

**Direction du suivi de l'état de l'environnement**

**METAL CONCENTRATIONS IN FISH AND  
SEDIMENTS FROM LAKES AUX DORÉS, CHIBOUGAMAU,  
OBATOGAMAU AND WACONICHI IN 2002**

**by Denis Laliberté**

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## METAL CONCENTRATIONS IN FISH AND SEDIMENTS FROM LAKES AUX DORÉS, CHIBOUGAMAU, OBATOGAMAU AND WACONICHI IN 2002

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### SUMMARY

Since 1998, in order to assess the quality of the fishery resource in the Chibougamau region, the ministère de l'Environnement du Québec and the Société de la faune et des parcs du Québec of the ministère des Ressources naturelles et de la Faune et des Parcs du Québec have been conducting analyses of metals and organic compounds in fish flesh. Four lakes have been under study: lakes Chibougamau, aux Dorés, Waconichi and Obatogamau.

The 2002 study is a follow-up to that of 2001 and has been designed to identify the extent of the zone of contaminated sediments located downstream from mining industries (for Lac aux Dorés) and to confirm the metal levels contained in sediments in sectors located both close to and far from mines (for Lac Chibougamau). It also aims to describe the impacts of the mining industry, if any, as evidenced in sediments from Lac Waconichi (control lake) and the Obatogamau lakes. In addition, the study attempts to determine whether fish from the Obatogamau lakes show mercury levels that vary according to distance from mining activities.

In 2002, the levels of 13 metals were measured in 39 sediment samples from lakes Chibougamau, aux Dorés, Waconichi and Obatogamau. Mercury analyses were also conducted on the flesh of 293 fish belonging to 6 species from Lac Chibougamau and the Obatogamau lakes. Composite flesh and liver samples, based on the size classifications of the different species, will soon be analysed with the aim of detecting a number of metals and PCBs, as well as dioxins and furans. Metal levels in certain small whole fish will also be measured.

### Results

Sediments from Lac Waconichi (control lake) show very low metal levels, in particular copper (9 mg/kg) and arsenic (4 mg/kg), pointing both to the absence of mining influence on this lake and of significant nearby mineralization.

For Lac aux Dorés, in the sector downstream from the Principale tailing site, only copper (400 mg/kg) and nickel (63 mg/kg) show concentrations that exceed the guidelines of probable effect (197 mg/kg and 61 mg/kg respectively). This contamination, especially with respect to copper, is noted on the western shore as far as over 3.5 km downstream from the aforementioned tailing site. The concentration levels are however lower than those observed in 2001 near the mines (upstream sector).

For Lac Chibougamau, a sediment sample taken in a ditch near the Eaton Bay tailing site shows a very high concentration of copper (1,300 mg/kg), i.e. 6.6 times the guidelines of probable effect. Levels of arsenic (41 mg/kg) and nickel (89 mg/kg) also exceed their respective guidelines at this site. These levels confirm the 2001 observations for this sector and the potential toxicity for aquatic organisms.

Still for Lac Chibougamau, sediments taken far from mining activities show concentrations of arsenic, chromium, nickel, lead and zinc that are significantly higher in the north than in the south. Different mineralizations may explain these discrepancies. For arsenic, chromium and nickel, the levels in the north (McKenzie Bay) are, respectively, 1.6, 1.3 and 2.3 times higher than the guidelines of probable effect.

Lac Chibougamau and Lac aux Dorés are influenced by the ultramafic rocks of the Cummings Complex located near the shore of Lac Chibougamau. This complex harbours abnormal contents of copper, chromium, nickel and cobalt, in part explaining the higher metal concentrations in this sector.

Concerning the Obatogamau lakes, Rivière Nemenjiche, a tributary draining a mining site, contains sediments with high concentrations of arsenic (85 mg/kg), copper (680 mg/kg), and mercury (0.77 mg/kg). These levels exceed the criteria of probable effect and represent a potential risk for aquatic organisms. The high mercury levels in the sediments could be attributed to the use of mercury on the Joe Mann mining site from 1956 to 1958.

On Rivière Nemenjiche, the differences observed downstream and upstream sediments from the mining site suggest that this industry could be responsible for increases in metal levels. High levels may be observed in the Obatogamau lakes as far as Lac Le Royer, located downstream. However, the proximity of Grenvillian faults in this sector is likely to increase the natural metal levels in the sediments, particularly concentrations of mercury. Other sediment samplings will have to be taken in order to identify the scope and origin of the contamination.

Concerning the Obatogamau lakes once again, mercury emissions originating from the mining site may have caused an increase in adjusted average mercury levels near the mouth of Rivière Nemenjiche varying from 0.07 mg/kg to 0.3 mg/kg according to the species in question. In percentages, these increases are  $\approx 41\%$  for northern pike,  $\approx 22\%$  for walleye,  $\approx 100\%$  for lake whitefish and  $\approx 94\%$  for burbot. However, part of this increase may be attributed to the presence of older fish, particularly walleye, in the Rivière Nemenjiche sector as compared to the western sector (Lac Fancamp) of the Obatogamau lakes.

In spite of the differences observed, the mercury contamination measured is not unusual and is comparable to levels at a number of Québec sites. As such, the average mercury levels for all species remain below or similar to the average levels measured across Québec. This situation is nevertheless far from ideal since Québec's waterways are subject to airborne pollution and levels frequently exceed the Health Canada standard (0.5 mg/kg).

In the Obatogamau lakes, the standard is exceeded in walleye and medium-sized and large northern pike as well as in burbot of all sizes, with the exception of those caught in the western

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sector (Lac Fancamp), an area not influenced by mining activity. Large whitefish and white suckers of all sizes show levels below the standard at all sites.

For Lac Chibougamau, the average mercury levels exceed the standard for large and medium-sized lake trout as well as for northern pike, walleye and large burbot.

Among the three metals (arsenic, mercury and selenium) analysed in the fish, only mercury levels exceed the Health Canada standards for the sale of fishery products.

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## INTRODUCTION

Since 1998, in order to assess the quality of the fishery resource in the Chibougamau region, the ministère de l'Environnement du Québec and the Société de la faune et des parcs du Québec of the ministère des Ressources naturelles et de la Faune et des Parcs du Québec have been conducting analyses of metals and organic compounds in fish flesh. Four lakes have been under study: lakes Chibougamau, aux Dorés, Waconichi and Obatogamau (since 2001).

These lakes are used in particular by Cree communities for sustenance fishing and by the residents of the James Bay Region and other Québec regions for sport fishing.

The shores of Lac Chibougamau and Lac aux Dorés are the location of significant surface-level mineralized zones, some of which have been mined. The Obatogamau lakes, for their part, are influenced by the presence of a mine located in the Rivière Nemenjiche basin while Lac Waconichi is considered as the control lake since there is no mining activity or significant mineralization in the immediate vicinity.

Previous studies showed that mercury levels in large lake trout from Lac Chibougamau were well above the 0.5 mg/kg standard recommended by Health Canada for the sale of fishery products. The average mercury levels for lake trout caught in 2000 were twice as high as those measured at Lac Waconichi, the lake used as a reference control site.

In a summer 2001 study designed to determine whether mining activities could have caused contamination of the aquatic environment, the ministère de l'Environnement du Québec and the Société de la faune et des parcs du Québec examined concentrations of metals and PCBs in two mining effluents as well as concentrations of dioxins and furans in tailings, sediments and fish from the Chibougamau region. The study focused on lakes Chibougamau, aux Dorés, Obatogamau and Waconichi; however the sediment study concerned only Lac aux Dorés and Lac Chibougamau. In September 2001, the results of the study carried out that spring by Covell and Masters (2001) for the Grand Council of the Cree were unveiled and they pointed to contamination of the aquatic environment in the vicinity of mining industries.

The results of the 2001 study demonstrated that metal contamination in fish flesh was limited to mercury. Certain species showed levels that exceeded the 0.5 mg/kg standard (Health Canada standard for the sale of fishery products). The highest levels were observed in the Obatogamau lakes. Nonetheless, the latter concentration levels were not unusual and were comparable to levels measured at many other locations in Québec. In addition, the data do not prove that mining activities near Lac Chibougamau and Lac aux Dorés have caused an increase in mercury or other metal levels in fish.

It was pointed out however that the PCB levels in lake trout from Lac aux Dorés and Lac Chibougamau should be monitored. The origin of the PCBs remains to be explained, and no PCBs were detected in sediments from Lac Chibougamau or Lac aux Dorés.

Sediments taken near tailing sites contained high levels of some metals, namely arsenic, cadmium, copper, nickel and zinc. Sites near the Copper Rand mine, located south of the

Principale mine and at the foot of the Principale tailing site, showed the highest concentrations of these metals. However, given the different types of mineralization at these sites, it was not possible to precisely distinguish the proportion of metals occurring naturally from the proportion of anthropic origin.

The toxins in one mining effluent and the high levels of certain metals in sediments near tailing sites at Lac aux Dorés and Lac Chibougamau are likely to cause toxicity in aquatic organisms and thus remain a cause for concern.

The elevated arsenic, cadmium, copper, nickel and zinc levels in sediments near tailing sites had no perceivable effect on the levels measured in fish flesh homogenates, which were similar to those at the control site (Lac Waconichi).

In fish, levels for toxic metals, such as arsenic, cadmium, chromium and lead, were weak or below the detection limit.

In light of these results, the objective of the 2002 study has been to identify the extent of the zone of contaminated sediments located downstream from mining industries (for Lac aux Dorés) and to confirm the metal levels contained in sediments in sectors located both close to and far from mines (for Lac Chibougamau). It also aims to describe the impacts of the mining industry, if any, as evidenced in sediments from Lac Waconichi (control lake) and the Obatogamau lakes. In addition, the study has attempted to determine whether fish from the Obatogamau lakes show mercury levels that vary according to distance from mining activities.

In 2002, the levels of 13 metals were measured in 39 surface sediment samples from lakes Chibougamau (7), aux Dorés (6), Waconichi (6) and Obatogamau (20). Mercury analyses were also conducted on the flesh of 293 fish belonging to 6 species from the southern and northern sectors of Lac Chibougamau (114) and the eastern and western sectors of the Obatogamau lakes (179). These analyses focused on walleye (112), northern pike (43), large whitefish (29), burbot (25), white sucker (28) and lake trout (56). Composite flesh samples, based on the size classifications of the different species, will soon be analysed with the aim of detecting a number of metals and PCBs, as well as dioxins and furans. Metal levels in certain small whole fish will also be measured.

## **DESCRIPTION OF THE AREA STUDIED**

Mining extraction in the lakes Chibougamau, aux Dorés and Obatogamau region began in the 1950s with the mining of copper and gold fields. Ore from the Chibougamau region was treated, and tailings were disposed, at the Copper Rand and Principale mining sites, the only two sites with both treatment plants and tailing sites. The Joe Mann mine was an exception to the extent that ore was treated on site for a few years after operations began in 1956.

The Copper Rand mining site is situated on the Gouin Peninsula separating Lac Chibougamau from Lac aux Dorés. Two mine tailing sites are located on this peninsula. Eaton Bay, currently inactive, contains some 9.8 million tonnes of mine tailings and is built in part on the shore of

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Lac Chibougamau. Copper Rand, currently active, holds approximately 11.5 million tonnes of mine tailings and is located directly on the shore of Lac aux Dorés. All dikes containing these mine tailings were built with these waste materials. The final mineral effluent from the Copper Rand waste site flows into Lac aux Dorés. Flotation was the procedure used to extract copper. A cyanidation circuit was installed in 1985 but was in operation for one year only. Ore extraction and concentration activities were halted in 1997 following the exhaustion of accessible reserves.

The former Principale mine site is located on Merrill Island on Lac aux Dorés. All dikes encompassing the waste sites, containing up to 19.3 million tonnes of mine tailings, were built in Lac aux Dorés at the start of the mine's operations in 1955. The dikes are made of waste materials. The final mineral effluent from the tailings flows into Lac aux Dorés. Copper is extracted using a flotation process followed by a cyanidation circuit. Operations at the plant were suspended from November 2000 up to January 2002 inclusively. Ore from the Joe Mann mine is currently treated at the mill of the former Principale mine site with flotation to extract copper and with cyanidation to extract gold.

Gold recovery through amalgamation (a process using mercury) has never been carried out at the Copper Rand or the former Principale mine sites.

The Joe Mann mine site is located on the shores of Rivière Nemenjiche in the basin of the Obatogamau lakes. The waters of this river flow into Lac La Dauversière. This gold recovery process was used at the Joe Mann site during its early operations, between 1956 and 1958, where ore treatment, followed by a cyanidation circuit, was carried out on site. The procedure required the on-site use of mercury, part of which was recovered along with the gold. Ore is currently being treated at the Principle mine.

## **METHODS**

### **Sediment sampling**

Surface lacustrine sediment samples were taken in September 2002 from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi (see Table 1). The samples were taken from sites located both close to and far from the Lac Chibougamau mining activities, downstream from those taking place at Lac aux Dorés, all along Lac Waconichi (the control lake) and at the Obatogamau lakes (lakes La Dauversière, Le Royer and Fancamp), as well as from Rivière Nemenjiche (see figures 1, 2 and 3). In total, 33 sites were sampled for sediments.

The sediments were sampled with the aid of a Ponar grab sampler attached to a winch. The grab sampler was systematically washed and rinsed with HNO<sub>3</sub> (10%) and demineralized water before each usage. One portion of the sediments (from the first two centimetres taken) was transferred into glass jars and then placed in an icebox. In order to avoid risks of contamination, new gloves were used at each sampling point before the samples were taken. To ensure reliable results, double samples were prepared at sites 2, 7, 13, 19, 20 and 33. The double samples were prepared by carrying out a second sampling with the grab sampler at the sampling point.

Table 1 Location and description of sediment sampling stations at lakes Chibougamau, aux Dorés, Waconichi and Obatogamau in 2002

Sampling station	Site	UTM (Nad 27) coordinates		Depth (metres)	Water temperature (°C)	Dissolved oxygen (mg/l)	pH
		East	North				
<b><u>LAC CHIBOUGAMAU</u></b>							
1	Lac Chibougamau, south of Boulder Island	554,177	5,514,600	19.8		8.3	7.0
2 *	Lac Chibougamau, east of Granite Island	551,810	5,519,647	42.9	8.0	9.0	7.3
3	Lac Chibougamau, Nepton Bay	569,967	5,529,093	28.0	8.0	8.3	6.9
4	Lac Chibougamau, centre of McKenzie Bay	562,477	5,534,898	28.0	8.0	9.8	6.7
5	Lac Chibougamau, eastern of McKenzie Bay	560,576	5,534,840	37.9	6.0	8.6	6.6
6	Lac Chibougamau, east of Pointe à Bouleau	553,960	5,526,400	59.4	5.0	10.9	7.5
<b><u>LAC AUX DORÉS</u></b>							
7 *	Lac aux Dorés, upstream from Ballicky Bay	547,182	5,520,894	14.8	16.0	8.2	6.7
8	Lac aux Dorés, downstream from Ballicky Bay	546,104	5,519,352	16.5	11.0	8.0	6.4
9	Lac aux Dorés, downstream from Noll Island	545,946	5,521,292	8.2	16.0	8.5	7.0
10	Lac aux Dorés, McQuade Bay	544,501	5,519,043	26.4	8.0	8.7	6.4
11	Lac aux Dorés, Malouf Bay	543,860	5,517,068	16.5	11.0	7.8	6.4
<b><u>LAC WACONICHI</u></b>							
12	Lac Waconichi, Spawning Bay	565,244	5,544,397	7.3	15.0	9.1	7.3
13 *	Lac Waconichi, near Richardson Lake	564,250	5,547,305	13.9	14.0	9.4	7.5
14	Lac Waconichi, near Musset Island	568,270	5,552,027	61.0	5.0	11.3	7.4
15	Lac Waconichi, at Mont du Bouleau	572,430	5,555,922	61.0	6.0	11.0	7.5
16	Lac Waconichi, near mouth	576,394	5,557,530	46.2	5.0	10.6	7.1
<b><u>OBATOGAMAU LAKES</u></b>							
17	Lac La Dauversière, north	546,850	5,492,478	10.2	16.9	7.9	6.7
18	Lac La Dauversière, northeast	548,261	5,492,114	7.6	17.0	7.8	6.5
19 *	Lac La Dauversière, south	546,548	5,488,158	4.9	18.0	9.6	7.0
19 *	Lac La Dauversière, south	546,564	5,448,133	4.9	18.0	9.6	7.0
20 *	Lac La Dauversière, southeast	541,450	5,485,306	2.0	15.8	9.5	6.7
21	Lac La Dauversière, east	543,332	5,489,099	19.8	16.9	7.6	6.5
22	Lac La Dauversière, east	542,502	5,490,136	12.2	17.1	8.4	6.5
23	Lac La Dauversière, near Rivière Nemenjiche	541,504	5,490,434	4.9	17.2	8.8	6.7
24	Lac La Dauversière, downstream from Rivière Nemenjiche	541,408	5,491,128	3.6	19.1	9.6	6.7
25	Lac La Dauversière, upstream from Lac Le Royer	540,795	5,491,794	10.6	16.7	8.4	6.4
26	Lac Le Royer	539,459	5,492,825	14.8	16.9	8.4	6.6
27	Lac Fancamp, south	531,312	5,491,247	5.9	18.0	9.0	6.6
28	Lac Fancamp, north	531,566	5,492,692	13.5	17.0	7.5	6.3
29	Rivière Nemenjiche, upstream from mining operations	538,929	5,481,278	1.0	12.8	9.4	6.5
30	Rivière Nemenjiche, near mining operations	539,533	5,481,894	1.3	14.1	9.4	6.6
31	Rivière Nemenjiche, downstream from mining operations	540,061	5,483,215	2.0	13.6	9.6	6.8
32	Rivière Nemenjiche, mouth	540,539	5,486,793	0.6	15.0	9.4	6.6
33 *	Rivière Nemenjiche, Trois Lacs Bay	540,310	5,487,082	1.0	15.1	9.8	6.6

\* Double sample.

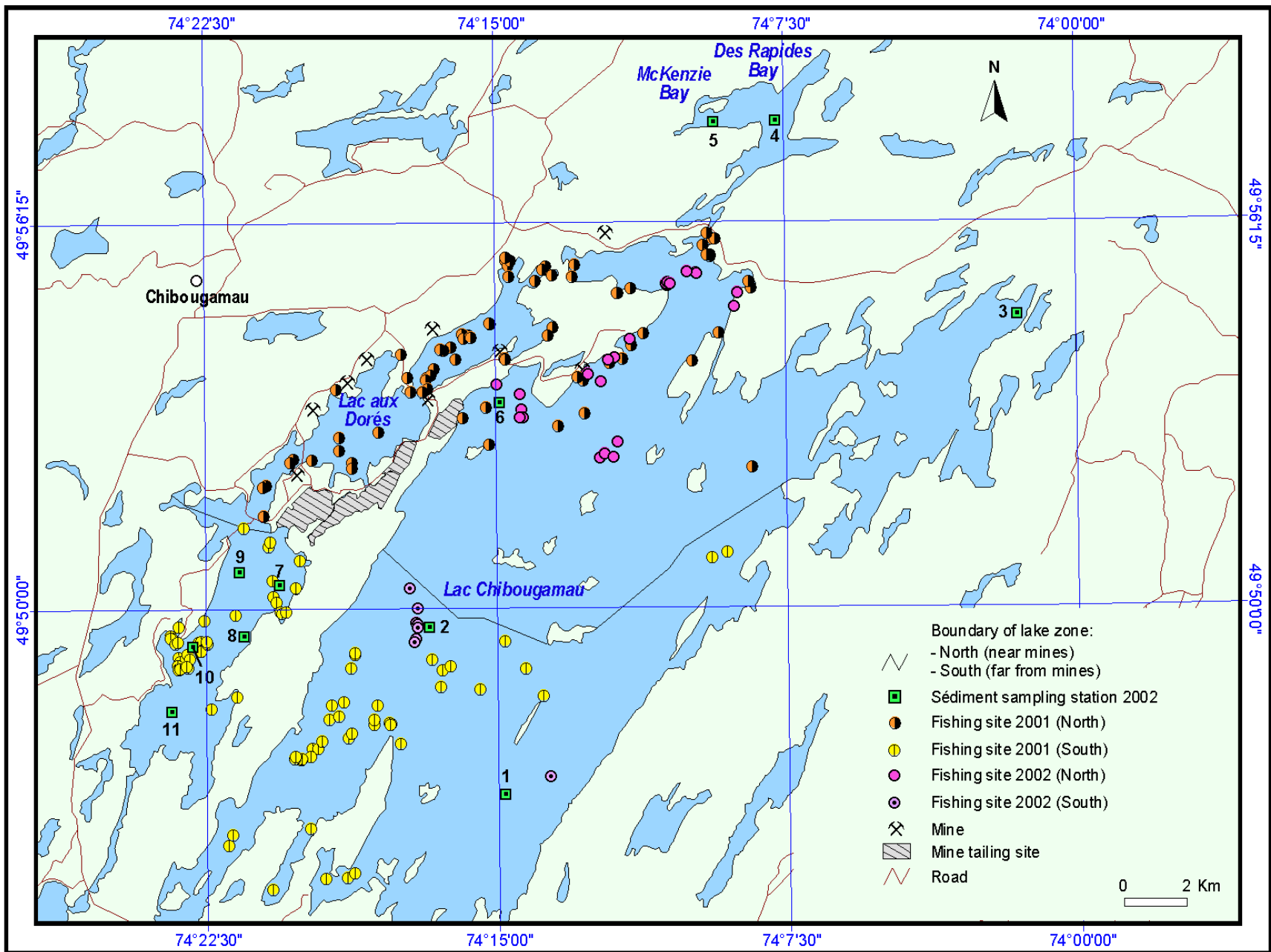


Figure 1 Location of fishing sites and sediment sampling stations at Lac Chibougamau and Lac aux Dorés, 2001-2002

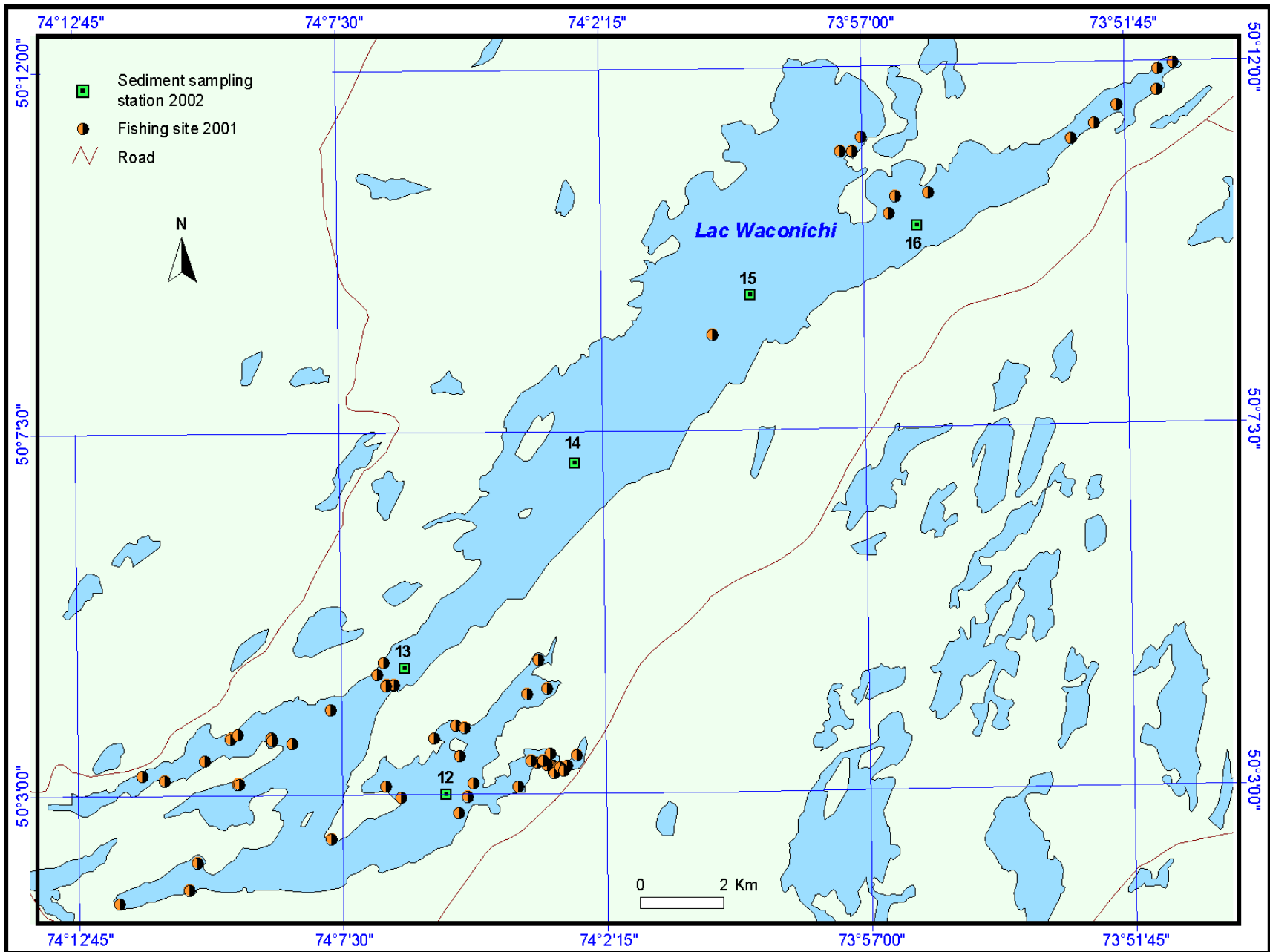


Figure 2 Location of fishing sites and sédiment sampling stations at Lac Waconichi, 2001 - 2002



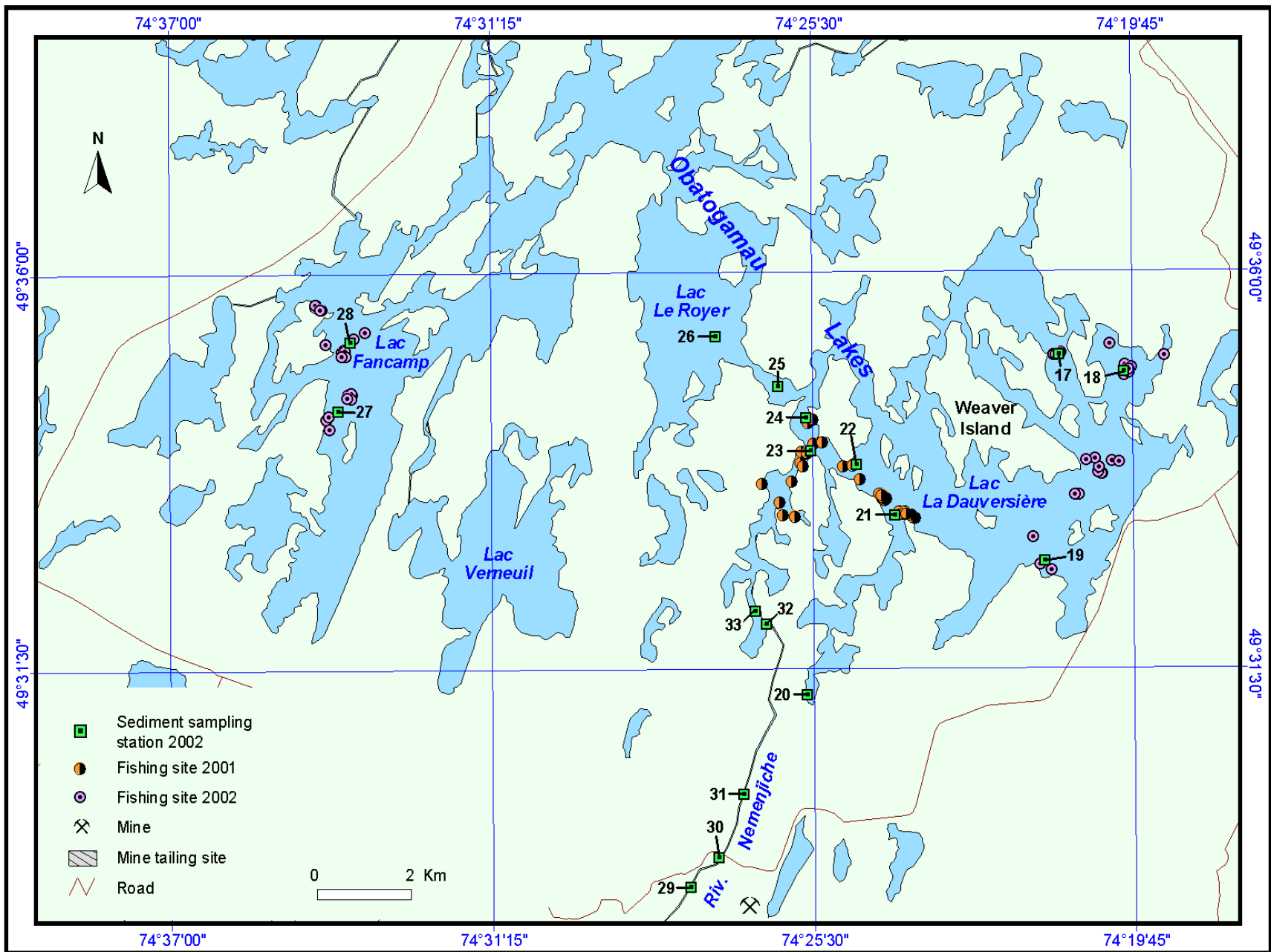


Figure 3 Location of fishing sites and sediment sampling stations at the Obatogamau lakes and Rivière Nemenjiche, 2001-2002

At the sediment sampling stations, the dissolved oxygen rate and temperature were measured at the bottom of the lake with the aid of an oximeter (see Table 1).

The samples were sent to the Centre d'expertise en analyse environnementale du Québec for analysis.

### **Fish sampling**

The fish were caught according to the protocol described in the Guide de normalisation des méthodes utilisées en faune aquatique par la Société de la faune et des parcs du Québec du ministère des Ressources naturelles, de la Faune et des Parcs du Québec (ministère de l'Environnement et de la Faune, 1994). Experimental transparent nylon mono-filament netting composed of 8 panels 7.6 metres long and 1.8 metres high, with stretched meshes measuring 25, 38, 51, 64, 76, 102, 127 and 152 mm assembled to a level of 50%, were used. The netting was cast in the habitats and preferred depths of the species being studied. In Lac Chibougamau and the Obatogamau lakes, nine fish species were caught: lake cisco (*Coregonus artedii*), walleye (*Stizostedion vitreum*), northern pike (*Esox lucius*), lake whitefish (*Coregonus clupeaformis*), burbot (*Lota lota*), lake minnow (*Couesius plumbeus*), white sucker (*Catostomus commersoni*), northern sucker (*Catostomus catostomus*) and lake trout (*Salvelinus namaycush*) (see figures 1 and 3). The lake cisco, northern sucker, lake minnow and lake trout were caught only in Lac Chibougamau.

Concerning the fish caught in Lac Chibougamau, links between mercury levels and the proximity of mines were evaluated by categorizing the above species as either close to or far from mining infrastructures. The dividing line between the two sectors was set at Granite Island. Waters to the north were considered close to and those to the south were considered far from the mines (see Figure 1). Fish from the Obatogamau lakes were caught in the western sector (Lac Fancamp), used as the control sector located far from mining activities and in the eastern sector (Lac La Dauversière), about 7 km upstream from Rivière Nemenjiche. Mining activities are located near Rivière Nemenjiche and the final effluent flows into this waterway (see Figure 3 and Appendix 1).

### **Laboratory analysis**

#### *Sediments*

The sediments were analysed to determine concentrations of aluminum, arsenic, beryllium, cadmium, chromium, copper, iron, mercury, nickel, lead, selenium, strontium, zinc and total organic carbon (TOC). The concentrations are expressed as dry weights (mg/kg).

Before analysis, the sediment sample is dried at 60°C. After drying, the aggregates are broken without crushing the particles, and the sample is put through a nylon sieve with an opening of 180 µm. Only particles smaller than 180 µm are analysed.

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### Mercury

The sediments are mineralized with the aid of potassium persulfate (5%), nitric acid (4 N), concentrated H<sub>2</sub>SO<sub>4</sub> and concentrated HCl in a block digester at a temperature of 95°C for 2 hours. A KMnO<sub>4</sub> solution (6%) is added to the cooled solution until the pink colouring lasts for 30 minutes, then an (NH<sub>2</sub>OH)<sub>2</sub>.H<sub>2</sub>SO<sub>4</sub> (6%) solution is added until there is discolouration. After remaining in this state overnight, the supernatant is analysed by adding a reducing solution made up of sulfuric acid, NaCl, (NH<sub>2</sub>OH)<sub>2</sub>.H<sub>2</sub>SO<sub>4</sub> and SnSO<sub>4</sub>; a flow of nitrogen then draws the mercury from the solution. The mercury is measured by flameless atomic absorption spectrophotometry by measuring the absorption at a wavelength of 254 nm. The detection limit for the method is 0.01 mg/kg, and the precision was 94% at a concentration of 1.44 mg/kg for the sediments (MA. method 207 – Hg 1.0).

### Arsenic

The sediments are mineralized at room temperature overnight with the aid of concentrated nitric acid, after which time concentrated hydrochloric acid is added to the solution then heated until complete evaporation. The forms of pentavalent arsenic are reduced to a trivalent state with sodium iodide. Next, the arsenic is transformed into a volatile hydride by creating a reaction in the sample with sodium borohydride (NaBH<sub>4</sub>) in acid. Lastly, the arsine thus formed is oxidized to elemental arsenic in a hot cell. The arsenic contained in the cell is measured by atomic absorption spectrophotometry by measuring the absorption at 193.7 nm. The detection limit for arsenic is 0.1 mg/kg, and the precision was 100% relative to the certified average value of 16.5 mg/kg for a SED-1 reference material (MA. method 205 – As 1.0).

### Selenium

The sediments are mineralized at room temperature overnight with the aid of concentrated nitric acid, after which time concentrated hydrochloric acid is added to the solution then heated until complete evaporation. The forms of hexavalent selenium are reduced to a tetravalent state by adding a second portion of hydrochloric acid (50%) to the cooled solution and heating one hour. Next the selenium is transformed into a volatile hydride by creating a reaction in the sample with sodium borohydride (NaBH<sub>4</sub>) in acid. The selenium hydride is then oxidized in elemental selenium in a hot cell. The selenium contained in the cell is measured by atomic absorption spectrophotometry by measuring the absorption at 196.0 nm. The detection limit for selenium is 0.1 mg/kg, and the precision was 79% relative to the certified average value of 1.92 mg/kg for a SED-1 reference material (MA. method 205 – Se 1.0).

### Other metals

The sediments are mineralized at 90°C with the aid of concentrated hydrochloric acid and concentrated nitric acid in a block digester overnight until evaporation to dryness, after which time the residue is cooled and dissolved with the same acids by heating for one hour at between 90°C and 100°C. The solution is then passed through a Whatman #41 filter prewashed with an HNO<sub>3</sub> (2%) and HCl (6%) solution. The metals contained in the filtrate are measured by argon plasma emission spectrophotometry by comparing luminous intensities. The detection limits vary

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from 0.15 mg/kg to 2.0 mg/kg according to the elements while the precision (for a certified reference material (MA. method 205 – Met/P 1.0)) are: 84% Al; 62% Be; 92% Cd; 79% Cr; 92% Cu; 96% Fe; 99% Ni, 95% Pb; not available Sr and 92% Zn.

### Total Organic Carbon (TOC)

The concentration of total organic carbon in the sediments is determined by bioassaying. A potassium bichromate solution is added to the sample in the presence of sulfuric acid. After the reaction, the concentration of total organic carbon is established based on the proportion of the bichromate that has not reacted with the sample. The detection limit for this method is 0.05%, and the precision was 94.5% for a 3.8% concentration of organic carbon (MA. Method - 405 - C 1.0).

### ***Fish***

Concerning fish, all species were analysed individually for mercury, except for very small fish such as lake minnows, each of which was analysed whole in groups of several fish. Arsenic and selenium were measured only in fish flesh homogenates (or in the entire fish for very small fish) by size according to species. Concentrations are measured in wet weights (mg/kg).

### Mercury

Biological tissue is mineralized with the aid of a concentrated HNO<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub> solution in a BD-40 block digester at a temperature of between 60°C and 90°C for 2 hours. A KMnO<sub>4</sub> solution (6%) is added to the cooled solution until the pink colouring lasts. After a night left at room temperature, (NH<sub>2</sub>OH)<sub>2</sub>.H<sub>2</sub>SO<sub>4</sub> (6%) is added until the MnO<sub>2</sub> dissolves. The supernatant is analysed by adding a reducing solution composed of sulfuric acid, NaCl, (NH<sub>2</sub>OH)<sub>2</sub>.H<sub>2</sub>SO<sub>4</sub> and SnSO<sub>4</sub>; a flow of nitrogen then draws the mercury out of the solution. The mercury is measured by flameless atomic absorption spectrophotometry by measuring the absorption at a wavelength of 254 nm. The detection limit for the method is 0.01 mg/kg, and the precision was 93% at a concentration of 0.28 mg/kg and 113% at a concentration of 0.47 mg/kg for biological tissue (MA. method 207 – Hg 1.0).

### Arsenic

Biological tissue is mineralized with the aid of concentrated HNO<sub>3</sub> and an MgNO<sub>3</sub> solution (80%) at room temperature overnight, after which time the solution is heated to dryness on a hot plate. The residue is recovered by adding HNO<sub>3</sub> and MgNO<sub>3</sub> until dry, in the process turning white or pale yellow. It is then put in an oven at 550°C for 12 hours. After cooling, the residue is dissolved with an HCl (50%) solution, and the solution is heated close to the boiling point for at least one hour. The arsenic is then transformed into a volatile hydride by creating a reaction in the sample with sodium borohydride (NaBH<sub>4</sub>) in acid. Lastly the arsine thus formed is oxidized to elemental arsenic in a hot cell. The arsenic in the cell is measured by atomic absorption spectrophotometry by measuring the absorption at 193.7 nm. The detection limit for arsenic is 0.05 mg/kg, and the precision was 100% at concentrations of 14 mg/kg, 24.6 mg/kg and

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18 mg/kg for reference materials NBS 1566a, TORT-1 and DORM-2 respectively (method 90.02/207 – As 1.1).

### Selenium

Biological tissue is mineralized with the aid of concentrated HNO<sub>3</sub> and an MgNO<sub>3</sub> solution (80%) at room temperature overnight, after which time the solution is heated to dryness on a hot plate. The residue is recovered by adding NHO<sub>3</sub> and MgNO<sub>3</sub> until dry, in the process turning white or pale yellow. It is then placed in an oven at a temperature of 550°C for 12 hours. After cooling, the residue is dissolved with an HCl solution (50%), and the solution is heated to nearly 100°C for at least an hour, thus making it possible to reduce the forms of selenium hexavalent to a tetravalent state, after which the selenium is transformed into a volatile hydride by creating a reaction in the sample with sodium borohydride (NaBH<sub>4</sub>) in acid. Lastly the hydride thus formed is oxidized to elemental selenium in a hot cell. The selenium contained in the cell is measured by atomic absorption spectrophotometry by measuring the absorption to 196.0 nm. The detection limit for selenium is 0.05 mg/kg, and the precision was 83% to 98% relative to the certified average value of 1.46 mg/kg for reference material MAB-3 (MA. method 207 – Se 1.0).

### **Standards and guidelines for comparing sediments and fish**

Metal concentrations in sediments were compared using guidelines established by the Canadian Council of Ministers of the Environment (CCME, 2001). The two sets of guidelines used in this study were the interim sediment quality guideline (ISQG) for freshwater sediments and the probable effect levels (PEL). These guidelines have been designed to protect organisms that either live in the sediments or come in direct contact with bottom materials, i.e. benthic and epibenthic organisms. The relative ISQG levels rarely show effects; those located between the ISQG and the PEL sometimes show effects; and those above the PEL often show harmful biological effects. The guideline for the metals analysed in this study are only available in some cases. The data were also compared to the reference sites as a means of detecting abnormal concentrations.

For fish, metal levels were compared using Health Canada standards for the sale of fishery products (mercury, 0.5 mg/kg and arsenic, 3.5 mg/kg). No standard exist for selenium. Mercury concentrations were also compared with the guidelines for the protection of terrestrial fish-eating wildlife. These limits are 0.033 mg/kg (CCME, 2001).

### **Statistical analysis**

Covariant parametric and non-parametric analyses were conducted to compare mercury concentrations and the age of fish caught on the different sites using length as the covariable (Appendix 2). Prior to the parametric analyses, the ages and mercury levels were transformed using log<sub>10</sub> (Hg +1) to reduce the variant. Parametric analyses were used to determine adjusted average levels and ages after calculating the antilogarithm.

Non-parametric covariant analysis was selected to determine whether there was a difference in the adjusted average levels and ages at the various sites. This type of analysis was chosen since

its application does not require a verification of the normality and equality of the variant, but rather the equality of the slopes of the regression lines. Equality of the slopes was obtained in almost all the statistical analyses. In the few cases where this was not possible, readings were taken based on individual regression lines.

The relations obtained, of age in relation to length, served to determine whether the growth rate for a same fish species was similar at different sites and made it possible to ensure that the fish were the same average age for a given average length. When significant differences were found among the sites, this factor was underlined as a variable that could explain the differences observed in the mercury concentrations from one site to another. Older fish that were exposed longer are likely to show a higher mercury level.

Statistical analyses dealt with limited size classifications in order to compare similar samples. Thus the largest and oldest fish were not included in the statistical analyses for northern pike, walleye and lake trout. In the statistical analyses, none of the compared samples showed significant differences in length, with the exception of lake trout from lakes Chibougamau, aux Dorés and Waconichi. The homogeneity in length was verified through an analysis of variance for unequal samples (GLM) as well as by using the LSD multiple comparison test of the SAS system.

Statistical analyses were carried out for northern pike (400-575 mm), walleye (300-600 mm), northern whitefish (370-520 mm), burbot (350-750 mm), white sucker (300-490 mm) and lake trout (500-750 mm). The statistical analyses concerned fish caught in lakes Chibougamau, aux Dorés, Obatogamau and Waconichi in 2000, 2001 and 2002 (Appendix 3). These analyses were designed to compare mercury levels per species at the various sites, both spatially and over time.

For walleye and lake trout, only specimens 17 years of age and under were considered in order to reduce the bias caused by this variable. Age data were not available for the northern whitefish, burbot or white sucker. Hence this variable has not been considered in the statistical analyses for these species.

For the yellow walleye, the northern pike and the lake trout mercury contents have been compared with those measured for the province of Quebec as a whole from 1976 to 1999 included (Laliberté, 2004). A statistical analysis related to three classes of each species has been implemented by nonparametric variance analysis for uneven samplings (GLM) and by the multiple comparison test of the SAS and LSD system.

The results of the statistical analyses were considered as being different whenever the probability was less than 0.05 ( $P < 0.05$ ).

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## RESULTS

### Sediments

Sediments from Lac Waconichi (control lake) show very low metal levels, in particular copper (9 mg/kg) and arsenic (4 mg/kg), pointing both to the absence of mining influence on this lake (see Table 2) and of significant mineralization in the drainage basin. The levels measured are comparable to or below the average levels of arsenic (2.5 mg/kg) and copper (31 mg/kg) measured in the lacustrine sediments by the Geological Survey of Canada (CCME, 2001).

For Lac aux Dorés, in the sector downstream from the Principale tailing site, only copper (400 mg/kg) and nickel (63 mg/kg) show concentrations that exceed the guidelines of probable effect (197 mg/kg and 61 mg/kg respectively). This contamination, especially with respect to copper, is noted on the western shore as far as over 3.5 km downstream from the aforementioned tailing site. The concentration levels are however lower than those observed in 2001 near the mines (upstream sector) (Laliberté, D. and G. Tremblay, 2002).

For Lac Chibougamau, a sediment sample taken in a ditch near the Eaton Bay tailing site shows a very high concentration of copper (1,300 mg/kg), i.e. 6.6 times the guidelines of probable effect. Levels of arsenic (41 mg/kg) and nickel (89 mg/kg) also exceed their respective guideline at this site. These levels confirm the 2001 observations for this sector and the potential toxicity for aquatic organisms.

Still for Lac Chibougamau, sediments taken far from mining activities show concentrations of arsenic, chromium, nickel, lead and zinc that are significantly higher in the north than in the south. For arsenic, chromium and nickel, the levels in the north (McKenzie Bay) are, respectively, 1.6, 1.3 and 2.3 times higher than the guidelines of probable effect (see Table 2 and Figure 4). Lac Chibougamau and Lac aux Dorés are influenced by the ultramafic rocks of the Cummings Complex located near the shore of Lac Chibougamau. This complex harbours abnormal contents of copper, chromium, nickel and cobalt, in part explaining the higher metal concentrations in this sector (Paradis, S. J. *et al.*, 1996, and Beaumier, M. and F. Kirouac, F., 1994).

Concerning the Obatogamau lakes, Rivière Nemenjiche, a tributary draining a mining site, contains sediments with high concentrations of arsenic (85 mg/kg), copper (680 mg/kg), and mercury (0.77 mg/kg). These levels exceed the guideline of probable effect and represent a potential risk for aquatic organisms (see Table 2 and figures 4 and 5). On Rivière Nemenjiche, the differences observed upstream and downstream from the mining site suggest that this industry could be responsible for increases in metal levels. High levels may be observed in the Obatogamau lakes as far as Lac Le Royer, located downstream. The mercury levels are often associated with a system of faults (Jonasson *et al.*, 1972). The proximity of Grenvillian faults in this sector is likely to increase the natural metal levels in the sediments, particularly concentrations of mercury (Paradis, S.J. *et al.*, 1996; Maurice *et al.*, 1995; Beaumier *et al.*, 1994). Other sediment samplings will have to be taken in order to identify the scope and origin of the contamination.

Table 2 Metal concentrations in the sediments of lakes Chibougamau, aux Dorés, Waconichi and Obatogamau in 2002

Station	Site	Al (mg/kg)	As (mg/kg)	Be (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Hg (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Sr (mg/kg)	Zn (mg/kg)	COT (%)	Hg 2% TOC (mg/kg)
	Min	4,400	0.5	<0.5	<0.5	<0.5	3.3	5,400	<0.02	9	6	0.2	11	32	1.2	<0.02
	Max	29,000	85.0	<0.5	3.0	120	1,300	100,000	0.77	140	68	6.9	49	240	14.8	0.28
	Average	14,403	12.8	<0.5	1.4	18.4	138	33,728	0.15	35	27	1.1	25	113	6.8	0.05
	Median	14,000	4.6	<0.5	1.5	13.0	30	26,000	0.12	29	19	0.7	26	120	5.1	0.03
	ISQG <sup>1</sup>	nd	5.9	nd	0.6	37.3	35.7	nd	0.17	35	35	nd	nd	123		
	PEL <sup>2</sup>	nd	17.0	nd	3.5	90	197	nd	0.486	61	91.3	nd	nd	315		
<b><u>LAC CHIBOUGAMAU</u></b>																
1	Lac Chibougamau, south of Boulder Island	14,000	1.9	<0.5	1.1	40.0	30	19,000	0.03	51	9	0.6	41	120	5.6	0.01
2 *	Lac Chibougamau, east of Granite Island	14,000	4.6	<0.5	1.9	36.0	25	26,000	0.02	67	14	0.4	49	110	2.4	0.01
2 *	Lac Chibougamau, east of Granite Island	16,000	5.2	<0.5	1.5	35.0	30	31,000	0.06	50	22	0.8	27	140	7.5	0.02
3	Lac Chibougamau, Nepton Bay	16,000	3.9	<0.5	1.9	18.0	19	21,000	0.23	20	54	1.1	33	150	14.5	0.03
4	Lac Chibougamau, centre of McKenzie Bay	18,000	23.0	<0.5	2.1	41.0	28	54,000	0.24	64	55	1.4	31	240	11.9	0.04
5	Lac Chibougamau, eastern McKenzie Bay	17,000	27.0	<0.5	2.5	120.0	24	61,000	0.24	140	48	1.3	28	210	12.5	0.04
6	Lac Chibougamau, east of Pointe à Bouleau	29,000	41.0	<0.5	2.4	<0.5	1,300	88,000	0.13	89	45	1.2	14	150	4.7	0.06
<b><u>LAC AUX DORÉS</u></b>																
7 *	Lac aux Dorés, upstream from Ballicky Bay	17,000	11.0	<0.5	1.7	31.0	400	28,000	0.14	62	36	1.4	30	190	6.6	0.04
7 *	Lac aux Dorés, upstream from Ballicky Bay	15,000	6.7	<0.5	1.4	32.0	180	28,000	0.07	43	24	0.9	32	150	6.4	0.02
8	Lac aux Dorés, downstream from Ballicky Bay	14,000	7.6	<0.5	1.2	31.0	300	21,000	0.12	37	34	0.9	30	130	8.1	0.03
9	Lac aux Dorés, downstream from Noll Island	9,900	4.1	<0.5	0.9	27.0	87	17,000	0.04	28	16	0.5	29	89	3.3	0.02
10	Lac aux Dorés, McQuade Bay	8,100	6.8	<0.5	2.6	13.0	100	31,000	0.04	63	19	0.4	27	160	2.0	0.04
11	Lac aux Dorés, Malouf Bay	11,000	4.1	<0.5	1.7	26.0	33	26,000	0.02	52	8	0.4	35	120	2.2	0.02
<b><u>LAC WACONICHI</u></b>																
12	Lac Waconichi, Spawning Bay	12,000	2.3	<0.5	0.9	18.0	11	14,000	0.05	12	13	0.6	29	110	7.4	0.01
13 *	Lac Waconichi, at Lac Richardson	8,500	0.8	<0.5	0.7	15.0	10	9,700	0.02	10	6	0.3	25	57	5.0	0.01
13 *	Lac Waconichi, at Lac Richardson	9,100	1.0	<0.5	0.8	16.0	10	10,000	0.03	11	6	0.5	28	59	3.3	0.02
14	Lac Waconichi, near Musset Island	9,200	12.0	<0.5	0.9	7.6	7	33,000	0.03	11	7	0.5	29	50	3.4	0.02
15	Lac Waconichi, at Mont du Bouleau	9,000	4.6	<0.5	1.6	11.0	9	21,000	0.05	12	46	0.7	26	77	4.0	0.03
16	Lac Waconichi, near mouth	9,100	3.5	<0.5	1.1	14.0	9	18,000	0.04	13	21	0.6	28	67	5.1	0.02

Double sample

<sup>1</sup> ISQG: Interim sediment quality guideline for freshwater sediments (CCME, 2001)<sup>2</sup> PEL: Probable effect level (CCME, 2001)



Table 2 Metal concentrations in the sediments of lakes Chibougamau, aux Dorés, Waconichi and Obatogamau in 2002 (continued)

Station	Site	Al (mg/kg)	As (mg/kg)	Be (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Hg (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Sr (mg/kg)	Zn (mg/kg)	COT (%)	Hg 2% TOC (mg/kg)
	Min	4,400	0.5	<0.5	<0.5	<0.5	3.3	5,400	<0.02	9	6	0.2	11	32	1.2	<0.02
	Max	29,000	85.0	<0.5	3.0	120	1,300	100,000	0.77	140	68	6.9	49	240	14.8	0.28
	Average	14,403	12.8	<0.5	1.4	18.4	138	33,728	0.15	35	27	1.1	25	113	6.8	0.05
	Median	14,000	4.6	<0.5	1.5	13.0	30	26,000	0.12	29	19	0.7	26	120	5.1	0.03
	ISQG <sup>1</sup>	nd	5.9	nd	0.6	37.3	35.7	nd	0.17	35	35	nd	nd	123		
	PEL <sup>2</sup>	nd	17.0	nd	3.5	90	197	nd	0.486	61	91.3	nd	nd	315		
<b>OBATOGAMAU LAKES</b>																
17	Lac La Dauversière, north	18,000	2.7	<0.5	1.2	21.0	18	26,000	0.15	27	33	0.2	20	100	13.4	0.02
18	Lac La Dauversière, northeast	21,000	3.8	<0.5	1.5	13.0	22	37,000	0.19	28	48	0.9	21	130	14.7	0.03
19 *	Lac La Dauversière, south	7,300	1.3	<0.5	<0.5	5.3	4	16,000	0.03	14	9	0.2	26	47	1.6	0.04
19 *	Lac La Dauversière, south	7,300	1.1	<0.5	0.6	7.2	5	13,000	0.03	11	11	0.2	22	50	2.2	0.03
20 *	Lac La Dauversière, southeast	4,900	0.6	<0.5	<0.5	8.4	6	5,700	0.02	9	9	0.2	21	38	3.7	0.01
20 *	Lac La Dauversière, southeast	4,400	0.5	<0.5	<0.5	9.3	5	5,400	<0.02	9	7	0.2	20	32	3.3	<0.02
21	Lac La Dauversière, east	21,000	6.1	<0.5	2.0	5.7	52	48,000	0.30	26	68	1.1	17	150	14.8	0.04
22	Lac La Dauversière, east	25,000	7.6	<0.5	3.0	<0.5	50	6,600	0.25	39	58	1.1	18	190	11.9	0.04
23	Lac La Dauversière, near Rivière Nemenjiche	21,000	15.0	<0.5	1.0	22.0	<b>680</b>	40,000	<b>0.77</b>	38	44	1.4	27	150	11.2	<b>0.14</b>
24	Lac La Dauversière, downstream from Rivière Nemenjiche	7,400	3.0	<0.5	0.5	7.0	94	14,000	0.13	14	13	0.4	19	53	2.9	<b>0.09</b>
25	Lac La Dauversière, upstream from Lac Le Royer	20,000	11.0	<0.5	1.7	7.3	<b>300</b>	49,000	<b>0.54</b>	33	47	1.3	20	140	12.7	<b>0.09</b>
26	Lac Le Royer	24,000	13.0	<0.5	3.0	<0.5	<b>220</b>	82,000	<b>0.50</b>	40	56	1.2	21	180	12.4	<b>0.08</b>
27	Lac Fancamp, south	20,000	4.5	<0.5	1.4	18.0	25	31,000	0.16	29	23	0.7	25	120	10.2	0.03
28	Lac Fancamp, north	19,000	4.6	<0.5	1.5	20.0	53	30,000	0.29	25	60	0.9	20	130	13.5	0.04
29	Rivière Nemenjiche, upstream from mining operations	5,500	1.5	<0.5	<0.5	12.0	3	10,000	<0.02	12	6	0.3	26	40	2.2	<0.02
30	Rivière Nemenjiche, near mining operations	8,000	2.3	<0.5	1.1	12.0	30	14,000	0.08	18	18	0.5	26	64	9.8	0.02
31	Rivière Nemenjiche, downstream from mining operations	13,000	<b>85.0</b>	<0.5	2.2	<0.5	<b>370</b>	100,000	0.12	48	9	6.9	12	93	1.2	<b>0.20</b>
32	Rivière Nemenjiche, mouth	18,000	<b>49.0</b>	<0.5	1.7	<0.5	<b>210</b>	83,000	0.13	44	9	4.3	11	100	1.5	<b>0.17</b>
33 *	Rivière Nemenjiche, Trois Lacs Bay	21,000	<b>62.0</b>	<0.5	1.5	8.0	<b>320</b>	74,000	0.35	42	13	2.7	13	120	2.5	<b>0.28</b>
33 *	Rivière Nemenjiche, Trois Lacs Bay	20,000	<b>55.0</b>	<0.5	1.8	7.8	<b>300</b>	74,000	0.34	41	13	2.8	14	120	3.0	<b>0.23</b>

Double sample

<sup>1</sup> ISGQ: Interim sediment quality guideline for freshwater sediments (CCME, 2001)<sup>2</sup> PEL: Probable effect level (CCME, 2001)

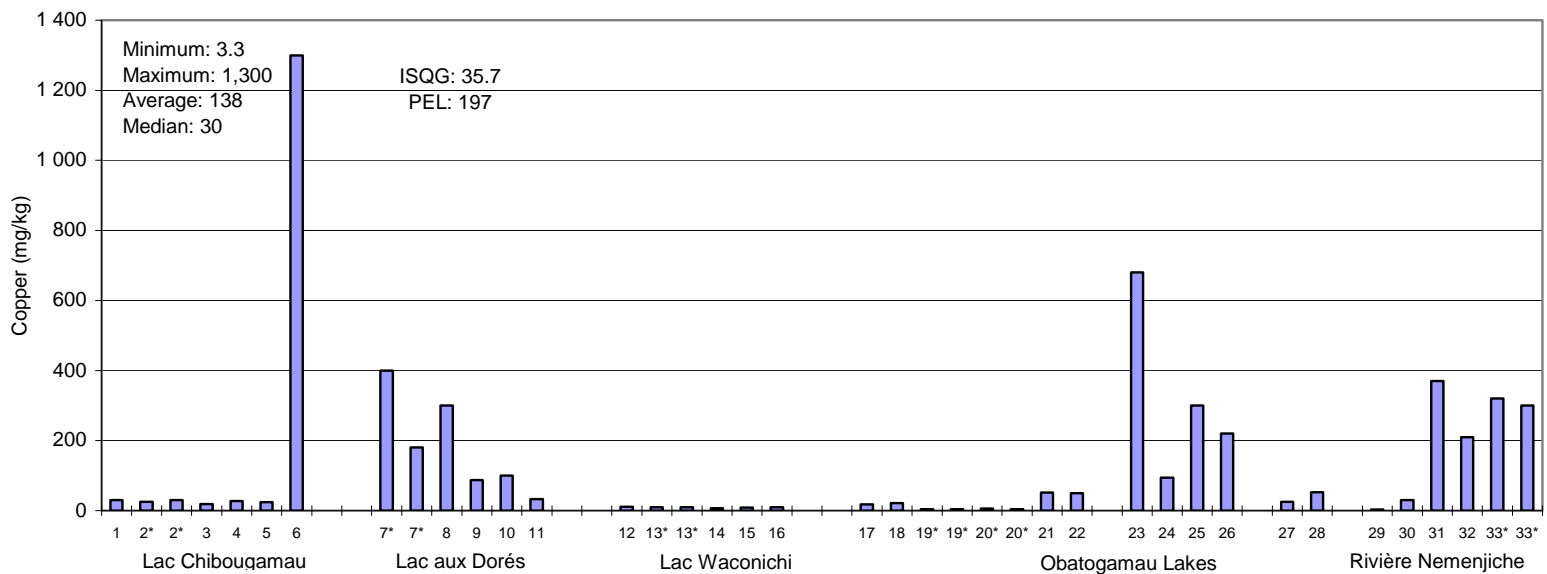
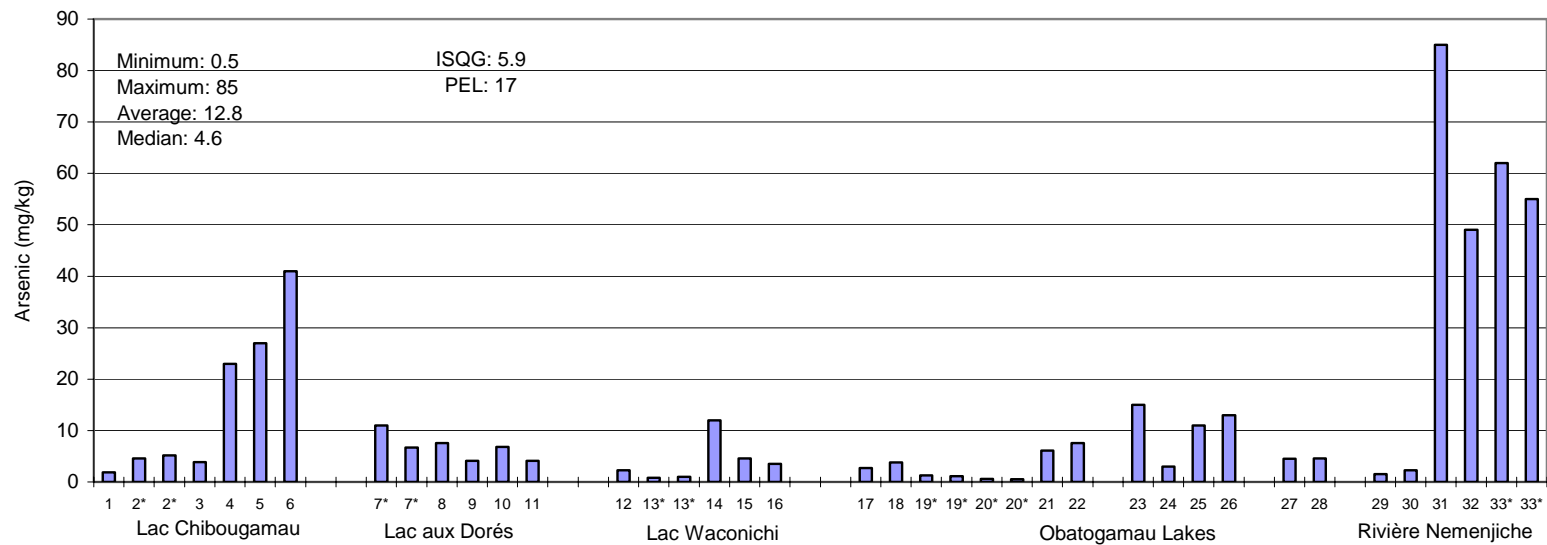


Figure 4 Concentrations of arsenic and copper in sediments from lakes Chibougamau, aux Dorés, Waconichi and Obatogamau and from Rivière Nemenjiche in 2002

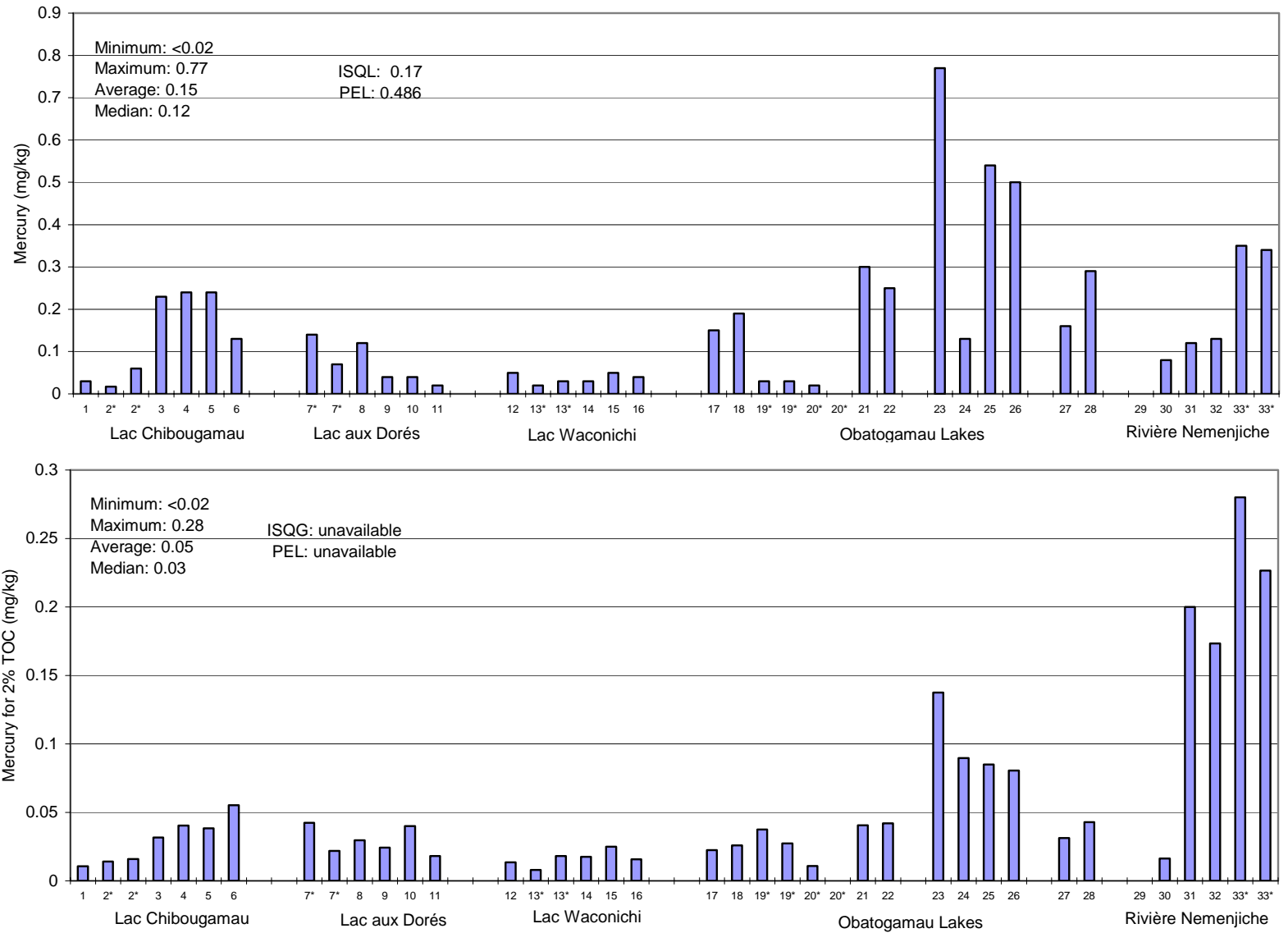


Figure 5 Mercury concentrations and mercury concentrations weighted for 2% TOC in sediments from lakes Chibougamau, aux Dorés, Waconichi and Obatogamau and from Rivière Nemenjiche in 2002

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## Fish

### *Comparison of mercury concentrations in fish spatially and over time*

In the Obatogamau lakes, fish caught near the mouth of Rivière Nemenjiche show adjusted average mercury levels that are higher than those for the same species coming from the western sector, i.e. from Lac Fancamp (control). The differences observed are  $\approx 41\%$  for northern pike (0.47 mg/kg vs. 0.33 mg/kg),  $\approx 22\%$  for walleye (0.56 mg/kg vs. 0.46 mg/kg),  $\approx 100\%$  for northern whitefish (0.14 mg/kg vs. 0.07 mg/kg) and  $\approx 94\%$  for burbot (0.62 mg/kg vs. 0.32 mg/kg) (see Table 3).

For northern pike and walleye for which the age of the specimens has been determined, there is no significant difference in growth rate (at a probability level of 0.05) among the catching sites.

However, given the probability limit for northern pike ( $P = 0.14$ ) and walleye ( $P = 0.10$ ), a small difference in growth rate could exist between the western sector and Rivière Nemenjiche. For the western, eastern and Nemenjiche sectors, the adjusted average ages for northern pike are 2.9, 3.0 and 3.4 years, while the adjusted average ages for walleye are 6.5, 6.4 and 7.8 years.

Same-sized older fish are likely to present higher mercury levels as a result of longer exposure. If fish caught near Rivière Nemenjiche do turn out to be older than those from the western sector (Lac Fancamp), the differences observed in adjusted average mercury levels could be attributed, in whole or in part, to the age of the fish.

In the eastern sector of the Obatogamau lakes (Lac La Dauversière), the adjusted average mercury levels for the fish species analysed are not significantly different from those of the same species caught at Rivière Nemenjiche. For northern pike and walleye, growth rates are not significantly different between the two sites but, given the respective probabilities ( $P = 0.22$  and  $P = 0.07$ ), a slight difference could indeed exist. In this sector, the adjusted average mercury levels for the various fish species fall between the levels measured in the western sector and those measured near Rivière Nemenjiche. With the exception of walleye, the adjusted average mercury levels for the different fish species from the eastern sector (Lac La Dauversière) are all significantly higher than those in the western sector (Lac Fancamp) (see Table 3). The differences observed for northern pike cannot be attributed to growth rates, which are similar in the eastern and western sectors. Growth rates remain unknown for species other than walleye.

Adjusted average mercury levels in the eastern sector (Lac La Dauversière) are higher than in the western sector (Lac Fancamp):  $\approx 21\%$  for northern pike (0.33 mg/kg vs. 0.40 mg/kg),  $\approx 57\%$  for northern whitefish (0.07 mg/kg vs. 0.11 mg/kg),  $\approx 63\%$  for burbot (0.32 mg/kg vs. 0.52 mg/kg) and  $\approx 20\%$  for white sucker (0.10 mg/kg vs. 0.12 mg/kg). There is no significant difference for walleye (0.46 mg/kg vs. 0.49 mg/kg).

In 2002 in Lac Chibougamau, analyses mainly involved walleye and lake trout caught in the southern and northern sectors of the lake.

Table 3 Results of statistical analyses of mercury concentrations and age in relation to the length of fish caught in lakes Obatogamau, Chibougamau, aux Dorés and Waconichi in 2000, 2001 and 2002

	Average mercury level (mg/kg)	Adjusted average mercury level (mg/kg)	ANCOVA* RANK	Adjusted average age (years)	ANCOVA* RANK	Average length (mm)	ANOVA*	Samples (N)
<b>OBATOGAMAU LAKES</b>								
<b>Northern pike (400-575 mm)</b>								
Western sector (2002)	0.33	0.33	B	2.9	A	499	A	13
Eastern sector (2002)	0.43	0.40	A	3.0	A	511	A	14
Rivière Nemenjiche (2001)	0.47	0.47	A	3.4	A	501	A	14
<b>Walleye (300-600 mm) (≤17 years)</b>								
Western sector (2002)	0.45	0.46	B	6.5	A	424	A	21
Eastern sector (2002)	0.52	0.49	AB	6.4	A	445	A	24
Rivière Nemenjiche (2001)	0.58	0.56	A	7.8	A	440	A	20
<b>Burbot (350-750 mm)</b>								
Western sector (2002)	0.36	0.32	B			590	A	12
Eastern sector (2002)	0.50	0.52	A			518	A	13
Rivière Nemenjiche (2001)	0.60	0.62	A			524	A	3 **
<b>Northern whitefish (370-520 mm)</b>								
Western sector (2002)	0.08	0.07	B			446	A	14
Eastern sector (2002)	0.10	0.11	A			432	A	15
Rivière Nemenjiche (2001)	0.13	0.14	A			430	A	3 **
<b>White sucker (300-490 mm)</b>								
Western sector (2002)	0.09	0.10	B			384	A	16
Eastern sector (2002)	0.13	0.12	A			404	A	12
<b>LAC CHIBOUGAMAU</b>								
<b>Walleye (300-600 mm) (≤17 years)</b>								
Southern sector (2001)	0.43	0.44	A	5.9	A	434	A	25
Southern sector (2002)	0.44	0.42	AB	5.5	A	450	A	27
Northern sector (2001)	0.36	0.35	BC	4.6	C	446	A	26
Northern sector (2002)	0.39	0.38	C	5.3	B	442	A	27
Southern sector (2001-2002)	0.44	0.43	A	5.7	A	442	A	52
Northern sector (2001-2002)	0.37	0.37	B	5.0	B	444	A	53
<b>LAKES CHIBOUGAMAU, OBATOGAMAU AND WACONICHI</b>								
<b>Walleye (300-600 mm) (≤17 years)</b>								
Chibougamau south (2001-2002)	0.44	0.42	B	5.6	C	442	A	52
Chibougamau north (2001-2002)	0.37	0.36	C	4.9	D	444	A	53
Obatogamau east and west (2002)	0.49	0.48	A	6.4	B	436	A	45
Rivière Nemenjiche (2001)	0.58	0.56	A	7.9	A	441	A	20
Waconichi (2001)	0.21	0.21	D	2.9	E	431	A	20
<b>LAKES CHIBOUGAMAU, AUX DORÉS AND WACONICHI</b>								
<b>Lake trout (395-750 mm) (≤17 years)</b>								
Chibougamau south (2001)	0.81	0.68	AB	9.8	AB	644	A	13
Chibougamau north (1999)	0.67	0.79	A	10.1	AB	553	BC	8
Chibougamau north (2000-2001)	0.76	0.66	AC	9.7	AB	621	A	24
Chibougamau north (2002)	0.67	0.59	BD	9.0	B	598	AB	38
Aux Dorés south (2001)	0.47	0.48	D	9.0	B	567	BC	18
Aux Dorés north (2000-2001)	0.56	0.61	BC	10.0	A	553	C	27
Waconichi (2000-2001)	0.31	0.32	E	9.5	AB	560	BC	27

\* Identical letters indicate that there is no significant difference from the 0.05 probability level.

\*\* Homogenates from 4 to 9 fish per sample.

Concerning walleye, adjusted average mercury levels measured in 2002 are slightly higher ( $\approx 11\%$ ) in the southern sector of Lac Chibougamau (far from the mines) than in the northern sector close to the mines (0.42 mg/kg compared to 0.38 mg/kg). This slight discrepancy may be explained by a lower growth rate in the southern sector where same sized fish are on average older (5.5 vs. 5.3 years). This difference is comparable to that observed in 2001. In each of the respective sectors, mercury levels in walleye were similar in 2001 and 2002. In the northern sector, the 2002 growth rate was nevertheless lower than in 2001 (5.3 vs. 4.6 years for the same adjusted average size).

Looking at 2001 and 2002, the combined results per sector show that walleye from the southern sector show higher adjusted average mercury levels ( $\approx 16\%$ ) than in the northern sector (0.43 mg/kg compared to 0.37 mg/kg). In the same vein, walleye in the southern sector are on average older than in the northern sector (5.7 vs. 5 years for a same adjusted average size).

The comparison of adjusted average mercury levels in walleye caught in the southern and northern sectors of Lac Chibougamau (2001-2002), the eastern and western sectors of the Obatogamau lakes (2002), the Rivière Nemenjiche sector of the Obatogamau lakes (2001), and Lac Waconichi (2001) reveals that walleye from the Obatogamau lakes show higher mercury levels (0.56 mg/kg and 0.48 mg/kg) than those from Lac Chibougamau (0.42 mg/kg and 0.36 mg/kg) and Lac Waconichi (0.21 mg/kg). The adjusted average mercury levels in walleye from Lac Waconichi are twice as low as those in walleye from other sectors. This significant difference is explained by a much higher growth rate in Lac Waconichi. For the same adjusted average size, the adjusted average age for walleye from this lake is 2.9 years, compared to 7.9, 6.4, 5.6 and 4.9 years for the Rivière Nemenjiche sector, the eastern and western sectors of the Obatogamau lakes, and the southern and northern sectors of Lac Chibougamau. Mercury levels in walleye increase proportionally with the adjusted average age of walleye from the different sites (see Table 3, Figure 6).

In Lac Chibougamau, the adjusted average mercury level in lake trout caught in the northern sector in 2002 (0.59 mg/kg) is slightly lower than that measured in 2000-2001 (0.66 mg/kg). This difference may be attributed to the adjusted average age of the lake trout, which was slightly lower in 2002 (9 years) than in 2000-2001 (9.7 years), a non-statistical difference, however. On the other hand, the adjusted average mercury level in lake trout from the northern sector in 2000-2001 and 2002 is not significantly different from the 2001 level from the southern sector (0.68 mg/kg). Here again, the adjusted average ages of lake trout are similar for the years and sites, although it is possible that lake trout from the southern sector in 2001 (9.8 years) were a little older than those from the northern sector in 2002 (9 years) (see Table 3, Figure 7).

When compared to the level for lake trout caught in lakes aux Dorés and Waconichi, the adjusted average mercury level for lake trout caught in the northern sector of Lac Chibougamau in 2002 (0.59 mg/kg) is similar to that for the northern sector of Lac aux Dorés in 2000-2001 (0.61 mg/kg), but different from levels for the southern sector of Lac aux Dorés in 2001 (0.48 mg/kg) and Lac Waconichi in 2000-2001 (0.32 mg/kg). However in Lac aux Dorés, the adjusted average age of lake trout in the northern sector (10 years) is a little higher than in the southern sector (9 years), explaining a slightly higher mercury level in the northern sector.

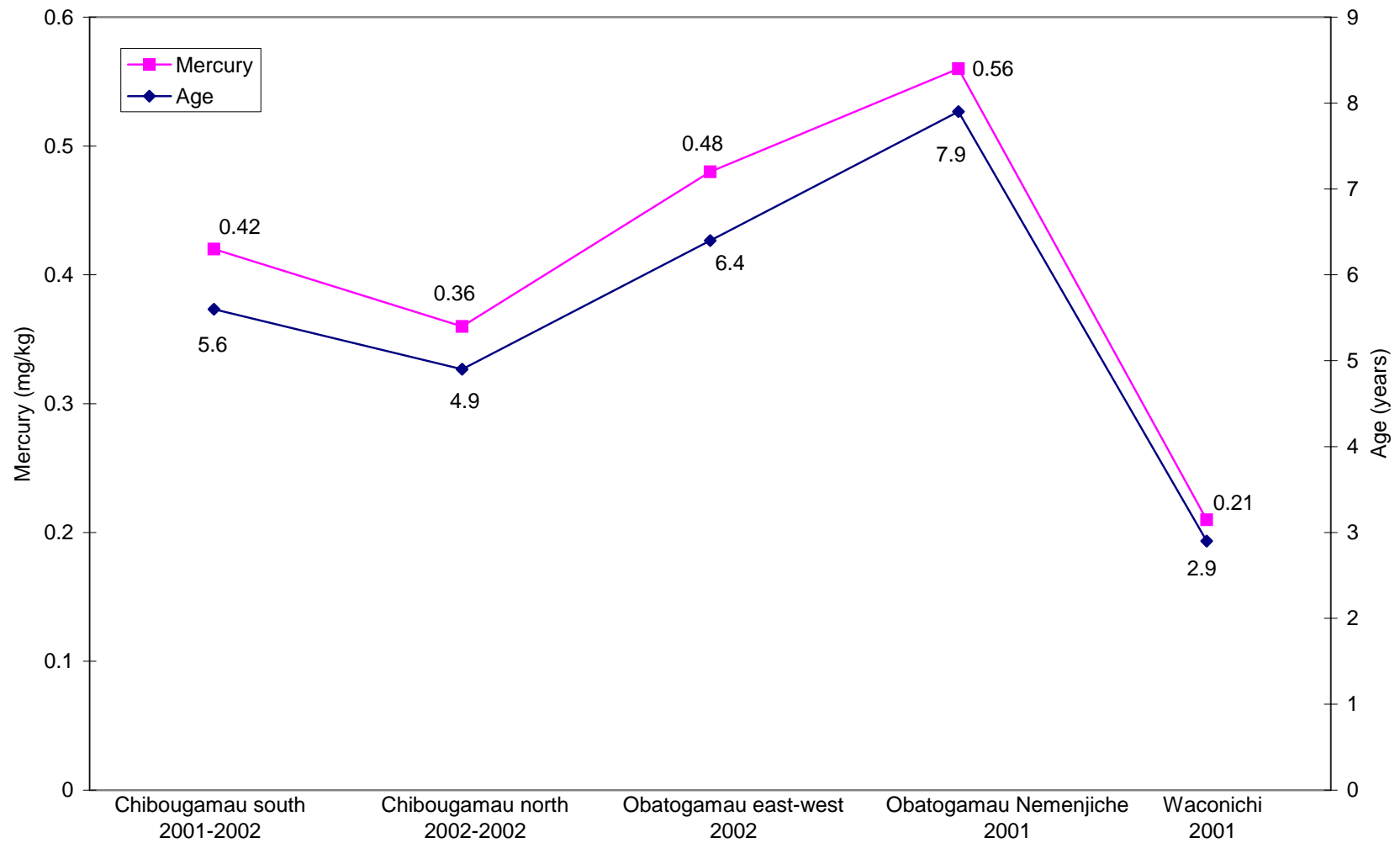


Figure 6 Adjusted average age and adjusted average mercury levels in walleye (300-600 mm) ( $\leq 17$  years) from lakes Chibougamau, Obatogamau and Waconichi – 2001-2002

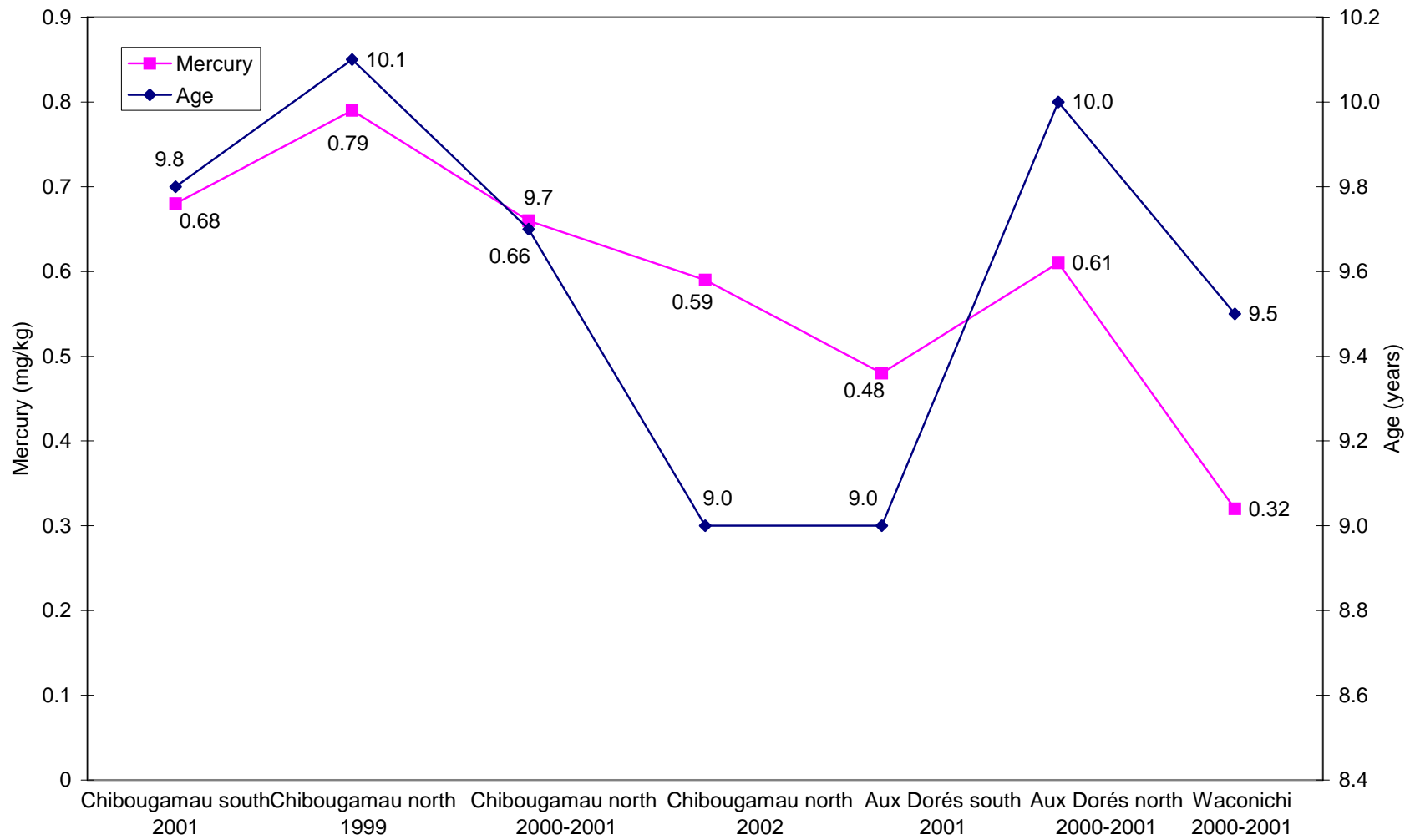


Figure 7 Adjusted average age and adjusted average mercury levels in lake trout (395-750 mm) ( $\leq 17$  years) from lakes Chibougamau, aux Dorés and Waconichi – 1999-2002



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Lake trout from Lac Waconichi have the lowest mercury levels (0.32 mg/kg), and their adjusted average age (9.5 years) is similar to those of lake trout from other lakes (9 to 10.1 years). The lower adjusted average mercury level for lake trout from Lac Waconichi can be attributed to factors other than growth rate since the adjusted average age is similar to those of lake trout caught on other sites in preceding years. One factor is that mercury levels in sediments from Lac Waconichi seem lower than those taken from lakes Chibougamau and aux Dorés. The physical conditions of the lakes are also different, which could influence the transfer of mercury into the food chain.

***Average arsenic, mercury and selenium levels according to classification sizes of fish species***

Among the three metals analysed, only mercury levels exceed Health Canada standards for the sale of fishery products (see Table 4). The standard for mercury is 0.5 mg/kg and is exceeded only in medium-sized and large lake trout and large northern pike caught in Lac Chibougamau, as well as in medium-sized and large northern pike and walleye from the Obatogamau lakes. The standard is also exceeded in large burbot from Lac Chibougamau as well as in medium-sized and large burbot from the Obatogamau lakes in the eastern sector and close to Rivière Nemenjiche. In the latter sector, the average mercury level in small burbot also exceeds the standard. On the other hand, as regards the Obatogamau lakes, mercury levels for burbot of all sizes caught in the western sector (Lac Fancamp) are below the standard, as is also the case for northern whitefish and white suckers of all sizes caught at all sites.

The average mercury levels in walleye and northern pike of all sizes and lake trout of small size are lower than ( $P < 0.05$ ) or similar to average levels measured for Québec as a whole (see Table 5) (Laliberté, 2004). Higher average levels appear only in medium-sized and large lake trout from the southern sectors of Lac Chibougamau and those of large sized from the northern sectors of this lake. The power of statistical analysis is reduced by the fact of the small number of results.

All mercury levels exceed the 0.033 mg/kg guidelines for the protection of fish-eating terrestrial wildlife. This guideline and the Health Canada standard are frequently exceeded in the natural environment of Québec. This is especially the case for fish-eating species such as walleye, northern pike and lake trout. Mercury levels exceeding 0.5 mg/kg have been observed in over 50% of medium-sized and large fish of these species (see Table 5). Atmospheric deposition of mercury and its biomagnification in the food chain (subsequent to its transformation into methylmercury by aquatic bacteria) are the main causes of the exceeding of these limits.

Arsenic levels in fish flesh are all very low, varying from  $<0.05$  mg/kg to 0.16 mg/kg; they are well below the Health Canada standard of 3.5 mg/kg relative to fish proteins (see Table 4).

Selenium levels in fish flesh range from 0.18 mg/kg to 0.61 mg/kg, without any apparent difference by sector. Levels are very similar for the same species from all sites where fish are caught. There is no standard for the sale of fishery products (see Table 4). In the whole lake minnow the selenium level is 1.42 mg/kg.

Table 4 Average concentrations of arsenic, mercury and selenium in the flesh of fish from lakes Chibougamau and Obatogamau in 2002 (Nemenjiche sector, 2001)

Species	Arsenic (mg/kg)					Mercury (mg/kg)					Selenium (mg/kg)				
	Lac Chibougamau		Obatogamau lakes			Lac Chibougamau		Obatogamau lakes			Lac Chibougamau		Obatogamau lakes		
	south	north	east	west	Nemenjiche	south	north	east	west	Nemenjiche	south	north	east	west	Nemenjiche
Northern pike - small - medium-sized - large			<0.05 (9)		<0.05 (4)			0.37 (9)	0.25 (9)	0.41 (9)			0.19 (9)		
		0.05 (2)		0.05 (4)	<0.05 (4)		0.43 (1)	<b>0.65 (9)</b>	<b>0.67 (9)</b>	<b>0.65 (9)</b>		0.33 (2)		0.34 (4)	0.41 (4)
Walleye - small - medium-sized - large						0.30 (9)	0.29 (9)	0.35 (9)	0.36 (9)	0.38 (8)					
						0.38 (9)	0.32 (9)	<b>0.52 (9)</b>	0.43 (9)	<b>0.56 (7)</b>					
	0.05 (9)	<0.05 (9)	<0.05 (9)	<0.05 (9)	0.05 (9)	<b>0.65 (9)</b>	0.50 (9)	<b>1.04 (9)</b>	<b>0.90 (9)</b>	<b>0.98 (9)</b>	0.32 (9)	0.36 (9)	0.36 (9)	0.37 (9)	0.42 (9)
Trout - small - medium-sized - large		0.05 (6)					0.30 (6)					0.34 (6)			
	0.07 (2)	0.07 (10)				<b>1.55 (2)</b>	<b>0.75 (25)</b>				0.36 (2)	0.36 (10)			
	0.15 (2)	0.11 (9)				<b>2.65 (2)</b>	<b>1.62 (17)</b>				0.58 (2)	0.52 (9)			
Lake cisco - small - medium-sized - large	0.08 (4)	0.15 (9)				0.17 (4)	0.27 (9)				0.33 (4)	0.34 (9)			
	<0.05 (6)	0.09 (9)				0.13 (6)	0.21 (9)				0.47 (6)	0.41 (9)			
	0.11 (9)	0.10 (9)				0.14 (9)	0.22 (9)				0.43 (9)	0.39 (9)			
Northern whitefish - small - medium-sized - large		<0.05 (6)					0.19 (6)	0.06 (5)	0.04 (4)	0.07 (6)		0.41 (6)			
		0.06 (6)				0.12 (2)	0.23 (6)	0.08 (5)	0.07 (5)	0.11 (9)		0.46 (6)			
		0.17 (8)	0.07 (5)	0.06 (5)	<0.05 (7)		0.27 (8)	0.16 (5)	0.11 (5)	0.22 (7)		0.49 (8)	0.61 (5)	0.61 (5)	0.54 (7)
Burbot - small - medium-sized - large	0.08 (9)	0.09 (9)				0.43 (9)	0.40 (9)	0.36 (5)	0.19 (2)	<b>0.57 (4)</b>	0.29 (9)	0.29 (9)			
	0.08 (9)	0.07 (9)	0.05 (5)			0.44 (9)	0.41 (9)	<b>0.57 (5)</b>	0.37 (5)	<b>0.57 (8)</b>	0.27 (9)	0.23 (9)	0.27 (5)		
	0.07 (7)	0.07 (9)	<0.05 (3)	<0.05 (5)	0.05 (5)	<b>0.54 (7)</b>	<b>0.53 (9)</b>	<b>0.61 (3)</b>	0.42 (5)	<b>0.65 (5)</b>	0.35 (7)	0.28 (9)	0.18 (3)	0.25 (5)	0.29 (5)
Common sucker - foraging - small - medium-sized - large		0.10 (52)					0.10 (52)					0.36 (52)			
								0.08 (2)	0.05 (5)						
			0.05 (5)	0.05 (6)				0.12 (5)	0.07 (6)				0.44 (5)	0.42 (6)	
			<0.05 (5)	<0.05 (5)				0.16 (5)	0.16 (5)				0.43 (5)	0.44 (5)	
Northern sucker - small - medium-sized - large	0.09 (9)	0.12 (9)				0.14 (9)	0.12 (9)				0.4 (9)	0.29 (9)			
	0.15 (9)	0.15 (9)				0.24 (9)	0.22 (9)				0.52 (9)	0.39 (9)			
	0.16 (9)	0.14 (9)				0.37 (9)	0.29 (9)				0.53 (9)	0.40 (9)			
Lake minnow - foraging*		0.06 (377)					0.11 (377)					1.42 (377)			

\* Whole fish

Table 5 Average provincial mercury concentrations in fish according to species size classifications

Species	Provincial mercury average			Size classification		
	Small (mg/kg)	Medium-sized (mg/kg)	Large (mg/kg)	Small (cm)	Medium-sized (cm)	Large (cm)
Lake cisco	0.21	0.17	0.22	20-25	25-30	>30
Walleye	0.50	<b>0.75</b>	<b>1.21</b>	30-40	40-50	>50
Northern pike	0.40	<b>0.64</b>	<b>1.08</b>	40-55	55-70	>70
Northern whitefish	0.18	0.20	0.28	35-40	40-45	>45
Burbot	0.38	<b>0.54</b>	<b>0.81</b>	30-45	45-60	>60
White sucker	0.17	0.22	0.32	30-35	35-40	>40
Northern sucker	0.17	0.22	0.32	30-35	35-40	>40
Lake trout	0.48	<b>0.75</b>	<b>1.24</b>	45-55	55-70	>70

## CONCLUSION

The results show that in Lac aux Dorés, high copper levels in sediments extend more than 3.5 km downstream from mining activities and are likely to cause toxicity in aquatic organisms.

In Lac Chibougamau, high arsenic, copper and nickel levels were measured east of Pointe-au-Bouleau, near mining activities. High natural levels of chromium and nickel were also measured in McKenzie Bay, located far from mining activities. These levels are likely to cause toxicity in aquatic organisms.

Sediments from Lac Waconichi (control lake) show very low metal levels, in particular copper, pointing both to the absence of mining activity and of significant mineralization on this lake.

In the Obatogamau lakes, a mining site may have contributed to the increase in metal concentrations in sediments (copper, arsenic and mercury). More sediment sampling will be required in order to pinpoint the extent and origin of these metals given the proximity of Grenvillian faults.

Metal concentrations are high enough to cause toxicity in aquatic organisms. High mercury levels in sediments may have caused an increase in mercury concentrations of between 22% and 100% depending on the fish species. However, part of this increase may be attributed to the presence of older fish, particularly walleye in the Rivière Nemenjiche sector, as compared to the western sector (Lac Fancamp) of the Obatogamau lakes. In spite of the differences observed, the mercury contamination measured is not unusual and is comparable to levels in a number of Québec sites. As such, the average mercury levels for all species caught in the Obatogamau lakes remain below or similar to the average levels measured across Québec. This situation is nevertheless not ideal since Québec's waterways are subject to airborne pollution, and levels frequently exceed the Health Canada standard (0.5 mg/kg).

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Mercury levels in the flesh of several fish species exceed the Health Canada standard of 0.5 mg/kg for the sale of fishery products. The highest levels are observed in lake trout from Lac Chibougamau.

Analyses for a number of metals, PCBs, dioxines and furans have yet to be carried out on fish flesh and livers.

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Appendix 1 Location of fishing stations on Lac Chibougamau and the Obatogamau lakes in 2002

Lac Chibougamau				Lac Obatogamau			
FAPAQ station	NAD 27 coordinates			FAPAQ station	NAD 27 coordinates		
	East	Zone	North		East	Zone	North
CEN1	556787	18	5530459	OF10	548285	18	5492079
CEN10	559688	18	5529783	OF12	546484	18	5488088
CEN11	560074	18	5529857	OF14	548293	18	5492285
CEN11E	560054	18	5529916	OF142	530839	18	5493490
CEN12	559657	18	5529334	OF143	531081	18	5491096
CEN12A	559782	18	5529357	OF148	530829	18	5493485
CEN12C	559622	18	5529385	OF15	546729	18	5487973
CEN12D	559745	18	5529381	OF154	530954	18	5493413
CEN12E	559745	18	5529381	OF6	546924	18	5492522
CEN12F	559784	18	5529401	OF7	548379	18	5492157
CEN12J	559804	18	5529340	OF8	548434	18	5492244
CEN12K	559818	18	5529380	OF9	546764	18	5492478
CEN13	559942	18	5529406	OF1	546801	18	5492492
CEN13A	559936	18	5529439	OF107	531394	18	5492511
CEN13B	559946	18	5529410	OF108	531449	18	5492547
CEN13C	559960	18	5529453	OF109	531645	18	5492791
CEN13E	560122	18	5529235	OF111	531538	18	5491617
CEN19	557109	18	5527158	OF112	531616	18	5491613
CEN1A	556828	18	5530416	OF113	531593	18	5491644
CEN1B	556786	18	5530373	OF114	531597	18	5491645
CEN2	557074	18	5530370	OF115	531111	18	5491148
CEN21	558215	18	5527242	OF117	531464	18	5492534
CEN21A	558071	18	5527299	OF118	531893	18	5492913
CEN24D	554009	18	5526704	OF120	531598	18	5491523
CEN25	554118	18	5526700	OF121	531140	18	5490884
CEN25A	554248	18	5526670	OF123	531499	18	5492414
CEN25B	554292	18	5526616	OF127	531513	18	5491551
CEN25E	554149	18	5526709	OF129	531390	18	5492412
CEN26	554598	18	5526653	OF158	531046	18	5492673
CEN26A	554633	18	5526661	OF160	530931	18	5493413
CEN28	557135	18	5527067	OF17	546327	18	5488648
CEN33	554676	18	5526200	OF18	547326	18	5489541
CEN42	554729	18	5525959	OF19	549148	18	5492497
CEN42A	554642	18	5525964	OF2	546891	18	5492515
CEN57	557638	18	5525260	OF20	547824	18	5489993
CEN65	557106	18	5524763	OF21	547804	18	5489996
CEN65C	557264	18	5524895	OF22	547736	18	5490021
CEN66	557532	18	5524776	OF27	547759	18	5490128
CEN8	560043	18	5530329	OF28	547990	18	5492726
CEN8B	560093	18	5530289	OF3	548386	18	5492110
CEN8C	559797	18	5530367	OF4	548391	18	5492188
CEN9	559191	18	5529950	OF27	547758	18	5490129
CEN9A	559166	18	5529957	OF29	548036	18	5490264
CEN9B	559162	18	5529956	OF30	548197	18	5490234
CEN9C	559188	18	5529975	OF31	547668	18	5490304
CEN9D	559223	18	5530003	OF34	547465	18	5490295
CEN9E	559142	18	5530020	OF36	547227	18	5489553
CEN9G	559187	18	5530024				
CEN9K	559272	18	5529993				
CR1	561342	18	5529749				
CR13	557545	18	5527778				
CR14	557364	18	5527718				
CR16	558021	18	5528323				
CR2	561221	18	5529334				
CR3	556748	18	5527285				
CR8	553911	18	5526943				
CES180	551229	18	5520812				
CES184	551471	18	5520214				
CES189	551419	18	5519817				
CES189A	551472	18	5519737				
CES189B	551469	18	5519649				
CES189C	551469	18	5519649				
CES196	551413	18	5519298				
CES196A	551398	18	5519206				
CES226	555573	18	5515174				





Appendix 2 Mercury concentrations in relation to the length of fish from Lac Chibougamau and the Obatogamau lakes

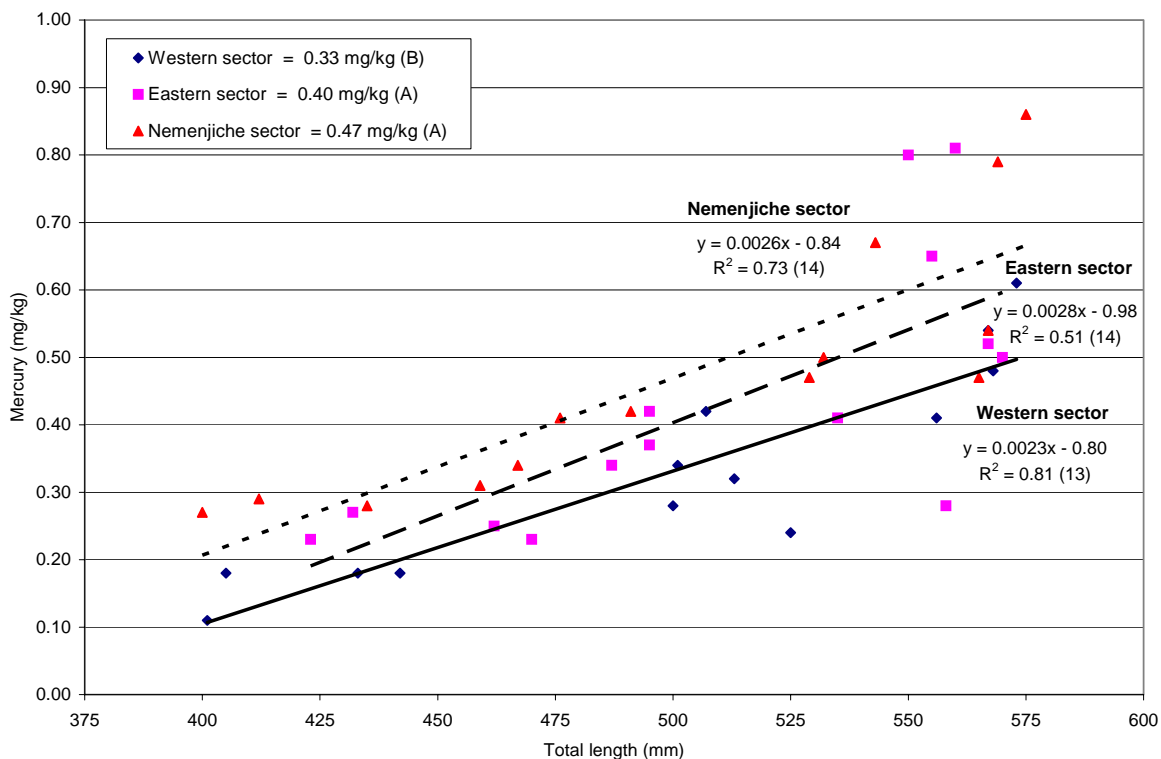


Figure 1 Mercury concentrations in relation to the length of northern pike (400 – 575 mm) in the Obatogamau lakes in 2001-2002

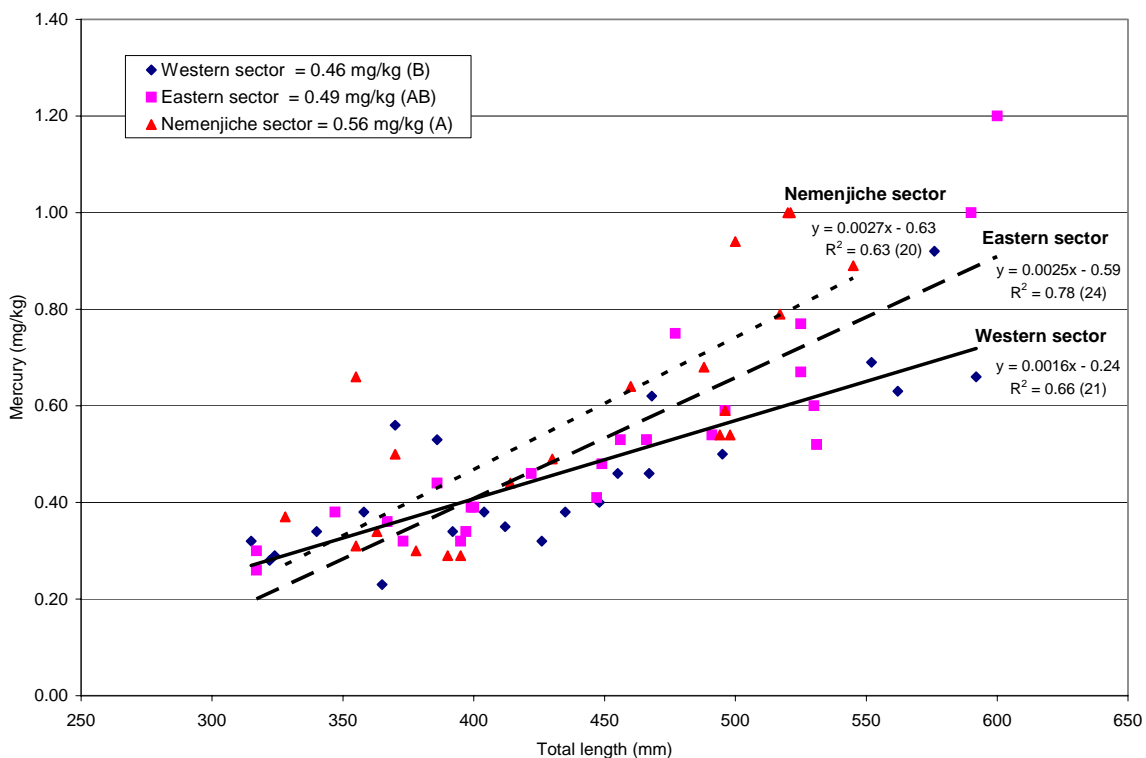


Figure 2 Mercury concentrations in relation to the length of walleye (300 – 600 mm and  $\leq 17$  years of age) in the Obatogamau lakes in 2001-2002

Appendix 2 Mercury concentrations in relation to the length of fish from Lac Chibougamau and the Obatogamau lakes (continued)

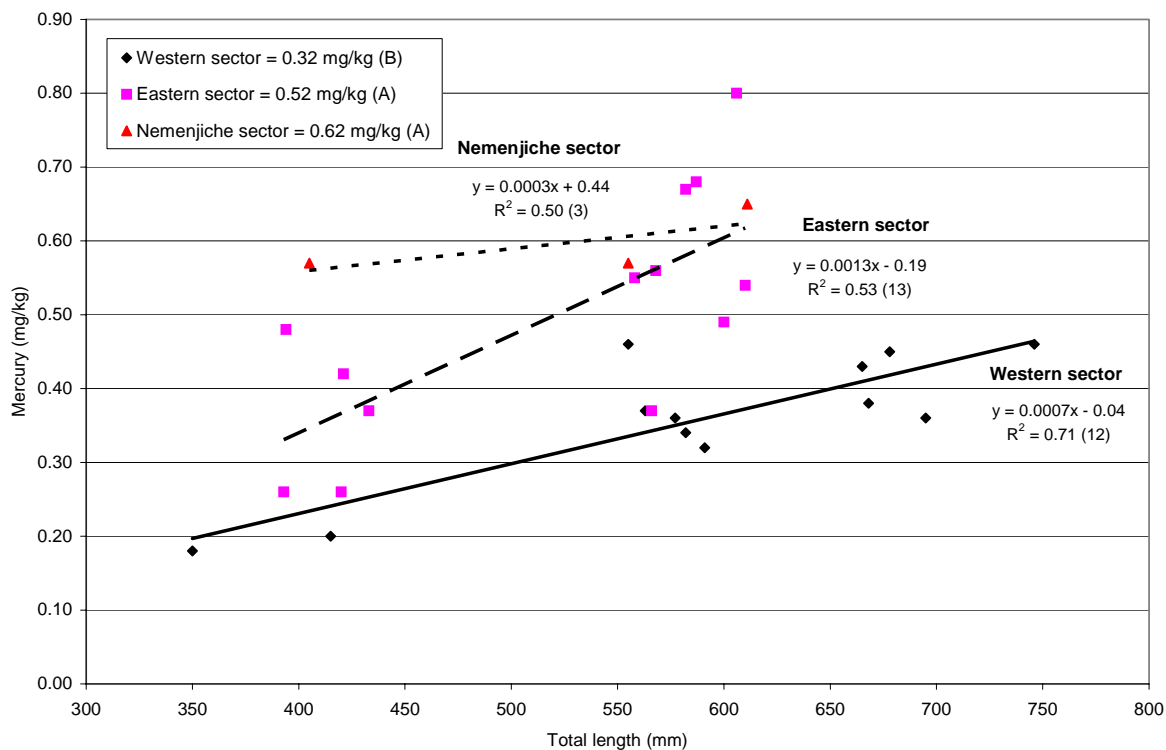


Figure 3 Mercury concentrations in relation to the length of burbot (350 – 750 mm) in the Obatogamau lakes in 2001-2002

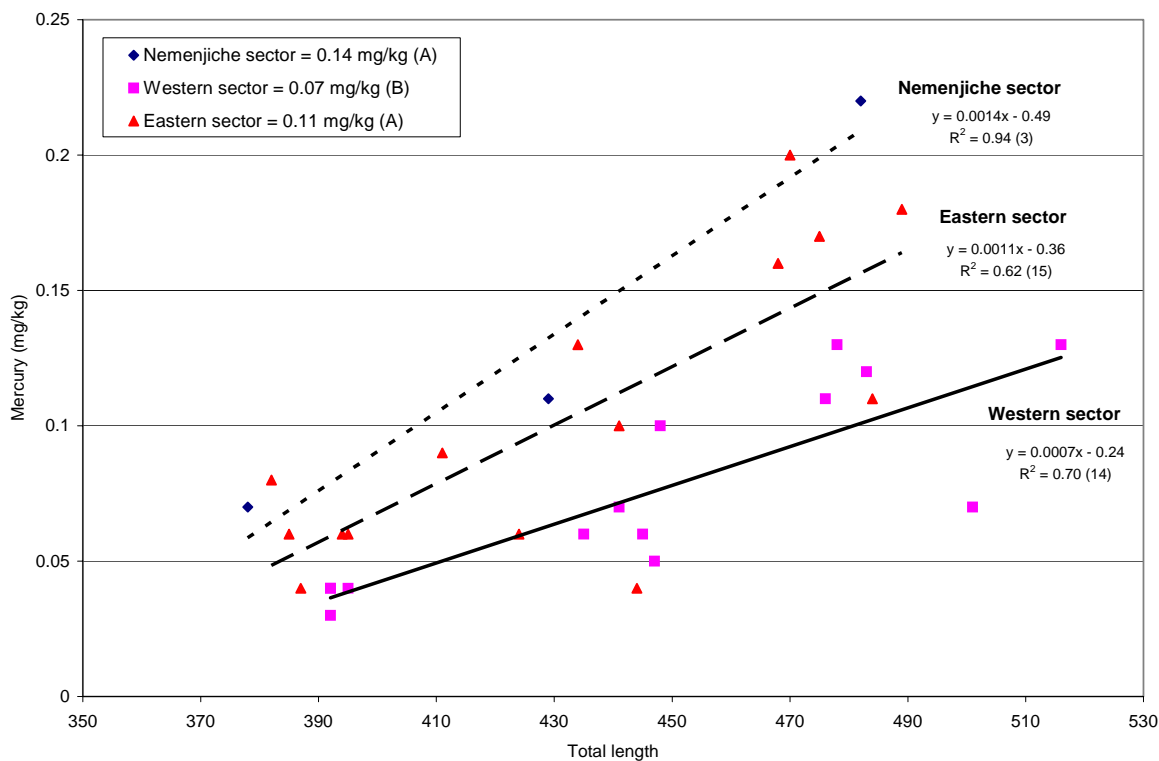


Figure 4 Mercury concentrations in relation to the length of lake whitefish (370 – 520 mm) in the Obatogamau lakes in 2001-2002

Appendix 2 Mercury concentrations in relation to the length of fish from Lac Chibougamau and the Obatogamau lakes (continued)

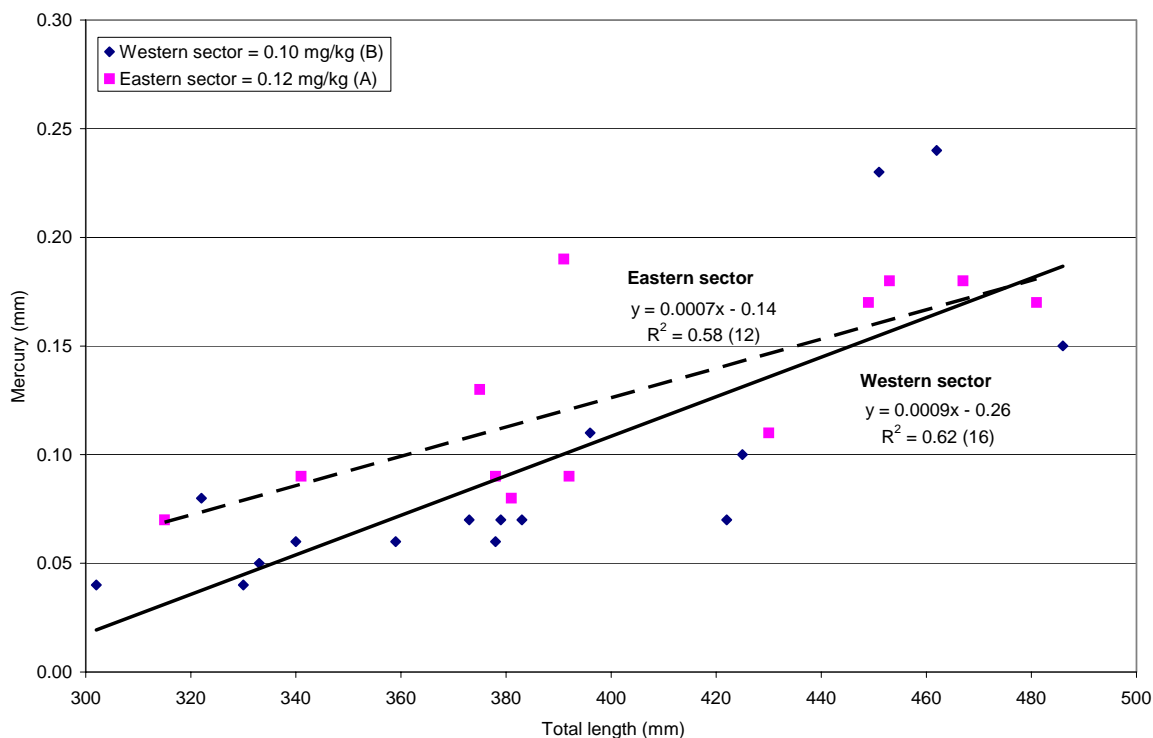


Figure 5 Mercury concentrations in relation to the length of white suckers in the Obatogamau lakes in 2002

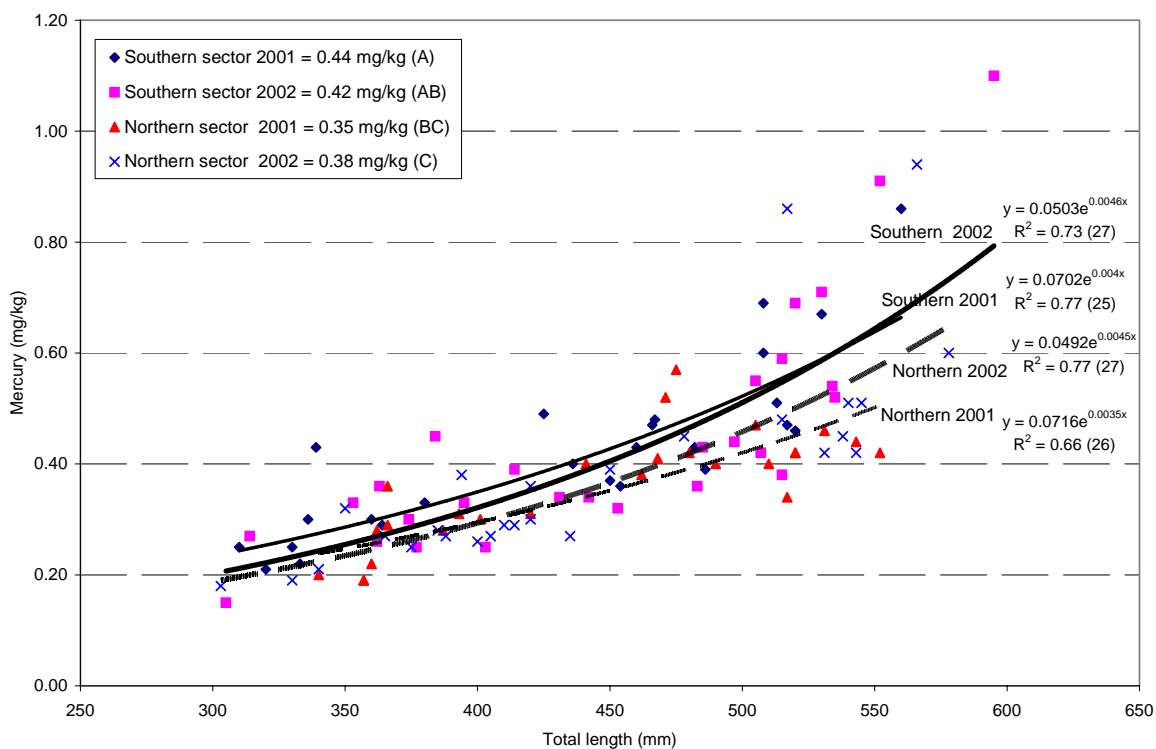


Figure 6 Mercury concentrations in relation to the length (300 – 600 mm and ≤17 years of age) of walleye in Lac Chibougamau in 2001-2002

Appendix 2 Mercury concentrations in relation to the length of fish from Lac Chibougamau and the Obatogamau lakes (continued)

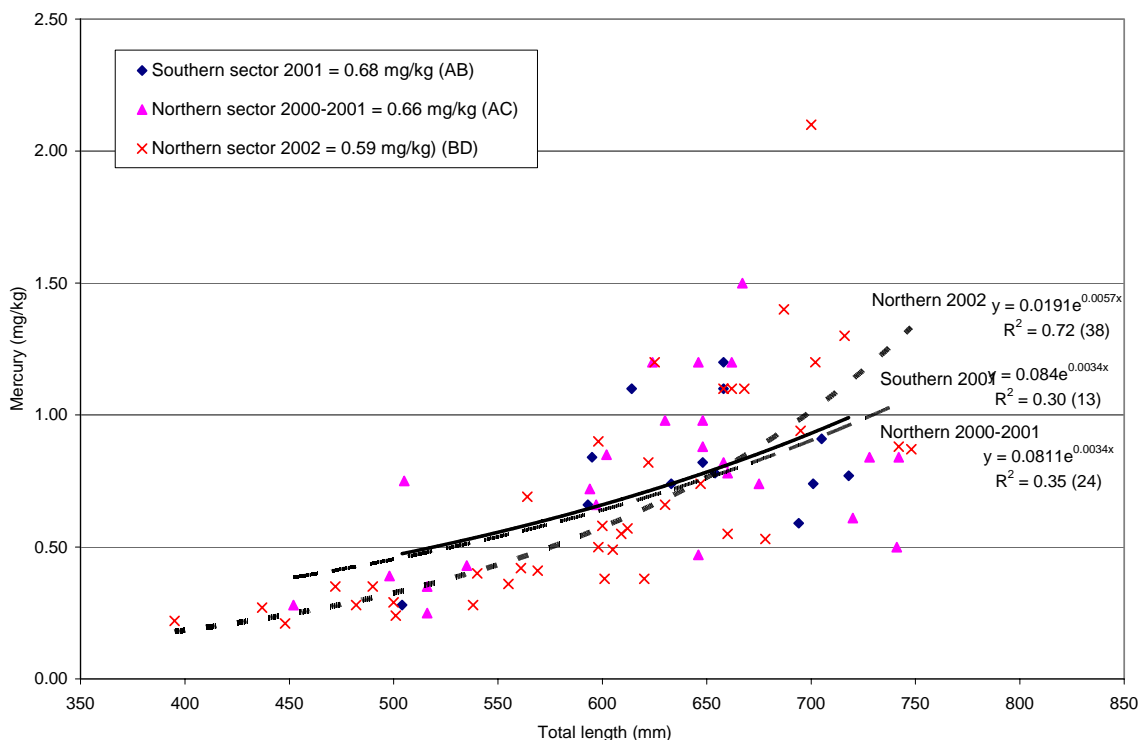


Figure 7 Mercury concentrations in relation to the length of lake trout (395 - 750 mm and ≤17 years of age) in Lac Chibougamau in 2000, 2001 and 2002

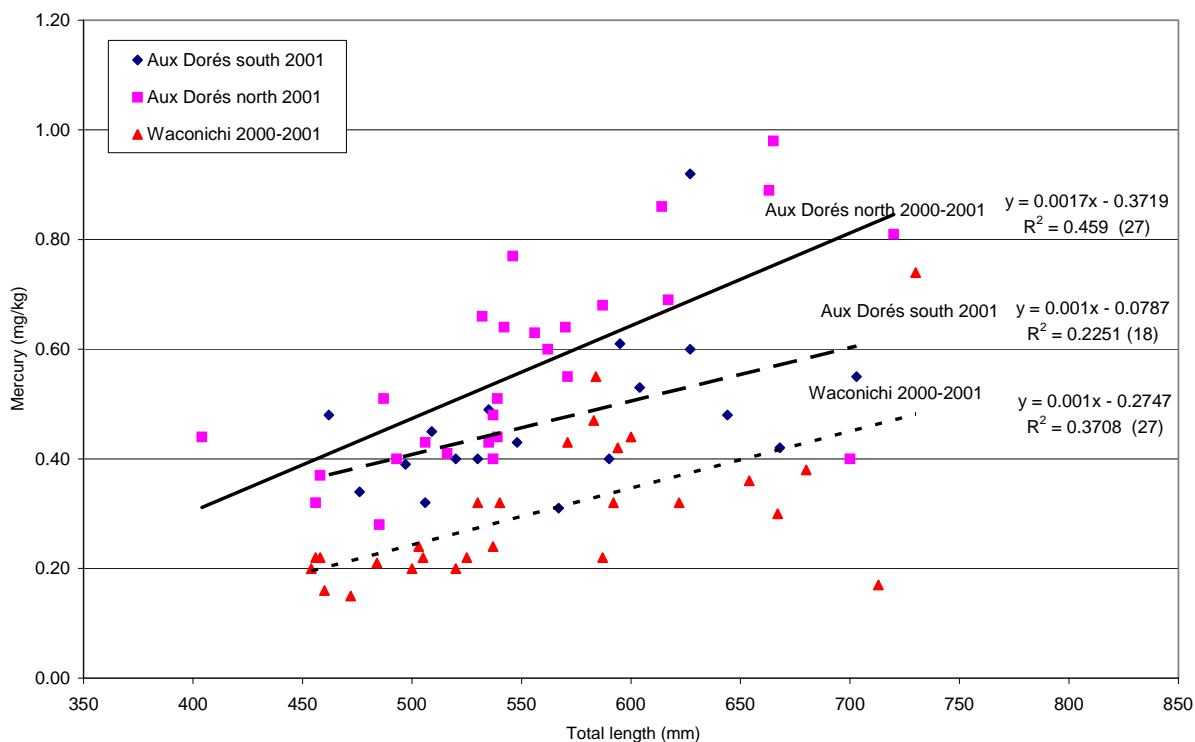


Figure 8 Mercury concentrations in relation to the length of lake trout (395 - 750 mm and ≤17 years of age) in Lac aux Dorés and Lac Waconichi in 2000-2001

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2000	90369	aux Dorés, near mines (northern)	lake trout	US	6	404	501	M	0.44
2000	90370	aux Dorés, near mines (northern)	lake trout	S	7	485	896	M	0.28
2000	90368	aux Dorés, near mines (northern)	lake trout	S	8	506	994	F	0.43
2000	90375	aux Dorés, near mines (northern)	lake trout	S	11	532	1340	M	0.66
2000	90376	aux Dorés, near mines (northern)	lake trout	S	9	535	1212	M	0.43
2000	90371	aux Dorés, near mines (northern)	lake trout	S	7	537	1344	M	0.40
2000	90367	aux Dorés, near mines (northern)	lake trout	S	9	546	1485	F	0.77
2000	90372	aux Dorés, near mines (northern)	lake trout	M	12	562	1681	M	0.60
2000	90373	aux Dorés, near mines (northern)	lake trout	M	18	603	1986	M	0.80
2000	90377	aux Dorés, near mines (northern)	lake trout	M	13	617	2191	M	0.69
2000	90374	aux Dorés, near mines (northern)	lake trout	M	22	651	2970	M	0.96
2000	90379	aux Dorés, near mines (northern)	lake trout	L	14	700	3672	M	0.40
2000	90378	aux Dorés, near mines (northern)	lake trout	L	22	780	6200	F	1.40
2001	54177	aux Dorés, near mines (northern)	pike	S	2	410	414	M	0.08
2001	54181	aux Dorés, near mines (northern)	pike	M	3	592	1440	F	0.11
2001	54179	aux Dorés, near mines (northern)	pike	M	4	608	1488	F	0.25
2001	54182	aux Dorés, near mines (northern)	pike	M	4	618	1495	F	0.33
2001	54186	aux Dorés, near mines (northern)	pike	M	4	650	1719	M	0.30
2001	54183	aux Dorés, near mines (northern)	pike	M	5	657	2000	M	0.56
2001	54180	aux Dorés, near mines (northern)	pike	M	5	660	1542	F	0.52
2001	54185	aux Dorés, near mines (northern)	pike	M	5	662	1399	M	0.66
2001	54178	aux Dorés, near mines (northern)	pike	M	4	676	1806	F	0.19
2001	54184	aux Dorés, near mines (northern)	pike	M	5	695	2000	M	0.31
2001	54187	aux Dorés, near mines (northern)	pike	L	6	716	2234	F	0.55
2001	54188	aux Dorés, near mines (northern)	pike	L	4	742	2893	F	0.54
2001	54141	aux Dorés, near mines (northern)	walleye	S	3	318	250	F	0.19
2001	54145	aux Dorés, near mines (northern)	walleye	S	2	318	298	F	0.20
2001	54143	aux Dorés, near mines (northern)	walleye	S	3	322	326		0.34
2001	54140	aux Dorés, near mines (northern)	walleye	S		324	297	M	0.23
2001	54142	aux Dorés, near mines (northern)	walleye	S	3	347	341	M	0.33
2001	54144	aux Dorés, near mines (northern)	walleye	S	3	356	417	F	0.29
2001	54146	aux Dorés, near mines (northern)	walleye	S	4	386	568	F	0.37
2001	54148	aux Dorés, near mines (northern)	walleye	S		393	619	F	0.32
2001	54147	aux Dorés, near mines (northern)	walleye	S		394	594	M	0.31
2001	54155	aux Dorés, near mines (northern)	walleye	M	5	408	599	F	0.23
2001	54156	aux Dorés, near mines (northern)	walleye	M	6	433	742	F	0.22
2001	54154	aux Dorés, near mines (northern)	walleye	M	4	457	797	F	0.33
2001	54149	aux Dorés, near mines (northern)	walleye	M		460	855	F	0.44
2001	54151	aux Dorés, near mines (northern)	walleye	M	6	462	984	M	0.45
2001	54153	aux Dorés, near mines (northern)	walleye	M	6	475	1007	M	0.53
2001	54150	aux Dorés, near mines (northern)	walleye	M	4	479	1092	F	0.42
2001	54152	aux Dorés, near mines (northern)	walleye	M	5	485	1117	F	0.41
2001	54157	aux Dorés, near mines (northern)	walleye	M	7	497	1458	M	0.33
2001	54163	aux Dorés, near mines (northern)	walleye	L	6	502	1240	F	0.37
2001	54169	aux Dorés, near mines (northern)	walleye	L	6	508	1323	F	0.31
2001	54175	aux Dorés, near mines (northern)	walleye	L	6	510	1650	F	0.43
2001	54165	aux Dorés, near mines (northern)	walleye	L	6	512	1450	M	0.35
2001	54171	aux Dorés, near mines (northern)	walleye	L	5	513	1362	F	0.23
2001	54170	aux Dorés, near mines (northern)	walleye	L	6	521	1491	F	0.31
2001	54166	aux Dorés, near mines (northern)	walleye	L	6	526	1500	F	0.29
2001	54172	aux Dorés, near mines (northern)	walleye	L	6	531	1516	F	0.29
2001	54161	aux Dorés, near mines (northern)	walleye	L	6	550	1595	F	0.42
2001	54162	aux Dorés, near mines (northern)	walleye	L	7	550	1694	F	0.36
2001	54168	aux Dorés, near mines (northern)	walleye	L	6	551	1847	F	0.47
2001	54174	aux Dorés, near mines (northern)	walleye	L	6	554	1880	F	0.49
2001	54160	aux Dorés, near mines (northern)	walleye	L	6	555	1788	F	0.39

US: under size      S: small      M: medium      L: large

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2001	54173	aux Dorés, near mines (northern)	walleye	L	6	556	2069	F	0.38
2001	54159	aux Dorés, near mines (northern)	walleye	L	6	582	2035	F	0.38
2001	54158	aux Dorés, near mines (northern)	walleye	L	8	584	1963	F	0.44
2001	54408	aux Dorés, near mines (northern)	lake trout	S	5	456	815	F	0.32
2001	54403	aux Dorés, near mines (northern)	lake trout	S	9	458	731	F	0.37
2001	54410	aux Dorés, near mines (northern)	lake trout	S	8	487	806	M	0.51
2001	54409	aux Dorés, near mines (northern)	lake trout	S	9	493	1019	F	0.40
2001	54404	aux Dorés, near mines (northern)	lake trout	S	6	516	1427	F	0.41
2001	54405	aux Dorés, near mines (northern)	lake trout	S	10	537	1258	M	0.48
2001	54406	aux Dorés, near mines (northern)	lake trout	S	10	539	1284	F	0.51
2001	54407	aux Dorés, near mines (northern)	lake trout	S	9	539	1359	F	0.44
2001	54402	aux Dorés, near mines (northern)	lake trout	S	11	542	1317	M	0.64
2001	54416	aux Dorés, near mines (northern)	lake trout	M	9	556	1530	M	0.63
2001	54413	aux Dorés, near mines (northern)	lake trout	M	10	570	1740	F	0.64
2001	54415	aux Dorés, near mines (northern)	lake trout	M	8	571	1551	M	0.55
2001	54418	aux Dorés, near mines (northern)	lake trout	M	10	587	1972	F	0.68
2001	54417	aux Dorés, near mines (northern)	lake trout	M	11	614	2209	M	0.86
2001	54411	aux Dorés, near mines (northern)	lake trout	M		663	2540	M	0.89
2001	54414	aux Dorés, near mines (northern)	lake trout	M	11	665	3424	F	0.98
2001	54423	aux Dorés, near mines (northern)	lake trout	L	13	720	3214	F	0.81
2001	54421	aux Dorés, near mines (northern)	lake trout	L	22	723	4235	M	1.30
2001	54425	aux Dorés, near mines (northern)	lake trout	L	19	740	4377	F	0.92
2001	54424	aux Dorés, near mines (northern)	lake trout	L	17	784	4719	M	0.68
2001	54420	aux Dorés, near mines (northern)	lake trout	L		900	10682	M	1.70
2001	54422	aux Dorés, near mines (northern)	lake trout	L	21	959	9300	M	1.70
2001	54606	aux Dorés, far from mines (southern)	pike	S	2	422	422	M	0.05
2001	54613	aux Dorés, far from mines (southern)	pike	M	3	569	1065	F	0.19
2001	54611	aux Dorés, far from mines (southern)	pike	M	2	590	1384	F	0.13
2001	54607	aux Dorés, far from mines (southern)	pike	M	6	645	1595	M	0.59
2001	54610	aux Dorés, far from mines (southern)	pike	M	4	651	1827	M	0.18
2001	54612	aux Dorés, far from mines (southern)	pike	M	5	658	1733	F	0.20
2001	54608	aux Dorés, far from mines (southern)	pike	M	4	659	1790	M	0.20
2001	54609	aux Dorés, far from mines (southern)	pike	M	5	675	1998	F	0.21
2001	54619	aux Dorés, far from mines (southern)	pike	L	5	719	2287	M	0.25
2001	54616	aux Dorés, far from mines (southern)	pike	L	4	720	2209	F	0.21
2001	54617	aux Dorés, far from mines (southern)	pike	L	6	723	2453	F	0.26
2001	54620	aux Dorés, far from mines (southern)	pike	L	9	757	2286	M	0.5
2001	54622	aux Dorés, far from mines (southern)	pike	L	6	763	2923	M	0.43
2001	54499	aux Dorés, far from mines (southern)	walleye	S	3	334	327	M	0.24
2001	54495	aux Dorés, far from mines (southern)	walleye	S	4	358	433	F	0.20
2001	54494	aux Dorés, far from mines (southern)	walleye	S	4	365	431	F	0.26
2001	54492	aux Dorés, far from mines (southern)	walleye	S	4	366	456	F	0.26
2001	54498	aux Dorés, far from mines (southern)	walleye	S	4	370	518	F	0.19
2001	54496	aux Dorés, far from mines (southern)	walleye	S	4	380	505	M	0.20
2001	54497	aux Dorés, far from mines (southern)	walleye	S	4	385	517	F	0.21
2001	54491	aux Dorés, far from mines (southern)	walleye	S	4	386	511	M	0.27
2001	54493	aux Dorés, far from mines (southern)	walleye	S	4	394	592	F	0.21
2001	54505	aux Dorés, far from mines (southern)	walleye	M	5	412	607	F	0.28
2001	54504	aux Dorés, far from mines (southern)	walleye	M	5	424	772	M	0.27
2001	54507	aux Dorés, far from mines (southern)	walleye	M	5	430	746	M	0.27
2001	54508	aux Dorés, far from mines (southern)	walleye	M	6	432	771	M	0.29
2001	54501	aux Dorés, far from mines (southern)	walleye	M	5	453	999	M	0.28
2001	54503	aux Dorés, far from mines (southern)	walleye	M	5	455	1023	F	0.17
2001	54500	aux Dorés, far from mines (southern)	walleye	M	5	460	1000	M	0.31
2001	54506	aux Dorés, far from mines (southern)	walleye	M	5	461	1038	M	0.29
2001	54502	aux Dorés, far from mines (southern)	walleye	M	6	487	2012	F	0.20

US: under size      S: small      M: medium      L: large

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2001	54522	aux Dorés, far from mines (southern)	walleye	L	6	507	1255	M	0.31
2001	54523	aux Dorés, far from mines (southern)	walleye	L	6	512	1356	M	0.27
2001	54511	aux Dorés, far from mines (southern)	walleye	L	7	518	1674	F	0.39
2001	54509	aux Dorés, far from mines (southern)	walleye	L	5	539		F	0.36
2001	54514	aux Dorés, far from mines (southern)	walleye	L	6	543	1829	F	0.30
2001	54513	aux Dorés, far from mines (southern)	walleye	L	6	544	1605	F	0.25
2001	54512	aux Dorés, far from mines (southern)	walleye	L	7	566	1976	F	0.49
2001	54520	aux Dorés, far from mines (southern)	walleye	L	8	578	2278	M	0.51
2001	54515	aux Dorés, far from mines (southern)	walleye	L	7	579	2233	F	0.31
2001	54517	aux Dorés, far from mines (southern)	walleye	L	8	603	2482	F	0.46
2001	54516	aux Dorés, far from mines (southern)	walleye	L	9	615	2696	F	0.42
2001	54510	aux Dorés, far from mines (southern)	walleye	L		732	4500	F	0.83
2001	54519	aux Dorés, far from mines (southern)	walleye	L	23	735	4756	F	0.98
2001	54521	aux Dorés, far from mines (southern)	walleye	L	20	736	4197	F	0.93
2001	54582	aux Dorés, far from mines (southern)	lake trout	S	5	462	780	F	0.48
2001	54586	aux Dorés, far from mines (southern)	lake trout	S	5	476	872	F	0.34
2001	54587	aux Dorés, far from mines (southern)	lake trout	S	6	497	956	M	0.39
2001	54589	aux Dorés, far from mines (southern)	lake trout	S	6	506	1137	F	0.32
2001	54590	aux Dorés, far from mines (southern)	lake trout	S	6	509	1180	F	0.45
2001	54584	aux Dorés, far from mines (southern)	lake trout	S	7	520	1100	F	0.40
2001	54583	aux Dorés, far from mines (southern)	lake trout	S	7	530	1251	M	0.40
2001	54588	aux Dorés, far from mines (southern)	lake trout	S	9	535	1196	F	0.49
2001	54585	aux Dorés, far from mines (southern)	lake trout	S	8	548	1417	F	0.43
2001	54594	aux Dorés, far from mines (southern)	lake trout	M	8	567	1482	M	0.31
2001	54598	aux Dorés, far from mines (southern)	lake trout	M	8	590	1833	F	0.40
2001	54593	aux Dorés, far from mines (southern)	lake trout	M		595	1691	M	0.61
2001	54597	aux Dorés, far from mines (southern)	lake trout	M	8	604	1993	F	0.53
2001	54595	aux Dorés, far from mines (southern)	lake trout	M	11	627	2375	M	0.60
2001	54596	aux Dorés, far from mines (southern)	lake trout	M	14	627	2282	M	0.92
2001	54592	aux Dorés, far from mines (southern)	lake trout	M	9	644	2269	M	0.48
2001	54591	aux Dorés, far from mines (southern)	lake trout	M	17	668	2362	M	0.42
2001	54604	aux Dorés, far from mines (southern)	lake trout	L	19	700	3072	M	0.64
2001	54601	aux Dorés, far from mines (southern)	lake trout	L	16	703	3249	M	0.55
2001	54603	aux Dorés, far from mines (southern)	lake trout	L	21	714	2725	M	0.43
2001	54599	aux Dorés, far from mines (southern)	lake trout	L		832	5500	F	0.63
2001	54600	aux Dorés, far from mines (southern)	lake trout	L		840	4060	M	1.50
2001	54602	aux Dorés, far from mines (southern)	lake trout	L	20	915	8000	M	0.72
1998	44489	Chibougamau, far from mines (southern)	pike	S	1	414	357	M	0.21
1998	44491	Chibougamau, far from mines (southern)	pike	S	2	430	502	M	0.22
1998	44488	Chibougamau, far from mines (southern)	pike	S	2	450	548	F	0.14
1998	44490	Chibougamau, far from mines (southern)	pike	S	2	500	732	M	0.29
1998	44487	Chibougamau, far from mines (southern)	pike	S	3	517	733	F	0.48
1998	44495	Chibougamau, far from mines (southern)	pike	M	3	589	1388	M	0.33
1998	44493	Chibougamau, far from mines (southern)	pike	M	4	596	1368	M	0.43
1998	44492	Chibougamau, far from mines (southern)	pike	M	4	605	1214	M	0.54
1998	44494	Chibougamau, far from mines (southern)	pike	M	3	629	1581	M	0.42
1998	44496	Chibougamau, far from mines (southern)	pike	M	4	677	1903	M	0.49
1998	44498	Chibougamau, far from mines (southern)	pike	L	4	727	2152	F	0.44
1998	44497	Chibougamau, far from mines (southern)	pike	L	5	773	2747	F	0.61
1998	44500	Chibougamau, far from mines (southern)	pike	L	6	800	3800	M	1.20
1998	44499	Chibougamau, far from mines (southern)	pike	L	7	976	6300	F	0.92
1998	44509	Chibougamau, far from mines (southern)	walleye	S	3	314	250	M	0.18
1998	44512	Chibougamau, far from mines (southern)	walleye	S	3	325	304	M	0.32
1998	44507	Chibougamau, far from mines (southern)	walleye	S	3	340	306	F	0.44
1998	44510	Chibougamau, far from mines (southern)	walleye	S	3	353	388	F	0.33
1998	44511	Chibougamau, far from mines (southern)	walleye	S	3	362	381	F	0.29

US: under size      S: small      M: medium      L: large

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
1998	44508	Chibougamau, far from mines (southern)	walleye	S	5	376	476	F	0.47
1998	44506	Chibougamau, far from mines (southern)	walleye	S	5	384	477	M	0.32
1998	44504	Chibougamau, far from mines (southern)	walleye	S	5	385	485	M	0.43
1998	44505	Chibougamau, far from mines (southern)	walleye	S	5	398	504	F	0.42
1998	44518	Chibougamau, far from mines (southern)	walleye	M	5	404	546	M	0.41
1998	44513	Chibougamau, far from mines (southern)	walleye	M	5	429	736	M	0.34
1998	44514	Chibougamau, far from mines (southern)	walleye	M	5	437	694	M	0.36
1998	44517	Chibougamau, far from mines (southern)	walleye	M	5	446	753	F	0.36
1998	44516	Chibougamau, far from mines (southern)	walleye	M	5	448	767	F	0.54
1998	44519	Chibougamau, far from mines (southern)	walleye	M	5	465	999	M	0.34
1998	44521	Chibougamau, far from mines (southern)	walleye	M	5	469	936	M	0.28
1998	44520	Chibougamau, far from mines (southern)	walleye	M	5	474	867	F	0.35
1998	44515	Chibougamau, far from mines (southern)	walleye	M	5	488	1068	F	0.38
1998	44522	Chibougamau, far from mines (southern)	walleye	L	9	505	1085	M	0.68
1998	44523	Chibougamau, far from mines (southern)	walleye	L	7	511	1292	M	0.54
1998	44524	Chibougamau, far from mines (southern)	walleye	L	9	516	1372	M	0.59
1998	44526	Chibougamau, far from mines (southern)	walleye	L	9	523	1306	M	0.62
1998	44530	Chibougamau, far from mines (southern)	walleye	L	9	533	1220	M	0.72
1998	44525	Chibougamau, far from mines (southern)	walleye	L	9	545	1625	M	0.74
1998	44528	Chibougamau, far from mines (southern)	walleye	L	9	550	1485	M	0.72
1998	44527	Chibougamau, far from mines (southern)	walleye	L	11	580	1700	M	0.97
1998	44528	Chibougamau, far from mines (southern)	walleye	L	11	580	2145	M	0.70
1998	44535	Chibougamau, far from mines (southern)	walleye	L	9	615	2386	F	0.80
1998	44538	Chibougamau, far from mines (southern)	walleye	L	25	623	2583	M	2.20
1998	44534	Chibougamau, far from mines (southern)	walleye	L	11	624	2563	F	1.10
1998	44536	Chibougamau, far from mines (southern)	walleye	L	13	631	2721	F	1.30
1998	44539	Chibougamau, far from mines (southern)	walleye	L	11	650	2881	F	0.77
1998	44533	Chibougamau, far from mines (southern)	walleye	L	11	674	3056	F	1.10
1998	44532	Chibougamau, far from mines (southern)	walleye	L	9	688	3134	F	0.98
1998	44537	Chibougamau, far from mines (southern)	walleye	L	18	710	3618	F	1.20
1998	44531	Chibougamau, far from mines (southern)	walleye	L	24	740	3807	F	2.00
2001	55215	Chibougamau, far from mines (southern)	pike	M	3	560	1000	F	0.16
2001	55220	Chibougamau, far from mines (southern)	pike	M	3	610	1372	F	0.33
2001	55216	Chibougamau, far from mines (southern)	pike	M	2	612	1636	F	0.17
2001	55218	Chibougamau, far from mines (southern)	pike	M	2	635	1866	M	0.30
2001	55217	Chibougamau, far from mines (southern)	pike	M	3	667	2046	F	0.29
2001	55214	Chibougamau, far from mines (southern)	pike	M	4	677	2117	F	0.35
2001	55221	Chibougamau, far from mines (southern)	pike	M	3	677	2420	M	0.51
2001	55219	Chibougamau, far from mines (southern)	pike	M	4	693	2042	F	0.39
2001	55225	Chibougamau, far from mines (southern)	pike	L	5	722	3014	F	0.68
2001	55223	Chibougamau, far from mines (southern)	pike	L	6	742	2598	M	0.52
2001	55227	Chibougamau, far from mines (southern)	pike	L	4	754	3400	F	0.39
2001	55222	Chibougamau, far from mines (southern)	pike	L	6	762	3496	M	0.72
2001	55226	Chibougamau, far from mines (southern)	pike	L	4	768	3266	F	0.47
2001	55224	Chibougamau, far from mines (southern)	pike	L	5	802	3900	F	0.47
2001	55228	Chibougamau, far from mines (southern)	pike	L	8	878	4664	F	0.91
2001	55080	Chibougamau, far from mines (southern)	walleye	S	3	310	227	F	0.25
2001	55084	Chibougamau, far from mines (southern)	walleye	S	3	320	306	M	0.21
2001	55081	Chibougamau, far from mines (southern)	walleye	S	4	330	261	M	0.25
2001	55086	Chibougamau, far from mines (southern)	walleye	S	3	333	330	F	0.22
2001	55083	Chibougamau, far from mines (southern)	walleye	S	4	336	304	F	0.30
2001	55078	Chibougamau, far from mines (southern)	walleye	S	4	339	289	F	0.43
2001	55085	Chibougamau, far from mines (southern)	walleye	S	4	360	476	F	0.30
2001	55079	Chibougamau, far from mines (southern)	walleye	S	4	364	364	F	0.29
2001	55082	Chibougamau, far from mines (southern)	walleye	S	5	380	460	M	0.33
2001	55088	Chibougamau, far from mines (southern)	walleye	M	6	425	599	F	0.49

US: under size      S: small      M: medium      L: large



Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2001	55090	Chibougamau, far from mines (southern)	walleye	M	6	436	632	F	0.40
2001	55091	Chibougamau, far from mines (southern)	walleye	M	6	450	817	F	0.37
2001	55092	Chibougamau, far from mines (southern)	walleye	M	6	454	796	F	0.36
2001	55093	Chibougamau, far from mines (southern)	walleye	M	6	460	920	M	0.43
2001	55087	Chibougamau, far from mines (southern)	walleye	M	6	466	754	F	0.47
2001	55089	Chibougamau, far from mines (southern)	walleye	M	6	467	858	F	0.48
2001	55095	Chibougamau, far from mines (southern)	walleye	M		482	1072	F	0.43
2001	55094	Chibougamau, far from mines (southern)	walleye	M	6	486	1118	F	0.39
2001	55100	Chibougamau, far from mines (southern)	walleye	L	12	508	1173	M	0.69
2001	55104	Chibougamau, far from mines (southern)	walleye	L		508	1528	M	0.60
2001	55103	Chibougamau, far from mines (southern)	walleye	L	6	513	1390	F	0.51
2001	55102	Chibougamau, far from mines (southern)	walleye	L	6	517	1608	F	0.47
2001	55101	Chibougamau, far from mines (southern)	walleye	L	8	520	1324	F	0.46
2001	55099	Chibougamau, far from mines (southern)	walleye	L	12	530	1245	M	0.67
2001	55097	Chibougamau, far from mines (southern)	walleye	L	14	560	1574	F	0.86
2001	55098	Chibougamau, far from mines (southern)	walleye	L	27	665	2684	M	1.20
2001	55096	Chibougamau, far from mines (southern)	walleye	L	13	667	1569	M	0.65
2001	55191	Chibougamau, far from mines (southern)	lake trout	S	6	504	1036	F	0.28
2001	55193	Chibougamau, far from mines (southern)	lake trout	M	9	593	1636	M	0.66
2001	55198	Chibougamau, far from mines (southern)	lake trout	M	13	595	1680	F	0.84
2001	55197	Chibougamau, far from mines (southern)	lake trout	M	12	614	1756	F	1.10
2001	55195	Chibougamau, far from mines (southern)	lake trout	M	12	633	2344	M	0.74
2001	55196	Chibougamau, far from mines (southern)	lake trout	M	10	648	2446	F	0.82
2001	55194	Chibougamau, far from mines (southern)	lake trout	M	10	654	2018	F	0.78
2001	55199	Chibougamau, far from mines (southern)	lake trout	M	17	658	2514	M	1.20
2001	55200	Chibougamau, far from mines (southern)	lake trout	M	16	658	2344	F	1.10
2001	55192	Chibougamau, far from mines (southern)	lake trout	M	11	694	3208	F	0.59
2001	55204	Chibougamau, far from mines (southern)	lake trout	L	12	701	3338	F	0.74
2001	55207	Chibougamau, far from mines (southern)	lake trout	L	15	705	3448	M	0.91
2001	55203	Chibougamau, far from mines (southern)	lake trout	L	9	718	3000	F	0.77
2001	55201	Chibougamau, far from mines (southern)	lake trout	L	18	722	3020	F	1.70
2001	55205	Chibougamau, far from mines (southern)	lake trout	L	20	724	4878	M	1.60
2001	55206	Chibougamau, far from mines (southern)	lake trout	L	13	762	4450	F	0.76
2001	55202	Chibougamau, far from mines (southern)	lake trout	L	25	862	8000	M	2.20
2002	84813	Chibougamau, far from mines (southern)	walleye	S	3	305	237	F	0.15
2002	84808	Chibougamau, far from mines (southern)	walleye	S	4	314	246	M	0.27
2002	84809	Chibougamau, far from mines (southern)	walleye	S	4	353	378	M	0.33
2002	84816	Chibougamau, far from mines (southern)	walleye	S	4	362	432	M	0.26
2002	84810	Chibougamau, far from mines (southern)	walleye	S	4	363	425	M	0.36
2002	84815	Chibougamau, far from mines (southern)	walleye	S	4	374	466	M	0.30
2002	84811	Chibougamau, far from mines (southern)	walleye	S	4	377	421	F	0.25
2002	84812	Chibougamau, far from mines (southern)	walleye	S	5	384	461	F	0.45
2002	84814	Chibougamau, far from mines (southern)	walleye	S	5	395	563	M	0.33
2002	84820	Chibougamau, far from mines (southern)	walleye	M	5	403	631	F	0.25
2002	84821	Chibougamau, far from mines (southern)	walleye	M	5	414	623	F	0.39
2002	84822	Chibougamau, far from mines (southern)	walleye	M	5	431	658	F	0.34
2002	84819	Chibougamau, far from mines (southern)	walleye	M	5	442	859	F	0.34
2002	84817	Chibougamau, far from mines (southern)	walleye	M	5	453	860	F	0.32
2002	84825	Chibougamau, far from mines (southern)	walleye	M	7	483	1095	F	0.36
2002	84824	Chibougamau, far from mines (southern)	walleye	M	6	485	1003	F	0.43
2002	84823	Chibougamau, far from mines (southern)	walleye	M	7	497	1031	F	0.44
2002	84827	Chibougamau, far from mines (southern)	walleye	L	7	505	1106	F	0.55
2002	84830	Chibougamau, far from mines (southern)	walleye	L	8	507	1311	F	0.42
2002	84818	Chibougamau, far from mines (southern)	walleye	L	7	515	1209	F	0.59
2002	84831	Chibougamau, far from mines (southern)	walleye	L	7	515	1195	F	0.38
2002	84829	Chibougamau, far from mines (southern)	walleye	L	7	520	1256	F	0.69

US: under size      S: small      M: medium      L: large

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2002	84832	Chibougamau, far from mines (southern)	walleye	L	7	530	1527	F	0.71
2002	84826	Chibougamau, far from mines (southern)	walleye	L	8	534	1340	F	0.54
2002	84833	Chibougamau, far from mines (southern)	walleye	L	7	535	1413	F	0.52
2002	84834	Chibougamau, far from mines (southern)	walleye	L	9	552	1445	F	0.91
2002	84828	Chibougamau, far from mines (southern)	walleye	L	9	595	1948	F	1.10
2002	84836	Chibougamau, far from mines (southern)	walleye	L	19	687	2760	F	1.50
2002	84795	Chibougamau, far from mines (southern)	lake trout	M	14	620	2038	F	1.10
2002	84794	Chibougamau, far from mines (southern)	lake trout	M	24	674	2318	F	20.00
2002	84797	Chibougamau, far from mines (southern)	lake trout	L	21	765	5400	F	2.10
2002	84798	Chibougamau, far from mines (southern)	lake trout	L	25	832	6350	F	3.20
1999	70089	Chibougamau, near mines (northern)	lake trout	S	6	497	946	F	0.36
1999	70088	Chibougamau, near mines (northern)	lake trout	S	6	503	1064	M	0.67
1999	70086	Chibougamau, near mines (northern)	lake trout	S	5	513	1146	F	0.42
1999	70087	Chibougamau, near mines (northern)	lake trout	S	7	529	1224	M	0.52
1999	70092	Chibougamau, near mines (northern)	lake trout	S	7	537	1266	M	0.63
1999	70091	Chibougamau, near mines (northern)	lake trout	M	13	600	1916	M	0.79
1999	70093	Chibougamau, near mines (northern)	lake trout	M	14	620	1936	M	0.89
1999	70094	Chibougamau, near mines (northern)	lake trout	M	12	630	2294	M	1.10
1999	70090	Chibougamau, near mines (northern)	lake trout	M	21	680	3130	M	2.20
1999	70098	Chibougamau, near mines (northern)	lake trout	L	27	735	4272	F	3.40
1999	70099	Chibougamau, near mines (northern)	lake trout	L	27	791	4726	M	2.40
1999	70100	Chibougamau, near mines (northern)	lake trout	L	26	791	5350	M	2.30
1999	70096	Chibougamau, near mines (northern)	lake trout	L	21	811	6100	M	3.00
1999	70097	Chibougamau, near mines (northern)	lake trout	L	37	845	7500	F	4.00
2000	90381	Chibougamau, near mines (northern)	lake trout	S	5	452	680	F	0.28
2000	90380	Chibougamau, near mines (northern)	lake trout	S	7	498	834	M	0.39
2000	90382	Chibougamau, near mines (northern)	lake trout	S	9	516	976	F	0.35
2000	90383	Chibougamau, near mines (northern)	lake trout	S	7	535	1352	F	0.43
2000	90384	Chibougamau, near mines (northern)	lake trout	M	9	597	1578	F	0.66
2000	90388	Chibougamau, near mines (northern)	lake trout	M	12	646	2515	F	1.20
2000	90385	Chibougamau, near mines (northern)	lake trout	M	14	660	2514	M	0.78
2000	90387	Chibougamau, near mines (northern)	lake trout	M	15	662	2690	F	1.20
2000	90386	Chibougamau, near mines (northern)	lake trout	M	15	667	2530	F	1.50
2000	90389	Chibougamau, near mines (northern)	lake trout	L	30	825	4662	M	1.70
2001	54627	Chibougamau, near mines (northern)	pike	S	2	549	967	F	0.24
2001	54628	Chibougamau, near mines (northern)	pike	M	3	550	908	F	0.29
2001	54631	Chibougamau, near mines (northern)	pike	M	2	593	1093	F	0.18
2001	54634	Chibougamau, near mines (northern)	pike	M	2	610	1320	F	0.16
2001	54635	Chibougamau, near mines (northern)	pike	M	3	619	1486	F	0.14
2001	54633	Chibougamau, near mines (northern)	pike	M	3	620	1447	M	0.23
2001	54632	Chibougamau, near mines (northern)	pike	M	3	667	1837	M	0.41
2001	54629	Chibougamau, near mines (northern)	pike	M	4	678	2055	M	0.46
2001	54636	Chibougamau, near mines (northern)	pike	M	5	678	2152	M	0.75
2001	54630	Chibougamau, near mines (northern)	pike	M	5	680	2056	M	0.73
2001	54637	Chibougamau, near mines (northern)	pike	M	4	686	1975	F	0.39
2001	54645	Chibougamau, near mines (northern)	pike	L	4	711	2482	F	0.34
2001	54638	Chibougamau, near mines (northern)	pike	L	5	721	2660	M	0.46
2001	54639	Chibougamau, near mines (northern)	pike	L	4	723	2192	F	0.40
2001	54642	Chibougamau, near mines (northern)	pike	L	5	724	2451	F	0.62
2001	54644	Chibougamau, near mines (northern)	pike	L	4	724	2371	F	0.69
2001	54640	Chibougamau, near mines (northern)	pike	L	4	758	3262	F	0.50
2001	54646	Chibougamau, near mines (northern)	pike	L	6	774	3120	M	0.64
2001	54641	Chibougamau, near mines (northern)	pike	L	4	789	3069	F	0.38
2001	54643	Chibougamau, near mines (northern)	pike	L	7	822	4136	M	0.85
2001	54647	Chibougamau, near mines (northern)	pike	L	6	850	4670	F	0.84
2001	54653	Chibougamau, near mines (northern)	walleye	S		340	345	F	0.20

US: under size      S: small      M: medium      L: large

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2001	54654	Chibougamau, near mines (northern)	walleye	S	3	357	390	M	0.19
2001	54658	Chibougamau, near mines (northern)	walleye	S	3	357	369	F	0.19
2001	54660	Chibougamau, near mines (northern)	walleye	S	3	360	390	F	0.22
2001	54657	Chibougamau, near mines (northern)	walleye	S	3	362	408	M	0.28
2001	54655	Chibougamau, near mines (northern)	walleye	S	4	366	452	M	0.36
2001	54659	Chibougamau, near mines (northern)	walleye	S	4	366	390	M	0.29
2001	54652	Chibougamau, near mines (northern)	walleye	S	4	387	566	F	0.28
2001	54656	Chibougamau, near mines (northern)	walleye	S	4	393	548	M	0.31
2001	54665	Chibougamau, near mines (northern)	walleye	M		401	807	F	0.30
2001	54668	Chibougamau, near mines (northern)	walleye	M	4	420	610	F	0.31
2001	54666	Chibougamau, near mines (northern)	walleye	M		441	680	F	0.40
2001	54667	Chibougamau, near mines (northern)	walleye	M	6	462	991	M	0.38
2001	54664	Chibougamau, near mines (northern)	walleye	M	6	468	768	M	0.41
2001	54662	Chibougamau, near mines (northern)	walleye	M	5	471	779	F	0.52
2001	54663	Chibougamau, near mines (northern)	walleye	M		475	816		0.57
2001	54661	Chibougamau, near mines (northern)	walleye	M		480	981	F	0.42
2001	54669	Chibougamau, near mines (northern)	walleye	M	6	490	992	F	0.40
2001	54671	Chibougamau, near mines (northern)	walleye	L	6	505	1058	M	0.47
2001	54678	Chibougamau, near mines (northern)	walleye	L	6	510	1292	F	0.40
2001	54676	Chibougamau, near mines (northern)	walleye	L		517	1356	F	0.34
2001	54672	Chibougamau, near mines (northern)	walleye	L	6	520	1279	F	0.42
2001	54677	Chibougamau, near mines (northern)	walleye	L	6	520	1366	F	0.42
2001	54674	Chibougamau, near mines (northern)	walleye	L	6	531	1599	M	0.46
2001	54673	Chibougamau, near mines (northern)	walleye	L	5	543	1603	F	0.44
2001	54675	Chibougamau, near mines (northern)	walleye	L	6	552	1497	F	0.42
2001	54679	Chibougamau, near mines (northern)	walleye	L	13	667	3103	F	1.00
2001	55063	Chibougamau, near mines (northern)	lake trout	S	6	505	1110	F	0.75
2001	55062	Chibougamau, near mines (northern)	lake trout	S	7	516	912		0.25
2001	55066	Chibougamau, near mines (northern)	lake trout	M	10	594	1903	F	0.72
2001	55071	Chibougamau, near mines (northern)	lake trout	M	11	602	2015	F	0.85
2001	55068	Chibougamau, near mines (northern)	lake trout	M	15	624	2385	F	1.20
2001	55072	Chibougamau, near mines (northern)	lake trout	M	17	630	2364	F	0.98
2001	55065	Chibougamau, near mines (northern)	lake trout	M	15	646	2521	M	0.47
2001	55067	Chibougamau, near mines (northern)	lake trout	M	12	648	2643	M	0.88
2001	55070	Chibougamau, near mines (northern)	lake trout	M	16	648	2456	M	0.98
2001	55064	Chibougamau, near mines (northern)	lake trout	M	12	658	2521	F	0.82
2001	55069	Chibougamau, near mines (northern)	lake trout	M	11	675	2990	M	0.74
2001	55076	Chibougamau, near mines (northern)	lake trout	L	15	720	3100	M	0.61
2001	55073	Chibougamau, near mines (northern)	lake trout	L	16	728	2897	M	0.84
2001	55075	Chibougamau, near mines (northern)	lake trout	L	13	741	3200	F	0.50
2001	55074	Chibougamau, near mines (northern)	lake trout	L	11	742	3972		0.84
2002	85083	Chibougamau, near mines (northern)	pike	M	5	633	1620	M	0.43
2002	85084	Chibougamau, near mines (northern)	pike	L	5	733	2714	F	0.39
2002	85085	Chibougamau, near mines (northern)	pike	L	7	922	5600	F	0.92
2002	85104	Chibougamau, near mines (northern)	walleye	S	3	303	283	-	0.18
2002	85103	Chibougamau, near mines (northern)	walleye	S	4	330	349	F	0.19
2002	85098	Chibougamau, near mines (northern)	walleye	S	3	340	328	M	0.21
2002	85101	Chibougamau, near mines (northern)	walleye	S	5	350	378	F	0.32
2002	85099	Chibougamau, near mines (northern)	walleye	S	5	365	461	F	0.27
2002	85096	Chibougamau, near mines (northern)	walleye	S		375	468	M	0.25
2002	85100	Chibougamau, near mines (northern)	walleye	S	4	385	542	F	0.28
2002	85097	Chibougamau, near mines (northern)	walleye	S	4	388	516	F	0.27
2002	85102	Chibougamau, near mines (northern)	walleye	S	5	394	536	F	0.38
2002	85109	Chibougamau, near mines (northern)	walleye	M	4	400	576	F	0.26
2002	85113	Chibougamau, near mines (northern)	walleye	M	4	405	593	F	0.27
2002	85110	Chibougamau, near mines (northern)	walleye	M	4	410	616	F	0.29

US: under size      S: small      M: medium      L: large

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2002	85106	Chibougamau, near mines (northern)	walleye	M	5	414	578	F	0.29
2002	85105	Chibougamau, near mines (northern)	walleye	M	5	420	731	F	0.36
2002	85107	Chibougamau, near mines (northern)	walleye	M	5	420	700	M	0.30
2002	85108	Chibougamau, near mines (northern)	walleye	M	5	435	746	M	0.27
2002	85111	Chibougamau, near mines (northern)	walleye	M	5	450	768	F	0.39
2002	85112	Chibougamau, near mines (northern)	walleye	M	7	478	1017	M	0.45
2002	85115	Chibougamau, near mines (northern)	walleye	L	7	515	1358	F	0.48
2002	85120	Chibougamau, near mines (northern)	walleye	L	4	517	1350	M	0.86
2002	85118	Chibougamau, near mines (northern)	walleye	L	8	531	1631	F	0.42
2002	85122	Chibougamau, near mines (northern)	walleye	L	7	538	1529	F	0.45
2002	85117	Chibougamau, near mines (northern)	walleye	L	7	540	1441	F	0.51
2002	85119	Chibougamau, near mines (northern)	walleye	L	8	543	1621	F	0.42
2002	85114	Chibougamau, near mines (northern)	walleye	L		545	1349	F	0.51
2002	85121	Chibougamau, near mines (northern)	walleye	L	15	566	1770	M	0.94
2002	85116	Chibougamau, near mines (northern)	walleye	L	7	578	1857	F	0.60
2002	85157	Chibougamau, near mines (northern)	lake trout	US	5	395	379	M	0.22
2002	85155	Chibougamau, near mines (northern)	lake trout	US	5	437	662	M	0.27
2002	85156	Chibougamau, near mines (northern)	lake trout	US	4	448	683	F	0.21
2002	85129	Chibougamau, near mines (northern)	lake trout	S	5	472	792	F	0.35
2002	85128	Chibougamau, near mines (northern)	lake trout	S	5	482	900	F	0.28
2002	85131	Chibougamau, near mines (northern)	lake trout	S	6	490	963	M	0.35
2002	85130	Chibougamau, near mines (northern)	lake trout	S	6	500	902	M	0.29
2002	85132	Chibougamau, near mines (northern)	lake trout	S	5	501	961	F	0.24
2002	85127	Chibougamau, near mines (northern)	lake trout	S	6	538	1348	M	0.28
2002	85167	Chibougamau, near mines (northern)	lake trout	S	8	540	1258	F	0.40
2002	85179	Chibougamau, near mines (northern)	lake trout	M	6	555	1602	F	0.36
2002	85141	Chibougamau, near mines (northern)	lake trout	M	7	561	1501	M	0.42
2002	85134	Chibougamau, near mines (northern)	lake trout	M	8	564	1228	F	0.69
2002	85140	Chibougamau, near mines (northern)	lake trout	M	9	569	1496	F	0.41
2002	85161	Chibougamau, near mines (northern)	lake trout	M	9	598	1845	F	0.50
2002	85164	Chibougamau, near mines (northern)	lake trout	M	13	598	1976	F	0.90
2002	85166	Chibougamau, near mines (northern)	lake trout	M	11	600	1666	F	0.58
2002	85142	Chibougamau, near mines (northern)	lake trout	M	7	601	1623	F	0.38
2002	85177	Chibougamau, near mines (northern)	lake trout	M	10	605	1750	F	0.49
2002	85182	Chibougamau, near mines (northern)	lake trout	M	13	609	2049	F	0.55
2002	85180	Chibougamau, near mines (northern)	lake trout	M	11	612	1926	F	0.57
2002	85178	Chibougamau, near mines (northern)	lake trout	M	9	620	1732	F	0.38
2002	85139	Chibougamau, near mines (northern)	lake trout	M	13	622	1843	M	0.82
2002	85159	Chibougamau, near mines (northern)	lake trout	M	13	625	1833	F	1.20
2002	85137	Chibougamau, near mines (northern)	lake trout	M	15	630	2369	M	0.66
2002	85158	Chibougamau, near mines (northern)	lake trout	M	10	647	2429	F	0.74
2002	85163	Chibougamau, near mines (northern)	lake trout	M	23	652	3077	F	0.93
2002	85135	Chibougamau, near mines (northern)	lake trout	M	22	655	2558	F	1.40
2002	85143	Chibougamau, near mines (northern)	lake trout	M	14	658	2379	F	1.10
2002	85138	Chibougamau, near mines (northern)	lake trout	M	15	660	2609	M	0.55
2002	85181	Chibougamau, near mines (northern)	lake trout	M	16	662	2701	F	1.10
2002	85136	Chibougamau, near mines (northern)	lake trout	M	14	668	2577	F	1.10
2002	85160	Chibougamau, near mines (northern)	lake trout	M	16	678	2687	M	0.53
2002	85165	Chibougamau, near mines (northern)	lake trout	M	14	687	2800	F	1.40
2002	85162	Chibougamau, near mines (northern)	lake trout	M	16	695	3202	M	0.94
2002	85147	Chibougamau, near mines (northern)	lake trout	L	14	700	3129	M	2.10
2002	85148	Chibougamau, near mines (northern)	lake trout	L		702	2704	M	1.20
2002	85150	Chibougamau, near mines (northern)	lake trout	L	18	707	2842	F	1.50
2002	85149	Chibougamau, near mines (northern)	lake trout	L	15	716	3331	F	1.30
2002	85145	Chibougamau, near mines (northern)	lake trout	L	27	735	4000	F	2.70
2002	85172	Chibougamau, near mines (northern)	lake trout	L	11	742	3600	F	0.88

US: under size      S: small      M: medium      L: large

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2002	85153	Chibougamau, near mines (northern)	lake trout	L		748	4600	M	0.87
2002	85169	Chibougamau, near mines (northern)	lake trout	L	20	756	4300	M	1.30
2002	85151	Chibougamau, near mines (northern)	lake trout	L		764	4300	M	1.30
2002	85168	Chibougamau, near mines (northern)	lake trout	L	15	778	5000	M	1.60
2002	85170	Chibougamau, near mines (northern)	lake trout	L	34	786	5000	M	1.90
2002	85152	Chibougamau, near mines (northern)	lake trout	L		807	5300	M	1.50
2002	85175	Chibougamau, near mines (northern)	lake trout	L	23	815	5200	F	2.60
2002	85171	Chibougamau, near mines (northern)	lake trout	L	41	828	5000	M	2.30
2002	85174	Chibougamau, near mines (northern)	lake trout	L		891	6100	F	2.50
2002	85146	Chibougamau, near mines (northern)	lake trout	L	35	895	8000	M	0.76
2002	85173	Chibougamau, near mines (northern)	lake trout	L	21	951	9500	F	1.30
2001	53664	Obatogamau, Nemenjiche sector	pike	S	2	400	335	F	0.27
2001	53666	Obatogamau, Nemenjiche sector	pike	S	2	412	370	F	0.29
2001	53671	Obatogamau, Nemenjiche sector	pike	S	2	435	430	M	0.28
2001	53680	Obatogamau, Nemenjiche sector	pike	S	2	459	517	F	0.31
2001	53668	Obatogamau, Nemenjiche sector	pike	S	3	467	550	F	0.34
2001	53665	Obatogamau, Nemenjiche sector	pike	S	3	476	628	F	0.41
2001	53667	Obatogamau, Nemenjiche sector	pike	S	3	491	675	F	0.42
2001	53670	Obatogamau, Nemenjiche sector	pike	S	5	529	756	M	0.47
2001	53669	Obatogamau, Nemenjiche sector	pike	S	4	532	879	M	0.50
2001	53672	Obatogamau, Nemenjiche sector	pike	S	6	543	935	M	0.67
2001	53673	Obatogamau, Nemenjiche sector	pike	M	4	565	1131	M	0.47
2001	53679	Obatogamau, Nemenjiche sector	pike	M	4	567	921	M	0.54
2001	53675	Obatogamau, Nemenjiche sector	pike	M	5	569	1021	M	0.79
2001	53674	Obatogamau, Nemenjiche sector	pike	M	4	575	1112	M	0.86
2001	53677	Obatogamau, Nemenjiche sector	pike	M	6	580	1067	M	0.71
2001	53678	Obatogamau, Nemenjiche sector	pike	M	5	580	1201	M	0.45
2001	53676	Obatogamau, Nemenjiche sector	pike	M	5	600	1091	F	0.91
2001	53681	Obatogamau, Nemenjiche sector	pike	M	4	602	1118	F	0.80
2001	53682	Obatogamau, Nemenjiche sector	pike	L		700	2200		1.20
2001	53683	Obatogamau, Nemenjiche sector	pike	L		755	2200		1.00
2001	53685	Obatogamau, Nemenjiche sector	pike	L	8	855	4049	F	1.30
2001	53684	Obatogamau, Nemenjiche sector	pike	L	9	1005	8040	F	1.90
2001	53848	Obatogamau, Nemenjiche sector	whitefish	S		378	482		0.07
2001	53849	Obatogamau, Nemenjiche sector	whitefish	M		429	774		0.11
2001	53850	Obatogamau, Nemenjiche sector	whitefish	L		482	1115		0.22
2001	53830	Obatogamau, Nemenjiche sector	walleye	S	4	328	362	F	0.37
2001	53825	Obatogamau, Nemenjiche sector	walleye	S		355	344	M	0.31
2001	53826	Obatogamau, Nemenjiche sector	walleye	S		355	408	F	0.66
2001	53827	Obatogamau, Nemenjiche sector	walleye	S		363	395	M	0.34
2001	53829	Obatogamau, Nemenjiche sector	walleye	S	6	370	436	M	0.50
2001	53828	Obatogamau, Nemenjiche sector	walleye	S	6	378	449	M	0.30
2001	53824	Obatogamau, Nemenjiche sector	walleye	S		390	505	F	0.29
2001	53823	Obatogamau, Nemenjiche sector	walleye	S		395	495	M	0.29
2001	53835	Obatogamau, Nemenjiche sector	walleye	M	6	414	634	M	0.44
2001	53833	Obatogamau, Nemenjiche sector	walleye	M		430	692	F	0.49
2001	53834	Obatogamau, Nemenjiche sector	walleye	M		460	838	M	0.64
2001	53832	Obatogamau, Nemenjiche sector	walleye	M		488	1020	M	0.68
2001	53837	Obatogamau, Nemenjiche sector	walleye	M	7	494	1167	F	0.54
2001	53831	Obatogamau, Nemenjiche sector	walleye	M	10	496	1155	F	0.59
2001	53836	Obatogamau, Nemenjiche sector	walleye	M	7	498	1100	F	0.54
2001	53840	Obatogamau, Nemenjiche sector	walleye	L	12	500	1154	M	0.94
2001	53843	Obatogamau, Nemenjiche sector	walleye	L	10	517	1303	M	0.79
2001	53839	Obatogamau, Nemenjiche sector	walleye	L	16	520	1389	M	1.00
2001	53841	Obatogamau, Nemenjiche sector	walleye	L	17	521	1370	M	1.00
2001	53842	Obatogamau, Nemenjiche sector	walleye	L	12	545	1524	F	0.89

US: under size      S: small      M: medium      L: large

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2001	53838	Obatogamau, Nemenjiche sector	walleye	L	17	606	2284	F	1.30
2001	53845	Obatogamau, Nemenjiche sector	walleye	L	18	626	2524	F	1.20
2001	53846	Obatogamau, Nemenjiche sector	walleye	L	13	635	2392	F	0.63
2001	53844	Obatogamau, Nemenjiche sector	walleye	L	19	699	2986	F	1.10
2001	53661	Obatogamau, Nemenjiche sector	burbot	S		405	462		0.57
2001	53662	Obatogamau, Nemenjiche sector	burbot	M		555	1046		0.57
2001	53663	Obatogamau, Nemenjiche sector	burbot	L		611	1244		0.65
2002	84264	Obatogamau, Lac Fancamp (western sector)	pike	S	1	401	346	M	0.11
2002	84267	Obatogamau, Lac Fancamp (western sector)	pike	S	1	405	344	F	0.18
2002	84263	Obatogamau, Lac Fancamp (western sector)	pike	S	2	433	450	M	0.18
2002	84268	Obatogamau, Lac Fancamp (western sector)	pike	S	2	442	480	M	0.18
2002	84266	Obatogamau, Lac Fancamp (western sector)	pike	S	3	500	716	M	0.28
2002	84260	Obatogamau, Lac Fancamp (western sector)	pike	S	3	501	656	M	0.34
2002	84261	Obatogamau, Lac Fancamp (western sector)	pike	S	5	507	738	M	0.42
2002	84262	Obatogamau, Lac Fancamp (western sector)	pike	S	4	513	704	F	0.32
2002	84265	Obatogamau, Lac Fancamp (western sector)	pike	S	3	525	954	M	0.24
2002	84273	Obatogamau, Lac Fancamp (western sector)	pike	M	3	556	867	M	0.41
2002	84272	Obatogamau, Lac Fancamp (western sector)	pike	M	4	567	929	F	0.54
2002	84271	Obatogamau, Lac Fancamp (western sector)	pike	M	4	568	1014	M	0.48
2002	84275	Obatogamau, Lac Fancamp (western sector)	pike	M	4	573	1027	M	0.61
2002	84276	Obatogamau, Lac Fancamp (western sector)	pike	M	3	578	1171	M	1.10
2002	84277	Obatogamau, Lac Fancamp (western sector)	pike	M	6	590	1194	M	0.47
2002	84270	Obatogamau, Lac Fancamp (western sector)	pike	M	4	591	1130	M	0.93
2002	84274	Obatogamau, Lac Fancamp (western sector)	pike	M	7	685	1941	M	0.80
2002	84269	Obatogamau, Lac Fancamp (western sector)	pike	M	6	691	1920	F	0.73
2002	84279	Obatogamau, Lac Fancamp (western sector)	pike	L	7	702	1987	F	0.89
2002	84280	Obatogamau, Lac Fancamp (western sector)	pike	L	6	710	1947	F	1.00
2002	84278	Obatogamau, Lac Fancamp (western sector)	pike	L	7	711	2284	M	0.98
2002	84281	Obatogamau, Lac Fancamp (western sector)	pike	L	9	1028	8200	F	1.30
2002	84296	Obatogamau, Lac Fancamp (western sector)	whitefish	S		392	564	-	0.03
2002	84298	Obatogamau, Lac Fancamp (western sector)	whitefish	S		392	480	F	0.04
2002	84299	Obatogamau, Lac Fancamp (western sector)	whitefish	S		392	611	M	0.04
2002	84297	Obatogamau, Lac Fancamp (western sector)	whitefish	S		395	625	F	0.04
2002	84301	Obatogamau, Lac Fancamp (western sector)	whitefish	M		435	835	M	0.06
2002	84300	Obatogamau, Lac Fancamp (western sector)	whitefish	M		441	427	M	0.07
2002	84302	Obatogamau, Lac Fancamp (western sector)	whitefish	M		445	856	F	0.06
2002	84304	Obatogamau, Lac Fancamp (western sector)	whitefish	M		447	907	M	0.05
2002	84303	Obatogamau, Lac Fancamp (western sector)	whitefish	M		448	881	F	0.10
2002	84309	Obatogamau, Lac Fancamp (western sector)	whitefish	L		476	1121	M	0.11
2002	84305	Obatogamau, Lac Fancamp (western sector)	whitefish	L		478	1106	M	0.13
2002	84308	Obatogamau, Lac Fancamp (western sector)	whitefish	L		483	1002	F	0.12
2002	84307	Obatogamau, Lac Fancamp (western sector)	whitefish	L		501	1271	F	0.07
2002	84306	Obatogamau, Lac Fancamp (western sector)	whitefish	L		516	1541	F	0.13
2002	84236	Obatogamau, Lac Fancamp (western sector)	walleye	S	5	315	280	M	0.32
2002	84230	Obatogamau, Lac Fancamp (western sector)	walleye	S	4	322	280	F	0.28
2002	84231	Obatogamau, Lac Fancamp (western sector)	walleye	S	5	324	283	M	0.29
2002	84235	Obatogamau, Lac Fancamp (western sector)	walleye	S	5	340	339	M	0.34
2002	84237	Obatogamau, Lac Fancamp (western sector)	walleye	S	5	358	413	F	0.38
2002	84238	Obatogamau, Lac Fancamp (western sector)	walleye	S	5	365	417	M	0.23
2002	84232	Obatogamau, Lac Fancamp (western sector)	walleye	S	5	370	473	M	0.56
2002	84233	Obatogamau, Lac Fancamp (western sector)	walleye	S	5	386	490	F	0.53
2002	84234	Obatogamau, Lac Fancamp (western sector)	walleye	S	4	392	546	F	0.34
2002	84241	Obatogamau, Lac Fancamp (western sector)	walleye	M	5	404	588	F	0.38
2002	84239	Obatogamau, Lac Fancamp (western sector)	walleye	M	6	412	670	F	0.35
2002	84246	Obatogamau, Lac Fancamp (western sector)	walleye	M	5	426	673	F	0.32
2002	84245	Obatogamau, Lac Fancamp (western sector)	walleye	M	5	435	770	M	0.38

US: under size      S: small      M: medium      L: large

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2002	84244	Obatogamau, Lac Fancamp (western sector)	walleye	M	7	448	809	M	0.40
2002	84243	Obatogamau, Lac Fancamp (western sector)	walleye	M	8	455	835	M	0.46
2002	84247	Obatogamau, Lac Fancamp (western sector)	walleye	M	7	467	922	F	0.46
2002	84242	Obatogamau, Lac Fancamp (western sector)	walleye	M	12	468	968	M	0.62
2002	84240	Obatogamau, Lac Fancamp (western sector)	walleye	M	7	495	1192	M	0.50
2002	84254	Obatogamau, Lac Fancamp (western sector)	walleye	L	26	552	1680	F	0.69
2002	84256	Obatogamau, Lac Fancamp (western sector)	walleye	L	11	562	1767	F	0.63
2002	84249	Obatogamau, Lac Fancamp (western sector)	walleye	L	9	576	1776	F	0.92
2002	84251	Obatogamau, Lac Fancamp (western sector)	walleye	L	9	592	1957	F	0.66
2002	84250	Obatogamau, Lac Fancamp (western sector)	walleye	L	13	620	2461	F	0.89
2002	84253	Obatogamau, Lac Fancamp (western sector)	walleye	L	9	630	2170	F	1.55
2002	84252	Obatogamau, Lac Fancamp (western sector)	walleye	L	7	644	2669	F	0.89
2002	84248	Obatogamau, Lac Fancamp (western sector)	walleye	L	13	669	3260	F	0.75
2002	84255	Obatogamau, Lac Fancamp (western sector)	walleye	L	18	682	2953	F	1.00
2002	84258	Obatogamau, Lac Fancamp (western sector)	walleye	L	18	695	3291	F	1.10
2002	84259	Obatogamau, Lac Fancamp (western sector)	walleye	L	27	722	3600	F	1.60
2002	84284	Obatogamau, Lac Fancamp (western sector)	burbot	S		350	268	-	0.18
2002	84283	Obatogamau, Lac Fancamp (western sector)	burbot	S		415	485	-	0.20
2002	84289	Obatogamau, Lac Fancamp (western sector)	burbot	M		555	1213	-	0.46
2002	84285	Obatogamau, Lac Fancamp (western sector)	burbot	M		563	1205	-	0.37
2002	84288	Obatogamau, Lac Fancamp (western sector)	burbot	M		577	1149	-	0.36
2002	84286	Obatogamau, Lac Fancamp (western sector)	burbot	M		582	1393	-	0.34
2002	84287	Obatogamau, Lac Fancamp (western sector)	burbot	M		591	1340	-	0.32
2002	84293	Obatogamau, Lac Fancamp (western sector)	burbot	L		665	1989	-	0.43
2002	84291	Obatogamau, Lac Fancamp (western sector)	burbot	L		668	2060	-	0.38
2002	84294	Obatogamau, Lac Fancamp (western sector)	burbot	L		678	2259	-	0.45
2002	84290	Obatogamau, Lac Fancamp (western sector)	burbot	L		695	2103	-	0.36
2002	84292	Obatogamau, Lac Fancamp (western sector)	burbot	L		746	2322	-	0.46
2002	84315	Obatogamau, Lac Fancamp (western sector)	sucker	S		302	298	-	0.04
2002	84313	Obatogamau, Lac Fancamp (western sector)	sucker	S		322	348	-	0.08
2002	84312	Obatogamau, Lac Fancamp (western sector)	sucker	S		330	473	-	0.04
2002	84314	Obatogamau, Lac Fancamp (western sector)	sucker	S		333	404	-	0.05
2002	84311	Obatogamau, Lac Fancamp (western sector)	sucker	S		340	434	-	0.06
2002	84317	Obatogamau, Lac Fancamp (western sector)	sucker	M		359	511	-	0.06
2002	84321	Obatogamau, Lac Fancamp (western sector)	sucker	M		373	588	-	0.07
2002	84319	Obatogamau, Lac Fancamp (western sector)	sucker	M		378	599	-	0.06
2002	84316	Obatogamau, Lac Fancamp (western sector)	sucker	M		379	573	-	0.07
2002	84320	Obatogamau, Lac Fancamp (western sector)	sucker	M		383	630	-	0.07
2002	84318	Obatogamau, Lac Fancamp (western sector)	sucker	M		396	700	-	0.11
2002	84325	Obatogamau, Lac Fancamp (western sector)	sucker	L		422	861	-	0.07
2002	84327	Obatogamau, Lac Fancamp (western sector)	sucker	L		425	841	-	0.10
2002	84326	Obatogamau, Lac Fancamp (western sector)	sucker	L		451	1035	-	0.23
2002	84324	Obatogamau, Lac Fancamp (western sector)	sucker	L		462	1036	-	0.24
2002	84323	Obatogamau, Lac Fancamp (western sector)	sucker	L		486	1565	F	0.15
2002	84000	Obatogamau, Lac La Dauversière (eastern sector)	pike	S	2	423	404	M	0.23
2002	83999	Obatogamau, Lac La Dauversière (eastern sector)	pike	S	2	432	522	F	0.27
2002	84002	Obatogamau, Lac La Dauversière (eastern sector)	pike	S	2	462	545	F	0.25
2002	84005	Obatogamau, Lac La Dauversière (eastern sector)	pike	S	2	470	607	M	0.23
2002	84001	Obatogamau, Lac La Dauversière (eastern sector)	pike	S	3	487	629	M	0.34
2002	84003	Obatogamau, Lac La Dauversière (eastern sector)	pike	S	4	495	756	F	0.42
2002	84004	Obatogamau, Lac La Dauversière (eastern sector)	pike	S	3	495	706	M	0.37
2002	84007	Obatogamau, Lac La Dauversière (eastern sector)	pike	S	4	535	958	F	0.41
2002	84006	Obatogamau, Lac La Dauversière (eastern sector)	pike	M	3	550	821	F	0.80
2002	84010	Obatogamau, Lac La Dauversière (eastern sector)	pike	M	4	555	1021	M	0.65
2002	84009	Obatogamau, Lac La Dauversière (eastern sector)	pike	M	3	558	1029	F	0.28
2002	84012	Obatogamau, Lac La Dauversière (eastern sector)	pike	M	5	560	1029	M	0.81

US: under size      S: small      M: medium      L: large

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2002	84011	Obatogamau, Lac La Dauversière (eastern sector)	pike	M	4	567	939	F	0.52
2002	84013	Obatogamau, Lac La Dauversière (eastern sector)	pike	M	4	570	1068	F	0.50
2002	84015	Obatogamau, Lac La Dauversière (eastern sector)	pike	M	4	577	1067	F	0.40
2002	84014	Obatogamau, Lac La Dauversière (eastern sector)	pike	M	4	610	1258	F	0.72
2002	84008	Obatogamau, Lac La Dauversière (eastern sector)	pike	M	6	623	1542	M	0.83
2002	84016	Obatogamau, Lac La Dauversière (eastern sector)	pike	M	5	645	1271	F	1.10
2002	84021	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	S		382	554	F	0.08
2002	84022	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	S		385	542	F	0.06
2002	84020	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	S		387	605	F	0.04
2002	84018	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	S		394	527	M	0.06
2002	84019	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	S		395	596	F	0.06
2002	84023	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	M		411	626	M	0.09
2002	84026	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	M		424	715	M	0.06
2002	84027	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	M		434	771	F	0.13
2002	84024	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	M		441	872	M	0.10
2002	84025	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	M		444	828	M	0.04
2002	84028	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	L		468	1019	M	0.16
2002	84032	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	L		470	1011	M	0.20
2002	84030	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	L		475	1018	M	0.17
2002	84029	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	L		484	1158	M	0.11
2002	84031	Obatogamau, Lac La Dauversière (eastern sector)	whitefish	L		489	1164	M	0.18
2002	83976	Obatogamau, Lac La Dauversière (eastern sector)	walleye	S	3	317	278	F	0.26
2002	83977	Obatogamau, Lac La Dauversière (eastern sector)	walleye	S	3	317	287	M	0.30
2002	83974	Obatogamau, Lac La Dauversière (eastern sector)	walleye	S	4	347	357	M	0.38
2002	83975	Obatogamau, Lac La Dauversière (eastern sector)	walleye	S	5	367	419	F	0.36
2002	83973	Obatogamau, Lac La Dauversière (eastern sector)	walleye	S	5	373	474	F	0.32
2002	83970	Obatogamau, Lac La Dauversière (eastern sector)	walleye	S	5	386	530	M	0.44
2002	83978	Obatogamau, Lac La Dauversière (eastern sector)	walleye	S	5	395	536	F	0.32
2002	83972	Obatogamau, Lac La Dauversière (eastern sector)	walleye	S	5	397	613	F	0.34
2002	83971	Obatogamau, Lac La Dauversière (eastern sector)	walleye	S	5	399	553	M	0.39
2002	83984	Obatogamau, Lac La Dauversière (eastern sector)	walleye	M	5	400	570	F	0.39
2002	83987	Obatogamau, Lac La Dauversière (eastern sector)	walleye	M	7	422	632	F	0.46
2002	83986	Obatogamau, Lac La Dauversière (eastern sector)	walleye	M	8	447	850	F	0.41
2002	83983	Obatogamau, Lac La Dauversière (eastern sector)	walleye	M	7	449	818	F	0.48
2002	83982	Obatogamau, Lac La Dauversière (eastern sector)	walleye	M	7	456	823	F	0.53
2002	83980	Obatogamau, Lac La Dauversière (eastern sector)	walleye	M	9	466	977	F	0.53
2002	83979	Obatogamau, Lac La Dauversière (eastern sector)	walleye	M	13	477	1059	M	0.75
2002	83985	Obatogamau, Lac La Dauversière (eastern sector)	walleye	M	7	491	1183	M	0.54
2002	83981	Obatogamau, Lac La Dauversière (eastern sector)	walleye	M	7	496	1083	F	0.59
2002	83988	Obatogamau, Lac La Dauversière (eastern sector)	walleye	L		525	1486	F	0.77
2002	83989	Obatogamau, Lac La Dauversière (eastern sector)	walleye	L	7	525	1287	F	0.67
2002	83990	Obatogamau, Lac La Dauversière (eastern sector)	walleye	L	7	530	1516	F	0.60
2002	83992	Obatogamau, Lac La Dauversière (eastern sector)	walleye	L	10	531	1490	F	0.52
2002	83994	Obatogamau, Lac La Dauversière (eastern sector)	walleye	L	21	545	1588	F	1.60
2002	83996	Obatogamau, Lac La Dauversière (eastern sector)	walleye	L	27	574	2154	M	1.60
2002	83993	Obatogamau, Lac La Dauversière (eastern sector)	walleye	L	13	590	1914	F	1.00
2002	83991	Obatogamau, Lac La Dauversière (eastern sector)	walleye	L	13	600	2107	F	1.20
2002	83995	Obatogamau, Lac La Dauversière (eastern sector)	walleye	L	19	611	2193	F	1.40
2002	83998	Obatogamau, Lac La Dauversière (eastern sector)	walleye	L	13	677	2999	F	1.00
2002	84050	Obatogamau, Lac La Dauversière (eastern sector)	burbot	S		393	474	F	0.26
2002	84049	Obatogamau, Lac La Dauversière (eastern sector)	burbot	S		394	382	M	0.48
2002	84048	Obatogamau, Lac La Dauversière (eastern sector)	burbot	S		420	436	M	0.26
2002	84051	Obatogamau, Lac La Dauversière (eastern sector)	burbot	S		421	487	F	0.42
2002	84052	Obatogamau, Lac La Dauversière (eastern sector)	burbot	S		433	521	-	0.37
2002	84057	Obatogamau, Lac La Dauversière (eastern sector)	burbot	M		558	1082	F	0.55
2002	84055	Obatogamau, Lac La Dauversière (eastern sector)	burbot	M		566	1146	F	0.37

US: under size      S: small      M: medium      L: large



Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2002	84054	Obatogamau, Lac La Dauversière (eastern sector)	burbot	M		568	1192	F	0.56
2002	84053	Obatogamau, Lac La Dauversière (eastern sector)	burbot	M		582	1252	M	0.67
2002	84056	Obatogamau, Lac La Dauversière (eastern sector)	burbot	M		587	1123	M	0.68
2002	84061	Obatogamau, Lac La Dauversière (eastern sector)	burbot	L		600	1072	-	0.49
2002	84060	Obatogamau, Lac La Dauversière (eastern sector)	burbot	L		606	1305	-	0.80
2002	84059	Obatogamau, Lac La Dauversière (eastern sector)	burbot	L		610	1346	M	0.54
2002	84035	Obatogamau, Lac La Dauversière (eastern sector)	sucker	S		315	331	-	0.07
2002	84034	Obatogamau, Lac La Dauversière (eastern sector)	sucker	S		341	456	F	0.09
2002	84037	Obatogamau, Lac La Dauversière (eastern sector)	sucker	M		375	557	-	0.13
2002	84038	Obatogamau, Lac La Dauversière (eastern sector)	sucker	M		378	539	-	0.09
2002	84040	Obatogamau, Lac La Dauversière (eastern sector)	sucker	M		381	605	-	0.08
2002	84036	Obatogamau, Lac La Dauversière (eastern sector)	sucker	M		391	700	-	0.19
2002	84039	Obatogamau, Lac La Dauversière (eastern sector)	sucker	M		392	793	-	0.09
2002	84042	Obatogamau, Lac La Dauversière (eastern sector)	sucker	L		430	891	F	0.11
2002	84046	Obatogamau, Lac La Dauversière (eastern sector)	sucker	L		449	1146	-	0.17
2002	84043	Obatogamau, Lac La Dauversière (eastern sector)	sucker	L		453	937	-	0.18
2002	84044	Obatogamau, Lac La Dauversière (eastern sector)	sucker	L		467	1223	F	0.18
2002	84045	Obatogamau, Lac La Dauversière (eastern sector)	sucker	L		481	1365	-	0.17
2000	90392	Waconichi	lake trout	S	7	454	735	F	0.20
2000	90393	Waconichi	lake trout	S	8	456	756	M	0.22
2000	90390	Waconichi	lake trout	S	6	472	825	F	0.15
2000	90391	Waconichi	lake trout	S	7	500	960	F	0.20
2000	90394	Waconichi	lake trout	S	8	537	1344	F	0.24
2000	90397	Waconichi	lake trout	M	11	571	1048	F	0.43
2000	90395	Waconichi	lake trout	M	7	587	1572	F	0.22
2000	90396	Waconichi	lake trout	M	9	622	2245	F	0.32
2000	90399	Waconichi	lake trout	M	11	654	2176	M	0.36
2000	90398	Waconichi	lake trout	M	11	667	2171	F	0.30
2000	90402	Waconichi	lake trout	L	10	713	2926	M	0.17
2000	90403	Waconichi	lake trout	L	14	730	4021	F	0.74
2000	90401	Waconichi	lake trout	L	10	766	4504	F	0.25
2000	90404	Waconichi	lake trout	L	13	828	5060	F	0.65
2000	90400	Waconichi	lake trout	L	12	834	5331	F	0.64
2001	53638	Waconichi	pike	US	1	252	92	M	0.04
2001	53637	Waconichi	pike	US	1	271	110	M	0.05
2001	53635	Waconichi	pike	S	2	518	586	F	0.09
2001	53636	Waconichi	pike	S	2	537	924	M	0.10
2001	53639	Waconichi	pike	S	3	538	1209	M	0.18
2001	53647	Waconichi	pike	M	2	574	1345	M	0.15
2001	53644	Waconichi	pike	M	3	585	1216	M	0.18
2001	53643	Waconichi	pike	M	2	590	1265	M	0.16
2001	53641	Waconichi	pike	M	2	600	1353	M	0.19
2001	53642	Waconichi	pike	M	2	600	1259	F	0.19
2001	53646	Waconichi	pike	M	3	609	1459	F	0.16
2001	53645	Waconichi	pike	M	3	616	1608	M	0.18
2001	53640	Waconichi	pike	M	4	658	743	F	0.10
2001	53648	Waconichi	pike	M	3	693	2120	M	0.25
2001	53651	Waconichi	pike	L	4	715	2014	M	0.21
2001	53655	Waconichi	pike	L	5	730	2600	M	0.15
2001	53649	Waconichi	pike	L	4	735	2674	M	0.21
2001	53652	Waconichi	pike	L	5	754	2730	M	0.18
2001	53657	Waconichi	pike	L	6	758	2767	F	0.30
2001	53654	Waconichi	pike	L	5	764	2915	M	0.34
2001	53656	Waconichi	pike	L	6	799	3575	M	0.26
2001	53659	Waconichi	pike	L	7	918	4500	M	0.39
2001	53653	Waconichi	pike	L	7	932	5060	F	0.40

US: under size      S: small      M: medium      L: large

Appendix 3 Mercury concentrations in and characteristics of fish from lakes Chibougamau, aux Dorés, Obatogamau and Waconichi – 1998-2002 (continued)

Year	Number	Lake	Species	Size	Age (years)	Total length (mm)	Weight (g)	Sex	Hg (mg/kg)
2001	53650	Waconichi	pike	L	7	950	7700	F	0.33
2001	53660	Waconichi	pike	L	11	1045	7500	F	0.58
2001	53531	Waconichi	walleye	S	2	309	262	F	0.13
2001	53533	Waconichi	walleye	S	2	318	337	M	0.14
2001	53527	Waconichi	walleye	S	2	355	498	M	0.14
2001	53530	Waconichi	walleye	S	2	368	472	F	0.16
2001	53526	Waconichi	walleye	S	2	373	535	M	0.15
2001	53532	Waconichi	walleye	S	2	377	531	M	0.14
2001	53529	Waconichi	walleye	S	2	380	380	M	0.15
2001	53525	Waconichi	walleye	S	2	393	621	M	0.18
2001	53528	Waconichi	walleye	S	2	395	395	M	0.10
2001	53538	Waconichi	walleye	M	2	415	749	F	0.15
2001	53542	Waconichi	walleye	M	3	420	739	M	0.16
2001	53541	Waconichi	walleye	M	3	453	974	M	0.14
2001	53537	Waconichi	walleye	M	3	458	1039	M	0.14
2001	53535	Waconichi	walleye	M	3	475	1162	M	0.19
2001	53539	Waconichi	walleye	M	4	475	1143	M	0.31
2001	53540	Waconichi	walleye	M	4	480	1228	M	0.72
2001	53543	Waconichi	walleye	M	4	484	1219	M	0.20
2001	53536	Waconichi	walleye	M	3	495	1362	F	0.19
2001	53546	Waconichi	walleye	L	5	592	2434	M	0.29
2001	53547	Waconichi	walleye	L	8	598	2596	M	0.35
2001	53545	Waconichi	walleye	L	8	676	3549	F	0.26
2001	53559	Waconichi	lake trout	S	9	458	756	M	0.22
2001	53562	Waconichi	lake trout	S	5	460	745		0.16
2001	53557	Waconichi	lake trout	S	7	484	894	F	0.21
2001	53556	Waconichi	lake trout	S	9	503	1034	F	0.24
2001	53563	Waconichi	lake trout	S	8	505	1083	M	0.22
2001	53555	Waconichi	lake trout	S	9	520	1144	M	0.20
2001	53561	Waconichi	lake trout	S	8	525	1160	M	0.22
2001	53558	Waconichi	lake trout	S	9	530	1335	F	0.32
2001	53560	Waconichi	lake trout	S	10	540	1332	M	0.32
2001	53569	Waconichi	lake trout	M	12	583	1557	M	0.47
2001	53567	Waconichi	lake trout	M	10	584	1794	F	0.55
2001	53565	Waconichi	lake trout	M	10	592	1937	M	0.32
2001	53564	Waconichi	lake trout	M	11	594	1637	M	0.42
2001	53568	Waconichi	lake trout	M	11	600	1889	M	0.44
2001	53566	Waconichi	lake trout	M	12	680	3017	F	0.38

US: under size      S: small      M: medium      L: large