	1.4
Perfluorohexanoic Acid	PFHxA	1.2	1.2

Since Chautauqua Lake is used as a source of drinking water by the Chautauqua Utility District, which serves Chautauqua Institution, and by the Town of Chautauqua Water District #2, which serves Chautauqua Lake Estates, they are both required to monitor for PFAS in their treated drinking water. Chautauqua Utility District has had no detections[11] and Chautauqua Water District #2 has detected PFOA at levels less than 1 ppt.

Potential sources for PFAS in Chautauqua Lake include sewage treatment plants, inactive landfills, hazardous waste, industrial discharges, certain fire suppressant chemicals and septic systems. There are three large municipal sewage treatment plants and a number of small treatment plants that discharge upstream of McCrea Point. The three large plants could be one source of PFAS and will likely be required to start monitoring for it in the future[12,13]. Monitoring of groundwater and surface seeps at the inactive Dinsbier Road landfill located in the Chautauqua Lake watershed near Mayville detected several PFAS compounds. Groundwater at the Standard Portable Site, the former location of a metalworking industry in Mayville not far from the Chautauqua lakeshore, is contaminated with petroleum byproducts and chlorinated solvents and is another potential source of PFAS since they can be found toegther[14]. In addition, samples collected by DEC from Mud Creek during the Mayville drinking water investigation showed low levels of PFAS and there are likely numerous other sites contributing PFAS to the lake that have not been studied, but at the same time may never be identified. Is this a problem? We don't know at this point but PFAS levels in Chautauqua Lake are well below existing and proposed standards for drinking water and lower than those found in many lakes across the country.

The fact that samples from our other inland lakes and the Jamestown Audubon pond showed no detections, suggest their watersheds are devoid of major PFAS sources and that the PFAS chemicals present in Chautauqua Lake are associated with urban and industrial activity. In fact, the other waterbodies sampled have little urbanization, industry and few if any contaminated sites.

It has been established that PFOS is present in many of our waterways across the US[9]. The quantities of PFAS on the order of 1 to 10 ppt were never imagined to be detectable in water just twenty-five years ago. As laboratory testing becomes more and more advanced and able to detect smaller and smaller amounts of contaminants, more and newer contaminants will be found in our environment.

PFAS in Fish and Deer

Current research is focusing not only on PFAS levels in waterways but also that found in fish tissue and its associated implications on public health. According to the research, PFOS appears to be the chemical of greatest concern because it's found at the highest levels in fish[15]. One study calculated how eating one 8 oz serving of fish per year compares to drinking contaminated water for a month[15]. As an example, they found that eating one serving of fish containing 8,410 ppt of PFOS (the median PFOS level found in freshwater fish across the US in samples collected by the EPA from 2013 to 2015) was equal to drinking water contaminated with 48 ppt of PFOS for one month (assumes a consumption of 1.3 liters of water per day)[15]. They also found that PFAS levels were higher in Great Lakes fish and that FDA testing of grocery store fish, including canned fish, contained much lower levels of PFAS than the freshwater fish tested by EPA. An interactive map showing PFOS levels in fish across the US is shown in Figure 4[16]. ORSANCO has recently started testing fish from the Ohio River for PFAS. They have been testing other chemicals of concern in fish tissue for years, such as PCBs and mercury, and are making PFAS testing routine as well[17].

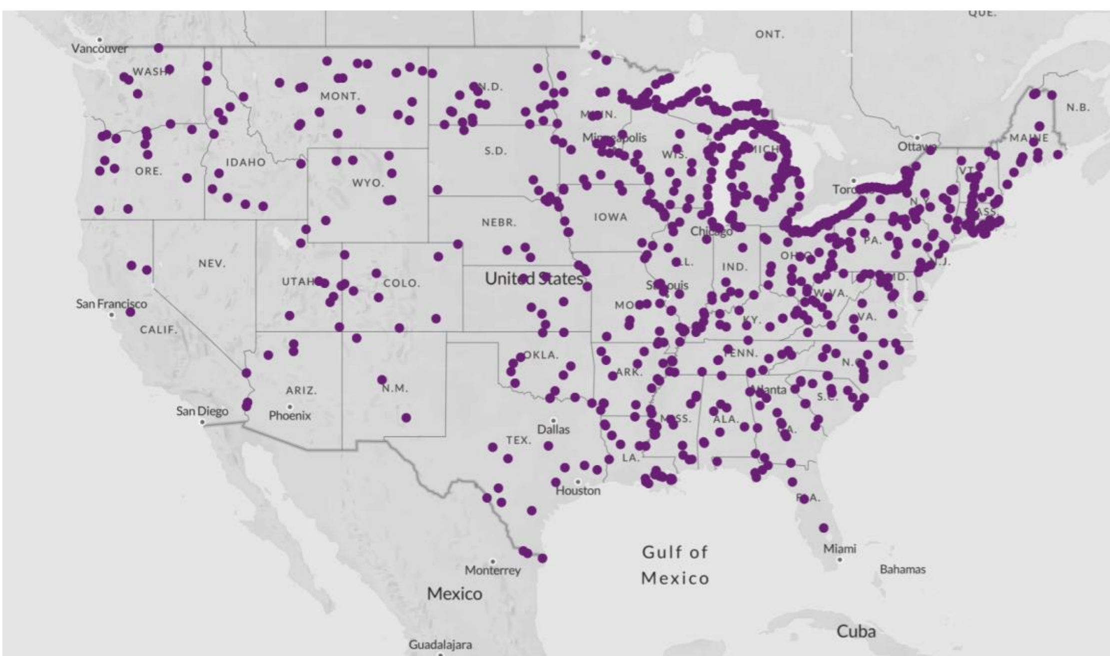

Figure 4: Screen shot of an interactive map showing the approximate location of fish that were tested for PFAS. Go to https://www.ewg.org/interactive-maps/pfas_in_US_fish/map/ to explore this map including the results of fish tissue analyses for each point. Prepared by the Environmental Working Group[16].

Public health officials are now wrestling with developing fish consumption guidelines for PFAS. Previously fish consumption advisories were based largely on PCBs and mercury. While there are an abundant number of health benefits gained by eating fish, those caught from certain waterbodies should be avoided. As of 2022 Indiana, Michigan, Minnesota, New York and Wisconsin all have PFAS-based fish consumption advisories that recommend limiting or avoiding eating fish from a small number of waterbodies in each state[18]. These guidelines emphasize that large fish contain higher levels of PFAS because it bioaccumulates in them as they age. These fish advisories identify women of child-bearing age, children under 15 years old and those with compromised immune systems as sensitive populations who are especially vulnerable. New York State's fish consumption advisories are limited to eight lakes/ponds and seven rivers/creeks where both water and fish have been tested, the closest being in central New York[18]. However, there is currently no state-run program to test the thousands of other waterways in New York. An important takeaway from this is that PFAS in fish is highly variable and more research is needed to understand it.

It was mentioned previously that PFAS is present in the blood of animals. It is widely accepted that all humans have at least trace levels of PFAS in their blood[2] and recently it was found at high levels in deer in Maine and Michigan, although only in areas where excessively high levels of PFAS were found in the environment[19,20]. In response, officials in those states issued do not consume advisories for venison in two isolated areas[21,22]. They have also issued advisories for consuming deer liver state-wide, as has New Hampshire[21,22,23]. No related advisory currently exists in New York.

Conclusion and Recommendations

While much has been learned about PFAS in the environment, there is much that is still unknown. It appears PFAS in our local lakes don't compromise public health, but more testing is needed. Most lakes in New York have not even been tested for PFAS and there has not been any routine, widespread testing of fish and animals. The approach by New York and other states has been typical, they react to contamination problems that create a public health risk rather than invest in research to better understand the occurrence and distribution of PFAS in the environment. It is time for states to be proactive and develop a holistic PFAS monitoring and reporting program for air, land, water, plants and animals, including humans, and for the federal government to provide funding.

Based on results from this limited water quality study, it is recommended that a more thorough PFAS study be conducted on Chautauqua Lake that includes collecting samples from multiple sites in the lake at different depths and during different seasons. Further sampling should be conducted at the other lakes to confirm this study's results and consideration given to sampling major creeks and rivers throughout the region.

Sampling Procedures and Quality Assurance of Lab Results

Sample collection and Field Processing

Water samples were collected in new 250 mL Nalgene bottles that were rinsed with distilled water and air dried prior to sampling. Two Consortium volunteers worked as a team to collect PFAS samples who were proficient in the collection of water quality samples with experience collecting PFAS samples from drinking supplies following NYS ELAP procedures. Both volunteers wore Nitrile gloves and made sure to dress in clothes that were not new, had not been recently laundered and did not contain any waterproof coatings. A new sample bottle was used at each site and either attached to a sample pole or hand dipped to collect the samples. Sample bottles were inverted and plunged into the lake water to a depth between six and twelve inches, then upturned under water to prevent collection of particles floating on the water surface (photo 3). Samples collected from an outfall pipe or water tap were filled directly (photo 4). All sample bottles were rinsed three times with the water being sampled.

All samples were collected following Cyclopure's procedures. Cyclopure sample kits consist of a 300 mL wide mouth sample funnel with PFAS selective absorbent filter paper at its base (photo 5). 200 mL of water is poured into the funnel, covered and allowed to drain through the filter paper. Once drained, the funnel is capped and placed in the shipping box with a competed sample form. Each sample has its own identifying number and shipping box. All samples were shipped the same day by USPS. As per Cyclopure's procedures, sample funnels do not require being kept cold.

Photo 3 *(above): William Boria collecting a sample from the outlet of Cassadaga Lakes using a sample pole.* ***Photo 4*** *(above right): Boria collecting a sample from the Village of Mayville's well before the water is treated to remove PFAS.* ***Photo 5*** *(right): Jane Conroe collecting and preparing a PFAS sample using a Cyclopure filter*.

Assessing the Quality of Cyclopure's Method and Laboratory

Two approaches were taken to assess the validity of Cyclopure's sampling and lab procedures.

One sample was collected from a drainage outfall previously sampled by NYSDEC during a preliminary site investigation of PFAS contamination in Mayville, NY. DEC collected a sample and a duplicate sample from the outfall on 1/7/2021 that was submitted to Eurofins laboratory, a NYS and EPA certified lab for PFAS analyses using EPA method 537 (modified) which analyzes the presence of 21 PFAS compounds. The same outfall was sampled by DEC again on 3/11/2021 without collecting a duplicate and submitted to Eurofins. Consortium volunteers collected a sample from the same outfall on 9/11/2023 on the same day that the four samples were collected from Chautauqua County Lakes. All five of these samples were submitted to Cyclopure for PFAS analyses using standard liquid chromatography/mass spectrometry analytical lab methods, which analyze the presence of the 55 PFAS (Table 1). Cyclopure's PFAS lab is not NYS or EPA certified, nor is their sample processing procedure.

PFAS results from the outfall samples are shown in Table 3. Duplicate samples are used to determine lab precision and are typically compared using Relative Percent Difference or RPD. An RPD of 20% is considered very good, however at lower concentrations close to zero, one can get a relatively high RPD with just a small difference in results. As shown, 14 of the 21 PFAS compounds tested by Eurofins were detected in the sample collected by DEC on 1/7/2021 and 15 were detected on 3/11/2021. Cyclopure detected 13 of the 55 PFAS compounds from the sample collected on 9/11/2023. If one disregards those detections reported by Eurofin flagged with a "j" which indicates an estimated concentration below the lab's reporting limit, Cyclopure detected 13 of the 14 compounds detected by Eurofins. The concentrations of the 13 compounds detected by Cyclopure align well (i.e. are mostly within the same order of magnitude) as those detected by Eurofins. Even though the 9/11 sample was collected more than two and one-half years after DEC's, during different seasons and flow conditions, it appears the water chemistry of the outfall has not changed appreciably.

***Table 3** : Comparison of Eurofins and Cyclopure Lab Results for Town of Chautauqua Outfall*

Compound Name	Acronym	Eurofins Lab				Cyclopure
		1/7/2021	1/7/2021 duplicate	(%RPD)	3/11/2021	9/11/2023
Perfluorobutanoic Acid	PFBA	40	39	2.5	23	11
Perfluoropentanoic Acid	PFPeA	150	150	0.0	110	75.7
Perfluorohexanoic Acid	PFHxA	84	85	1.2	67	56.8
Perfluoroheptanoic Acid	PFHpA	69	68	1.5	85	57.6
Perfluorooctanoic Acid	PFOA	63	74	16.1	210	34.6
Perfluorononanoic Acid	PFNA	4,900	6,300	25.0	10,000	1,467.9
Perfluorodecanoic Acid	PFDA	94	130	32.1	700	37
Perfluoroundecanoic Acid	PFUnA	1,500	2,000	28.6	7,900	1,305.4
Perfluorododecanoic Acid	PFDoA	7.4	12	47.4	60	10.2
Perfluorotridecanoic Acid	PFTrDA	36	33	8.7	420	75.1
Perfluorotetradecanoic Acid	PFTeA	na	na		5.7	<1.0
Perfluorobutane Sulfonic Acid	PFBS	0.59 j	0.63 j	6.6	0.7 j	<1.0
Perfluorohexane Sulfonic Acid	PFHxS	2	2	0.0	1.0 j	<1.0
Perfluorooctane Sulfonic Acid	PFOS	3.5	4.7	29.3	3.3	1.3
6:2 Fluorotelomer Sulfonate	6:2 FTS	22	23	4.4	80	7.2
8:2 Fluorotelomer Sulfonate	8:2 FTS	18	26	36.4	180	11.9
Total PFAS		6,988.9	8,947.3	24.6	19,845.7	3,151.7
Estimated flow at time of sampling:		**10 gpm**			**10 gpm**	**1-2 gpm**

All results in ng/L = parts per trillion (ppt)

U = undetected; J = analyte present between minimum detection limit and reporting limit

na = not analyzed; gpm = gallons per minute

*%RPD = Relative Percent Difference = absolute value of ((X2-X1)/((X2+X1)/2))*100*

The second approach used duplicate samples submitted to different labs to assess the precision of Cyclopure results. On 11/15/2023, duplicate samples were collected from a well in Mayville, NY known to contain PFAS. One sample was submitted to ALS Group USA, a NYS and EPA certified lab, and the duplicate submitted to Cyclopure. ALS used EPA method 537.1 and analyzed the sample for 18 PFAS compounds. As shown in Table 4, and disregarding the ALS sample flagged with "J", Cyclopure detected all of the five compounds detected by ALS. The RPD of the five compounds ranged from 23.1 to 35.7%. This is in-line with the RPDs shown in Table 3 from DEC sampling, which ranged from 0 to 47.4%. The average RPD from each set of duplicates was 16.5% for Eurofins and 31% for Cyclopure/ALS. Of note is the fact that Eurofins lab knew where the duplicate was from, whereas Cyclopure and ALS had no idea that duplicate samples were collected and sent to different labs.

***Table 4** : Comparison of Cyclopure and ALS Group Lab Results for Mayville Well 1 Raw Water Field Duplicates*

Compound Name	Acronym	Cyclopure	ALS	(%RPD)
Perfluoropentanoic Acid	PFPeA	3.0	na	
Perfluorohexanoic Acid	PFHxA	2.3	2.9	23.1
Perfluoroheptanoic Acid	PFHpA	1.6	2.3	35.9
Perfluorooctanoic Acid	PFOA	3.5	4.6	27.2
Perfluorononanoic Acid	PFNA	153.4	220	35.7
Perfluorobutane Sulfonic Acid	PFBS	<1.0	0.74 J	
N-Methylperfluorobutanesulfonamide	MeFBSA	1.6	na	
Total PFAS		165.4	230.54	32.9
Reporting Limit		1.0	2.0	

All results in ng/L = parts per trillion (ppt)
U = undetected; J = analyte present between minimum detection limit and reporting limit
na = not analyzed
*%RPD = Relative Percent Difference = absolute value of ((X2-X1)/((X2+X1)/2))*100*

Table 1 at the beginning of the report shows the PFAS compounds analyzed by Cyclopure, Eurofins and ALS laboratories.

Cyclopure detected 13 of the 14 PFAS compounds detected by Eurofins from samples collected at the drainage outfall. The one compound not detected by Cyclopure was PFTeA which was only analyzed in one of the three Eurofins samples. The Cyclopure sample was collected in September following a relatively dry summer two and a half years after the Eurofins samples were collected; the Eurofins samples were collected in January and March during a relatively mild, yet wet winter. The outfall flow was estimated during all sample events: 10 gallons per minute (gpm) during both 2021 events and 1 to 2 gpm during 2023 event (Table 3). This makes the flow in late summer 2023 about an order of magnitude less than the flow in winter 2021 and should have a significant effect on water chemistry. In fact, the concentration of all the PFAS compounds detected by Cyclopure were lower than Eurofins with the exception of PFTrDA. One would expect there to be differences in PFAS concentration from samples collected under much different conditions, but the fact that the same compounds were detected indicates the PFAS chemistry from the outfall appears fairly consistent and Cyclopure results appear to be reliable.

Furthermore, duplicate samples from a well that is known to contain PFAS compounds submitted to separate labs show a strong correlation to one another. All of the same compounds were detected by both labs, however Cyclopure results were on average 31% lower than ALS results. More importantly, there was no variation in detects between labs, validating Cyclopure results.

Cyclopure's sampling and lab method for PFAS showed good results that correlate to private NYS and EPA certified labs. The cost for Cyclopure's analyses are one-third the cost for that of a commercial lab, making it an affordable and relatively accurate means of monitoring PFAS for non-regulatory purposes. The economics of Cyclopure's method lends itself for use as a screening tool in studies where numerous water samples must be collected or where a homeowner might want to test their private water supply. Depending on the results and potential health exposure, Cyclopure analyses could be followed up by utilizing a state and EPA certified lab.

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About the Author

William (Bill) Boria has worked for the past thirty-five years on the evaluation, management and protection of Chautauqua County's water resources. He retired following thirty years with the Environmental Health Division of the Chautauqua County Health Department where he worked first as a water resource specialist, then senior water resource specialist and finally as the director. Prior to this he worked for two years as a research associate for SUNY Fredonia and for five years as a civil engineering technician for Urban Engineers. He has a master's degree in geology and a bachelor's degree in geophysics from SUNY Fredonia and is a New York State licensed professional geologist.

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c. MN: https://www.health.state.mn.us/communities/environment/fish/index.html
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