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RESULTS OF TOXICITY SCREENING TESTS AND BIOMASS ESTIMATIONS ON SEDIMENT SAMPLES COLLECTED FROM THE OTTAWA RIVER, LAC DES DEUX MONTAGNES, LAC SAINT LOUIS AND CANAL DE BEAUHARNOIS, 1985

by
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ABSTRACT

A total of 32 sediment samples were collected from the Ottawa River, Lac des Deux Montagnes, Lac Saint Louis and Canal de Beauharnois for toxicity screening tests and ATP (biomass) concentrations. Within Lac Saint Louis, the distribution and concentration of toxicants and ATP concentrations were similar to those found in the 1984 study of this area. There appears to be a band of sediments between Ile de la Paix and the south shore of Lac Saint Louis where toxicants are readily found.

No toxicants as measured by the Microtox procedure were found in sediment samples from the Ottawa River and Lac des Deux Montagnes.

Résultats des essais de dépistage de la toxicité et des estimations de la biomasse des échantillons de sédiments recueillis dans la rivière des Outaouais, le lac des Deux Montagnes, le lac Saint-Louis et le canal de Beauharnois, 1985. K.K. Kwan et B.J. Dutka.

SOMMAIRE

On a recueilli au total 32 échantillons de sédiments de la rivière des Outaouais, du lac des Deux Montagnes, du lac Saint-Louis et du canal de Beauharnois pour effectuer des essais de dépistage de la toxicité et mesurer les concentrations (biomasse) d'ATP. Pour le lac Saint-Louis, la distribution et les concentrations de substances toxiques et d'ATP se sont révélées semblables aux valeurs mesurées en 1984 lors de l'étude menée dans la région. Il semble y avoir une bande de sédiments s'étendant entre l'Île de la Paix et la rive sud du lac Saint-Louis dans laquelle on est plus susceptible de découvrir des substances toxiques.

On n'a décelé aucune substance toxique dans les échantillons provenant de la rivière des Outaouais et du lac des Deux Montagnes en analysant les sédiments au moyen de la méthode Microtox.

EXECUTIVE SUMMARY

This study is the continuation of the 1984-85 Analytical Methods Division, Microbiological Laboratories Section project to study the distribution patterns of toxicants in the sediments of Lac St. Louis due to industrial discharges. Data from the 1985 study indicated that the distribution and concentration of toxicants and ATP (biomass) concentrations were similar to those found in the 1984 study. No toxicant activity was found by the techniques used in sediments collected from Ottawa River and Lac de Deux Montagnes.

The 1984 and 1985 data from the Lac Saint Louis sediments indicate that toxicant screening test (Microtox) provides a useful technique for establishing the extent of toxicant influence and the effect of decreasing toxicant discharges. However, the biomass parameter, ATP, does not appear to be a sensitive enough indicator of sediment stresses when a period of time (2+ years?) has passed between toxicant discharge and the testing for ATP. Based on our 1984 and 1985 Lac Saint Louis studies, we believe viable biomass concentration tests as measured by ATP have a more practical application in measuring the effect of recent large spills.

INTRODUCTION

This study is a continuation of the 1984-85 Analytical Methods Division, Microbiological Laboratories Section Project No. 625, which was one part of a major project on St. Lawrence River sediments coordinated by Mr. H. Sloterdijk, Quebec Region, IWD, DOE. The original goals of this project were to study the toxic effects of industrial waste discharges on the sediment microbiota and to establish the distribution and biodegradation patterns of these wastes in the sediments of Lac Saint Louis. In this study, some of the 1984-85 sampling sites in Lac Saint Louis were resampled and some new sites were also tested. In addition, sediment samples were collected from the Ottawa River immediately above Lac des Deux Montagnes and the Canal de Beauharnois. This report presents the results of Microtox toxicity screening tests and ATP concentration tests on the 32 sediments collected during the summer of 1985.

METHODS

Samples

During the period June to August 1985, a total of 32 Ekman dredge sediment samples (Fig. 1) were collected for ATP (biomass) and Microtox toxicity screening tests. Upon collection, the surface water

was drained off and the sediment samples representing approximately the top 10-12 cm were placed into sterile 500 mL polypropylene bottles by means of a spatula. The bottles of sediment were placed in melting ice until processing could be completed. All samples were processed for total biomass (ATP) and toxicants (Microtox) within 24 hours of collection.

Total Biomass

The polytron procedure described by Tobin et al. (1978) was used to extract ATP from 0.5 mL of sediment slurry after weighing. The total biomass (ATP) was estimated by using the Turner Designs model TD-20e luminometer and following the procedure described in the Turner Luminescence Review 1983. The total biomass was expressed as grams of ATP per gram wet weight of sediment.

Toxicant Screening

For each sample, 100 grams of sediment slurry were weighed and placed into an acid washed and Milli-Q reagent grade water rinsed (5 times) BOD bottle. One hundred mL of Milli-Q reagent grade water was added to the bottle of sediment and the bottle was stoppered and shaken vigorously by hand for two minutes. The mixture was then poured into 250 mL Nalgene centrifuge tubes and centrifuged for 20

minutes at 10,000 rpm at 4°C. The supernatant was used to test for toxicants via the Microtox toxicity screening procedure.

The Microtox toxicity screening test was carried out following the procedure detailed in the 1982 Beckman Instruments Inc. Manual, with contact time of 15 minutes (Dutka and Kwan, 1982). Data are reported as a percentage of 1 mL of sediment extract that produced a 50% reduction (EC_{50}) in light output.

RESULTS AND DISCUSSION

In Figure 1, the 32 sediment sampling sites are shown. The results of the Microtox toxicity screening tests on these sediments are presented in Table 1 and Figure 2. Here it can be seen that the majority of the sediments with the greatest toxicant activity are found in an area bounded by Station L12 at the entrance of the St. Lawrence River into Lac Saint Louis, thence southeast through the channel between Ile de la Paix and the south shore of Lac Saint Louis (L1, L3, L4, L5, L6, L7 and L8).

The sediment sample with the highest concentration of toxicants was found at Station L20, near the north shore of Lac Saint Louis, between Pointe Claire and Dorval. This station (L20) is very close to the 1984 Stations F3 and F4 which ranked 1 and 4 in toxicant concentrations (Kwan and Dutka, 1984) (Fig. 3).

The pattern of toxicant distribution and concentrations in Lac Saint Louis was very similar to those observed during the 1984 study

with homogenized sediments (Fig. 3). The finding of no toxicant activity in the sediments collected from the Ottawa River and Lac des Deux Montagnes coupled with the finding of toxicant activity in sediments L15, L16 and L18, suggests that the scouring action of the river water during high water periods was sufficiently strong to inhibit toxicant build up.

The results of the 1985 study confirm that the 1984 toxicant distribution pattern was real and reproducible.

Of the three sediments screened for toxicant activity from the Canal de Beauharnois, only B1 was found to contain any toxicant activity as measured by the 15 minute Microtox procedure. The source of the toxicants at B1 are not known. As the other two sites (B2, B3) were negative for toxicant activity, it is surmised that the source of B1 toxicants may be a small discharging local site. A more detailed local study would be required to substantiate this suspicion.

The ATP concentrations (biomass) found in the 32 sediments are shown in Table 2 and displayed in Figure 4. One striking feature noted is the low ATP concentrations found in the Ottawa River and Lac des Deux Montagnes sediments. This finding of low biomass concentrations supports the hypothesis that the scouring action of the river flow is sufficiently great to inhibit the settling of toxicants and the growth of a heavy microbial population in the remaining sediments. The sediments found in Lac Saint Louis contain biomass (ATP) concentration patterns similar to those noted in the 1984 study (Kwan and Dutka, 1984).

There do not appear to be any obvious relationships between toxicant concentrations and biomass (ATP levels). For instance, even though the nearby Stations L2 and L3 have sediments with the lowest microbial biomass (Rank 32 and 31), L2 sediment was found not to have any toxicant activity while L3 had the 9th highest concentration of toxicants (Microtox activity). Also Station L8 sediment had the highest concentration of ATP (Rank 1) as well as having the third highest concentration of toxicants.

These anomalies strongly suggest that: (1) microbial biomass (ATP) may be related to sediment accumulation areas and (2) that the biota have enormous recuperative powers and only react for a short time to the stress of toxicants before adapting and continuing to multiply or being replaced by hardier species.

The 1984 and 1985 data from the Lac Saint Louis sediments indicate that toxicant screening test (Microtox) provides a useful technique for establishing the extent of toxicant influence and the effect of decreasing toxicant discharges. However, the biomass parameter, ATP, does not appear to be a sensitive enough indicator of sediment stresses when a period of time (2+ years?) has passed between toxicant discharge and the testing for ATP. Based on our 1984 and 1985 Lac Saint Louis studies, we believe viable biomass concentration tests as measured by ATP have a more practical application in measuring the effect of recent large spills.

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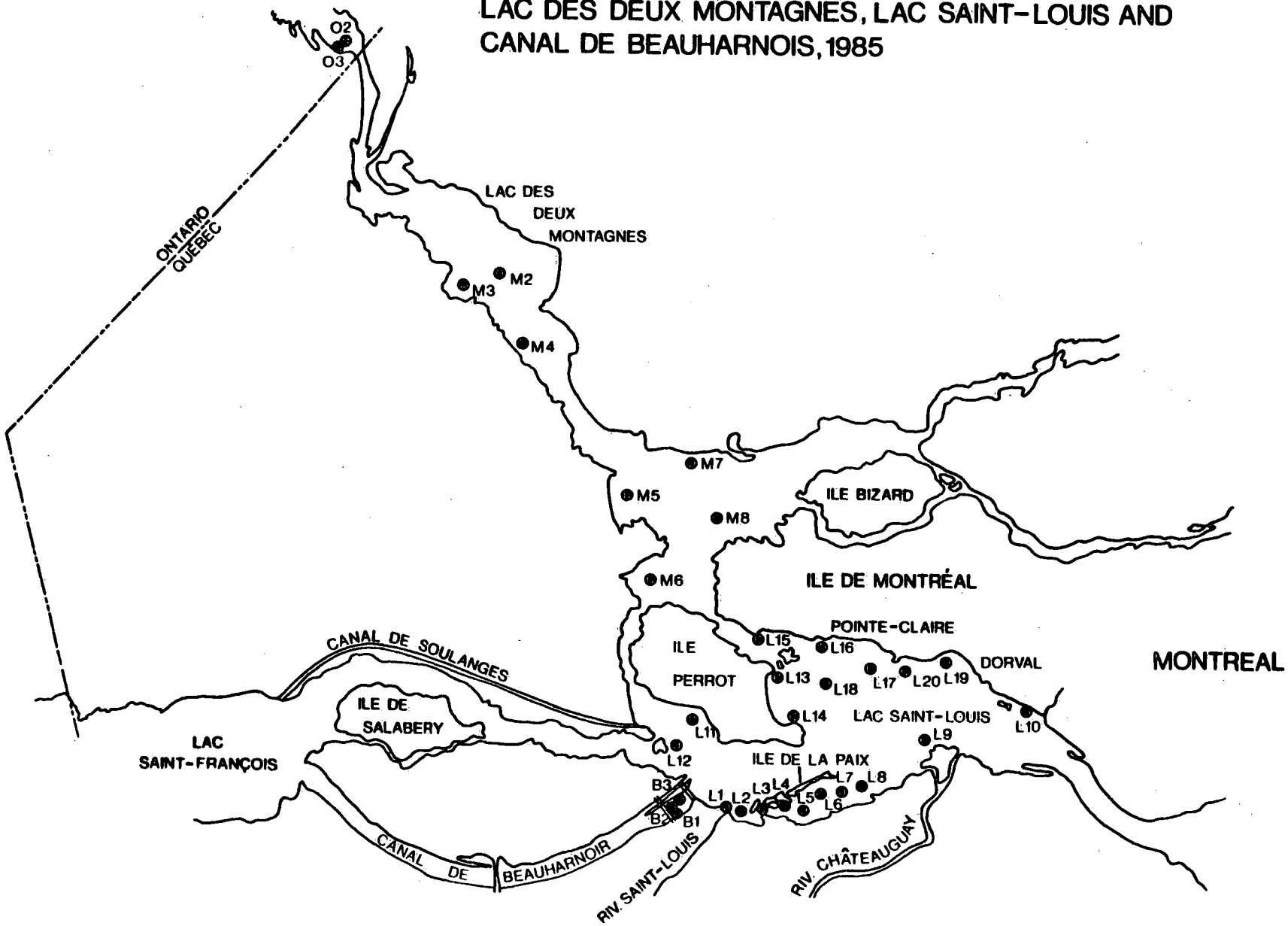
FIGURE 1. LOCATION OF SEDIMENT SAMPLING SITES–OTTAWA RIVER, LAC DES DEUX MONTAGNES, LAC SAINT-LOUIS AND CANAL DE BEAUHARNOIS, 1985



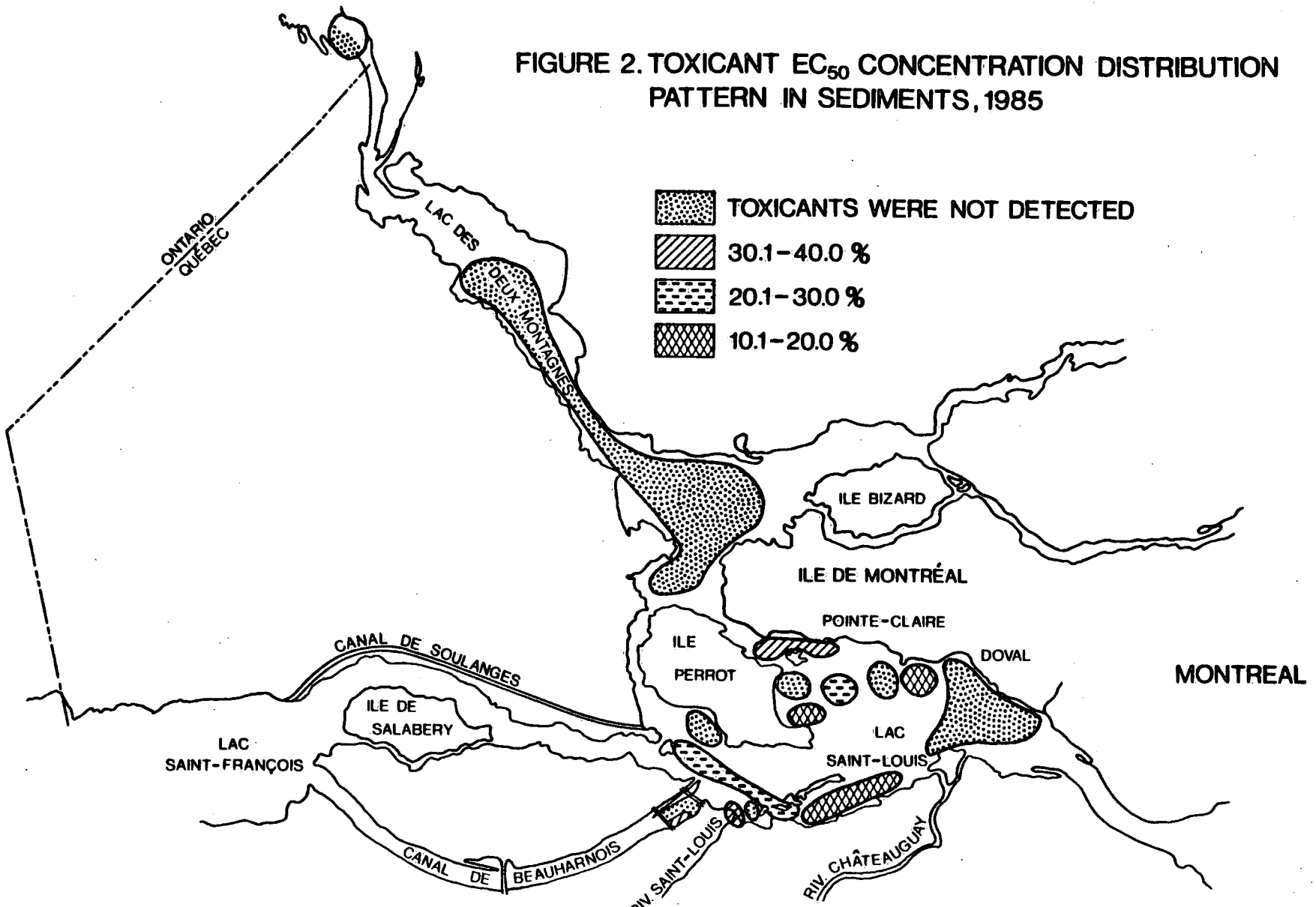


FIGURE 2. TOXICANT EC_{50} CONCENTRATION DISTRIBUTION PATTERN IN SEDIMENTS, 1985
TOXICANTS WERE NOT DETECTED
30.1-40.0 %
20.1-30.0 %
10.1-20.0 %
ONTARIO
QUÉBEC
LAC DES DEUX MONTAGNES
ILE BIZARD
ILE DE MONTRÉAL
POINTE-CLAIRE
ILE PERROT
DOVAL
MONTREAL
CANAL DE SOULANGES
ILE DE SALABERY
LAC SAINT-FRANÇOIS
LAC SAINT-LOUIS
CANAL DE BEAUHARNOIS
RIV. SAINT-LOUIS
RIV. CHÂTEAUGUAY

Figure 3

TOXICANT CONCENTRATION, DISTRIBUTION PATTERN, HOMOGENIZED 10cm SEDIMENTS: 1984

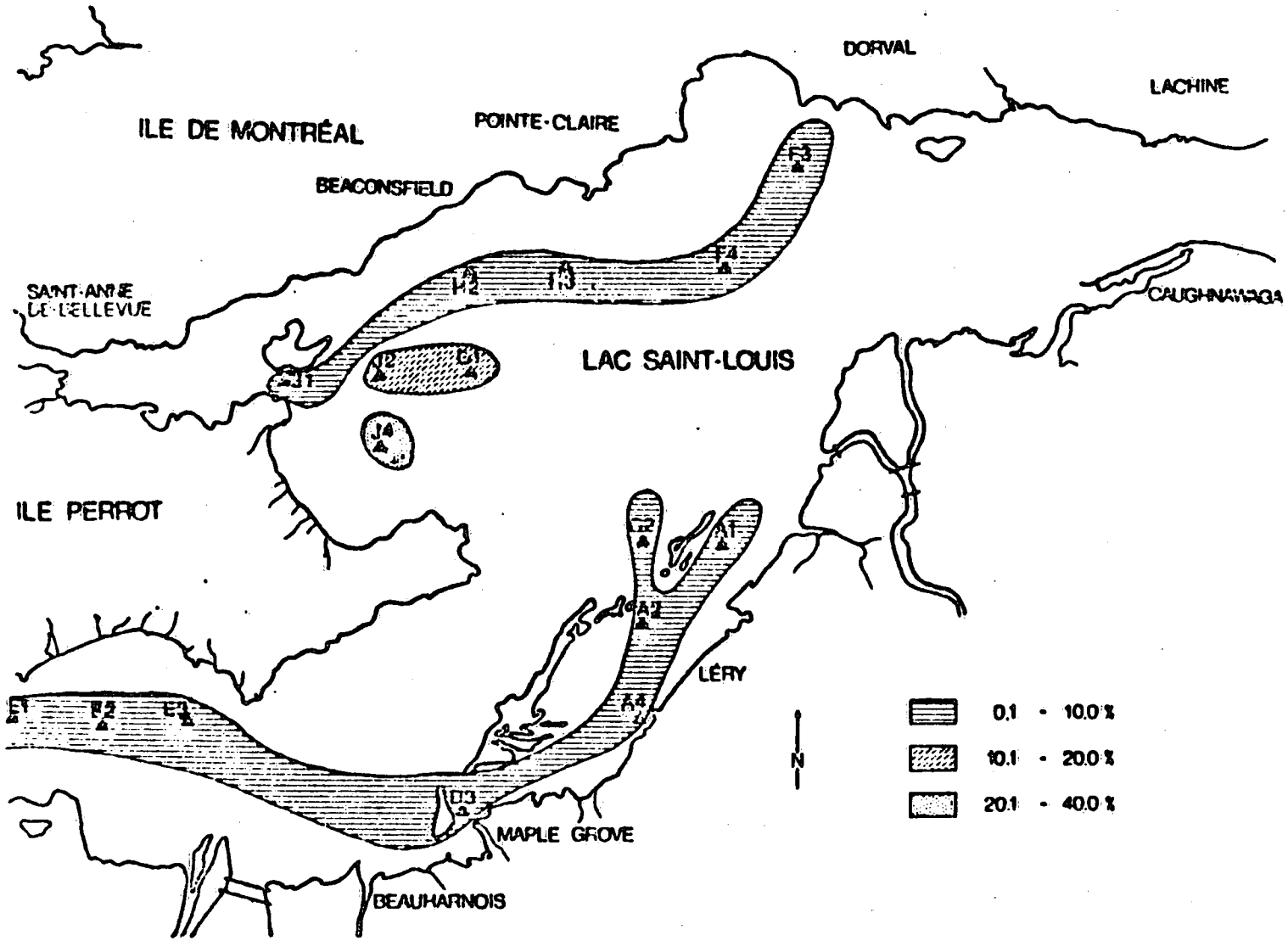


FIGURE 4. MICROBIAL BIOMASS DISTRIBUTION PATTERN IN SEDIMENTS AS MEASURED BY ATP CONCENTRATIONS, 1985

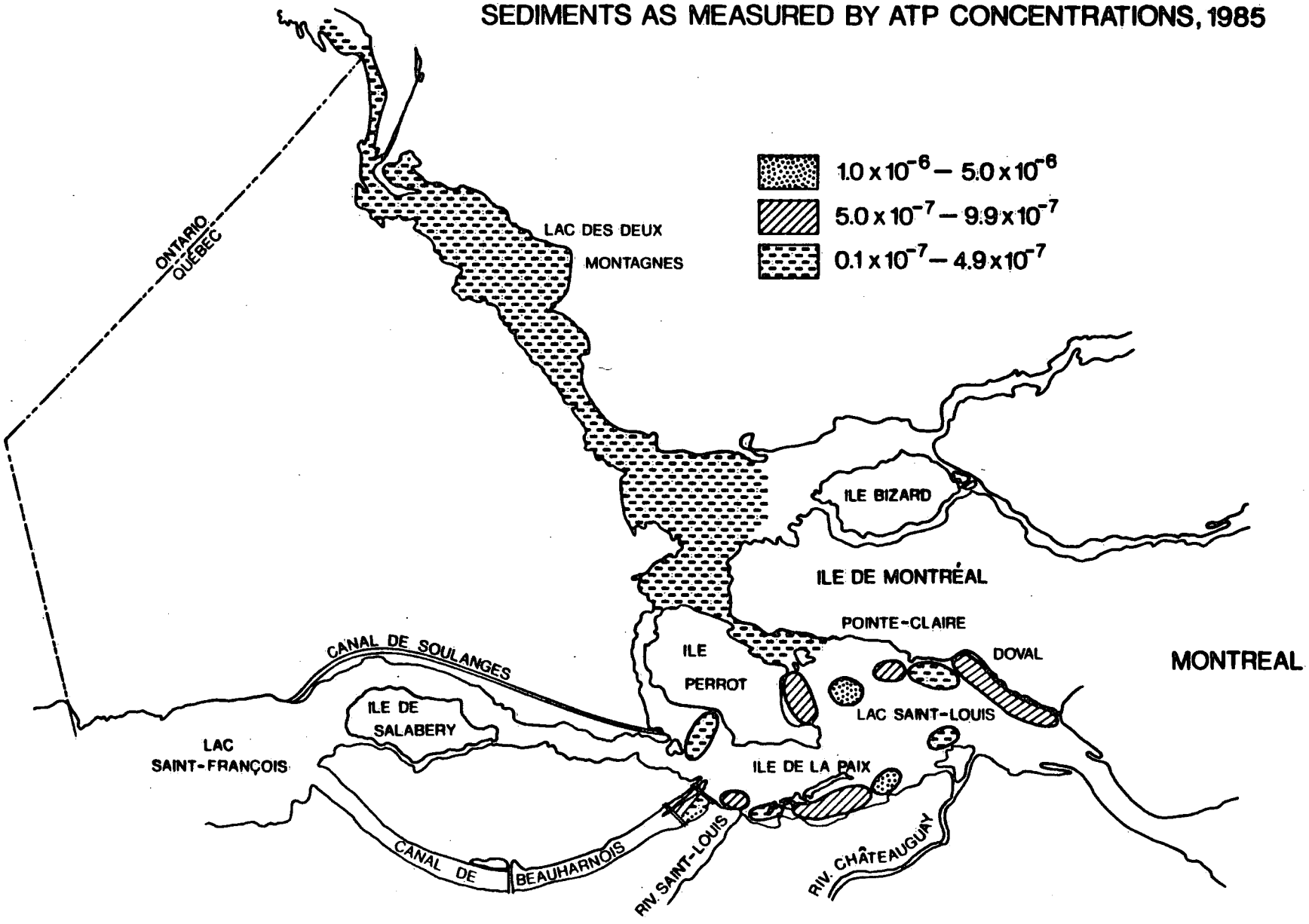


TABLE 1 Microtox EC_{50} values of sediment samples from Ottawa River, Lac des Deux Montagnes, Lac Saint Louis and Canal de Beauharnois. Ranking most to least toxic, is also shown.

Station Number	EC_{50}	Ranking Order Most Toxic to Least
[1]O2	N.D.[5]	15
O3	N.D.	15
[2]M2	N.D.	15
M3	N.D.	15
M4	N.D.	15
M6	N.D.	15
M7	N.D.	15
M8	N.D.	15
[3]L1	37.5%	12
L2	N.D.	15
L3	28.8%	9
L4	28.8%	9
L5	18.8%	5
L6	18.4%	4
L7	16.3%	2
L8	17.5%	3
L9	N.D.	15
L10	N.D.	15
L11	N.D.	15
L12	22.5%	8
L13	N.D.	15
L14	18.8%	5
L15	39.4%	13
L16	48.8%	14
L17	N.D.	15
L18	21.3%	7
L19	N.D.	15
L20	13.4%	1
L21	N.D.	15
[4]B1	32.5%	11
B2	N.D.	15
B3	N.D.	15

[1]O Ottawa River
[2]M Lac des Deux Montagnes
[3]L Lac Saint Louis
[4]B Canal de Beauharnois
[5]N.D. Not Detected

TABLE 2 ATP concentration in sediment samples collected from the Ottawa River, Lac des Deux Montagnes, Lac Saint Louis and Canal de Beauharnois. Ranking highest to lowest is also shown.

Station Number	Gm ATP/GM Wet Wt. Sediment ($x10^{-7}$)	Ranking Highest Concentration ATP to Lowest
[1]02	2.5	23
03	2.1	27
[2]M2	3.4	18
M3	2.2	26
M4	3.1	21
M6	2.5	23
M7	2.3	25
M8	2.0	28
[3]L1	7.7	7
L2	1.0	32
L3	1.1	31
L4	9.9	4
L5	5.1	12
L6	5.0	14
L7	7.6	8
L8	13.0	1
L9	2.6	22
L10	6.7	9
L11	2.0	28
L12	4.3	15
L13	9.8	5
L14	5.8	10
L15	3.3	19
L16	3.3	19
L17	5.1	12
L18	10.0	3
L19	5.2	11
L20	4.2	16
L21	4.0	17
[4]B1	11.0	2
B2	8.8	6
B3	1.3	30

[1]O Ottawa River
[2]M Lac des Deux Montagnes
[3]L Lac Saint Louis
[4]B Canal de Beauharnois