

MERCURY CONCENTRATIONS IN FISH IN A REMOTE CANADIAN ARCTIC LAKE

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Abstract. Lac Ste. Thérèse, a remote Canadian Arctic lake in the Northwest Territories, Canada, has high natural (non-point source) mercury concentrations in fish. The high mercury levels have persisted for over 18 years. Lac Ste. Thérèse has had consistently higher mercury concentration in fish than the other three lakes sampled within the basin, regardless of species tested.

1. Introduction

The Canadian Arctic is perceived by the general public to be a pristine environment which is completely free of contamination. This is not the case, as global atmospheric deposition of anthropogenic contaminants and local physiographic factors can impact on the quality of northern ecosystems (Barrie *et al.*, 1992). The presence of mercury within the ecosystem is generally well documented. Lower levels are normally associated with either natural or long range transport from anthropogenic sources while higher levels are usually the result of some direct anthropogenic source, such as mining or dams (Lindqvist, 1985; Zillioux *et al.*, 1993). The elevated mercury levels in Lac Ste. Thérèse, a remote lake in the Johnny Hoe River basin, Northwest Territories, Canada, are of interest because there is no development within the basin.

This study examines the relationship of mercury concentration in fish from Lac Ste. Thérèse over time and compares the results to other lakes within the basin.

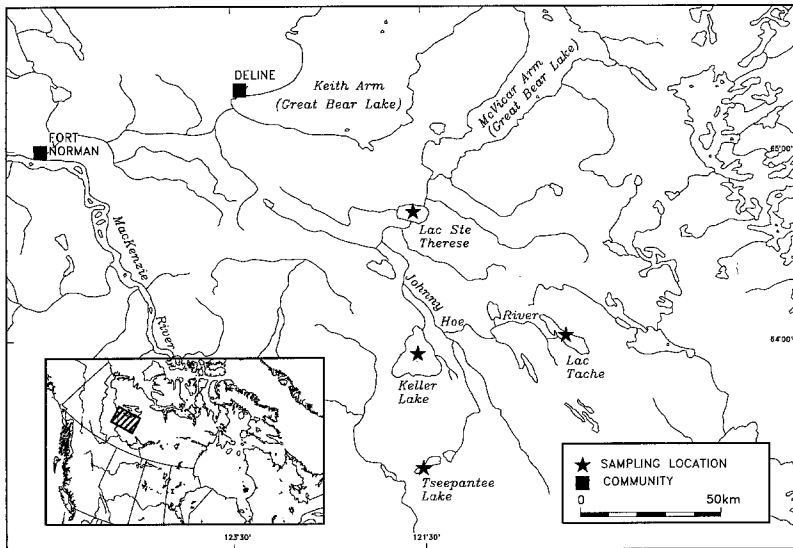
2. Methods and Materials

2.1. SAMPLE LOCATION

Lac Ste. Thérèse was the primary sampling site to determine if the historically high mercury values were still relevant to any future discussions about the lake in light of land claims. The other three lakes (Keller Lake, Lac Taché and Tseepanteë Lake) in the Johnny Hoe River Basin (Figure 1.) were sampled to determine if high mercury concentrations in fish are consistent throughout the basin. The water quality is similar for all of the lakes with only minor differences (G.R. Stephens, unpublished data).

2.2. SAMPLE COLLECTION

The collection of fish species was prioritized by their importance for both human health consumption and the ecosystem. Top level piscivores such as walleye (*Stizostedion vitreum*) and lake trout (*Salvelinus namaycush*) were the primary focus. Northern pike (*Esox lucius*), another piscivore, was sampled because it is not generally restricted by lake chemistry like walleye and lake trout. Lake whitefish (*Coregonus clupeaformis*) was also collected since it represents a lower trophic feeder found in most northern Canadian lakes.



Fish were collected from Lac Ste. Thérèse in August 1992 and 1993 using 89 mm and 115 mm mesh gill nets with multiple sets of 4 to 12 hours in duration. The other three lakes were sampled in August 1993 using the same equipment and timing. In all instances, basic biological data were recorded including fork length, weight and sex. The appropriate ageing structures were recovered. A boneless, skinless fillet (~100 g) was collected from the area lateral and ventral to the dorsal fin. Each sample was placed in a whirl pack bag and frozen before being shipped to the Environmental Chemistry Lab at the Freshwater Institute in Winnipeg, MB. Total mercury concentrations were determined using the method described by Hendzel and Jamieson (1976).

3. Results

The reported mean mercury concentrations are unadjusted for length, weight or age of fish since both simple and exponential regression analysis showed no significant correlation.

3.1. TEMPORAL TRENDS IN LAC STE. THÉRÈSE

When the data collected in 1992 and 1993 for Lac Ste. Thérèse are compared with the 1975 (walleye) and 1980 (walleye, lake trout and northern pike) data from the Department of Fisheries and Oceans (DFO) Inspection Services Branch (Hendzel, pers. comm.), they create an 18 year record of mercury concentrations in walleye and a 13 year record for lake trout and northern pike. There is no historic information available for lake whitefish in Lac Ste. Thérèse.

Table I illustrates the unadjusted mean mercury concentrations in walleye, lake trout, northern pike and lake whitefish from Lac Ste. Thérèse over time. Both walleye and lake trout continued to have high unadjusted mean mercury concentrations. The concentrations in pike appear to have decreased along with mean length and weight. For

all species the 1980 samples had higher mean lengths and weights than the 1992 or 1993 samples. The lake whitefish had higher unadjusted mean mercury concentrations in 1993 than 1992, while the mean length and weight have decreased.

Table I
Historic unadjusted mercury concentrations and biological information for fish from Lac Ste. Thérèse.

YEAR	SPECIES	N	MERCURY (ppm)		LENGTH (mm)		WEIGHT (g)		AGE (years)	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range
1975	Walleye	8	1.00	0.59-1.43	484	438-565	1126	907-1643	-	-
1980	Walleye	12	1.39	1.09-1.82	505	472-553	1457	824-1884	-	-
1992	Walleye	30	1.34	0.71-2.31	463	410-520	1016	700-1400	15.0	9-20
1993	Walleye	30	1.49	0.29-1.99	453	387-507	893	655-1191	14.0	9-17
1980	Lake Trout	12	1.25	0.80-2.52	849	700-1012	6962	4068-11291	-	-
1992	Lake Trout	4	0.949	0.68-1.40	658	620-688	2638	2250-3100	21.5	16-27
1993	Lake Trout	2	1.34	1.34	667	599-734	2593	2148-3018	35.5	32-39
1980	Northern Pike	9	1.45	0.62-2.51	841	729-985	4380	2674-6587	-	-
1992	Northern Pike	12	0.914	0.37-1.78	736	600-994	3079	1550-6300	11.7	6-21
1993	Northern Pike	4	0.735	0.25-1.09	684	535-750	2347	1160-2873	8.0	6-11
1992	Lake Whitefish	23	0.132	0.044-0.50	463	410-503	1324	850-1750	13.0	9-17
1993	Lake Whitefish	15	0.273	0.079-1.37	438	333-535	1109	445-2090	14.6	3-30

3.2. AREAL EXTENT WITHIN THE JOHNNY HOE RIVER BASIN

Table II summarizes the results of the comparison of mercury concentrations in walleye, lake trout, northern pike and lake whitefish from the four lakes within the basin for 1993. Not all of the species (walleye and lake trout) found in Lac Ste. Thérèse were present in all lakes. For all species the unadjusted means for mercury concentrations in Lac Ste. Thérèse fish were higher than those in the other lakes. While there might have been differences in length or weight between lakes, the ages of the fish were always similar.

4. Discussion

The results indicate that mercury concentrations in fish from Lac Ste. Thérèse have remained high over time implying that the input of mercury has been relatively constant. Since the data are not standardized, it is difficult to make definitive conclusions regarding the trend of mercury concentrations.

The comparison of lakes within the basin reveals that Lac Ste. Thérèse has the highest mercury concentrations in fish regardless of the species. While more work is required to accurately determine the reasons for these differences, the higher mercury concentrations can generally be attributed to water quality and basin morphology (Håkanson *et al.*, 1988; Wiener *et al.*, 1990; Bodaly *et al.*, 1993). Lac Ste. Thérèse is a brown-water lake located at the mouth of the drainage basin. Tseepantee Lake has the second highest unadjusted mercury levels and is also a brown-water lake but located at the headwaters of the basin. It is also a smaller, shallower lake than Lac Ste. Thérèse. Both

Keller Lake and Lac Taché are clear-water lakes that are part of independent subcatchments.

Table II
1993 unadjusted mercury concentrations and biological information for fish from the lakes within the Johnny Hoe River system.

LOCATION	SPECIES	N	MERCURY (ppm)		LENGTH (mm)		WEIGHT (g)		AGE (years)	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range
Lac Ste. Thérèse	Walleye	30	1.49	0.29-1.99	453	387-507	893	655-1191	14.0	9-17
Tseepantee Lake	Walleye	15	0.926	0.25-1.42	439	364-479	820	531-973	16.9	11-23
Lac Ste. Thérèse	Lake Trout	2	1.34	1.34	667	599-734	2593	2148-3018	35.5	32-39
Keller Lake	Lake Trout	15	0.412	0.22-1.05	560	495-766	1811	1350-4325	19.6	8-32
Lac Taché	Lake Trout	5	0.345	0.13-0.59	662	556-774	2738	2029-4025	24.8	8-37
Lac Ste. Thérèse	Northern Pike	4	0.735	0.25-1.09	684	535-750	2347	1160-2873	8.0	6-11
Keller Lake	Northern Pike	1	0.445	0.445	769	769	2917	2917	-	-
Lac Taché	Northern Pike	10	0.347	0.13-0.68	689	520-987	2528	1000-6750	9.2	4-15
Tseepantee Lake	Northern Pike	6	0.475	0.39-0.71	512	453-557	770	565-870	7.5	6-8
Lac Ste. Thérèse	Lake Whitefish	15	0.273	0.079	446	336-535	1175	478-2090	14.1	6-24
Keller Lake	Lake Whitefish	15	0.064	0.036	471	377-553	1370	650-2313	11.6	7-19
Lac Taché	Lake Whitefish	15	0.068	0.025	402	312-500	797	420-1625	12.7	7-22
Tseepantee Lake	Lake Whitefish	15	0.102	0.037	425	345-460	1161	642-1440	11.7	6-21

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