Butyltins in sediments of St. Lawrence River (Canada)

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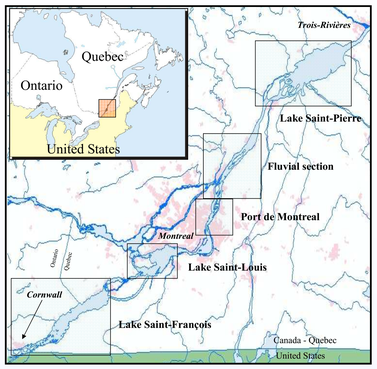
Introduction

Butyltins have been used as biocides in antifouling paints for ship hulls, in fungicides, insecticides and wood preservation products and as stabilizers in polyvinyl chloride (PVC) since 1960. Although their use on small vessels is regulated in Canada since 1989, butyltins are still used as antifouling agent by a significant portion of the worldwide commercial fleet. Butyltins can be found in sediments in the form of tributyltin and its degradation products, dibutyltin and monobutyltin. These organic metals are persistent in the environment, bioaccumulate in aquatic organisms and cause toxicity. As a part of collaboration between monitoring and research programs on the chemical contamination in the St. Lawrence River (Canada), we analyzed butlytin in 250 sediment samples carry out in fluvial lakes, commercial harbours, and marinas along the river.



Sediment quality assessment

In Canada, there are no sediment quality assessment criteria for butyltins (BTs). However, it seems reasonable to use Norway's criteria, which are based on the systems of the European Union, which define quality standards for the environment and the assessment of environmental risk (Bakke et al., 2010). The criteria form 5 quality classes comparable to those used for the management of contaminated sediments defined in Quebec for other contaminants (EC and MDDEP, 2007). In addition, we used an interim criterion has been proposed for Great Lakes harbours (Bartlett et al., 2005) in order to form a sixth quality class named "extreme".

Legend

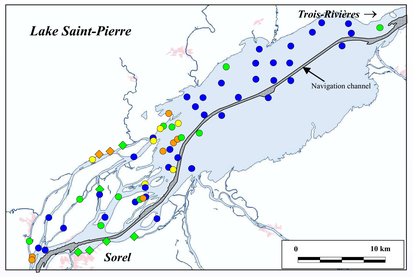
Symbols	Quality Classes	Butyltins Concentration
Port de Montreal	Extreme	> 800 ng Sn/g
Marina	Very poor	100 à 800 ng Sn/g
	Poor	20 à 100 ng Sn/g
St. Lawrence River	Moderate	5 à 20 ng Sn/g
	Good	1 à 5 ng Sn/g
Contrecœur	Background	<1 ng Sn/g

Adapted from Bakke et al 2010

St. Lawrence River

Surface sediment samples were collected in the three fluvial lakes, fluvial section, and Montreal sector outside the harbour. According to the analytical findings, 50% of the samples contain one of three forms of BT, with monobutyltin (MBT) being the form most frequently found. Given the low median concentration of BTs, most stations are at the "background" level. Of the stations that contain BTs, 25% are of moderate quality and 24% are of poor quality and are located in the depositional basins of the fluvial lakes. These stations of lesser quality contain primarily MBT, which suggests that BTs in the St. Lawrence River are considerably degraded.

St. Lawrence River (n:133)	**MBT** (ng Sn/g)	**DBT** (ng Sn/g)	**TBT** (ng Sn/g)	**BT** (ng Sn/g)
Minimum	<DL	<DL	<DL	<DL
Median	<DL	<DL	<DL	0.8
Maximum	88	4	66	91
% detection	38	17	23	50

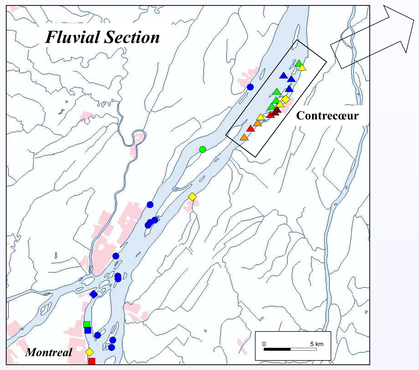


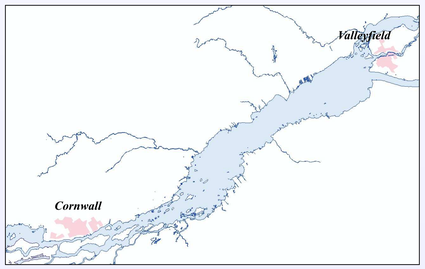
Marina

Sediment samples were collected in 20 marinas located between Cornwall and Trois-Rivières. Almost all of the samples (96%) contained detectable BT concentrations. The percent detection rates of MBT, dibutyltin (DBT) and tributyltin (TBT) were 81%, 56% and 48%, respectively, and suggest that the BTs are relatively highly degraded.

For stations containing BTs, 27% are of moderate quality, 23% are of poor quality and 15% are of very poor quality. The most heavily contaminated marina is the basin of the Charron Island, which contains only TBT (330 ng Sn/g), an indication that the contamination is very recent.

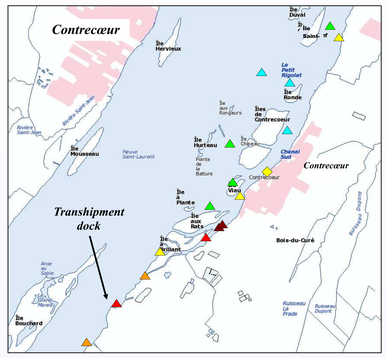
Marina (n:27)	**MBT** (ng Sn/g)	**DBT** (ng Sn/g)	**TBT** (ng Sn/g)	**BT** (ng Sn/g)
Minimum	<DL	<DL	<DL	<DL
Median	1.40	2.10	<DL	9.40
Maximum	120	97	330	330
% detection	81	56	48	96





Contrecœur

The sector of the Contrecœur Islands, located in the fluvial section of the river between Montreal and Lake Saint-Pierre, is a natural area that has been designated a national wildlife area. All surface sediment sampling stations contain BTs, 50% of which range in quality from moderate to extreme. The two highest concentrations, namely 2093 ng Sn/g and 982 ng Sn/g, are found at stations in an area of calm water, with 75% and 56% TBT, indicating that the BT is relatively undegraded. The BT contamination may come from an occasionally used transhipment dock located in high current velocity several kilometres upstream of the islands. A BT concentration of 218 ng Sn/g consisting entirely of TBT was detected near this dock.



Contrecoeur n:16)	**MBT** (ng Sn/g)	**DBT** (ng Sn/g)	**TBT** (ng Sn/g)	**BT** (ng Sn/g)
Minimum	<DL	<DL	<DL	0.4
Median	<DL	1.4	2.7	10.1
Maximum	12	480	1603	2093
% detection	50	63	69	100

References

Bakke, T., T. Källqvist, A. Ruus, G.D. Breedveld and K. Hylland. (2010) Development of sediment quality criteria in Norway. *J. Soils Sediments* 10:172-178.

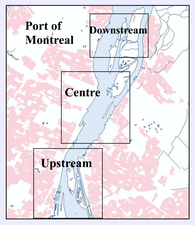
Bartlett, A.J., U. Borgmann, D.G. Dixon, S.P. Batchelor and R.J. Maguire. (2005) Toxicity and bioaccumulation of tributyltin in *Hyalella azteca* from freshwater harbour sediments in the Great Lakes Basin, Canada. *Can. J. Fish. Aquat. Sci.* 62:1243-1253.

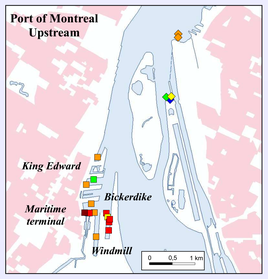
Environment Canada and Ministère du Développement durable, de l'Environnement et des Parcs du Québec. 2007. Criteria for the Assessment of Sediment Quality in Quebec and Application Frameworks: Prevention, Dredging and Remediation. 39 pages.

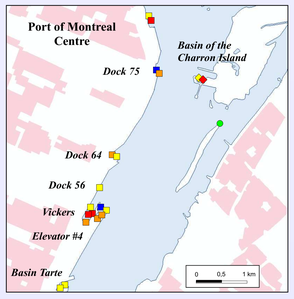
Port of Montreal

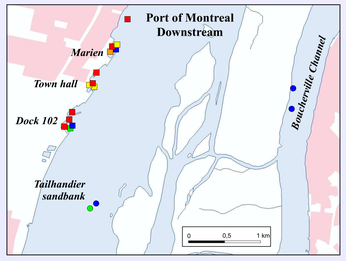
The Port of Montreal is located along the south shore of the Island of Montreal, between the Lachine Rapids and Pointe-aux-Trembles. Surface sediment samples were collected at 47 stations near the main docks. Overall, the median of the BT concentrations is 54 ng Sn/g and BTs were detected in 91% of the stations. Of the stations containing BTs, 28% are of moderate quality, 28% are of poor quality, 37% are of very poor quality and 2% are in the extreme class. The upstream sector contains a large number of high concentrations of relatively undegraded BTs, with 75% TBT. The basins of the maritime terminal and Bickerdike terminal are the most heavily contaminated, with extreme values of 1341 ng Sn/g and 356 ng Sn/g, respectively.

Port of Montreal (n:47)	**MBT** (ng Sn/g)	**DBT** (ng Sn/g)	**TBT** (ng Sn/g)	**BT** (ng Sn/g)
Minimum	<DL	<DL	<DL	<DL
Median	<DL	5.6	31.0	54.2
Maximum	170	259	1099	1341
% detection	47	66	74	91









Findings

The grouping of the BT results from various monitoring and research projects related to the contamination of the St. Lawrence River paints a relatively positive picture for the three fluvial lakes and fluvial section, with the exception of the Contrecœur Islands sector. In contrast, measured BT concentrations in sediments in the Contrecœur Islands show high concentrations of relatively undegraded BTs. Most marinas contain sediments contaminated with highly degraded BTs, and one marina shows a high TBT contamination. Overall, sediments in the Port of Montreal contain relatively high BT concentrations, particularly in the upstream sector. The concentrations of the various forms of butyltins show that they are relatively undegraded, which reveals that BT inputs from paint biocides continue to be high.

Next Steps

- Additional data from navigation lock and Port of Québec
- Statistical analyses (spatial pattern, relationship with chemical and environmental characteristics, Nondetect And Data Analysis (NADA), etc)
- Complementary assessment in Contrecoeur Islands area (temporal trends, bioaccumulation, bioamplification, etc)

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