

Monitoring the State of the ST. LAWRENCE RIVER

WATER

SEDIMENTS

SHORELINES

BIOLOGICAL
RESOURCES

USES

Water quality of the Richelieu and Yamaska rivers

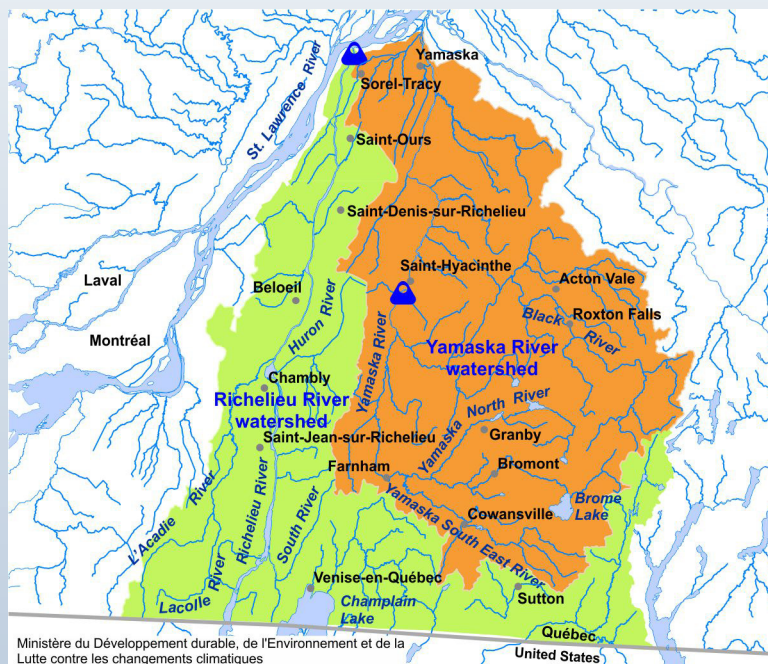
Toxic contamination

Issue

The watersheds of the Richelieu and Yamaska rivers are located in the Centre du Québec region, where there are numerous socio-economic activities. With a drainage basin area of 23 720 km², the Richelieu River is the most significant tributary on the south shore

of the St. Lawrence River. Its mean annual flow was 323 m³/s during the 2001–2003 period, and 484 m³/s during the 2004–2013 period at the municipality of Sorel-Tracy. From its source in Lake Champlain in the United States, the river flows northward into the St. Lawrence River at Sorel-Tracy. Its main tributaries in Quebec are the South, Huron, Lacolle and Acadia rivers. The Canadian part of the basin measures 3855 km², which represents 16% of its total area.

Figure 1 Drainage basins of the Richelieu and Yamaska rivers



The Yamaska River starts in Brome Lake and empties into the St. Lawrence River in the Lake Saint-Pierre area. Its watershed covers a total area of 4784 km² and is drained by three main tributaries: Black, Yamaska North and Yamaska South East rivers. The river's runoff volume is six times smaller than that of the Richelieu River. For the 2001–2003 and 2004–2013 periods, its estimated runoff volume was 46 m³/s and 70 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. Some of 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) and polybrominated diphenyl ethers (PBDEs), all of which are present in the waters of the Richelieu and Yamaska rivers.



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Sources of PCB, PAH, PCDD/F and PBDE contaminants

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 of PCBs has been prohibited in sealed electrical equipment such as transformers. Despite this restriction, PCBs are still present in the environment.

PAHs released into the environment have natural and anthropogenic (human-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).

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). PCDD/Fs are known for their high toxicity.

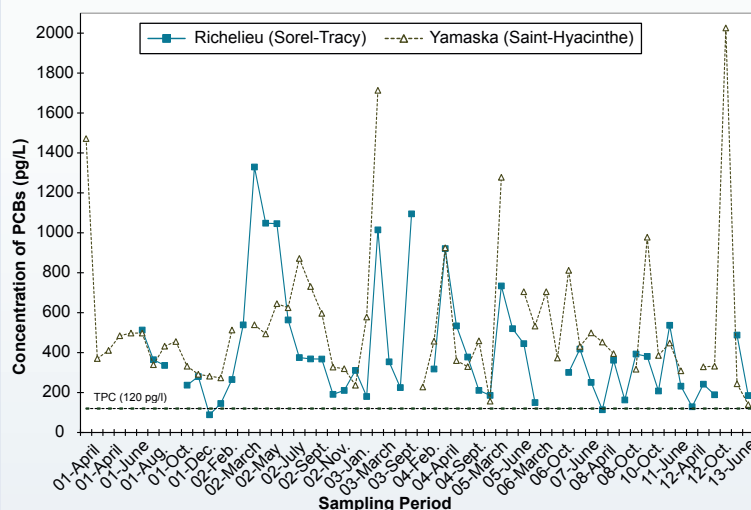
PBDEs were added to various plastic dies, synthetic resins and textile fibres to reduce the flammability of a wide range of consumer products: furniture upholstery materials, casing for electronic equipment, automobile parts, etc. After their use, these compounds are released into the environment and bioaccumulate in the food chain.

Overview of the situation

Between 2001 and 2013, the Ministère du Développement durable, de l'Environnement et des Parcs collected 53 samples from the Yamaska River at Saint-Hyacinthe and 50 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, PCDD/F and PBDE concentrations in water. The concentrations that were measured were subsequently compared with quality criteria for protection of terrestrial piscivores. 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, 2013). It should be noted that PCB and PCDD/F concentrations could be compared, but no criterion is available for PAHs or PBDEs.

An analysis of the temporal evolution of the concentration of these substances between the periods of 2001–2003 and 2004–2013 was conducted for the Richelieu and Yamaska rivers.

Figure 2 PCB concentrations in the waters of the Richelieu and Yamaska rivers (2001–2013)



Polychlorinated biphenyls

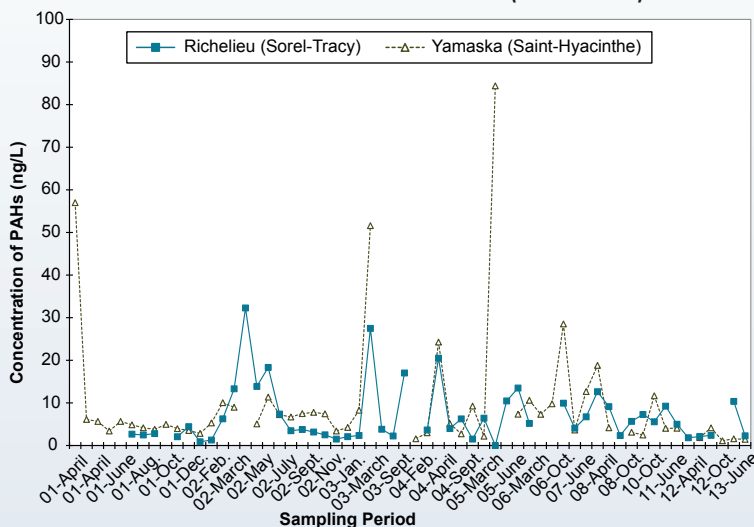
Findings show that, in the Richelieu River, concentrations of PCBs varied from 89 pg/L to 1330 pg/L (median: 354 pg/L) during the 2001–2003 period and from 114 to 1095 pg/L (median: 318 pg/L) during the 2004–2013 period. Average concentrations of PCBs adjusted for a turbidity of 23 nephelometric turbidity units (NTUs) were not significantly different from one period to the next; they were 363 pg/L and 330 pg/L, respectively (Figure 2).

During both periods, median concentrations of PCBs exceeded the criteria of 120 pg/L for protection of terrestrial piscivores. The seven predominant PCB congeners during the two periods studied were International Union of Pure and Applied Chemistry (IUPAC) numbers 138, 153, 101, 110, 118, 52 and 149. These seven congeners represented, on average, from 30% to 37% of the total concentration of PCBs.

Findings show that, in the Yamaska River, concentrations of PCBs varied from 237 pg/L to 1714 pg/L (median: 489 pg/L) during the 2001–2003 period, and from 140 pg/L to 2026 pg/L (median: 431 pg/L) during the 2004–2013 period. Average concentrations of PCBs adjusted for a turbidity of 16 NTUs were not significantly different from one period to the next; they were 460 pg/L and 416 pg/L, respectively. During both periods, median concentrations of PCBs exceeded the criteria of 120 pg/L for protection of terrestrial piscivores. The seven predominant PCB congeners during the two periods studied were IUPAC numbers 138, 153, 101, 110, 52, 95 and congener 49 or 95, depending on the period. These seven congeners represented, on average, from 32% to 35% of the total concentration of PCBs.

The total median concentrations of PCBs measured in both of the bodies of water studied are three to four times higher than the TPC. That means that wildlife species that feed primarily on fish could be exposed to high quantities of PCBs, considering the bioaccumulation of these substances in the food chain.

Figure 3 PAH concentrations considered to have a carcinogenic potential in waters of the Richelieu and Yamaska rivers (2001–2013)



Polycyclic aromatic hydrocarbons

The presence of PAHs in the Richelieu and Yamaska rivers follows patterns that are similar to PCBs.

In the Richelieu River, total PAH concentrations varied from 7 to 86 ng/L (median: 16 ng/L) during the 2001–2003 period, and from 9 to 81 ng/L (median: 24 ng/L) during the 2004–2013 period, while PAH concentrations for Group 1 (having a carcinogenic potential) varied from 1 ng/L to 32 ng/L (median: 3.17 ng/L) and from 0 ng/L to 21 ng/L (median: 5.67 ng/L), respectively. As for the average adjusted concentrations of total PAHs and the PAH concentrations of Group 1 for a turbidity of 23 NTUs, they were not significantly different from one period to the next. During the 2001–2003 and 2004–2013 periods, they were 19.5 ng/L and 23.5 ng/L for total PAHs, and 4.34 ng/L and 5.19 ng/L for PAHs of Group 1, respectively.

In the Yamaska River, total PAH concentrations varied from 15 ng/L to 154 ng/L (median: 23 ng/L) during the 2001–2003 period, and from 10 ng/L to 194 ng/L (median: 20 ng/L) during the 2004–2013 period, while the PAH concentrations of Group 1 (having a carcinogenic potential) varied from 3 ng/L to 57 ng/L (median: 5.65 ng/L) and from 1 to 84 ng/L (median: 4.15 ng/L), respectively (Figure 3). As for the average adjusted concentrations of the total PAHs for a turbidity of 16 NTUs, they were not significantly different from one period to the next; during the 2001–2003 and 2004–2013 periods, they



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were 25 ng/L and 21.8 ng/L, respectively. However, the average adjusted concentrations of the PAHs of Group 1 for a turbidity of 16 NTUs were higher during the 2001–2003 period than during the 2004–2013 period, i.e., 5.83 ng/L compared with 4.60 ng/L.

Polychlorinated dioxins and furans

In the Richelieu River, total concentrations of chlorinated dioxins and furans varied from 2 pg/L to 92 pg/L (median: 16 pg/L) during the 2001–2003 period, and from 4 to 61 pg/L (median: 22 pg/L) during the period from 2004 to 2013. As for concentrations in toxic equivalents of 2,3,7,8 TCDD¹, they varied from 0.003 pg/L to 0.619 pg/L (median: 0.048 pg/L) during the first period and from 0.007 pg/L to 0.232 pg/L (median: 0.081 pg/L) during the second (Figure 4). Average adjusted concentrations of chlorinated dioxins and furans and average concentrations in toxic equivalents of 2,3,7,8 TCDD for a turbidity of 23 NTUs were not significantly different from one period to the next during the 2001–2003 and 2004–2013 periods; they were 18.2 and 17 pg/L for the first and 0.063 pg/L and 0.055 pg/L for the second, respectively. During the two periods studied, average concentrations in toxic equivalents of 2,3,7,8 TCDD exceeded the criteria of 0.003 pg/L for protection of terrestrial piscivores.

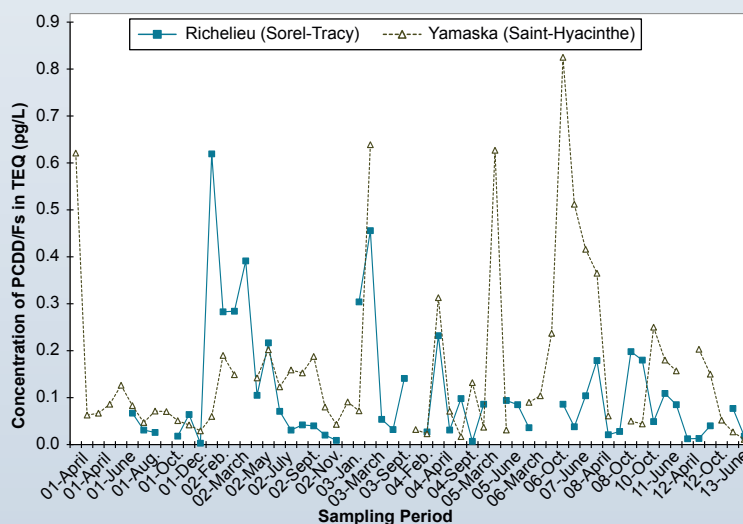
In the Yamaska River, total concentrations of chlorinated dioxins and furans varied from 10 to 137 pg/L (median: 19 pg/L) during the 2001–2003 period, and from 5 to 128 pg/L (median: 18 pg/L) during the 2004–2013 period.

As for concentrations in toxic equivalents of 2,3,7,8 TCDD, they varied from 0.029 pg/L to 0.639 pg/L (median: 0.085 pg/L) during

the first period, and from 0.011 pg/L to 0.825 pg/L (median: 0.104 pg/L) during the second. Average adjusted total concentrations of chlorinated dioxins and furans for a turbidity of 16 NTUs were higher during the 2001–2003 period than during the period from 2004 to 2013, i.e., 21.9 pg/L compared with 15.5 pg/L. However, average adjusted concentrations in toxic equivalents of 2,3,7,8 TCDD for a turbidity of 16 NTUs were not significantly different from one period to the next; they were 0.098 pg/L during the 2001–2003 period and 0.110 pg/L during the 2004–2013 period, respectively. During the two periods studied, median concentrations in toxic equivalents of 2,3,7,8 TCDD exceeded the criteria of 0.003 pg/L for protection of terrestrial piscivores.

As in the case of PCBs and PAHs, concentrations of PCDD/Fs in waters of the Richelieu and Yamaska rivers generally change with the flow and level of turbidity.

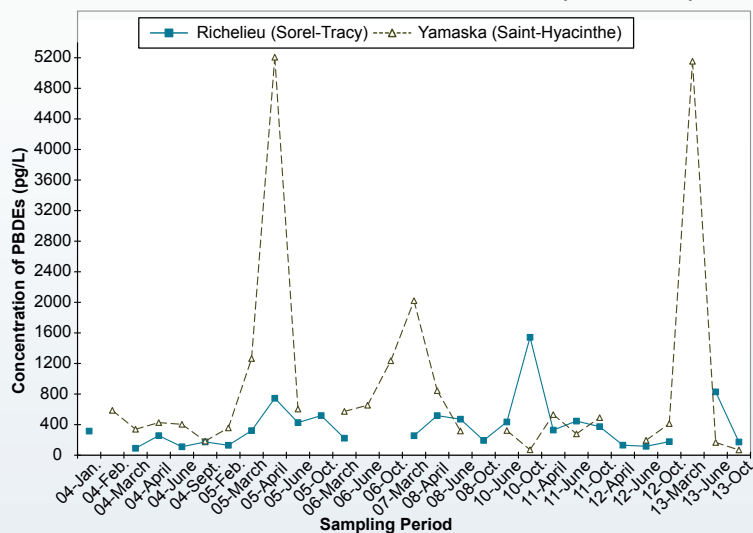
Figure 4 PCDD/F concentrations in toxic equivalents (TEQ) in waters of the Richelieu and Yamaska rivers (2001–2013)



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

Polybrominated diphenyl ethers

Figure 5 PBDE concentrations in waters of the Richelieu and Yamaska rivers (2004–2013)



In the Richelieu and Yamaska rivers, PBDE analyses were conducted only for the 2004–2013 period. In the Richelieu River, concentrations varied from 91 pg/L to 1543 pg/L (median: 316 pg/L), whereas the average concentration for a turbidity of 23 NTUs was 397 pg/L. In the Yamaska River, concentrations varied from 69 pg/L to 5207 pg/L (median: 427 pg/L), whereas the average concentration for a turbidity of 16 NTUs was 466 pg/L.

Perspectives

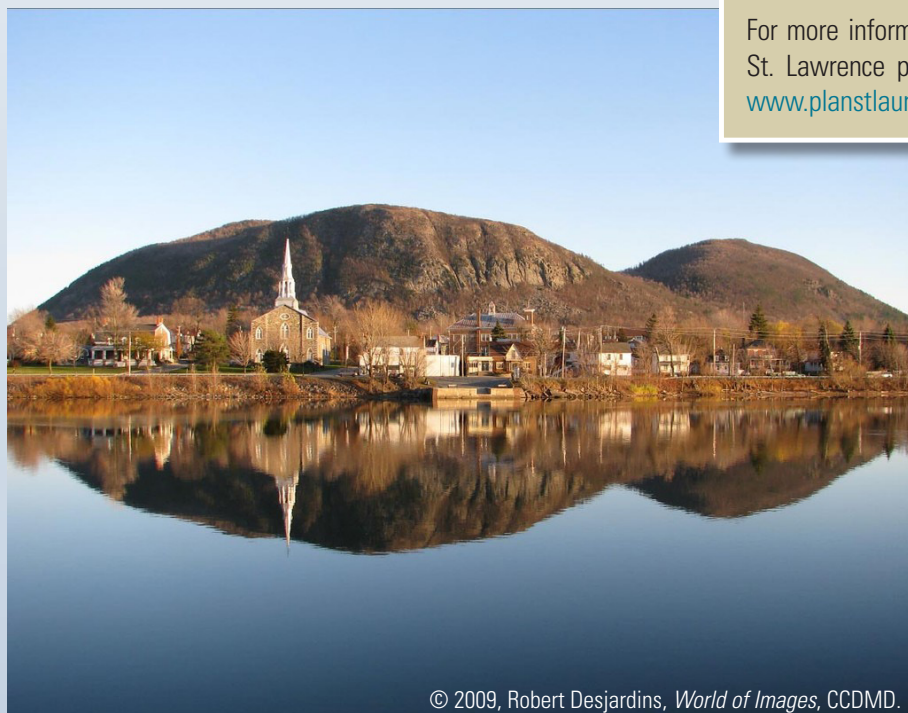
Future studies will focus on the monitoring of the same contaminants studied in the Richelieu and Yamaska rivers. Long-term monitoring of the contamination of the aquatic environment can then be ensured.

Monitoring the State of the St. Lawrence program

Five government partners—Environment Canada, Fisheries and Oceans Canada, Parks Canada, the ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques du Québec, the ministère des Forêts, de la Faune et des Parcs du Québec—and Stratégies Saint-Laurent, a non-governmental organization active within riverside communities, are pooling their expertise and their efforts to report back to the public on the state and long-term evolution of the St. Lawrence.

To do that, environmental indicators have been developed from the data gathered within the framework of the environmental monitoring activities that each organization has been pursuing over the years. Those activities concern the main components of the environment, namely water, sediments, biological resources, uses and shorelines.

For more information on the Monitoring of the State of the St. Lawrence program, please visit the following website: www.planstlaurent.qc.ca.



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For more information

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