

Eastmain-1-A and Sarcelle Powerhouses and Rupert Diversion



Environmental Follow-Up During Operation Phase – Mercury Levels in Fish, 2011 Monitoring

Executive Summary – July 2012



 GENIVAR

Presented to Hydro-Québec

 Hydro Québec



Context

Monitoring at the La Grande complex has shown that fish mercury levels increase greatly, although temporarily, after the impoundment of reservoirs. Increases in fish mercury levels may potentially pose a health risk to regular fish consumers. Consequently, for each new reservoir, fish consumption advisories are issued to ensure that mercury exposure of fish consumers remains within safe levels. By following the recommendations provided in these advisories, consumers may continue to benefit from the health advantages of fish consumption and avoid any ill effects related to mercury.

Objective

The main objective of monitoring mercury levels in fish found in water bodies modified by the impoundment of Eastmain 1 reservoir and the Rupert diversion is to provide the necessary data to allow the Cree Board of Health and Social Services of James Bay (CBHSSJB) to revise fish consumption guides.

Methods

The main fish species harvested by the Crees were captured with gillnets at 18 sampling stations covering Eastmain 1 reservoir, the Rivière Eastmain directly below Eastmain-1 powerhouse, Opinaca reservoir, the area directly below the La Sarcelle water control structure, Lac Village Sud (a lake in contact with the Eastmain 1 reservoir), Rupert forebay, Rupert tailbay, the sections of the Nemiscau and Rupert rivers downstream of the diversion bays, a lake in contact with with Rupert forebay, and two natural control lakes (see Map 1 and Figures 1 and 2). A flesh sample was collected from each fish for mercury analysis, and length, weight, sex and sexual maturity were recorded. Mercury

concentrations were determined by an independent laboratory. Statistical analyses were used to calculate average mercury levels for fish of consumption size. These average mercury levels are used to submit fish consumption recommendations for each fish species and sampled water body, for approval by the CBHSSJB.

Results

Figures 3 and 4 shows the water bodies sampled in 2011 and the average mercury levels measured in consumption-size fish, whereas Table 1 shows the fish consumption recommendations that will be submitted to the CBHSSJB.

Eastmain 1 reservoir

For Eastmain 1 reservoir, mercury levels measured in piscivorous fish (fish that eat other fish) of consumption size were still increasing in 2011, six years after impoundment. The average mercury levels measured in 20-in. walleye (2.30 ppm), in 28-in. pike (1.64 ppm) and in 33-in. pike (2.16 ppm) were all higher than those obtained in 2009 and higher than the range of values typical of the area's natural lakes. In 20-in. lake whitefish, which feed mainly on insects and plankton, the average mercury level obtained in 2011 (0.28 ppm) is still similar to those of natural lakes or to those measured since 2007.

Opinaca reservoir

As mercury is exported downstream from reservoirs, it was predicted that the impoundment of Eastmain 1 reservoir would also cause an increase in fish mercury levels in Opinaca reservoir, although to a lesser degree. It seems that the impoundment of Eastmain 1 reservoir did not cause an increase of mercury levels in 20-in lake whitefish in Opinaca reservoir, as its 2011 mean concentration (0.31 ppm) is not significantly



different from those measured since 2000, i.e. before the impoundment of Eastmain 1. However, average mercury levels measured in 2011 in 28-in. pike (1.70 ppm), in 33-in. pike (2.22 ppm) and in 20-in. walleye (1.75 ppm) are all significantly higher than those measured before the impoundment of Eastmain 1 reservoir and correspond well to values predicted for the sixth year after impoundment.

Lac Village Sud

A small stream would allow the passage of fish between Lac Village Sud and Eastmain 1 reservoir. Mercury levels in fish living in this lake were thus measured again to determine whether mercury-rich fish from Eastmain 1 reservoir would move into Lac Village Sud. The follow-up results indicate no such movement, as mercury levels in all fish of consumption size have, since 2007, remained within the range of values recorded for the area's natural lakes.

Immediately downstream of Eastmain 1 and Opinaca reservoirs

In 2011, as was the case in 2009, mercury levels in most fish species caught downstream of Eastmain 1 reservoir showed significantly higher mercury levels than those caught in the reservoir itself or in natural lakes. Downstream of Opinaca reservoir, mercury levels were higher than in natural lakes for piscivorous species, but remained similar to those measured in the reservoir itself. Mercury levels in lake whitefish were higher downstream of both reservoirs.

Rupert diversion bays

In 2011, two years after the Rupert diversion became operational, mean mercury levels in consumption-size fish of most species caught in both diversion bays remained within the range of

values measured in natural surrounding lakes, with the exception of 28-in. and 33-in pike, for which levels (1.28 and 2.14 ppm respectively) were significantly higher. However, mercury levels in smaller-size fish of all monitored species had increased in both diversion bays, compared to corresponding values reported in natural lakes, which indicates that levels in consumption-size fish will soon be increasing, as predicted in the project's Environmental Impact Assessment (EIA).

Nemiscau and Rupert rivers downstream of the diversion bays

At the three sampling stations along the section of the Rivière Rupert downstream of Rupert forebay, mean mercury levels in lake whitefish, lake sturgeon, pike and walleye of consumption-size remained in 2011 within the range of values recorded for natural lakes of the area. In the Rivière Nemiscau downstream of Rupert tailbay, mercury levels in consumption-size pike (0.87 and 1.19 ppm for 28 and 33-in. fish respectively) were higher than the range of values recorded for the area's natural lakes. Such an increase, only two years after the Rupert diversion became operational, suggests that mercury levels in all species will increase in the years to come, as predicted in the project's EIA.

Lake in contact with Rupert forebay

As requested by the tallyman of M26 trapline, fish mercury levels were also measured in a small lake communicating with Rupert forebay. In lake trout of this lake, mercury levels remained within the range of values recorded in natural lakes of the area.

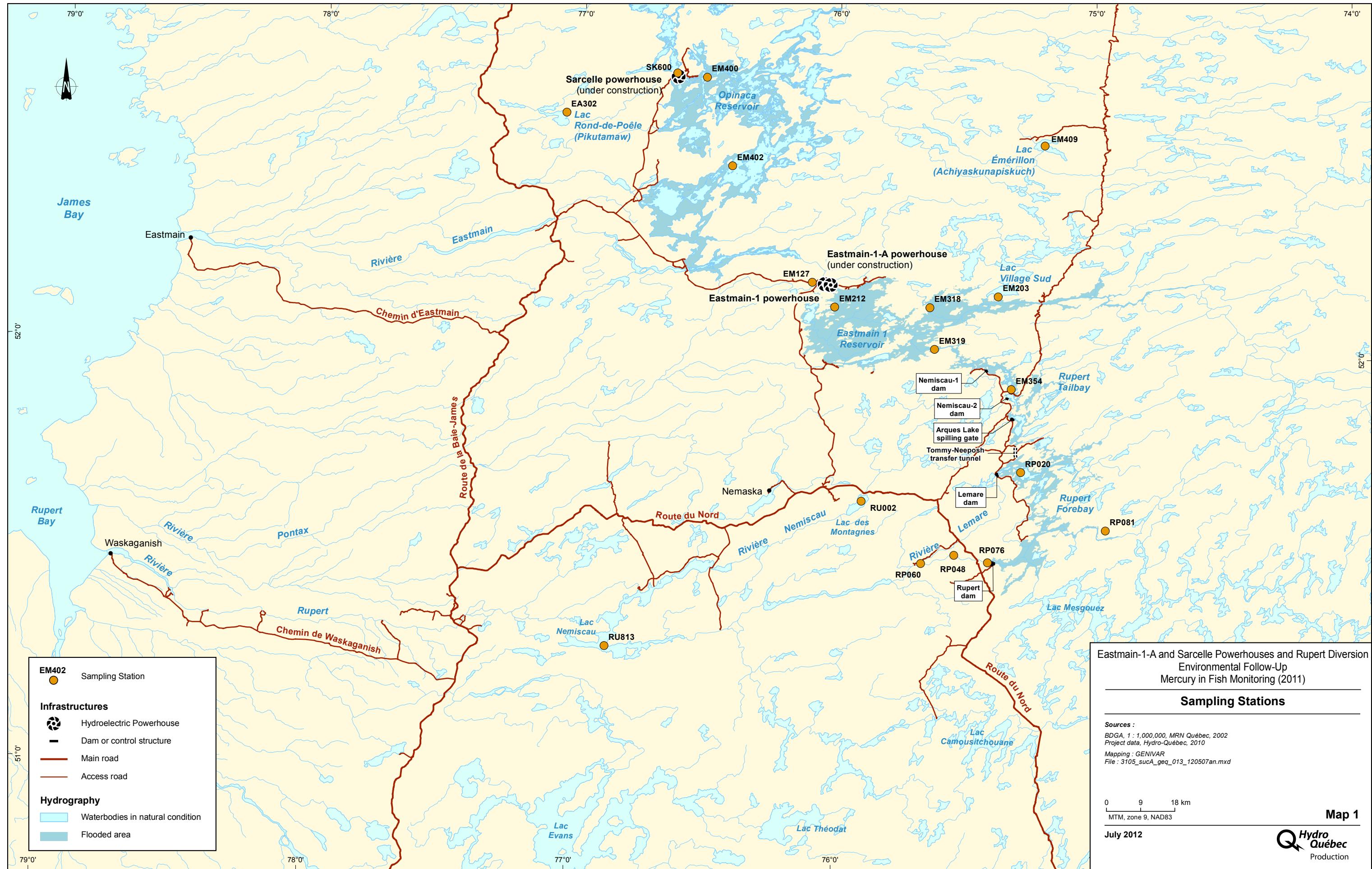
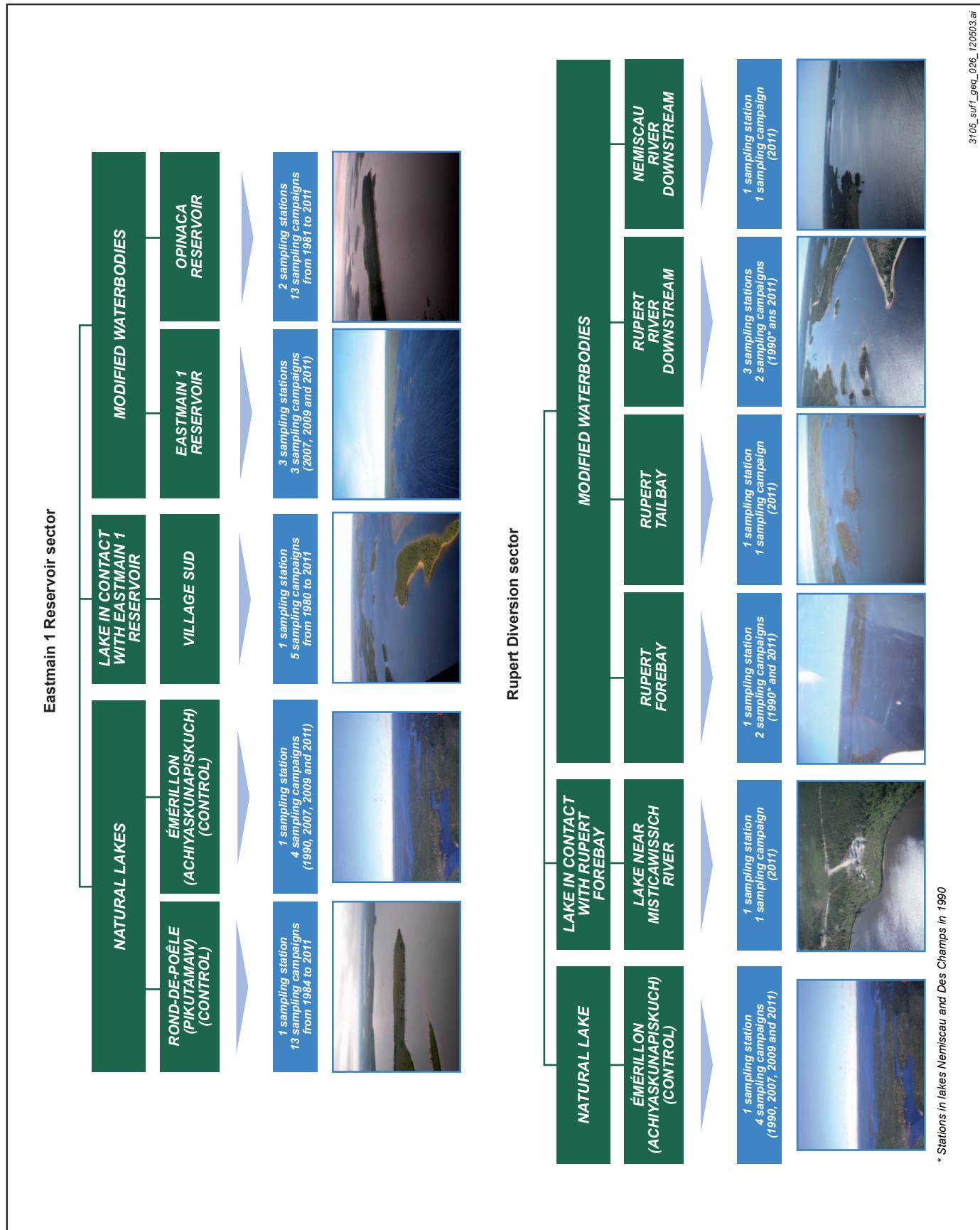


Figure 1 Methodology applied for the 2011 follow-up of mercury levels in fish



* Stations in lakes Nemiscau and Des Champs in 1990

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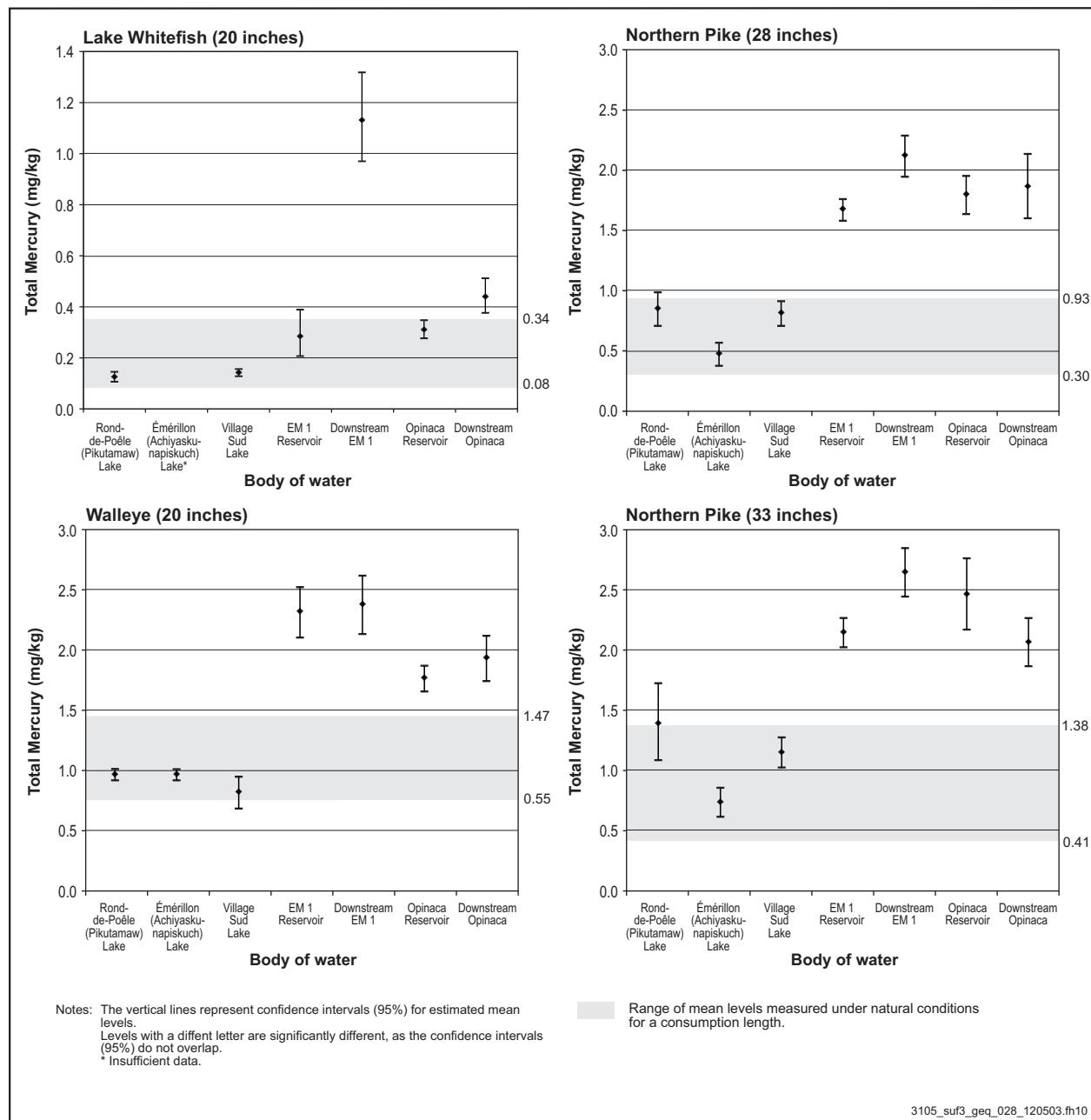
Figure 2 Methodology applied for the 2011 follow-up of mercury levels in fish



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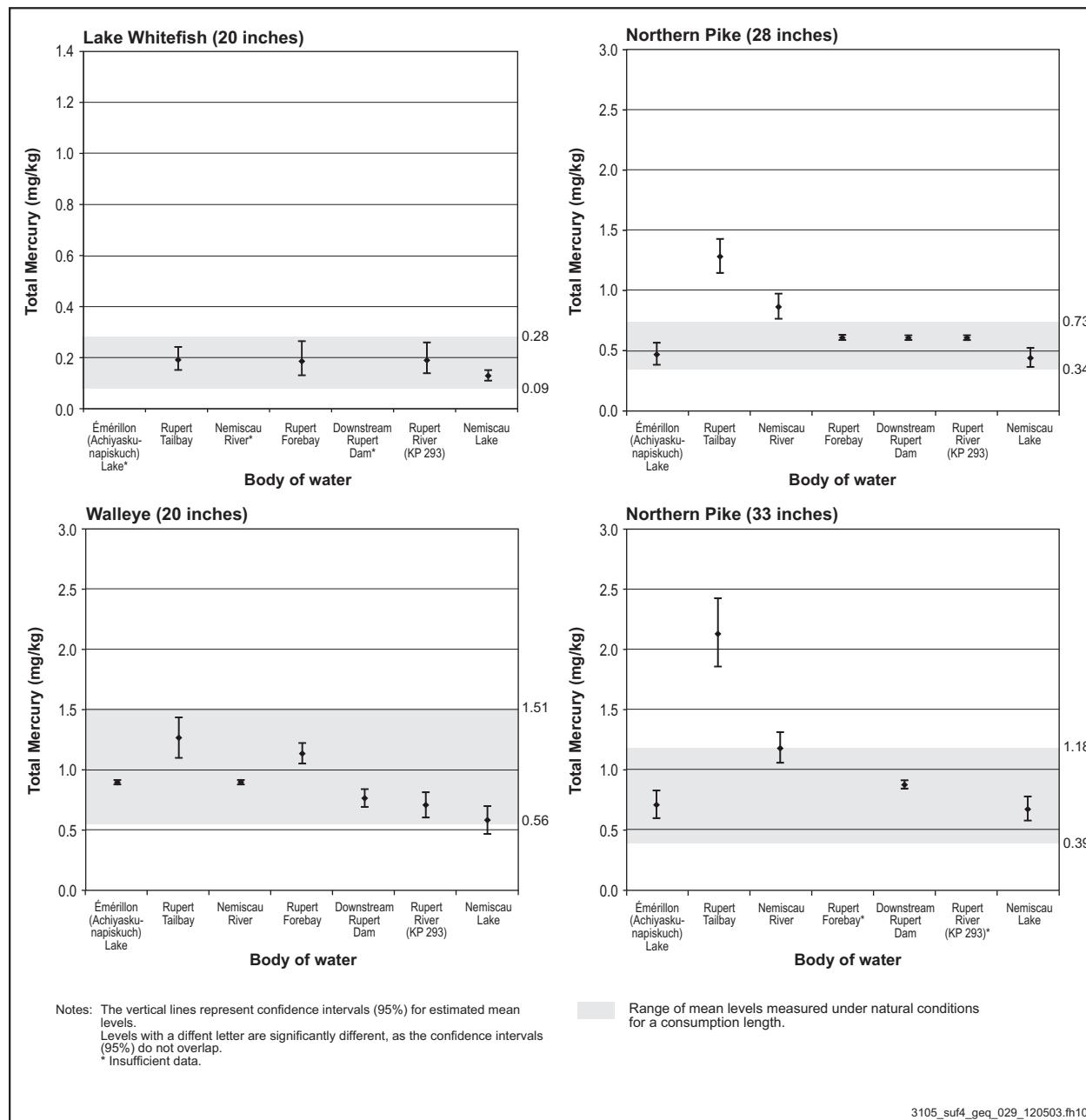
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Figure 3 Mercury levels in fish of consumption lengths in the Eastmain 1 area in 2011



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Figure 4 Mercury levels in fish of consumption lengths in the Rupert Diversion area in 2011



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Table 1 Consumption recommendations proposed to the Cree Health Board and Social Services of James Bay

Mean mercury levels in main fish species, for consumption lengths, in modified water bodies of the Eastmain 1 Region and consumption recommendations³

Water body	Species (length)	2011 measured level (mg/kg)	Consumption recommendation based on 2011 levels ²	Maximum forecast level (mg/kg) ¹	Consumption recommendation based on maximum forecast levels ²
Natural	Lake Whitefish (20 in.)	0.17	Unrestricted consumption	0.17	Unrestricted consumption
	Northern Pike (28 in.)	0.59	Occasional consumption	0.59	Occasional consumption
	Northern Pike (33 in.)	0.90	Occasional consumption	0.90	Occasional consumption
	Walleye (20 in.)	0.96	Occasional consumption	0.96	Occasional consumption
Eastmain 1 Reservoir	Lake Whitefish (20 in.)	0.28	Regular consumption	< 0.50	Regular consumption
	Northern Pike (28 in.)	1.64	Occasional consumption	< 3.00	Consumption not recommended
	Northern Pike (33 in.)	2.16	Consumption not recommended	< 4.00	Consumption not recommended
	Walleye (20 in.)	2.30	Consumption not recommended	4.10	Consumption not recommended
Immediately downstream of Eastmain 1 Reservoir	Lake Whitefish (20 in.)	1.12	Occasional consumption	1.80	Occasional consumption
	Northern Pike (28 in.)	2.12	Consumption not recommended	3.77	Consumption not recommended
	Northern Pike (33 in.)	2.64	Consumption not recommended	5.02	Consumption not recommended
	Walleye (20 in.)	2.36	Consumption not recommended	4.10	Consumption not recommended
Opinaca Reservoir	Lake Whitefish (20 in.)	0.31	Regular consumption	0.31	Regular consumption
	Northern Pike (28 in.)	1.70	Occasional consumption	2.43	Consumption not recommended
	Northern Pike (33 in.)	2.22	Consumption not recommended	2.90	Consumption not recommended
	Walleye (20 in.)	1.75	Occasional consumption	2.28	Consumption not recommended
Immediately downstream of Opinaca Reservoir	Lake Whitefish (20 in.)	0.43	Regular consumption	0.82	Occasional consumption
	Northern Pike (28 in.)	1.86	Occasional consumption	2.50	Consumption not recommended
	Northern Pike (33 in.)	2.06	Consumption not recommended	3.64	Consumption not recommended
	Walleye (20 in.)	1.92	Occasional consumption	2.28	Consumption not recommended

Recommended number of meals per month:				
12 or more	8	4	2	1 or less

Notes:

- 1 For modified water bodies, it is the maximum forecast level.
- 2 To be validated by the CHBSSJB
- 3 For adults in general



Effect on fish consumption

Eastmain 1 sector

The impoundment of Eastmain 1 reservoir led to an increase in mercury levels in fish of most modified water bodies. Mercury levels in these fish are expected to reach maximum values 5 to 12 years following impoundment of Eastmain 1 reservoir. To ensure that mercury exposure of local fish consumers remains within safe levels, the CBHSSJB will revise fish consumption guides for these water bodies according to fish mercury levels. To avoid issuing continuously changing fish consumption advisories, since fish mercury levels evolve gradually, fish consumption recommendations will be based on the predicted maximum levels, validated with the 2011 follow-up results (see Table 1). Accordingly, the following recommendations will be submitted to the CBHSSJB:

- ❖ the consumption of 20-in. lake whitefish caught in natural water bodies of the area and in Lac Village Sud will remain without restriction, whereas a regular consumption (maximum of 8 meals per month) will be recommended for those in the Eastmain 1 and Opinaca reservoirs, and occasional consumption (maximum of 2 to 4 meals per month) will be suggested for those caught immediately downstream of these reservoirs;
- ❖ for 20-in. walleye, 28-in. pike and 33-in. pike, occasional consumption will be recommended for those caught in natural lakes and in Lac Village Sud, while consumption will not be recommended for those caught in Eastmain 1 and Opinaca reservoirs, as well as those caught directly downstream from them.

These recommendations will be validated by the CBHSSJB which, under the *Mercury Agreement* (2001), is responsible for issuing fish consumption advisories for the Crees.

Diversion bays sector

It is too early to correctly validate the maximum predicted mercury levels in fish of the water bodies modified by the Rupert diversion. In 2011, consumption-size fish had not lived long enough in these new environments, as mercury accumulation is a relatively slow process. The results of the next mercury follow-up campaign, scheduled for 2014, will make it possible to reliably validate the predicted maximum levels and propose adequate fish consumption advisories.

Conclusion

The results of the 2011 follow-up of mercury levels in fish confirm that the impoundment of Eastmain 1 reservoir caused increases in mercury levels in fish of Eastmain 1 and Opinaca reservoirs, as well as fish in their immediate downstream areas. For the diversion bays area, it is still too early to confirm the expected increases in fish mercury levels, as the accumulation of mercury is a relatively slow process. The data collected in 2011 will enable the CBHSSJB to revise fish consumption advisories for the water bodies modified by the impoundment of Eastmain 1 reservoir, to ensure that the Crees may continue to benefit from health advantages of fish consumption and avoid any potential ill effects related to mercury.