

IP: The Presence of PFAS in the Ceded Territories

Biology 152

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The Presence of PFAS in the Ceded Territories

Abstract

Per- and poly-fluoroalkyl substances (PFAS) pose significant environmental and health risks. This study explores the prevalence of PFAS in aquatic ecosystems within historically Indigenous lands, now known as Ceded Territories. The focus is on assessing the impact of PFAS on Tribal communities dependent on resources like wild rice, sugar bush sap, and fish. Results reveal a statistically significant correlation between lake and sap PFAS concentrations. Maps illustrating testing locations reveal a weak negative correlation between the distance from PFAS sources and concentrations in lakes, which sparks questions on the influence of proximity on contamination levels. These findings contribute valuable insights to the ongoing discourse on PFAS exposure in Indigenous territories, emphasizing the importance of continued monitoring and awareness for both environmental and human health.

Introduction

Per and poly-fluoroalkyl substances (PFAS) are a group of man-made chemicals that are used for hundreds of industrial applications and consumer products because of their extreme resilience and durability (Krafft, 2015). This thermal stability and chemical inertness is caused by their strong fluorine and carbon bond which has coined the term “forever chemicals” because of their inability to break down in the environment (NASF, 2019). These toxic environmental contaminants are the most prevalent contaminants in wildlife throughout the world. Animal studies showing the effects of PFAS revealed reproductive, developmental, hepatic, neurological, immunosuppressive, and endocrine disruptive toxicity in laboratory animals (Krafft, 2015). These compounds have the potential to bioaccumulate and bio-magnify through the food chain which disrupts the intricate balance of interspecies relationships in wildlife (Cui, 2020). Human toxicology studies found PFAS have been linked to obesity, cancer, developmental effects, immune suppression in children, and other adverse health effects (Cui, 2020). The presence of PFAS in aquatic ecosystems of the Great Lakes Region concerns Tribal Nations, water quality managers, and the public. Data on the PFAS contamination of aquatic environments in the Ceded Territories will lead to information about the bioaccumulation factors of different plants and animals. This study will quantify the amount of PFAS contaminants in flora and fauna that are a concern for Tribal communities (e.g., wild rice, sugar bush sap, and fish). I anticipate that there

will be a direct correlation between the amount of PFAS contamination recorded in the Lakes and that of the PFAS found in the sap collected in trees near each representative lake.

In conducting this research, we seek to address gaps in knowledge regarding PFAS distribution, fostering informed environmental management strategies and mitigating potential risks to both ecosystems and public health in Indigenous territories.

Methods

The PFAS concentration in lakes is expected to exhibit a direct correlation with the PFAS concentration found in the Tree Sap of nearby trees. Tree Sap is a commonly ingested substance by the indigenous people, by quantifying the amount of PFAS content in the sap it can provide insights on the transport mechanisms of the environmental contaminant throughout various regions and environmental zones. Water samples were taken from 47 different lakes. These selected lakes all lie within the Ceded Territories, and most of them have high harvest levels (walleye, wild rice), and varying distances from PFAS sources. These criteria give rise to a variety of data to analyze.

To ensure the reliability of our study, we followed Environmental and Great Lakes Division (EGLE, 2022) guidelines for sample collection. While sampling the lake water it is important to not use any equipment containing fluoropolymers because this can affect the accuracy of the data collected (EGLE, 2022). Water samples were collected using powderless nitrile gloves and PFAS-free containers, employing direct sampling techniques with considerations for varying conditions. Samples were opened just before collection, promptly capped, and double-bagged in resealable bags. Sent to the Wisconsin State Laboratory of Hygiene, water samples were quantified for PFAS in ng/L. Subsequently, sap collection for maple syrup tapping utilized basic tools and followed a similar process. Trees near the lakes meeting the minimum diameter of 10 inches were selected, and sap samples were collected. After the samples have been taken, they too are sent to the Wisconsin State Laboratory of Hygiene to quantify the PFAS contaminants present in the sap samples. This thorough approach to sample collection adhered to standardized procedures, ensuring the overall validity and precision of our study's collected data.

Results

Column1	Column2	Lake PFAS Concentration mean (ng/L)	Sap PFAS Concentration mean (ng/L)
	Location		
1	Allequash L	0.279	0.269
2	Aurora L	0.286	0.277
3	Grindstone L_WI	0.43	0.416
4	Balsam Lake	0.255	0.245
5	Bear River	0.342	0.328
6	Bearskin Lake	0.627	0.614
7	Pelican Lake	0.278	0.266
8	Big Lake (MI border)	0.356	0.337

Table 1: PFAS Concentrations of Lake and Sap Samples

The Pearson Correlation Coefficient calculates the correlation between two sets of data. The value of one showing a strong correlation and the value of zero showing little to no correlation between to variables. The calculated coefficient between the Lake PFAs concentration and the Sap PFAs concentration is 0.9997. This is a strong positive correlation, which means that high Lake PFAs scores are correlated with high Tree Sap PFAs scores (and vice versa).

It is assumed that each observation (each lake and its corresponding sap sample) is independent of the others. This assumption implies that the presence or absence of a certain PFAS concentration in one lake does not affect the presence or absence of PFAS in another lake or its sap sample. It is also assumed the sample locations were randomly selected to ensure that the results can be generalized to the larger population of lakes and trees within the Indigenous Territories.

Map of testing locations:



Figure 1: Map of PFAS Testing Sites

The major sources of PFAS contamination in drinking water, groundwater, soils, and air include industrial sites (factories), landfills and wastewater treatment plants. The Wisconsin Department of Natural Resources reports PFAS sites of concern both currently open for investigation and closed. The source sites on the Wisconsin PFAS Interactive Data Viewer are mapped in *Figure 2* below.

Major PFAS Sources Map:

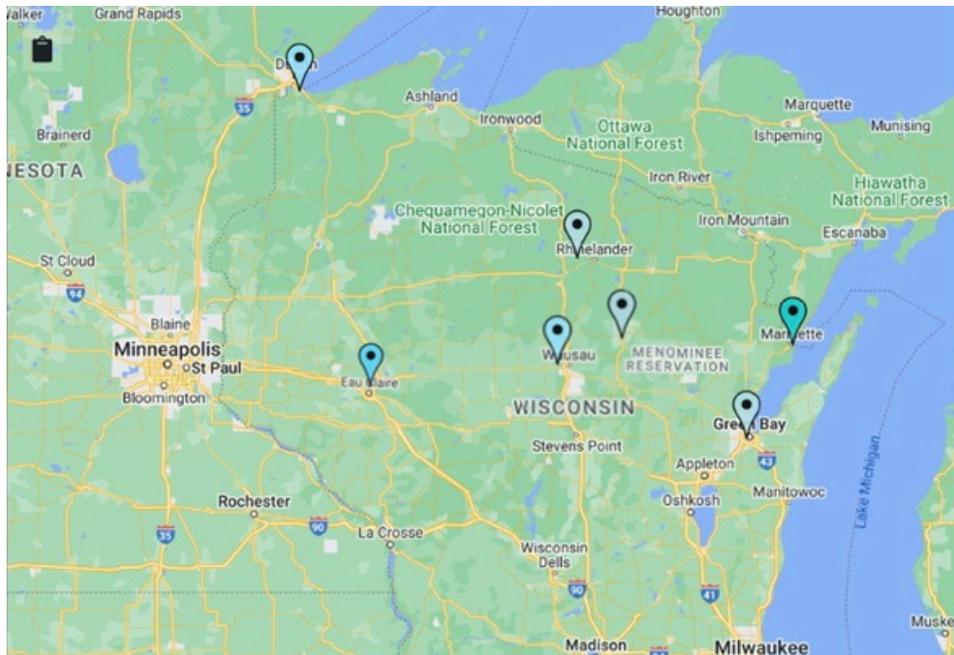


Figure 2: Map of Wisconsin DNR PFAS Source Sites

The primary PFAS sources examined in this study encompass industrial, landfill, and oil spill-related sources. All of these sites are open for investigation and further analysis. It is noteworthy that none of the sites currently have mandated drinking water advisories. Additional information on the source sites is included in the table below.

PFAS Source Sites:

Site Name	Source Type	Confirmed PFAS-Impacted Media
Rhineland/Onieda Landfill Woodboro, WI	Open- Landfill	Groundwater and leachate
Superior Refining Company Superior, WI	Open- Industrial	Groundwater, surface water, sediment and soil
Georgia-Pacific Broadway Mill Expansion Green Bay, WI ChemDesign Products Factory	Open- Industrial	Groundwater and soil
Marinette, WI Chippewa Valley Regional Airport	Open- Industrial	Groundwater and soil
Eau Claire, WI	Open- Airport	Groundwater and soil
Wagner Oil Spill Elmhurst, WI	Open- Oil Spill (2019)	Groundwater and soil
Wausau Business Incubator Wausau, WI	Open- Industrial	Groundwater and soil

Table 2: Information on DNR PFAS Source Sites

The closest site distance was recorded in miles and the average distance between all 7 sites of concern were calculated and recorded in *Table 4* below.

Testing Locations Distance from PFAs Sources (mi):

Location	Onieda Landfill	Superior Refining Company	Georgia-Pacific Broadway Mill Expansion	ChemDesign Products	Chippewa Valley Regional Airport	Wagner Oil (Spill 2019)	Wausau Business Incubator
Allequash L	37	155	180	154	178	86	88
Aurora L	40	158	183	152	181	85	91
Grindstone L_WI	123	75	252	237	103	164	154
Balsam Lake	157	97	263	291	84	203	165
Bear River	50	137	193	167	148	99	101
Bearskin Lake	14	171	156	134	154	71	64
Pelican Lake	27	199	116	97	150	27	59
Big Lake (MI border)	50	142	193	167	168	99	101

Table 3: Testing Locations distance from the PFAS Source Sites

Testing Locations Distance to Sources (mi):

Location	Lake PFAS Concentration mean (ng/L)	
	Distance to Nearest Major PFAs Source	Avg Distance to Major PFAs Sources
Allequash L	0.279	125.429
Aurora L	0.286	127.143
Grindstone L_WI	0.43	158.286
Balsam Lake	0.255	180
Bear River	0.342	127.857
Bearskin Lake	0.627	109.143
Pelican Lake	0.278	96.429
Big Lake (MI border)	0.356	131.429

Table 4: Testing locations nearest and average distances from PFAS Source Sites

Analyzing the association between the distance from the nearest PFAS source site and concentration levels at testing locations reveals a Pearson Correlation Coefficient (R) of -0.3893, signifying a technically negative correlation. However, it is crucial to emphasize that this correlation signifies a weak relationship between the variables. Despite observing a correlation between PFAs concentration and the proximity to the nearest major PFAs source—implying higher concentrations with closer proximity—the overall results remain ambiguous, lacking clear and definitive outcomes.

Discussion

The findings of this study indicate the significant prevalence of PFAS contamination in aquatic ecosystems within the Ceded Territories and the potential risks it poses to Tribal communities relying on these vital resources. The identified correlation between PFAS concentrations in lakes and adjacent tree sap emphasizes the intricate interplay between environmental factors and the effect on natural resources humans rely on.

The uptake of environmental contaminants by humans stemming from soil contamination is due to the process of the plant's uptake of contaminants through the soil and bioaccumulation occurring when humans ingest contaminants from vegetation growing in compromised soil (Rosen 2002). Through the process of Phyto screening chemicals in a plant can be extracted and tested to determine their prevalence. Studies utilizing this approach can then ascertain the exposure risks to organisms consuming the plant by quantifying the concentrations of such contaminants.

The calculated correlation supported by Pearson correlation coefficient test between lake and sap PFAS concentrations, provides compelling evidence of the transfer of PFAS through the ecosystem. This correlation is particularly noteworthy given the diverse range of lakes selected, each with varying distances from PFAS sources and different harvest levels.

The observed mean PFAS concentrations in lakes and sap samples offer valuable insights into the potential risks faced by Tribal communities dependent on local resources. For instance, lakes such as Bearskin Lake and Grindstone Lake exhibit higher concentrations, suggesting an elevated risk of PFAS exposure for communities relying on these water bodies.

The weak negative correlation between the distance from PFAS sources and concentrations in lakes, presents a limitation and potential source of error in the conducted study and is something that lends itself to future research. Initial expectations, guided by existing literature and an understanding of infiltration, would have predicted a strong negative correlation. According to this expectation, as the distance decreases, the PFAS concentration in the water should increase, emphasizing the impact of proximity to contamination sources. Contrary to these expectations, the results of this calculation do not demonstrate this anticipated relationship, leaving the overall conclusions inconclusive.

The PFAs sources documented on the Wisconsin Department of Natural Resources page possibly do not comprehensively encompass all potential PFAs sources. This highlights an area where future studies and funding, can contribute to a more thorough understanding and identification of PFAs sources. The spatial analysis conducted enhances our current limited understanding of PFAS distribution patterns, offering valuable insights that can guide future monitoring efforts and resource management strategies.

The implications of PFAS contamination extend beyond ecological concerns to potential health risks for Tribal communities. The documented links between PFAS exposure and adverse health effects, including obesity, cancer, and immune suppression, emphasize the urgency of addressing these contamination issues within Tribal communities (Cui, 2020). Despite valuable insights, limitations exist, such as the study's regional focus limiting the generalizability of the findings. Additionally, while the correlation between lake and sap PFAS concentrations is established, further investigation into PFAS transfer mechanisms through Phyto screening is warranted.

In conclusion, this study contributes essential knowledge to the ongoing discourse on PFAS contamination in Indigenous territories. The correlation between lake and sap concentrations emphasizes the need for comprehensive monitoring programs and awareness campaigns to

safeguard the health and well-being of Tribal communities. Future research should strive to develop mitigation strategies to ensure the sustainable use of natural resources in these vulnerable environments.

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