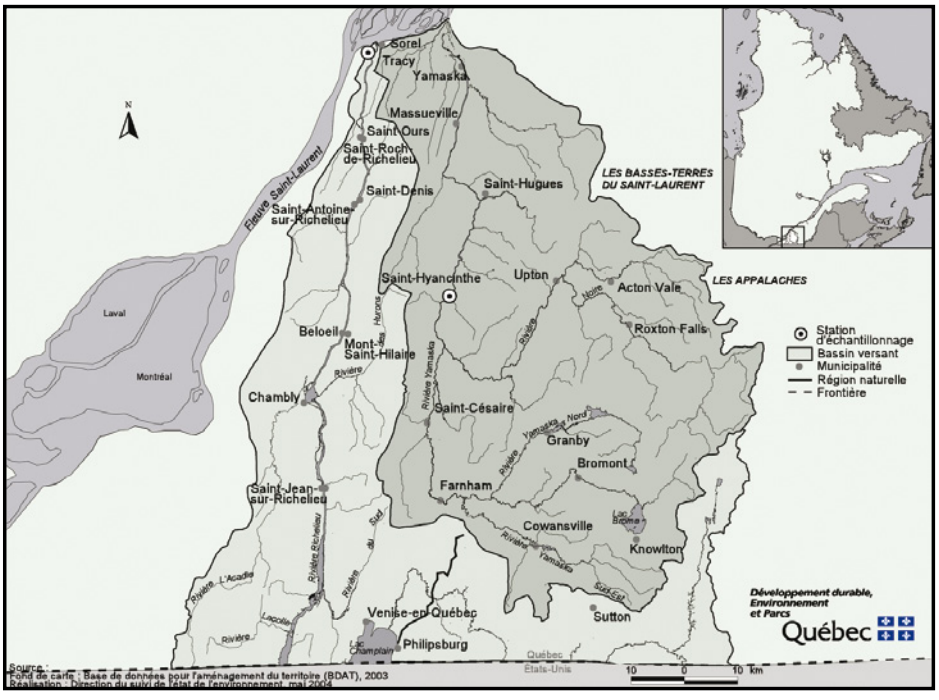
Water quality of the Richelieu and Yamaska rivers

Contamination by Toxic Substances

The Situation

The watersheds adjacent to the Richelieu and Yamaska rivers are located in the *Centre-du-Québec* region where a number of social and economic activities are present. The watershed region of the Richelieu River covers an area of 23,720 km² and is the largest tributary on the south shore of the St. Lawrence River. The river's average annual runoff volume for the period 2001-2003 was 341 m³/s in the municipality of Sorel-Tracy. Rising in Lake Champlain in the U.S., the river flows north and empties into the St. Lawrence River in the Sorel-Tracy region. Its main tributaries in Québec are the Du Sud, Des Hurons, Lacolle and L'Acadie rivers. The Canadian portion of the watershed region covers an area of 3,855 km², representing 16% of its total area.

Figure 1. Watershed regions of the Richelieu River and Yamaska River



The Yamaska River rises in Brome Lake and empties into the St. Lawrence River in the Lake Saint-Pierre area. Its watershed covers a total area of 4,784 km2 and is drained by three main tributaries: the Noire, Yamaska Nord and Yamaska Sud-Est rivers. The river's runoff volume is six times smaller

than that of the Richelieu River. For the period 2001-2003, its estimated runoff volume was 51 m³/s at Saint Hyacinthe.

The watershed regions of the Richelieu and Yamaska rivers are home to a number of industries specialized in agri-food, chemicals, metals processing, plastics and textiles. These past or current industrial activities are likely to result in the release of toxic substances into the environment, including polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated dioxins and furans (PCDD/Fs), all of which are present in the waters of the Richelieu and Yamaska rivers.

Situation Profile

Between 2001 and 2003, the Ministère du Développement durable, de l'Environnement et des Parcs collected 26 samples from the Yamaska River at Saint Hyacinthe and 22 samples from the Richelieu River at Sorel-Tracy. Samples were collected using an automatic sampler (ECSOTE) described in the study conducted by Laliberté and Mercier (2006). The target objectives were to determine PCB, PAH and PCDD/F concentrations in water. The concentrations that were measured were subsequently compared to quality criteria for protection of terrestrial piscivores (TPC). These criteria are concentrations of a substance in water that, over several generations, will not cause a significant decline in the viability or commercial and recreational value of an animal population that has been exposed to a contaminant through water consumption or diet (MENV, 2001). It should be noted that PCB and PCDD/F concentrations could be compared, but no criterion is available for PAHs.

Photo: MDDEP

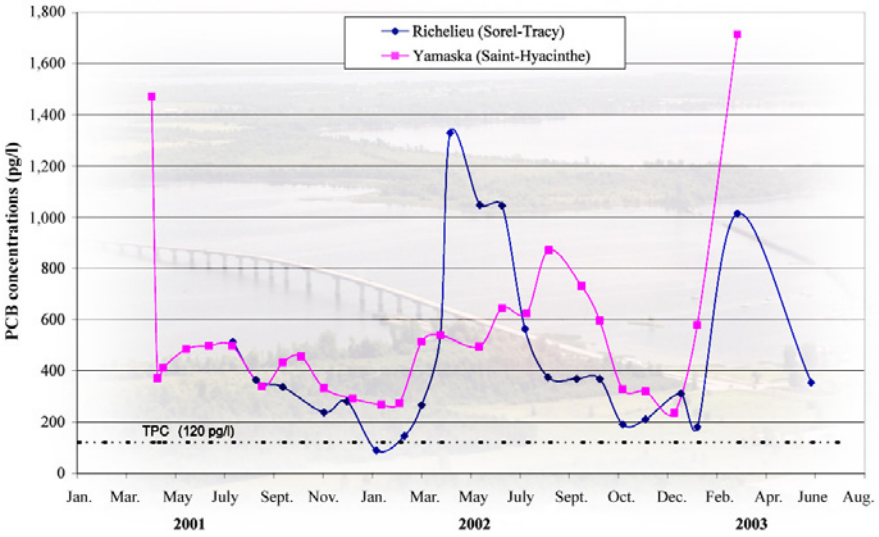
SOURCES OF PCB, PAH AND PCDD/F CONTAMINANTS

Polychlorinated biphenyls (PCBs) are very stable compounds but not readily biodegradable; they are one of the most persistent contaminants in the environment. Since 1980 in North America, the manufacture, import or use PCBs has been prohibited in sealed electrical equipment such as transformers. Despite this restriction, PCBs are still present in the environment.

Polycyclic aromatic hydrocarbons (PAH) released into the environment have natural and anthropogenic (man-made) sources. It is therefore difficult to determine the exact sources of PAHs that are present in a water environment. Forest fires are the largest natural source of PAHs in Canada. There are, however, a number of anthropogenic sources: aluminum smelters, wood burning for home heating, creosote-treated products, spills of petroleum products, metallurgical plants, coking plants, thermal electric power stations, transportation, waste incineration, etc. (Environment Canada and Health Canada, 1994).

Polychlorinated dioxins and furans (PCDD/Fs) are by-products of materials that have been burned and the manufacture of chemical compounds. Forest fires, incineration, wood burning, use of fossil fuels (coal, fuel oil and exhaust fumes from motor vehicles), electricity production and effluent from textile industries are sources of dioxin and furan emissions. In Canada, the principal source of PCDD/Fs is the burning of municipal and medical waste (Health Canada, 2004). Polychlorinated dioxins and furans are known for their high toxicity.

Figure 2. PCB concentrations in the waters of the Richelieu and Yamaska rivers (2001-2003)



In the case of the Yamaska River, changes in the concentrations of these substances were examined over time between the periods of 1997-2001 and 2001-2003. To estimate the total amounts of PCBs, PAHs and PCDD/Fs that both of these rivers carry, we calculated the mass flux of each river, which consists of multiplying average concentrations of the substances in question by the flow measurement at the sample collection site.

Polychlorinated Biphenyls (PCBs)

In the Yamaska River at Saint-Hyacinthe, between April 2001 and April 2003, total concentrations of PCBs ranged between 237 pg/l and 1.714 pg/l with an average concentration of 551 pg/l. Total concentrations of PCBs in the Richelieu River at Sorel-Tracy, between July 2001 and July 2003, ranged between 89 and 1.330 pg/l, with an average concentration of 461 pg/l (figure 2). We noted that total concentrations of PCBs in river waters generally fluctuated according to water flow and turbidity.

The recognized criterion for protection of terrestrial piscivores (TPC) is 120 pg/l (MENV, 2001). Average total concentrations of PCBs measured in both of the rivers under study were approximately four times higher than the TPC. This means that wildlife that consumes a diet of mainly fish may be exposed to high PCB levels, given the bioaccumulation of these substances in the food chain.

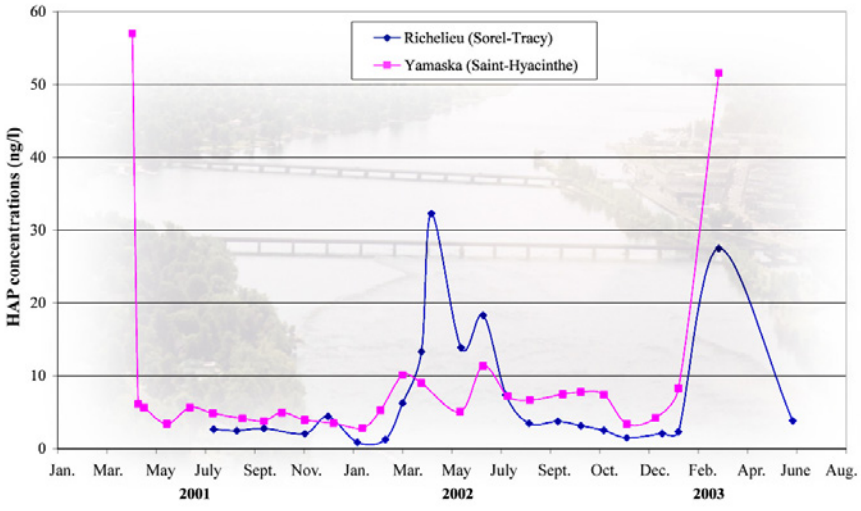
Measurements over two different periods revealed a significant estimated 43% drop in average PCB concentrations when adjustments were made on the basis of turbidity in the Yamaska River between 1997-2001 (790 pg/l) and 2001-2003 (447 pg/l).

Calculation of mass fluxes revealed that, during the period of 2001-2003, the amount of PCBs carried each year by the Richelieu River was five times higher than in the Yamaska River – 6.2 kg/yr *versus* 1.24 kg/yr –, which can be attributed to, among other things, the larger flow of the Richelieu River.

Polycyclic Aromatic Hydrocarbons (PAHs)

The presence of PAHs in the Yamaska and Richelieu rivers follows patterns that are similar to PCBs. Average PAH levels are higher in the Yamaska River. Mass fluxes are higher in the Richelieu River than the Yamaska River.

Figure 3. HAP concentrations considered to have a carcinogenic potential in waters of the Richelieu and Yamaska rivers (2001-2003)



In the Yamaska River, PAH levels with a carcinogenic potential varied between 2.84 ng/l and 57 ng/l, with an average concentration of 9.65 ng/l. Concentrations in the Richelieu River at Sorel-Tracy varied between 0.88 ng/l and 32.28 ng/l, with an average concentration of 7.19 ng/l (figure 3).

For the period 2001-2003, annual mass fluxes of PAHs were an estimated 110 kg/yr in the Richelieu River at Sorel-Tracy and 31 kg/yr in the Yamaska River at Saint-Hyacinthe. Like PCBs, PAH concentrations generally follow the same pattern as the river flow and degree of turbidity.

A comparison of average PAH levels adjusted on the basis of turbidity in the Yamaska River between 1999-2001 (5.6 ng/l) and 2001-2003 (6.8 ng/l) did not reveal significant changes over time.

Polychlorinated Dioxins and Furans (PCDD/Fs)

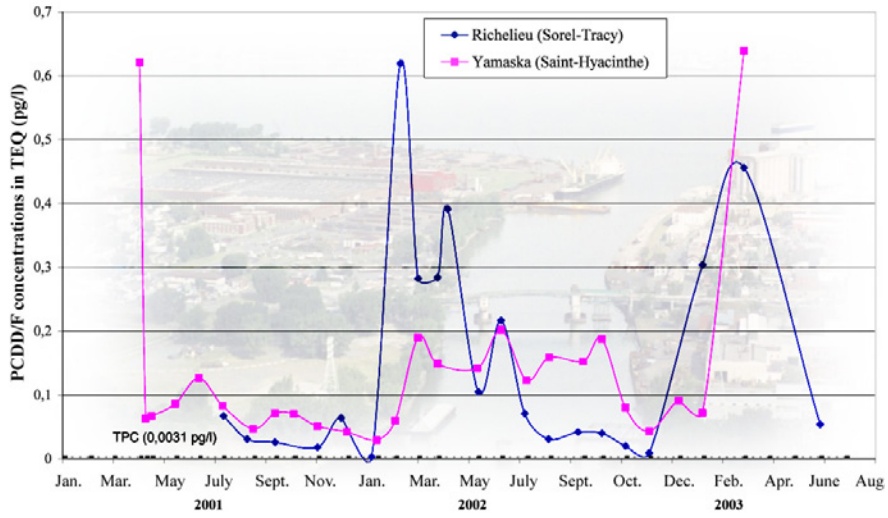
The situation of polychlorinated dioxins and furans (PCDD/F)[1] in the rivers under study is somewhat different than the situation of PCBs and PAHs because average concentrations are slightly higher in the Richelieu River than in the Yamaska River.

In the Yamaska River at Saint-Hyacinthe, concentrations of dioxins and furans in total toxic equivalents (TEQ) ranged between 0.029 and 0.639 pg/l, with an average concentration of 0.140 pg/l. In the Richelieu River, concentrations ranged between 0.003 and 0.619 pg/l, with an average concentration of 0.149 pg/l (figure 4). Like PCBs and PAHs, PCDD/F concentrations in the waters of the Richelieu and Yamaska rivers generally change with the flow and degree of turbidity.

Average PCDD/F concentrations in total toxic equivalents (TEQ) measured in both of the rivers under study are approximately 45 times higher than the criterion of 0.0031 pg/l for protection of terrestrial piscivores (TPC) (MENV, 2001).

1. PCDD/F concentrations are expressed in total toxic equivalents.

Figure 4. PCDD/F concentrations in toxic equivalents (TEQ) in waters of the Richelieu and Yamaska rivers (2001-2003)



The mass fluxes calculated during the period of 2001-2003 were higher in the Richelieu River than the Yamaska River. Due to the small concentrations measured, the mass fluxes represent small amounts, more specifically 0.0018 kg/yr for the Richelieu River at Sorel-Tracy and 0.0004 kg/yr for the Yamaska River at Saint-Hyacinthe.

An analysis of changes in PCDD/F concentrations in the Yamaska River revealed similar results for the periods 2001-2003 and 1998 2001, since average concentrations adjusted according to turbidity were 0.09 pg/l and 0.12 pg/l respectively.

Interpretation

Of those Québec rivers tested for toxic substances – which included, among others, the Chaudière, De La Perdrix, Du Moulin, Jacques-Cartier, À Mars, Nicolet, Saint Charles, Saint-François, Saint-Maurice, Richelieu and Yamaska rivers – the Richelieu and Yamaska rivers revealed the highest concentrations in water. For example, the Saint-François, Nicolet and Chaudière rivers, also located on the south shore of the St. Lawrence, had lower average concentrations of PCBs, PAHs and PCDD/Fs respectively than the Yamaska and Richelieu rivers, more specifically 1.3 to 3.3 times, 1.6 to 8.2 times and 4.4 to 16.6 times.

The difference is even greater when figures are compared to upstream sections of the À Mars and Ha! Ha! rivers, located in the Saguenay–Lac-Saint-Jean region, and when compared to the De La Perdrix River, in the Chaudière-Appalaches region. Average concentrations of PCBs, PAHs and PCDD/Fs were respectively 3 to 6 times lower, 6 to 19 times lower and 28 to 75 times lower.

Future studies will focus on monitoring these contaminants and on a new group of contaminants, polybrominated diphenyl ethers (PBDEs). These substances are used primarily as flame retardants in polyurethane foams that are used in furniture, carpet underlay, textiles, thermoplastics and casings of computers and televisions.

Photo: MDDEP

For more information:

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Prepared by: Denis Lalilberté
Direction du suivi de l'état de l'environnement
Ministère du Développement durable, de l'Environnement et des Parcs

State of the St. Lawrence Monitoring Program

Under the current Canada-Québec agreement, the St. Lawrence Plan for a Sustainable Development, six government partners – Environment Canada, the Ministère du Développement durable, de l'Environnement et des Parcs du Québec, Fisheries and Oceans Canada, the Ministère des Ressources naturelles et de la Faune du Québec, the Canadian Space Agency, and the Parks Canada Agency – together with Stratégies Saint-Laurent, a non-governmental organization that works actively with riverside communities, are pooling their expertise to provide Canadians with information on the state of the St. Lawrence River at regular intervals.

To obtain the fact sheets and additional information about the State of the St. Lawrence Monitoring Program, please visit our Web site at:

www.planstlaurent.ca

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