

**Location of lake sturgeon  
(*Acipenser fulvescens*)  
spawning grounds in  
the upper part of  
the Lachine rapids  
(St. Lawrence River)**

Direction de l'aménagement de la faune de Montréal, de Laval et de la Montérégie



Société de la faune et des parcs du Québec

**TECHNICAL REPORT 16-15E**

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**Location of lake sturgeon (*Acipenser fulvescens*)  
spawning grounds in the upper part of the Lachine rapids  
(St. Lawrence River)**

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## SUMMARY

Aboriginal fishing activities of lake sturgeon have been under way for a few years in the upstream portion of the Lachine Rapids. This new fishery is practiced year-round and even in spring during the species' spawning period. In May and June 2001, a study carried out jointly by the Société de la Faune et des Parcs du Québec (FAPAQ) and the Mohawk Council of Kahnawake showed that the sturgeons present in this sector had characteristics associated with the reproductive part of the St. Lawrence River stock. While no spawning ground was located during that study, several indicators show that the upstream sector of the Lachine Rapids likely contains one or more lake sturgeon spawning grounds, in particular the capture of larvae in June 2000 at the outlet of these rapids (Pierre Bilodeau, FAPAQ biologist, personal communication). Following up on the recommendations made during the first study in 2001, FAPAQ, in collaboration with the Mohawk Council of Kahnawake, the Secrétariat aux affaires autochtones and the ministère de l'Agriculture, des Pêcheries et de l'Alimentation, decided to continue work in the spring of 2002 in order to evaluate the use made of the rapids zone at the outlet of Lac Saint-Louis as a lake sturgeon reproduction area.

The objectives of this study are: 1- to confirm lake sturgeon egg deposition; 2- to determine the limits of the lake sturgeon spawning sectors; 3- to compare the results obtained with those observed on other spawning grounds; 4- to develop a new method for sturgeon eggs sampling. The results of this study were supposed to make it possible, beyond all reasonable doubt, to confirm or rule out the presence of lake sturgeon spawning grounds in the upstream portion of the Lachine Rapids. The sampling techniques were oriented towards the search for lake sturgeon spawn in rapids. The main gear used to harvest eggs was unusual and not well known in Québec prior to the start of the work. It is comprised of a cement parpen covered with a section of air filter measuring 90 cm in length and 30 cm in width (a latex-coated horsehair filter). The parpen is attached to one or more floats by means of a rope. Sturgeon eggs are sticky shortly after egg-laying. Those that drift and the ones that are stirred up adhere to the fibres or simply are held in place. Two other spawn harvesting methods, the standard dip nets and drift nets, were used to describe and monitor egg development on the identified egg-laying sites. The habitats of the area under study were stratified according to the spawning potential of the lake sturgeon (mapping study and review of the literature). The levels and physical characteristics chosen were: depth of 0 m to 5 m, current of 0.6 m/sec to 1.8 m/sec and green, brown or mixed water habitat with a rough substrate free from aquatic vegetation. Nine zones were chosen on the basis of these criteria. This choice was validated in the field prior to sampling. Monitoring took place from May 16 to June 20, 2002 at a temperature varying between 10 and 14°C. In all, 199 stations were monitored in the spring of 2002 in these nine sectors. The number of stations per sector varied between 11 and 37. More than 1000 gear-lifting operations were performed, with a 3-to-6-day interval between each lift. The effort varied slightly, ranging from 5.36 to 6 lifting operations/station per sector.

The results obtained made it possible to confirm the presence of one spawning ground in the upstream part of the Lachine Rapids in a sector located on the right shore, about 400 m downstream from Mercier Bridge. Given its surface area and its location, this spawning ground could be of significant importance for the St. Lawrence River population. It is bathed by good quality water and is far from the shore. Moreover, the rocky substrate that makes up the spawning ground is clean and unobstructed. The stratification of the habitat towards high potential spawning sites for the lake sturgeon greatly contributed to the success of the study. However, in light of the recent results obtained in certain tributaries of the Great Lakes, the depth that should be covered could be increased to 8 m and the flow rate to 2 m/s. The status of this new spawning ground is of concern as two aboriginal fishing sectors identified in the spring of 2001 overlap it.



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## 1 INTRODUCTION

Aboriginal sustenance fishing activities of lake sturgeon have been under way for many generations in the Lachine Rapids. However, since the end of the 1990s, a new fishery is practiced in these rapids during the species' spring spawning period. A study carried out jointly by the Société de la faune et des parcs du Québec (FAPAQ) and the Mohawk Council of Kahnawake showed that the sturgeons present in this sector during the spring of 2001 had characteristics associated with the reproductive part of the St. Lawrence River stock (La Haye and Clermont 2003). Following these results, it was recommended to prohibit every form of lake sturgeon harvesting in this sector during the spring period. This restriction applies to all North American jurisdictions to ensure the perpetuation of sturgeon populations including that of the St. Lawrence River. The results obtained also showed the interest of completing the work begun, by trying to identify and locate the lake sturgeon reproduction sites in this portion of the rapids.

Several studies carried out by FAPAQ have shown that the lake sturgeon stock (*Acipenser fulvescens*) of the St. Lawrence River has been over-fished for more than two decades. Fishing regulations have been adjusted to better protect this stock and to ensure the sustainability of the commercial fishery that is dependent upon it. One of FAPAQ's objectives was to reduce annual landings from over 200 tonnes before 1999 to 80 tonnes in 2002 (Dumont et al. 2000).

The commercial and recreational lake sturgeon fishery is prohibited from the start of November until mid-June throughout the St. Lawrence River, except for a small fishing zone around Ile d'Orléans, where the regulations have been adjusted to those of the Atlantic sturgeon (*A. oxyrinchus*). This period largely covers the migration period of spawners and the breeding season, which extends from the beginning of May to mid-June in southwestern Québec. Spawners are particularly vulnerable during this period as they move towards small sites where they lose their natural distrust during reproduction activities.

In the St. Lawrence River and its tributaries, lake sturgeon spawning grounds are rare and the number of spawners present is likely in sharp decline (Fortin et al. 2002). Less than a dozen spawning grounds are known and have been identified. In addition to the results obtained in the spring of 2001, several indicators show that the Lachine Rapids sector likely contains one or more lake sturgeon spawning sites. One of these clues is the capture of larvae made by FAPAQ

biologists using drift nets in June 2000 at the outlet of these rapids (Pierre Bilodeau, FAPAQ biologist, personal communication). Furthermore, recent testimonies concerning catches or observations of spawners, including egg-bearing females, have been frequent.

Finally, the late Réjean Fortin (professor-researcher, Université du Québec à Montréal), who studied the biology of the sturgeons of the St. Lawrence River for much of his life, believed that the number of currently known spawning grounds and the potential number of larvae that they produce each year are insufficient to support the fishing yields of the past few decades. However, during the 1980s, major studies were made within the context of the Archipel project to identify and locate spawning grounds in Lachine rapids. Despite the capture of a few large mature specimens, it has not been possible to identify sturgeon spawning grounds (Guay and Couillard 1985).

Following up on the recommendations made during the first study in 2001, FAPAQ, in collaboration with the Mohawk Council of Kahnawake, the SAA and MAPAQ, decided to continue the work in the spring of 2002 with a view to evaluating the use of the rapids zone at the outlet of Lac Saint-Louis as a lake sturgeon reproduction area.

The objectives of this study are:

- To confirm sturgeon egg deposition in the study area;
- To determine the limits of lake sturgeon spawning grounds in the sector under study;
- To compare the results obtained with those observed on other spawning grounds;
- To develop a new method for sturgeon eggs sampling.

The results of this study, slated to cover a two-year period, were supposed to make it possible, beyond all reasonable doubt, to confirm or rule out the presence of lake sturgeon spawning grounds on the territory in question.

## **2 MATERIAL AND METHODS**

### **2.1 Delimitation of the study area**

The study area covers only a portion of the Lachine Rapids that extend up to the Laprairie Basin. The upstream limit is located between Dixie Island on the left shore and Saint-Nicholas Island on the right shore. A distance of about 10 km separates this upstream limit from Mercier Bridge. The power transmission line upstream from Aux Hérons Island, about 3.5 km from Mercier Bridge, is the downstream limit.

The sampled section is less vast than the aforementioned territory. A set of criteria made it possible to delimit high-potential zones for lake sturgeon spawning. A series of shoals were chosen based on these criteria and the available resources. The criteria and the approach used for the choice of these zones are described in detail in sections 2.3.2 and 2.3.3.

### **2.2 Sampling techniques for locating egg deposition**

The sampling techniques used in the spring of 2002 were basically geared towards the search for lake sturgeon spawn in rapids and not towards catching juveniles and adults. Cement parpens covered with air filter material, standard dip nets and drift nets were used to catch eggs and larvae. The chosen sites were systematically covered in time and space using parpens. The other spawn harvesting methods were used to describe and monitor the development of eggs on the identified egg-laying sites.

The main sampling gear is comprised of a cement parpen 39 cm in length, 19 cm in width and 9 cm in thickness, and a section of air filter measuring 90 cm in length and 30 cm in width (latex-coated horsehair filter model BA 136). The gear is connected to one or more floats by means of a braided nylon rope (Photo 1). The filter covers each side of the cement parpen and is held in place by an elastic band with hooks (Photo 2).



Photo 1. Elements making up the sampling gear used for the systematic search for lake sturgeon eggs in the upstream portion of the Lachine Rapids, spring of 2002: cement parpen, piece of air filter, elastic band with hooks, rope and floats.



Photo 2. Assembled sampling gear; the parpen is covered with the piece of air filter which is held in place by the elastic band.

This sampling gear was developed by American biologists to harvest lake sturgeon eggs in quick and deep water areas (Jennifer Hayes, biologist, New York State University, Syracuse, personal communication). In Québec, it was first utilized and improved upon by La Haye and Clermont (2002) in the spring of 2001 to monitor the use of a spawning ground by lake sturgeon. The principle behind this gear is simple : sturgeon eggs are sticky immediately after egg-laying, when floating or stirred up from the river bottom; they easily adhere to the filter's fibres or are simply caught in the fibre mesh. Within the context of this study, the permanent tie that was used to hold the filter section on the parpen was replaced by an elastic band with hooks. This improvement made it possible to avoid unnecessary weight during field visits, as only the pieces of filter were collected on site and replaced with new ones.

Based on the experience acquired over the years by our work team, the sturgeon egg dispersion area during spawning is such that the parpen should permit the harvesting of eggs deposited on a section upstream, measuring about 20 m long by 5 m wide. The intensity of sampling was determined taking into account this estimate.

The parpens were systematically placed on the riverbed in sectors chosen prior to the start of the sampling period. The chosen sectors had three very different types of morphologies. Some were round in shape, others elongated in the direction of the flow whereas some, narrower in size, followed the periphery of the shoreline. The parpens were generally arranged in a chequered pattern along more or less rectilinear transects in a cross-wise position in relation to the current. In those sectors that were most conducive to lake sturgeon spawning, the distance between the parpens did not exceed 30 m. The round-shaped sectors were covered using several transects in order to adequately sample the entire surface. Another approach was used for the second type of sector. Two very close lines (less than 30 m apart) were placed on the downstream edge of the sector in order to offer a tighter cross-stream coverage. Finally, the spawning habitat appeared to be more intermittent in those sectors located near the shores. Pairs of parpens separated more than 40 m apart were placed downstream from interesting micro-habitats along the shore. When all of the interesting sectors were completely covered, additional lines were added to these sectors or to other secondary sites offering good spawning potential for the lake sturgeon.

## **2.3 Sampling strategy for locating egg deposition**

### **2.3.1 Review of the physical characteristics of the territory under study**

The sectors offering a good lake sturgeon spawning potential were first identified by a mapping study and a review of the information available on the physical characteristics of the area under study. The main characteristics that oriented the choice of sectors possibly containing a sturgeon spawning ground were as follows: the depth, the type of substrate, the speed of the current and the presence or absence of vegetation. Several documents were consulted :

- the nautical chart of Lac Saint-Louis (# 1410, year 1976. Scale 1:25,000) which indicates the water depths and the location of aquatic vegetation;
- the study reports prepared as part of the Archipel project in the early 1980s including that of Roche (1985, Volume 7) which consists of a booklet of maps. The list of the plates consulted is available upon request. The Roche report (1985, Volume 2, Book 1) on the same project was also used;
- aerial photographs dating back to 1975 to the scale of 1:5000;
- the Leclerc (1984) and Beak (1982) reports on the location of potential habitats of various fish species.

### **2.3.2 Stratification of the habitat according to the spawning potential**

The sectors potentially containing a sturgeon spawning ground were delimited according to the following steps:

1. The depths were determined by 2-m segments based on the nautical chart.
2. Initially, plans provided for flying over the entire territory under study in a helicopter. However, the spring high water level, which made the water cloudy, and the bad weather conditions forced us to abandon this idea. To remedy this shortcoming, a mosaic was created using aerial photographs in order to cover the entire sector. The field experience and the knowledge accumulated by work team members on the biology of the species made it possible to pinpoint the potential spawning sites on each of the photos. We established a certain number of criteria applicable to the area under study and pertaining to the resolution of maps, charts, photographs and other documents available, to identify

potential sturgeon spawning sites based on the works of Leclerc (1984) and La Haye (1992). These criteria were: a current speed of between 0.6 and 1.8 m/sec, a hard substrate (gravel or rock), the absence of vegetation, and a depth varying from 0.6 to 4.0 m. We did not take into account the type of water (green water of the Great Lakes, brown water of the Outaouais River, mixed water) in the choice of the sectors to be covered.

Transparency overlays on the various maps and photos made it possible to considerably reduce the search area for potential spawning sites, which went from 12.0 km<sup>2</sup> initially to 2.6 km<sup>2</sup> following the filtering of the available information. Some information obtained from officers of the regional Direction de la protection de la faune and cooperation from aboriginal residents allowed us to clarify the location of certain high-potential areas. The FAPAQ experimental fishing databank was also used to show lake sturgeon catches on the territory under study during the spawning period. Interviews with local users in Lachine (hunting and fishing store, sport fishers) provided additional information. Finally, several concentrations of spawners were located during the study carried out in the spring of 2001 on the territory under study (La Haye and Clermont 2003).

The sectors chosen at the time monitoring began are delineated in Figure 1.

### **2.3.3 Validation of the stratification of the habitat in the field**

The pre-selection of potential spawning sectors was validated in the field from May 13th to 15th prior to the commencement of systematic monitoring. Two boats equipped with sonar covered all of the chosen sectors and the remainder of the territory under study. These operations made it possible to delineate the areas to be covered using a few buoys and to identify new sectors that had gone unnoticed during the preliminary stratification. The area that was finally covered went from 2.6 km<sup>2</sup> to 0.3 km<sup>2</sup>. This difference mainly ensues from the abandoning of certain flats whose substrate, rocky according to the maps, was in actual fact soft and loose or covered with aquatic vegetation. The selection criteria finally applied in the field were as follows:

- depth range from 0 m to 5 m,
- green, mixed or brown water habitats
- substrate composed of gravel, rocks or pebbles,
- current range from 0.6 m/sec to 1.8 m/sec,
- absence of aquatic vegetation.

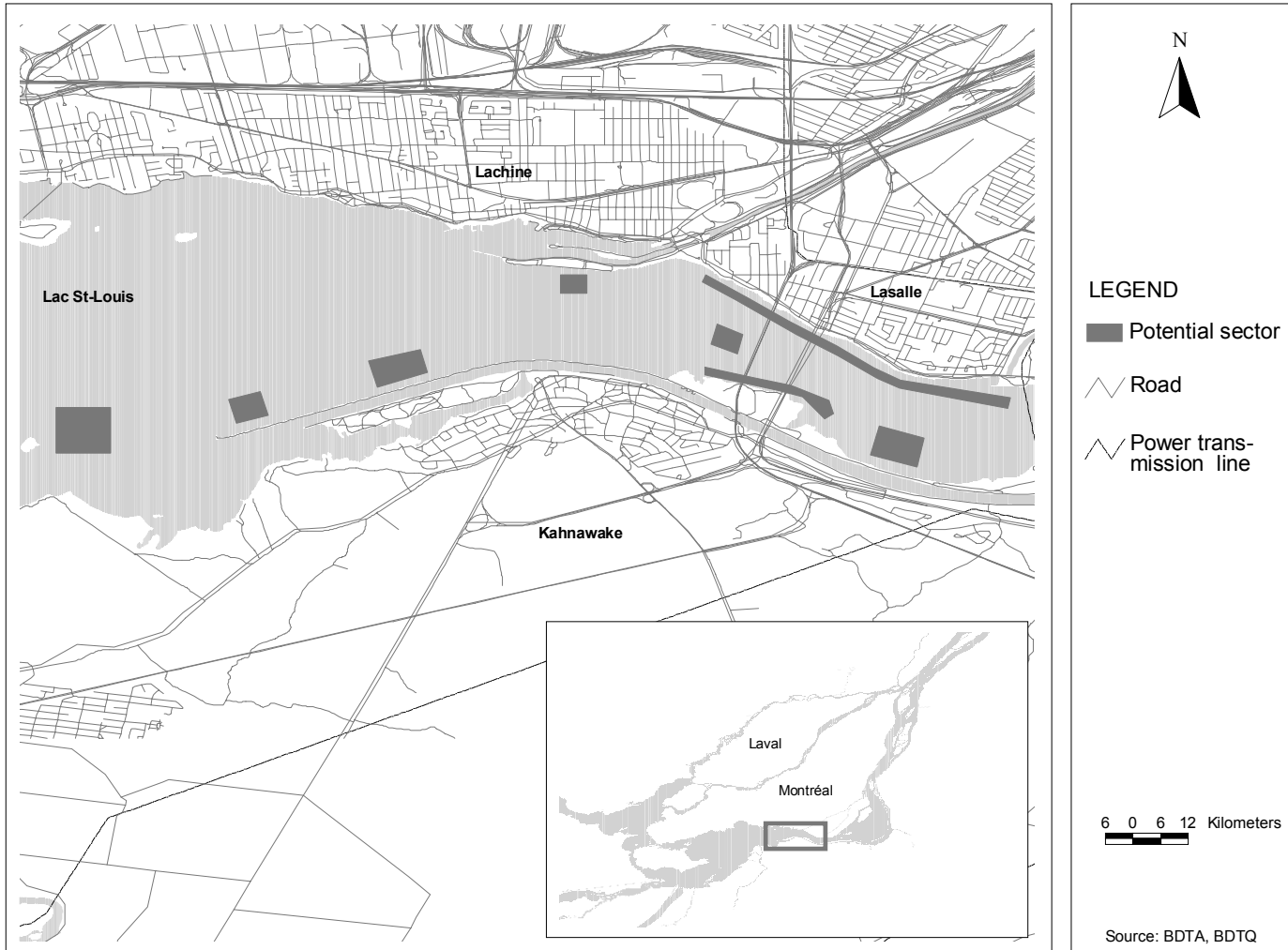


Figure 1. Potential sectors chosen following the preliminary filtering of available information, upstream portion of the Lachine Rapids, spring of 2002.

The nine sectors chosen and covered during the study by means of various types of sampling gear are illustrated in Figure 2. To facilitate the description of the results and the discussion, these sectors were named based on a series of landmarks. In relation to the initial selection, a potential spawning sector was identified in front of Lachine, the coverage of the Lasalle sector just downstream from Mercier Bridge was cut, the first flat downstream near the right shore was extended and finally, three pairs of parpens were added on the right shore near the two bridges in the south shore 2-bridges sector to meet the needs of another study to determine the location of the outflow of the Kahnawake treatment plant operated by the Mohawk Council.

#### **2.3.4 Period and rhythm of sampling using cement parpens**

The installation of the parpens was progressive in time and space (from May 16th to 21st). The initial setting up caused a few problems, as it was hard to clearly delineate the area to be covered and to align the parpens properly (Photo 3). The teams were made up of three persons, two of whom were in charge of placing and removing the parpens, while the third was responsible for manoeuvring the boat. Such a team could install, lift, examine and clean (by means of a pressure spray unit; Photo 4) some thirty filter sections per 7-hour workday. The average time between the fertilization of the egg and the hatching of lake sturgeon larvae is about six to seven days. After that period, the larvae bury themselves in the substrate and are no longer vulnerable to sampling gear. We decided to apply a three-day removal frequency to reduce the risks of losing information (damage to equipment, bad weather, etc...). This frequency was increased to six days on a few occasions in less promising sectors. The maximum number of parpens that could be put in place was about 180 units (30 parpens/team-day X 2 teams X 3 days = 180 units).

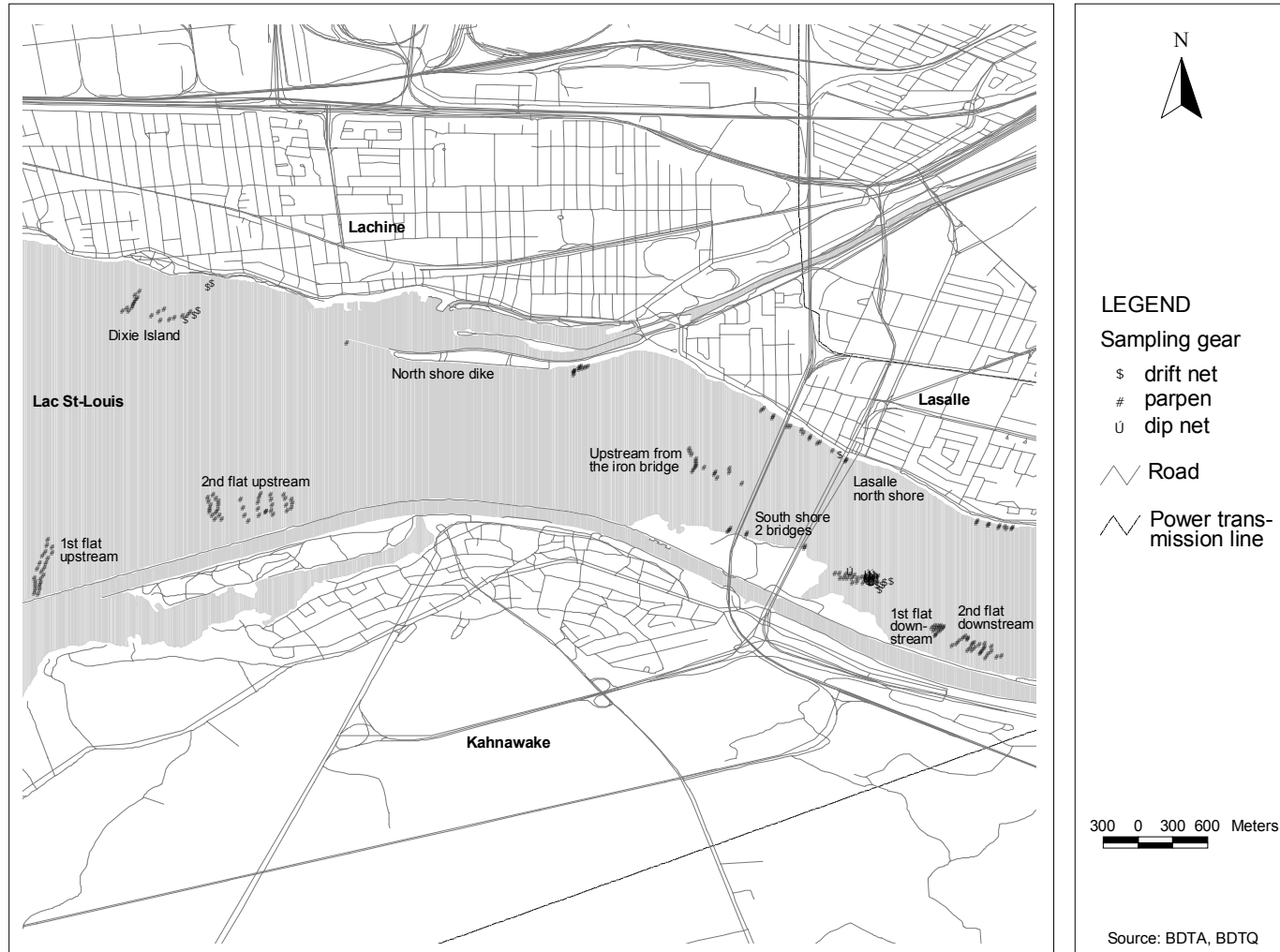


Figure 2. Sectors covered using parpens, a kick net and a drift net during monitoring, upstream portion of the Lachine Rapids, spring of 2002. The detailed location of the stations appears in appendices 1 to 9.



Photo 3. Systematic installation of parpens, upstream portion of the Lachine Rapids, spring of 2002. The distance between the first two floats was set so that for an observer standing some twenty metres away, the space that separates the parpens is completely covered by the person's thumb, thereby facilitating the estimate of distances on the body of water.



Photo 4. Parpen cleaning technique involving the use of a support and a high-pressure sprayer, upstream portion of the Lachine Rapids, spring of 2002.

### 2.3.5 Sampling effort using parpens

The number of stations and the sampling effort per sector are reported in Table 1. The spatio-temporal progression of this effort in the study area is presented by means of six plates covering all of the sampling period from May 16 to June 20, 2002 (Figure 3). In all, 199 different stations were chosen and monitored in the spring of 2002 in nine sectors (Figure 2). According to the total surface area of each sector and its importance, the number of stations varied from 11 for the North Shore dike to 37 for the 2nd flat downstream. More than 1000 gear-lifting operations (station-days) were performed during the monitoring. With the exception of three sites where the effort was less than 5 lifting operations/station, Dixie Island, the 1st flat upstream and the 2nd flat downstream, the effort made was almost equal in all of the sectors, namely between 5.36 and 6 lifting operations/station. As mentioned above, the Dixie Island sector was added after the start of the work and was subject to a limited effort. The other two lightly sampled sectors presented less interesting spawning conditions.

Table 1. Number of stations covered and gear-lifting operations performed in the nine sectors under study, upstream portion of the Lachine Rapids, spring of 2002.

<b>Sectors (Figure 2)</b>	<b>Maximum number of stations</b>	<b>Number of lifting operations</b>	<b>Number of lifting operations/station</b>
<b>1st flat upstream</b>	23	105	4.57
<b>2nd flat upstream</b>	37	204	5.51
<b>Dixie Island</b>	20	94	4.70
<b>North shore dike</b>	11	59	5.36
<b>Upstream from Iron Bridge</b>	16	95	5.94
<b>South shore 2 bridges</b>	29	162	5.59
<b>Lasalle north shore</b>	32	175	5.47
<b>1st flat downstream</b>	13	78	6.00
<b>2nd flat downstream</b>	25	101	4.04
<b>Total</b>	199	1073	37.13

The putting in place of the parpens began in the following sectors: the 1st and 2nd flats downstream, upstream from the iron bridge, in part, south shore 2 bridges sector and Lasalle north shore (Figure 3, upper left plate). It was completed between May 20th and 24<sup>th</sup> (Figure 3,

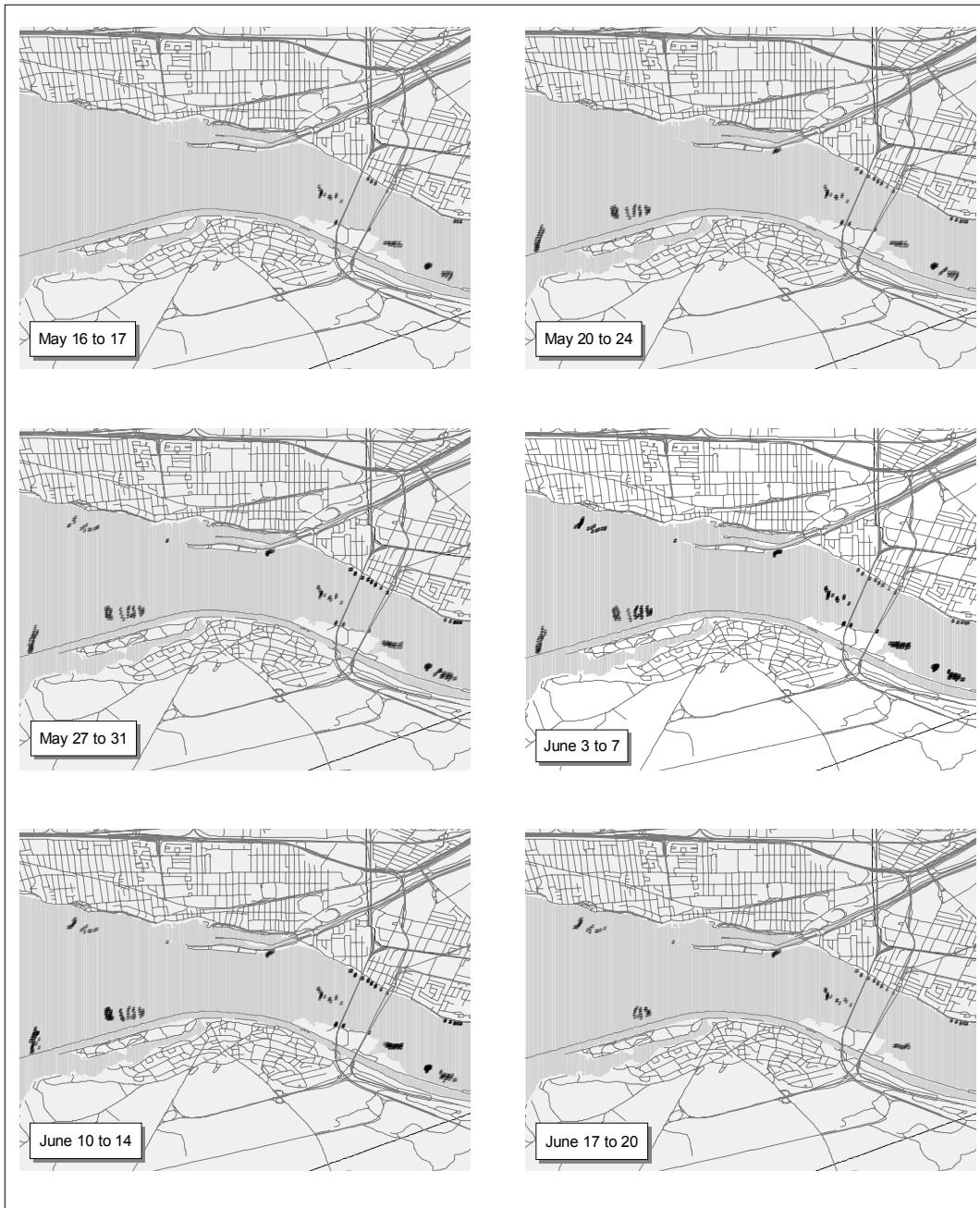


Figure 3. Spatio-temporal progression of the putting in place and removal of the parpens on the territory under study per four-day period between May 16 and June 20, 2002, upstream portion of the Lachine Rapids.

upper right plate). The installation of the parpens continued in the north shore dike sector and at the two flats upstream. Finally, the coverage of the Dixie Island sector began on May 27th (Figure 3, centre left plate). The breakdown of the sampling effort remained the same from the end of May until June 13th. Following the decline in the river's water level, the sampling of eggs using parpens ended on June 14th on the 2nd flat downstream and on the 1st flat upstream. Indeed, these sites were partially exposed and the current had become very weak (Figure 3, lower right plate). The gradual removal of the sampling stations began that same day in the south shore 2 bridges sector and in the 2nd flat upstream sector. We stopped sampling these sectors around June 18th. The other parpens were removed from the water between June 18th and 20th.

The spatial distribution of the stations in the nine sectors is represented by a series of individual large-scale plates (Appendices 1 to 9). With the exception of the north shore dike and upstream from the iron bridge sectors, all of the sectors were covered according to a pre-established sampling plan (section 2.2). The 1st flat upstream sector, elongated in shape, was sampled using two tight lines of parpens having 11 and 12 stations (Appendix 1). The second sector located upstream from the territory under study comprised two round-shaped shoals that were covered by a series of seven lines set fairly far apart (Appendix 2). At Dixie Island, the coverage was more scattered (Appendix 3). The sampling stations were placed behind the most interesting shoals on the big flat that begins at Dixie Island a few kilometres upstream. The downstream tip of the pier of Lachine marina and a few plots of suitable habitat located two-thirds of the distance downstream were covered individually by a few stations (Appendix 4). Three narrow shoals located in the main course of the river were covered just upstream from the iron bridge using three lines of parpens (Appendix 5). The potential spawning habitats were located along the shore in the upstream portion of the south shore 2 bridges sector and just downstream from a rocky point (Appendix 6). The upstream portion of this sector was covered using three series of parpens arranged in pairs or groups of three located a good distance from each other. The other sector was covered very intensively (distance of less than 20 to 30 m between the stations and the transverse lines), given that several observations made during the previous monitoring operation suggested the presence of a lake sturgeon spawning ground somewhere in this sector (La Haye and Clermont 2003).

The high potential spawning sites were spread out intermittently on a long narrow strip along the shore of the Lasalle north shore sector. A series of pairs of parpens were arranged along this

strip, behind each potential spawning habitat (Appendix 7). Finally, two round-shaped flats located a good distance from the right (south) shore downstream from the south shore 2 bridges sector were sampled non-intensively using several lines of parpens (Appendices 8 and 9, 1st and 2nd flat downstream).

### **2.3.6 Sampling effort using a drift net**

Five sampling stations involving the use of a drift net (0.5 m in diameter, 1.5 m in length, nytex 500  $\mu\text{m}$ , equipped with a removable bucket) were arranged in such a way as to cover the left downstream tip of the south shore 2 bridges sector where lake sturgeon eggs had been harvested during monitoring (Figure 2 and Appendix 6). Three other stations covered the downstream portion of the Dixie Island sector and two others the shore bordering it (Figure 2 and Appendix 3). The location of these stations was chosen on the basis of the knowledge of one of the aboriginal collaborators (Stewart Philips Jr., game warden, Kahnawake, personal communication). Finally, a last station was set up under Mercier Bridge in the Lasalle north shore sector (Figure 2 and Appendix 7). It covered a rapid sector located between the railway bridge upstream and Mercier Bridge downstream, which offered good spawning conditions.

The nets were laid in the afternoon and were raised the next morning from June 11th to 14th and from June 17th to 20th (Table 2). Overall, the daily sampling effort was relatively constant, between 5:00 p.m. and 9:00 p.m.

### **2.3.7 Counting of eggs and larvae**

#### **Parpens**

At the time of a gear-lifting operation, the filter section of the sampling station was systematically replaced by another clean and dry filter section. This operation took place between each lifting operation, while the team was proceeding to the following station. The parpen equipped with a clean filter section was placed on the riverbed by one of the team members at the same time as a second member was lifting the one already in place. The filter sections collected during the lifting operations were identified individually and placed in a plastic case. After the visits, the sections were carefully examined one by one by several observers to collect the eggs or larvae

that might be present. This operation was carried out at a space reserved for this purpose at the Lachine marina.

All of the fish eggs and larvae, regardless of the species, were kept in a solution of 5% formalin. The samples were identified with the station and the lifting date. In most cases, the eggs and the larvae were identified on site whereas the counting was done at FAPAQ laboratories .

### Drift net

The content of each bucket of the drift nets was carefully collected and rinsed several times on a fine filter (nylon fly screen) in order to reduce the volume and to facilitate the examination. Sorting was done on site. The examination of the contents was exhaustive; as the volume of

Table 2. Effort (in hours), date of installation and sampling period using a drift net in three sectors of the territory under study, upstream portion of the Lachine Rapids, spring of 2002. (Location of the stations: see Figure 2 for the entire territory and in the order of presentation appendices 6, 7 and 3 for the three sectors).

Sector	Station	June	June	June	June	June	June	Total
		11	12	13	17	18	19	
<b>South shore 2 bridges</b>	fd0		19	19		20	18	76
	fd1	20						20
	fd1-1		19	19		20	18	76
	fd2	21	19	19		20	18	96
	fd3		19	19		20	18	76
<b>Lasalle north shore</b>	fd10		19	19	18	19		75
<b>Dixie Island</b>	fd20		19	17	18	19	18	92
	fd21		19	17	18	19	18	92
	fd22					19	18	37
	fd23					19	18	37
	fd24					19	18	37

material collected was relatively high, the sample was divided into several parts and diluted with water on a metal tray. All of the fish larvae found were kept in a solution of 5% formalin.

### **2.3.8 Other observations**

The water temperature was recorded daily in the main course of the St. Lawrence River. The temperature of the brown water from the des Outaouais River on the left shore was also taken on several occasions. Lake sturgeons may jump during the spawning period. We paid special attention to the observation of this behaviour. Local users' knowledge of the territory was also turned to good account during interviews dealing with the presence of groups of spawners (spawning activities, jumps, concentrations of big fish, etc.). Finally, every anomaly and every change in the environmental conditions were noted (turbid water, change of level, etc.).

## **2.4 Characterization of egg deposition sites**

The method advocated to characterize the spawning habitat in the spring of 2002 had to be identical to the one described and developed by La Haye and Fortin (1990), La Haye et al. (1990) and La Haye and Clermont (in preparation). This method was successfully applied to other rivers of Québec. The goal of this characterization consists of highlighting the physical conditions preferred by the lake sturgeon during spawning. The variables that best express these conditions are the depth, the size distribution of the substrate and the speed of the current. Only one biological variable is taken into account, the number of eggs harvested in a standard-size sampling plot (1.25 m X 0.45 m) using a dip net. The opening of the net measures 25 cm across and 45 cm in length. A rectangular bag made of fine nytex (100 µm) is attached to this frame using Velcro strips. This gear is then attached to a wooden pole measuring 2 m in length. The technique is simple; it requires the participation of two operators. The first operator holds the net pressed down on the substrate, with the opening facing the current. The second operator disturbs the substrate with a rake in such a way as to cover a surface equivalent to the product of the width of the net by about one metre in length. The substrate is disturbed until all of the fine materials have been stirred up. The eggs are counted inside the net.

A readily accessible lake sturgeon egg deposition site was located this spring. However, the characterization of this site could not be completed due to the adverse conditions encountered (high current speed and deep water). Moreover, the eggs sampling using a dip net was very

arduous at all of the stations characterized. The only parameters that could be measured at some fifteen stations were the depth (sonar) and the velocity of the current (Price Gurley current meter) (see dip net sampling stations; Figure 2; Appendix 6). To evaluate the flow rate of the water column above the station, three measurements were taken at about 0.2, 0.6 and 0.8 times the depth, when the latter exceeded 1.5 m and at 0.6 time at sites that were not as deep. The average flow rate on the column was calculated using the following equation:

$$V_{\text{water column}} = (V_{0.2} \times (2 \times V_{0.6}) \times V_{0.8}) / 4$$

In light of the arduous conditions encountered above the spawning site, the dominance of substrate particles could not be evaluated with sufficient precision. The remainder of the characterization was done from a boat anchored at several points above the station being characterized. The surveys were done on June 6th and 7th.

## **2.5 Organization of work teams**

Each three-member team had a boat equipped with a GPS and a sonar to perform the gear-lifting operations. The coverage of the terrain was separated between the two shores, from upstream to downstream, to allow the two teams to remain in visual contact during the gear-lifting operations.

## **2.6 Mapping**

The geographical coordinates of all of the points of interest (sampling stations, spawning site, etc.) were obtained by means of a Furuno GPS, GP36 DGPS Navigator model or by means of a Garmin GP12 portable GPS. The geomatics software used to produce the maps is ArcView version 3.1. The geographical coordinates (latitudes and longitudes) were transformed manually into decimal coordinates using Excel, 2000 version.

### **3 RESULTS**

#### **3.1 Location of lake sturgeon egg deposition sites**

Lake sturgeon spawn was found in two sectors of the area under study. Thirty-five eggs and four larvae were harvested using parpens at 11 stations spread out along the south shore 2 bridges sector on June 3rd (23 eggs and four larvae) and on June 11th (12 eggs) (Figure 4 Table 3). This sector was not sampled between these dates to give the eggs time to develop, Spawning likely occurred between May 28th, date of the last visit, and June 3rd. It was during this period that the presence of lake sturgeons was most noticeable with jumps observed on May 28th and June 3rd on the 2nd flat upstream and on June 4th at Dixie Island. A large specimen was observed upstream from the south shore 2 bridges sector on May 28th. A final jump was observed on June 14th at the same location, prior to the removal of the parpens. No lake sturgeon egg was harvested elsewhere on the territory under study.

Sturgeon spawn observations were also made in the drift nets. Two larvae were caught at two stations of the Dixie Island sector on June 18th and 19<sup>th</sup>, whereas seven larvae were collected downstream from the south shore two bridges sector at four different stations on June 14th and between June 18th and 20th (Table 4). No sturgeon larva was collected at the drift net station located in the Lasalle north shore sector.

Finally, during the characterization of the spawning ground, one lake sturgeon larva was caught on June 4th directly in the spawning zone (Figure 2 and Appendix 6), out of the some fifteen stations sampled with a dip net.

#### **3.2 Characterization of the spawning zone**

The characteristics of the spawning zone at the time of the surveys are presented in Table 5. The average depth is close to 2 m with a range varying from 1.5 m to 3.0 m. The high value of the variance in relation to the average indicates a high variability in the depth at the spawning zone. The speed of the current is generally faster near the surface (V0.2) and declines as the depth increases (V0.6 and V0.8), going from an average of 1.6 m/s to 1.31 m/s. It is also more variable at the surface where there are several turbulence zones.

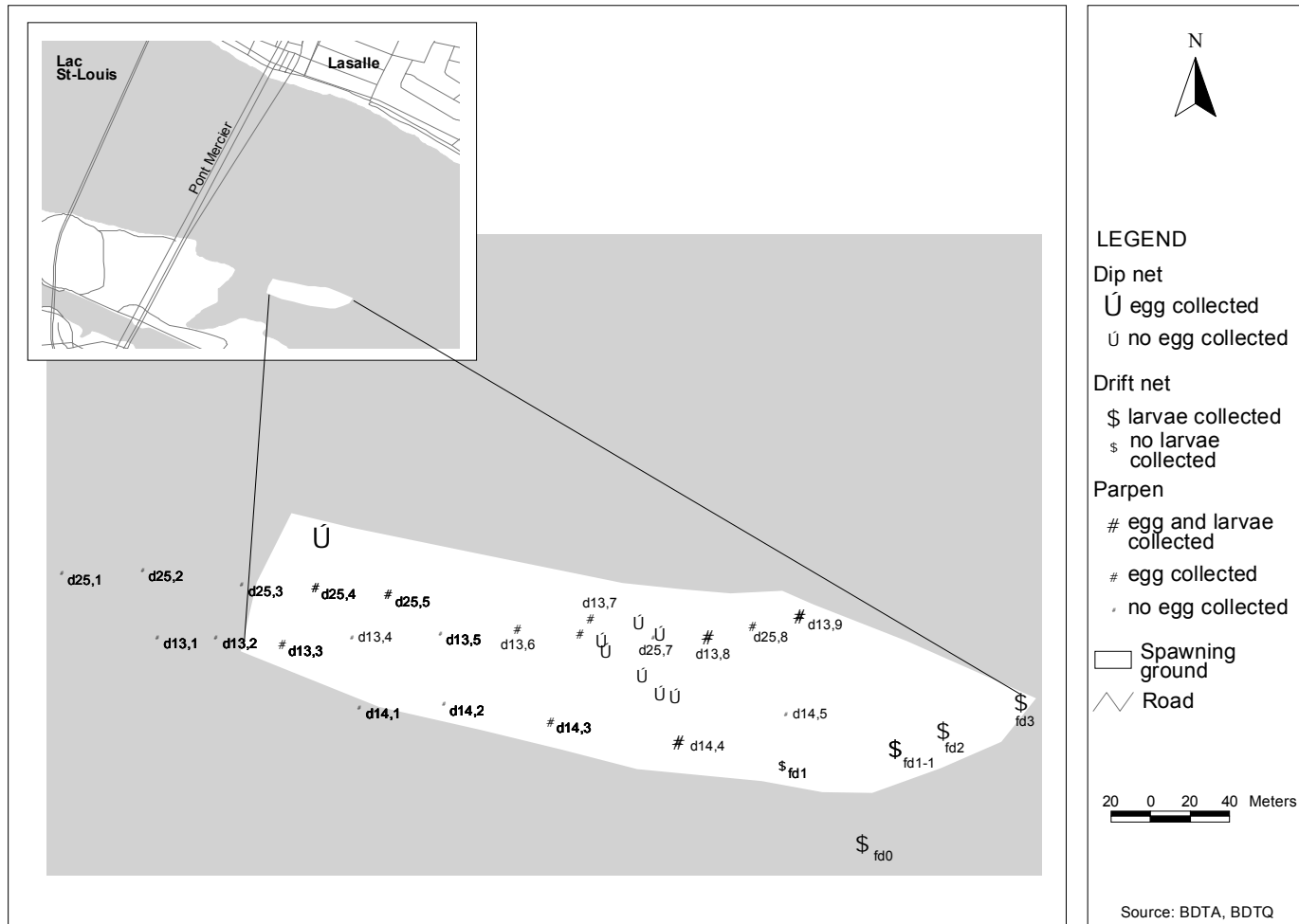


Figure 4. Location of the lake sturgeon spawning zone in the south shore 2 bridges sector and of the stations (parpens, drift net and dip net) with the presence of eggs or larvae, upstream portion of the Lachine Rapids, spring of 2002.

Table 3. Number of lake sturgeon eggs and larvae harvested using parpens in the south shore 2 bridges sector, upstream portion of the Lachine Rapids, spring of 2002. (See Figure 4 for the location of the stations).

Date	Station	Lake sturgeon	
		eggs	larvae
June 3	d13-6	5	
June 3	d13-7	8	
June 3	d13-8	3	2
June 3	d13-9	3	1
June 3	d14-4	1	1
June 3	d25-4	1	
June 3	d25-5	2	
June 11	d13-3	1	
June 11	d13-9	1	
June 11	d14-3	1	
June 11	d25-4	1	
June 11	d25-5	2	
June 11	d25-6	4	
June 11	d25-8	2	
<b>Total</b>		<b>35</b>	<b>4</b>

Table 4. Number of lake sturgeon larvae caught using a drift net in three sectors of the territory under study, upstream portion of the Lachine Rapids, spring of 2002. (Location of the stations: see Figure 2 for the entire territory and in the order of presentation appendices 6,7 and 3 for the three sectors).

Sector	Station	June 11	June 12	June 13	June 17	June 18	June 19	Total
<b>South shore 2 bridges</b>	fd0		0	1		1	0	2
	fd1	0						0
	fd1-1		0	1		1	1	3
	fd2	0	0	0		1	0	1
	fd3		0	0		1	0	1
<b>Lasalle north shore</b>	fd10		0	0	0	0		0
	fd20		0	0	0	0	0	0
<b>Dixie Island</b>	fd21		0	0	1	0	0	1
	fd22					0	0	0
	fd23					1	0	1
	fd24					0	0	0
<b>Total</b>		0	0	2	1	5	1	9

At the time of the characterization, the flow rate of the water column was between 1.02 m/s and 1.91 m/s (Table 5). When the measurements were taken, we noted that the strength of the current appeared to vary a great deal from one station to the next. The extent of the variance in flow rate values in the water column confirms this perception.

Table 5. Characterization of the spawning zone, measurements, means and standard deviations of the speed of the current (m/s) and the depth, upstream portion of the Lachine Rapids, spring of 2002. (V 0.2 = speed 0.2 from the surface, V0.6 = 0.6 from the surface and V0.8 = 0.8 from the surface) (See Figure 4 for the location of the stations).

<b>Date</b>	<b>Depth (m)</b>	<b>V 0.2</b>	<b>V 0.6</b>	<b>V 0.8</b>	<b>V column (m/s)</b>
June 6	2.00	1.57	1.46	1.17	1.41
June 6	1.90				
June 6	1.40	1.53	1.41	1.34	1.42
June 6	1.50	1.44	1.26	1.12	1.27
June 6	2.10	1.29	1.23	0.90	1.16
June 6	2.10	1.19	1.07	0.74	1.02
June 6	2.00	1.38	1.23	1.12	1.24
June 6	2.10	1.41	1.16	1.16	1.22
June 6	1.50		1.43		1.43
June 6	1.70		1.57		1.57
June 7	2.70	1.79	1.51	1.03	1.46
June 7	1.80	1.99	2.01	1.46	1.87
June 7	2.00	2.12	2.00	1.53	1.91
June 7	3.00	1.84	1.54	0.72	1.41
<b>Average</b>	1.99	1.60	1.45	1.12	1.31
<b>Variance</b>	0.19	0.09	0.08	0.07	0.2

The nature of the substrate could not be evaluated satisfactorily due to the conditions prevailing in the spawning zone at the time of the characterization. The high velocity of the current, combined with relatively large depths, limited the use of regular measuring instruments. However, it was possible to observe the substrate of the spawning zone at a few locations from the surface during sunny periods. The substrate appears to be composed of a heterogeneous mix of boulders, rocks and gravels (diameter of the particles varying between 0.2 m and 1.5 m). Several large boulders (diameter > 2.0 m) are located on the upstream edge of the spawning zone (Figure 4) and a few directly on it. At the time of spawning, the substrate appeared to be free from aquatic plants or periphyton.

The area that surrounds the spawning zone is variable in nature. Indeed, the depth increases rapidly downstream from the spawning ground and towards the right shore, with the rapids

environment gradually turning into a river environment, followed by a calmer lacustrine environment. Downstream, a series of pools follow one another up to the 1st flat downstream sector (Figure 2). The water flow remains strong and quick towards the centre of the river, north of the spawning zone. The latter was sporadically covered with a plume of very turbid water that seemed to come from the Châteauguay River during high-water periods. This phenomenon occurred mainly after storms or heavy rains.

### **3.3 Other observations**

#### **3.3.1 Temperature variations**

The water that circulates on study area originates from two separate sources. Clear water from the Great Lakes often known as "green water" feeds the main course of the St. Lawrence River up to some one hundred metres from the north shore. The spawning zone is bathed by this source. A turbid brown water, rich in tannins, from the de Outaouais River flows in a narrow strip along the Island of Montréal. It mixes partially with the green water at the Lachine Rapids. It covers the Dixie Island, Lachine North shore dike and Lasalle north shore sectors. The demarcation between these two types of water is very clear on the site. The green water tends to warm up later than the brown water in spring. As the chronology of the spawning of sturgeons depends in large part on the temperature of the water, this parameter was measured regularly in the main course of the river and on a few occasions near the north shore. During the presumed spawning period (between May 28th and June 3rd), the temperature of the river's water increased by 2°C rising from 10.8 to 12.8°C. It was already above these values in the brown water where it exceeded 13°C on May 29th. Despite the few measurements available for brown water, the difference in the warm-up periods between the two types of water is clear in Figure 5.

#### **3.3.2 Capture of eggs and larvae of other fish groups**

Eggs of other fish taxa were collected (Table 6), in particular those of redhorse (*Moxostoma sp*). A large quantity of eggs of this fish family was collected near the north shore between the railway bridge and Mercier Bridge (Figures 2 and 10). Mooneye (*Hiodon tergisus*) eggs were also collected between these two bridges as well as on the two upstream flats. The observations of spawn of other taxa, including darters (*Etheostoma sp*), were much less abundant in the catches.

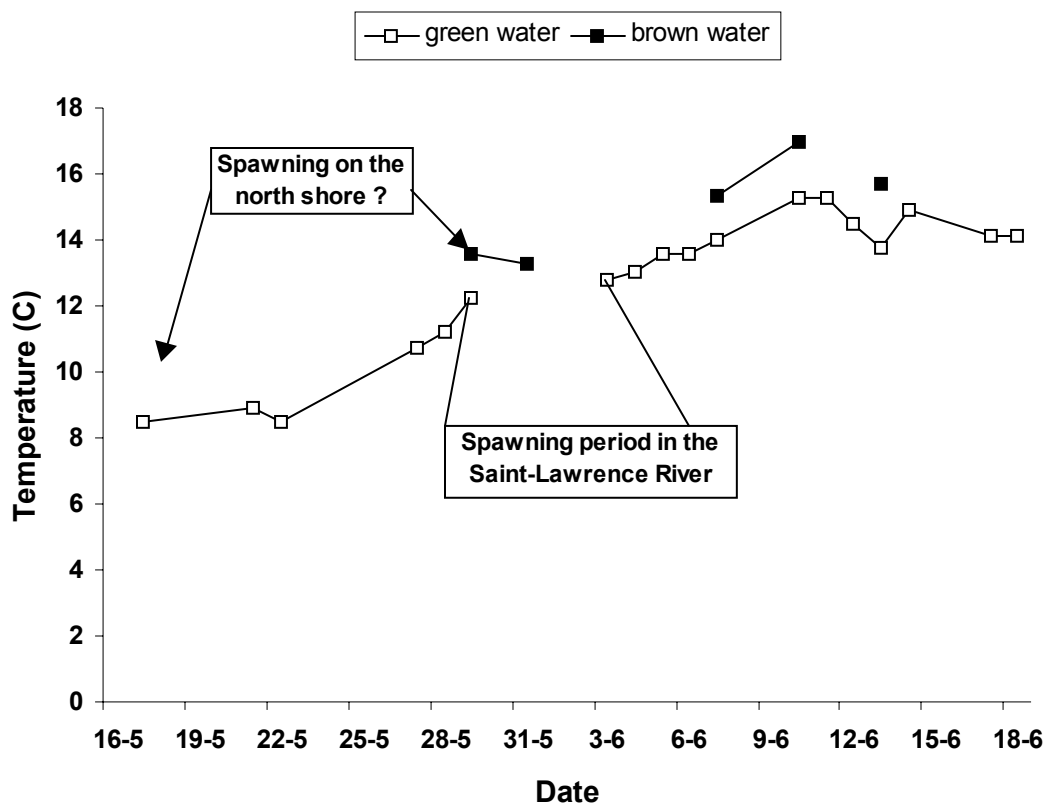


Figure 5. Temperature variations (°C) in the main course of the St. Lawrence River (green water) and the northern part of the territory under study (brown water north shore), spring of 2002.

Table 6. Number of eggs of other taxa harvested using parpens by sector, upstream portion of the Lachine Rapids, spring of 2002.

Sectors	Percidae	Mooneye	Redhorse	Darters	Unknown
1st flat upstream		7	1		1
2nd flat upstream		5			
Dixie Island					1
North shore dike			8		1
Upstream from iron bridge			1		
South shore 2 bridges			10		1
Lasalle north shore	not counted	10	37		4
1st flat downstream				not counted	3
2nd flat downstream					1
<b>Total</b>		<b>22</b>	<b>57</b>		<b>12</b>

#### 4 DISCUSSION

The study carried out in the upstream portion of the Lachine Rapids in the spring of 2001 made it possible to highlight the sector's importance for the reproduction of the lake sturgeon (La Haye and Clermont 2003). Numerous spawners were caught there, including several mature females in proportions exceeding close to ten times those observed in the Lac Saint-Louis fishery. Another indicator of the presence of spawning activity by the species in the Lachine Rapids is the capture of six larvae in June 2000 downstream from île aux Hérons (Pierre Bilodeau, biologist, FAPAQ, personal communication). A few highly experienced biologists of Québec have proposed that these rapids or the rapids of Sainte-Marie (between the Champlain and Victoria bridges) are home to one or more sturgeon spawning grounds (Jean-René Mongeau, retired biologist, the late Réjean Fortin, personal communications).

To date, only one lake sturgeon spawning ground has been surveyed in the Québec portion of the St. Lawrence River, in the residual bed between Lac Saint-François and Lac Saint-Louis. This is a reproduction site with a limited surface area and which undoubtedly was of greater importance prior to the diversion of a significant portion of the river flow into the Beauharnois Canal. The other known spawning grounds are located in the tributaries of the St. Lawrence River (La Haye and Clermont, in preparation). However, even during the preliminary work of the Archipel project in the early 1980s, the Lachine Rapids were never systematically covered with a proven approach for the collection of lake sturgeon spawn in such a wide and deep quick water system. The sampling strategy and methods used this spring appear to have made up for these shortcomings, as a large spawning zone was located in the south shore 2 bridges sector about 400 m downstream from Mercier Bridge opposite a rocky point on the right shore. Elongated in shape, it extends over about 350 m cross-wise to the direction of the current, over a distance of about 100 m in its widest section. This discovery corroborates the observations made in 2000 and in 2001 by FAPAQ. Given its surface area and its location, this spawning ground could be of significant importance for the St. Lawrence River population. It benefits from good quality water and is far from the shore. Moreover, the rocky substrate that makes up this habitat is clean and unimpeded. Its characteristics are very different from those surveyed to date in southwestern Québec. La Haye and Clermont (in preparation) recently made a comprehensive review of the literature on the physical characteristics of lake sturgeon spawning grounds in this region of Québec. The speed and depth intervals observed here (1.02 m/s - 1.91 m/s and 1.5 m – 3.0 m) are greater than what has most often been reported in the various

studies consulted. One of Québec's most productive spawning grounds, that of Rivière des Prairies, is also large in size. However, it is located in the tail-race of a dam after a series of emerging shoals. This environment is completely different from the Lachine Rapids, which are vast and open.

In contrast, the characteristics of the spawning ground discovered this spring are similar to several other known spawning grounds in the United States in the St. Lawrence River or in major tributaries of the Great Lakes. Jennifer Hayes (biologist, New York State University, Syracuse, personal communication) has collected eggs up to a depth of 7 m at the foot of the Moses-Saunders hydroelectric dam (State of New York). Two other important spawning grounds have been studied in the Saint-Clair River in the State of Michigan. Spawning activities have been observed there since 1992 on an artificial shoal exposed to high current speeds ( $> 1$  m/s) in 6 to 7 m of depth (Bruce Manny, USGS, Great Lakes Science Center, Ann Arbor, Michigan, personal communication). This spawning ground is located near the city of Algonac northeast of Lake Saint-Clair. The third spawning zone is located near Port Edward (Ontario). It is a succession of artificial reefs behind which fine substrate has accumulated over the years. Sturgeons spawn here in small groups, taking shelter from the current that often exceeds 1.5 m/s in this part of the Saint-Clair River. These small spawning zones are between 8 m and 12 m in depth (Jim Boase, biologist, USFWS, Alpena Michigan, personal communication). These spawning sites and the one discovered downstream from Mercier Bridge this spring have several points in common: they are situated in very transparent water and at great depths. Based on these observations, it would appear that sturgeons exposed to transparent water are hesitant about spawning at shallow depths. It is also likely that spawning habitats that are shallow and free from vegetation or periphyton are not available or are available only in very small number in these systems. It should be noted that with one exception, all of the other known spawning grounds in southern Québec are bathed by dark, brown water, rich in tannins, where sturgeons spawn at depths as little as 30 cm, even if other deeper levels are available and accessible.

The presence of obstacles, such as large boulders located on the upstream edge of the Mercier Bridge spawning ground, are another common point between these spawning sites. These boulders appear to play an important role by providing spawning micro-habitats where sturgeons likely find a mixture of substrate and the velocity that suit them. All of these observations lead us to believe that other spawning sites are likely present in the upstream

portion of the Lachine Rapids at greater current speeds and greater depths than those covered in the spring of 2002. Additional studies are necessary to confirm this hypothesis.

The comparison of the results with those obtained at other spawning sites in Québec is limited by the use of the sampling method developed this spring. This approach, involving a stratified sampling by means of parpens, has never been used elsewhere in Québec or in North America. Given the immense size of the territory and the limited amount of time that we had to cover it, the number of stations with a presence of eggs and the number of lake sturgeon eggs collected are more than satisfactory. This approach was not designed to harvest a large number of eggs at a time but rather to quickly cover as much territory as possible. The results obtained using a dip net, a method commonly employed in Québec, were very limited (only one larva). This method appears inefficient in the turbulent and deep environment of the Lachine Rapids. Finally, the number of larvae caught at the spawning ground using a drift net was relatively low in comparison with the thousands of larvae harvested at Rivière des Prairies since 1994 (Thibodeau et al. 1998; Thibodeau et al. 1999; Fortin et al. 2002). However, the effort made this spring with this sampling gear was limited in time for logistical reasons.

Two well-developed larvae were caught using a drift net at the end of the work (June 18th and 19th) in the Dixie Island sector near the north shore. Aside from these catches, several other indicators suggest the presence of a spawning ground in this sector. According to Mr. Stewart Philips, Jr., one of the aboriginal participants, this spawning site has been known for a long time among older Mohawk fishers. Indeed, it was Mr. Philips who chose the location of one of the stations near the shore, where one of the two larvae was caught (Appendix 3). This sector, which is very vast, should be covered more intensively during the next monitoring operation. Given the difference in warm-up times between the two types of water (green water – brown water), the fieldwork should begin earlier in this sector bathed by brown water. When the environmental conditions are appropriate, the sturgeon begins its spawning activities between 10°C and 12°C in southern Québec. This interval is very similar to the one observed during spawning this spring (May 28th to June 3rd, 10.8 °C to 12.8 °C). This temperature range is generally reached in mid-May at the Rivière des Prairies spawning ground, which is also bathed by brown water, whereas it is rarely attained before the start of June in the main course of the St. Lawrence River.

A few sites situated in brown water presented suitable physical characteristics for the spawning of the lake sturgeon, namely the portion of the Lasalle north shore sector located between the iron bridge and Mercier Bridge, and the shoal in the Lachine north shore dike sector. However, no sturgeon egg was harvested despite a good coverage. It is possible that sturgeons had the time to spawn prior to the start of the fieldwork in these sectors. Under these conditions, the larvae may have buried themselves in the substrate before the parpens were put in place. Consequently, the sequence of the next fieldwork should be planned, taking into account the difference in warm-up times between the two types of water.

During the study of 2001, one of the two best fishing zones of aboriginal fishers was located downstream from a rocky point under Mercier Bridge (La Haye and Clermont 2003). This fishing zone is located just upstream from the spawning ground, less than 150 m away. At the time, the perception of the members of the 2001 team was that sturgeons appeared to favour the right shore when moving about. The discovery of the spawning ground near this shore in the spring of 2002 confirms this intuition and shows once again the vulnerability of the species in the sector during the reproduction period.

The catching of eggs of several other taxa shows that the parpen method can be used for other species.

## 5 CONCLUSION

The results of this study have made it possible to confirm beyond any doubt the presence of a spawning ground in the upstream portion of the Lachine Rapids in the spring of 2002. The discovery of a new lake sturgeon spawning ground in such a vast territory was not by chance; it is the result of a systematic approach that was well structured in time and space. The stratification of the habitat towards high-potential spawning sites for the lake sturgeon greatly contributed to the success of the study this spring. Indeed, given the diversity of the environments within this immense territory, it would have been unthinkable to organize a sampling campaign based solely on the observations in the field at the start of the work. The experience of the members assigned to the campaign and the smooth operation of the field team contributed to the development of the sampling method and technique in a very short time period prior to the start of the work. This effort was decisive, as it allowed us to concentrate the fieldwork on the validation of the pre-sampling stratification, the delimitation of the sectors to be covered and the search for spawning grounds. The experience acquired in the spring of 2002 will unquestionably be very useful for the continuation of the study in the Lachine Rapids. However, in light of the recent results obtained in certain tributaries of the Great Lakes, the depth level that should be covered could be increased to 8 m instead of 5 m and the flow rate to 2.0 m/s (see section 2.3.3).

The gear developed in the spring to look for egg deposition, a cement parpen covered with a section of air filter, appears to be very effective in rapid and deep water environments. This characteristic differentiates it from other sampling gear (dip net, vortex pump, etc.), which are not very effective under such circumstances. This gear is inexpensive and easy to use in the field. Between 30 and 40 parpens can be handled per day by a 3-member team. In the absence of serious problems and under favourable weather conditions, each team can put in place and visit at least 100 units over a three-day period in a territory not exceeding 10 km in length. This sampling effort appears to be optimal and should be kept for subsequent monitoring operations.

The south shore of the rapids is bathed by the brown water of the Outaouais River. This water warms up faster than that from the Great Lakes (green water). A difference of close to two weeks has already been observed between the time it takes the two types of water to reach lake sturgeon spawning temperatures (10°C to 12°C in southern Québec). The chronology of the sampling of the various sectors will have to take this difference into account in the future.

Indeed, sturgeon larvae were caught in brown water (Dixie Island sector) at the end of the work even though the presence of a spawning ground had not been detected beforehand by means of parpens.

The organization and daily planning of the study involved the participation of all the members including the two aboriginal assistants. Their presence in the boats and their indications regarding the parts of the territory frequented by aboriginal fishers were very helpful. The organization of the teams in 2002 should be kept during the next set of monitoring operations.

These results are partial in that there is still some doubt as to the presence of one or more spawning grounds in the territory under study. To check for this presence, the sampling will have to be extended to certain periods and habitat levels not covered in 2002. However, like the results obtained in 2001, the results of the spring of 2002 clearly confirm, with even greater force, the need to put an end to all forms of lake sturgeon harvesting during the spring period.

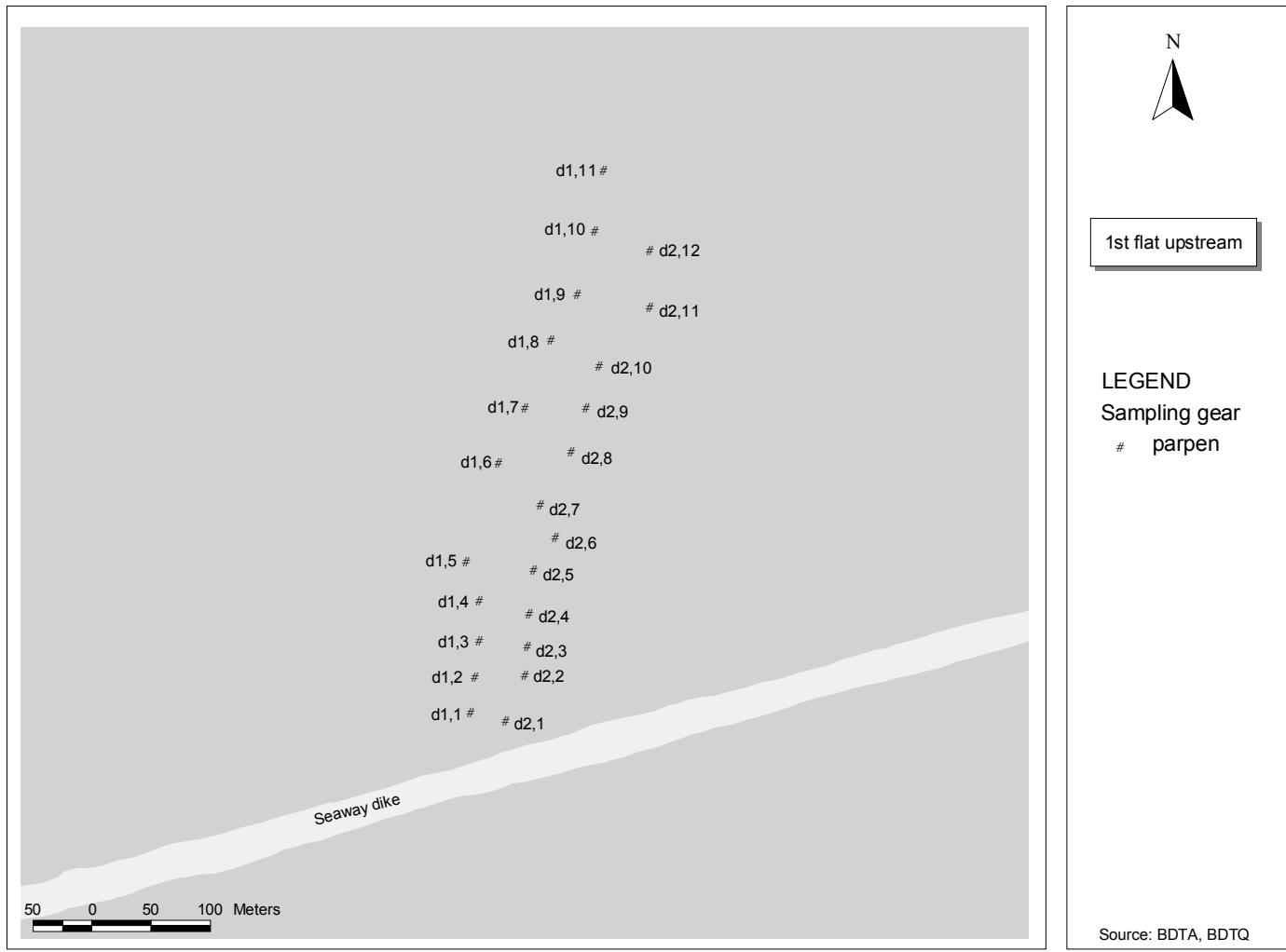
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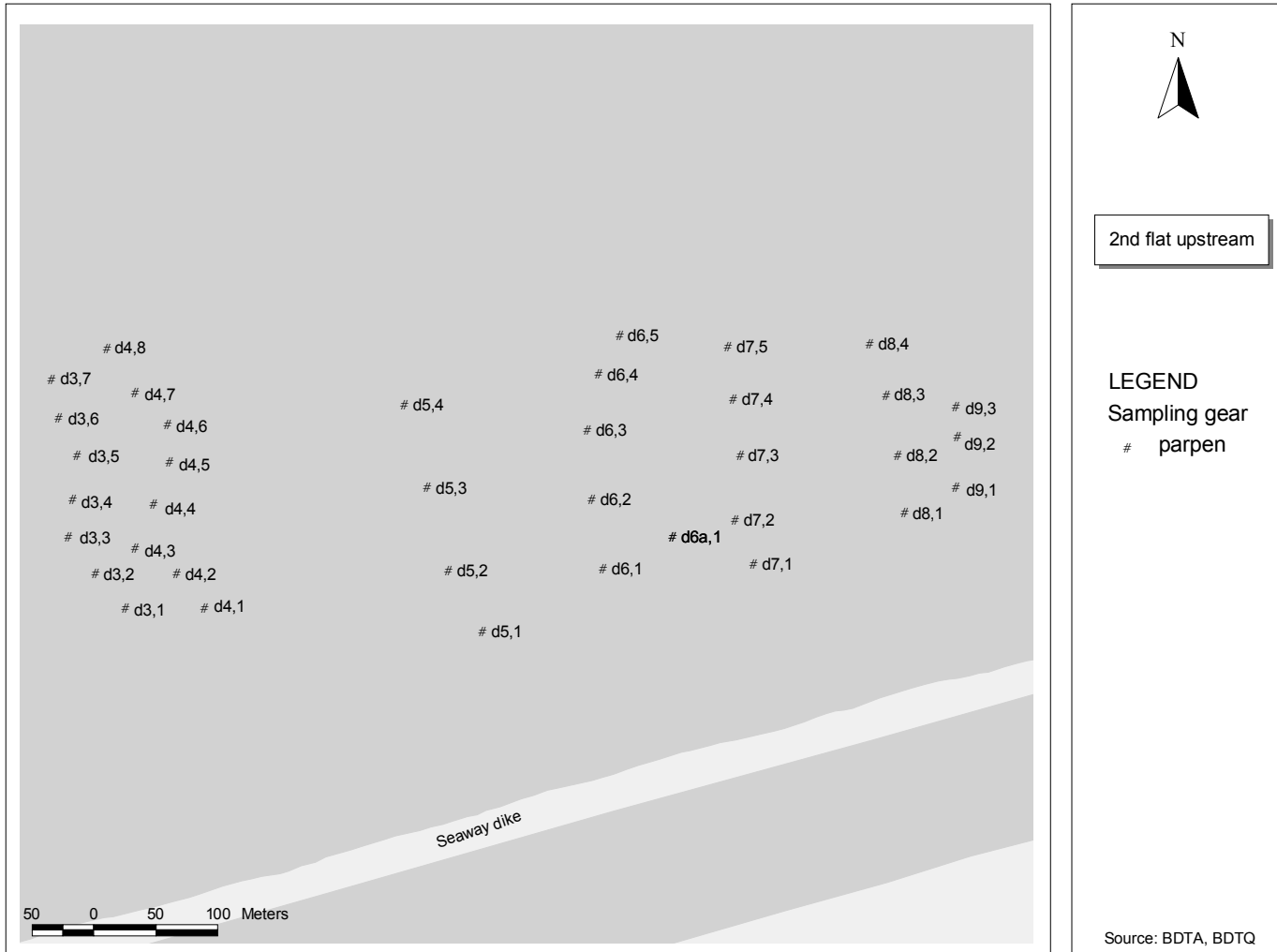
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**APPENDIXES**

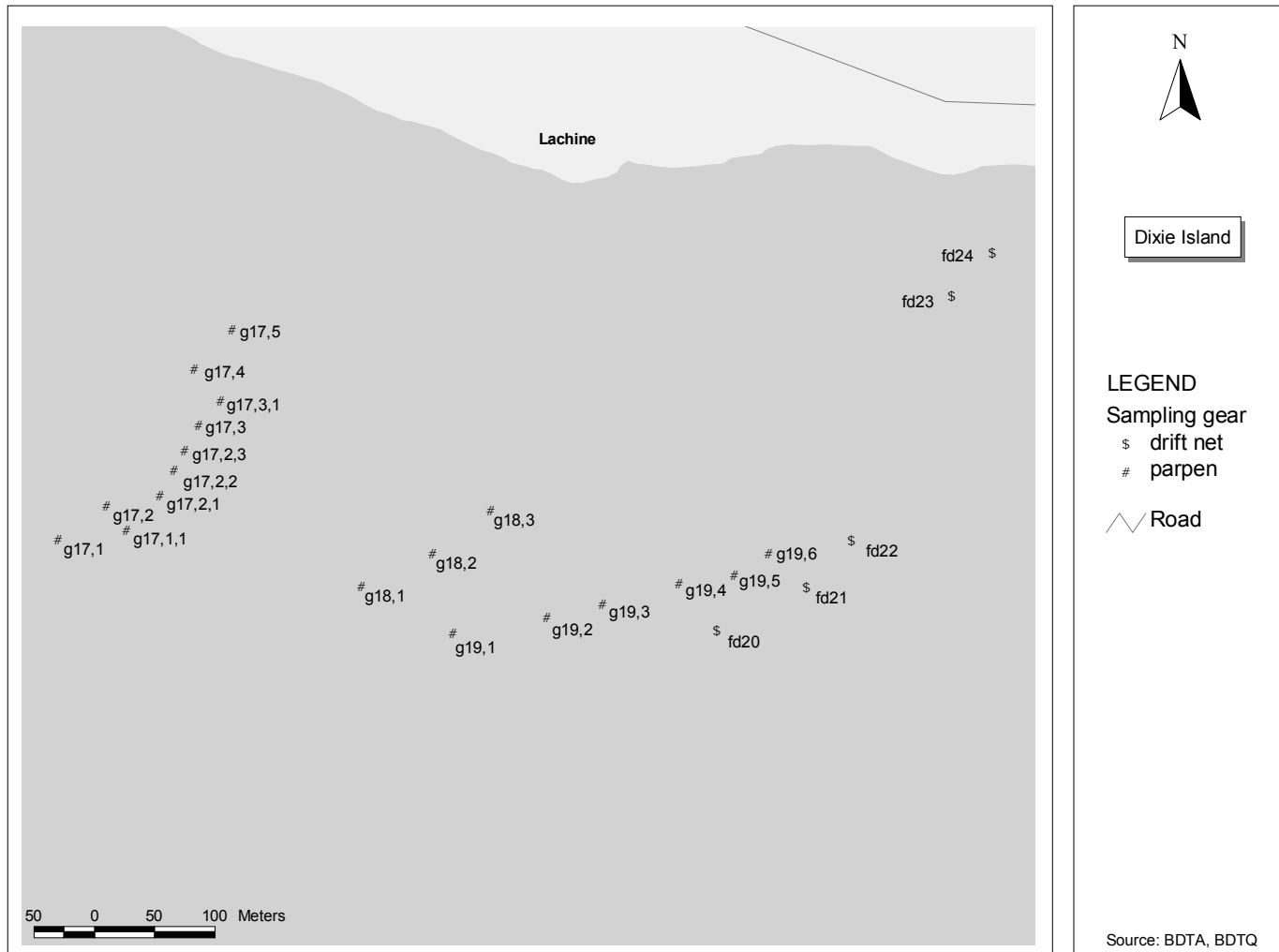




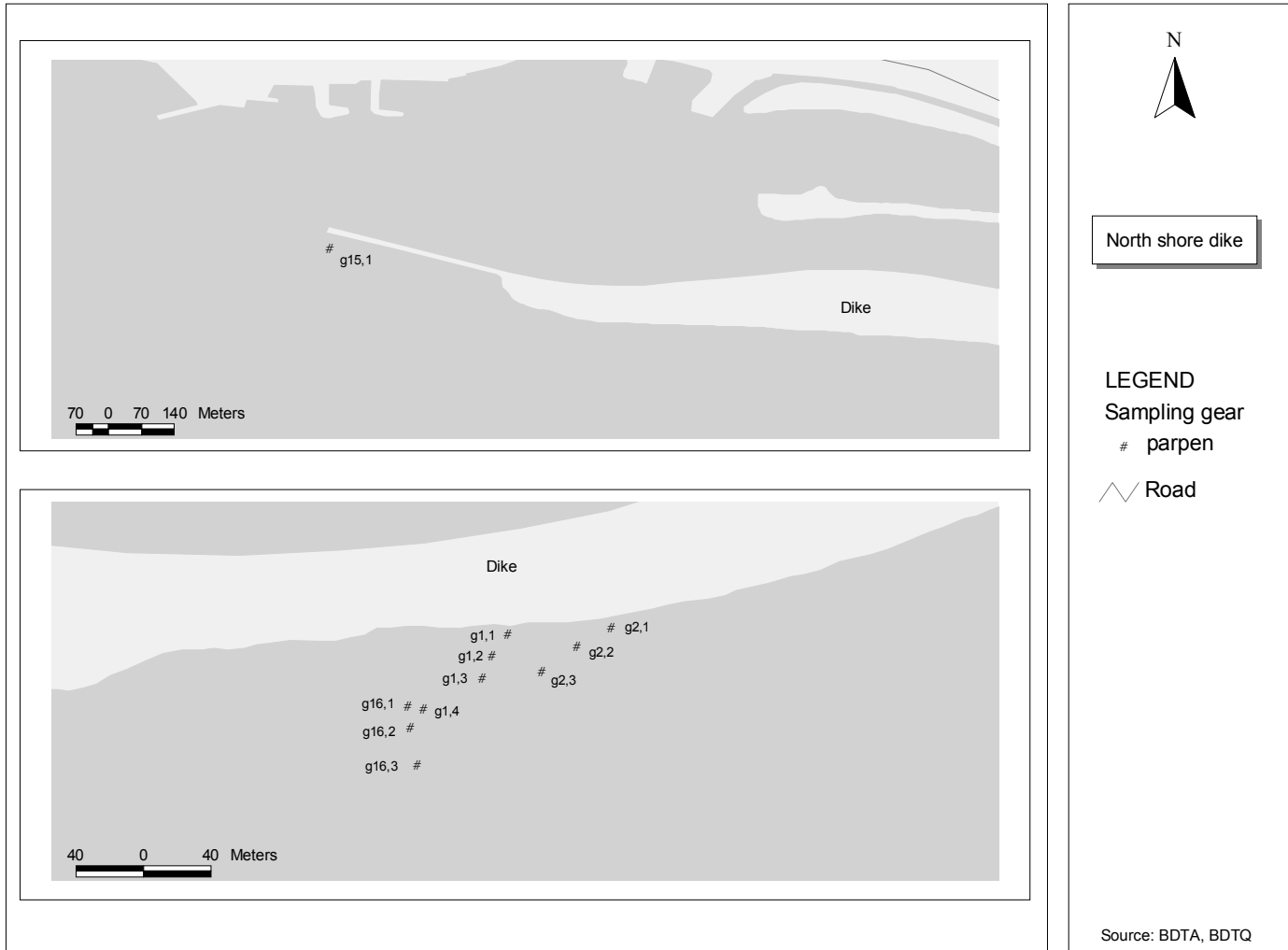
Appendix 1. Spatial coverage in the 1st flat upstream sector using parpens, upstream portion of the Lachine Rapids, spring of 2002.



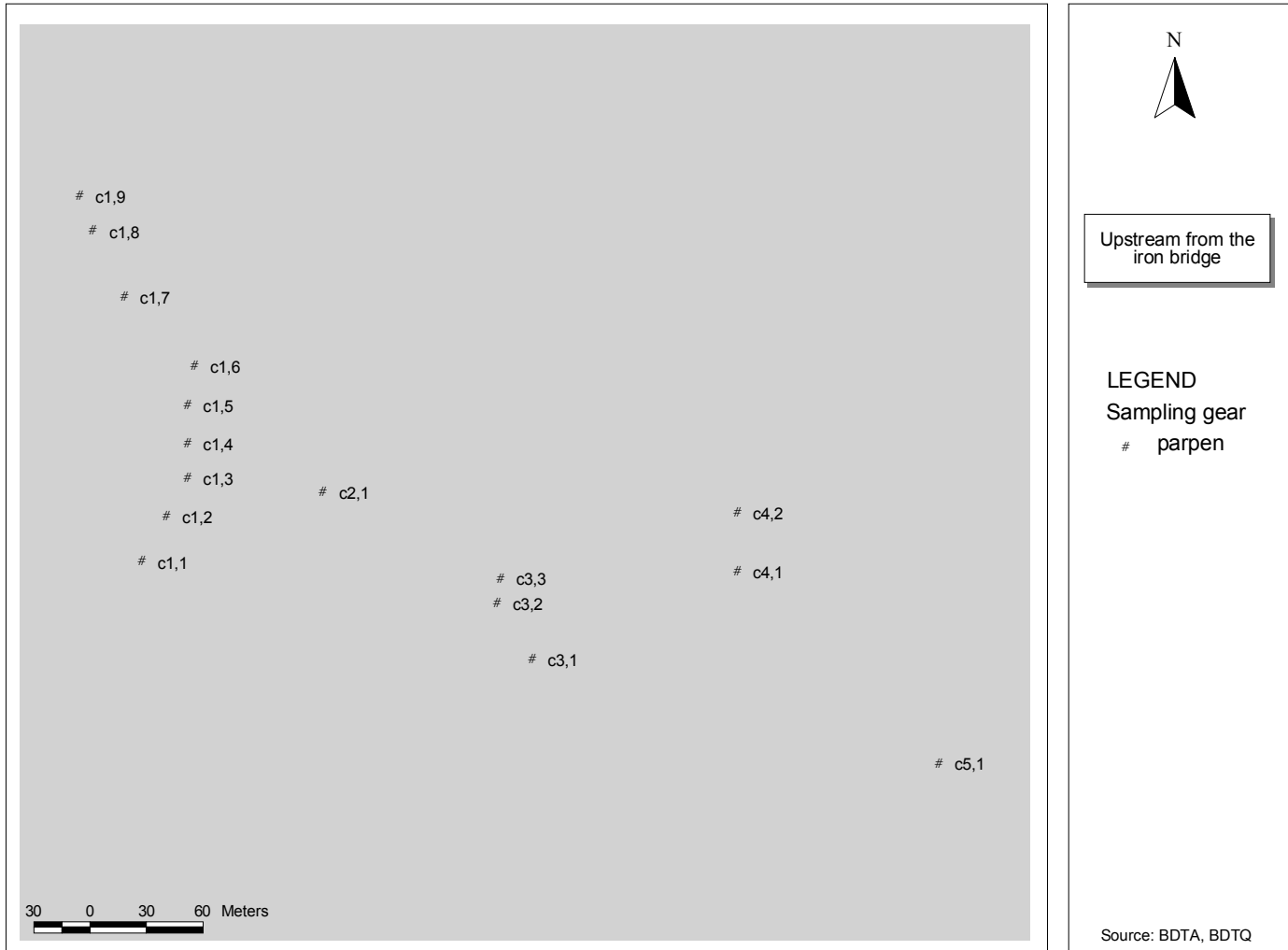
Appendix 2. Spatial coverage in the 2nd flat upstream sector using parpens, upstream portion of the Lachine Rapids, spring of 2002.



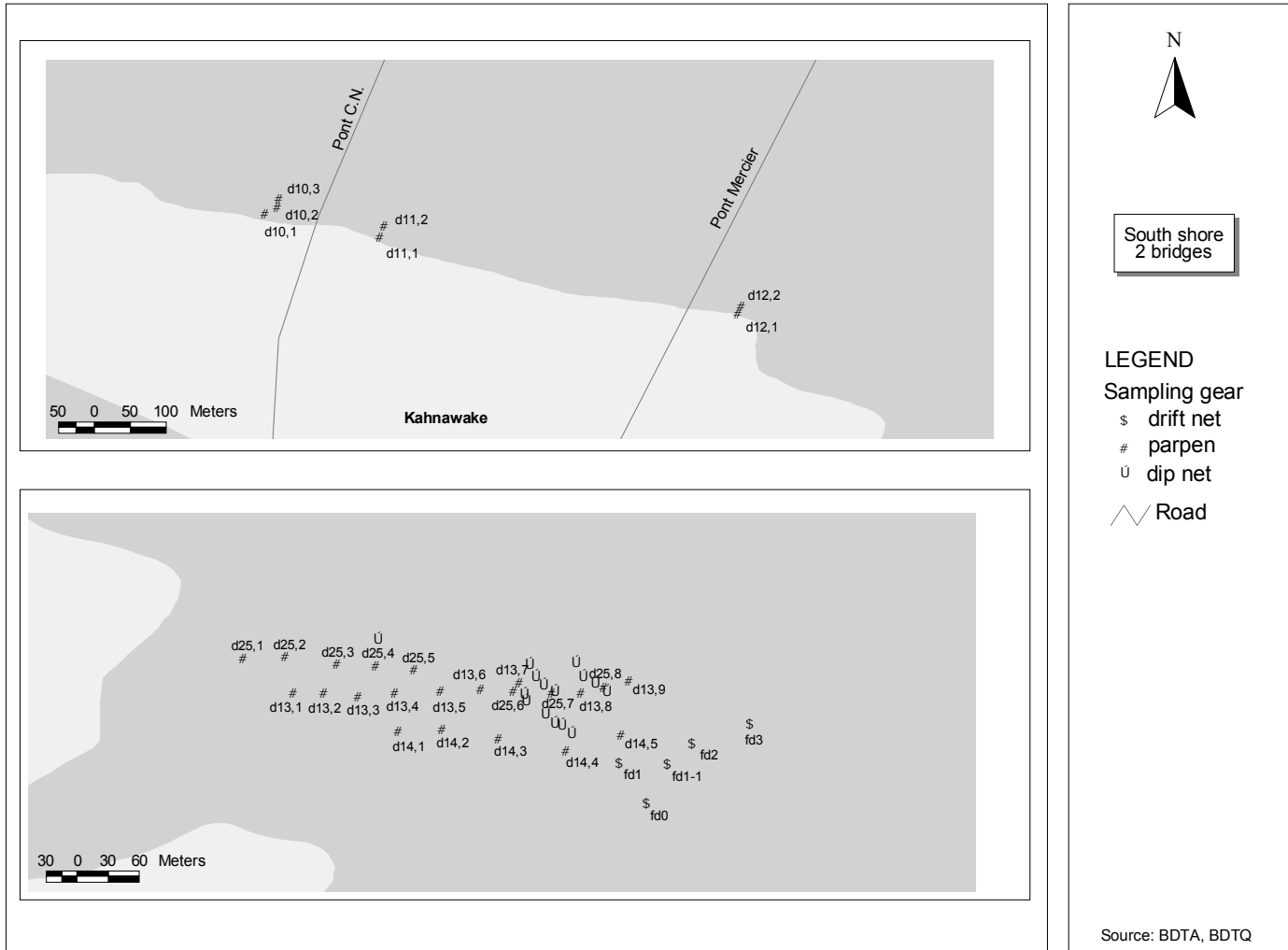
**Appendix 3. Spatial coverage in the Dixie Island sector using parpens, upstream portion of the Lachine Rapids, spring of 2002.**



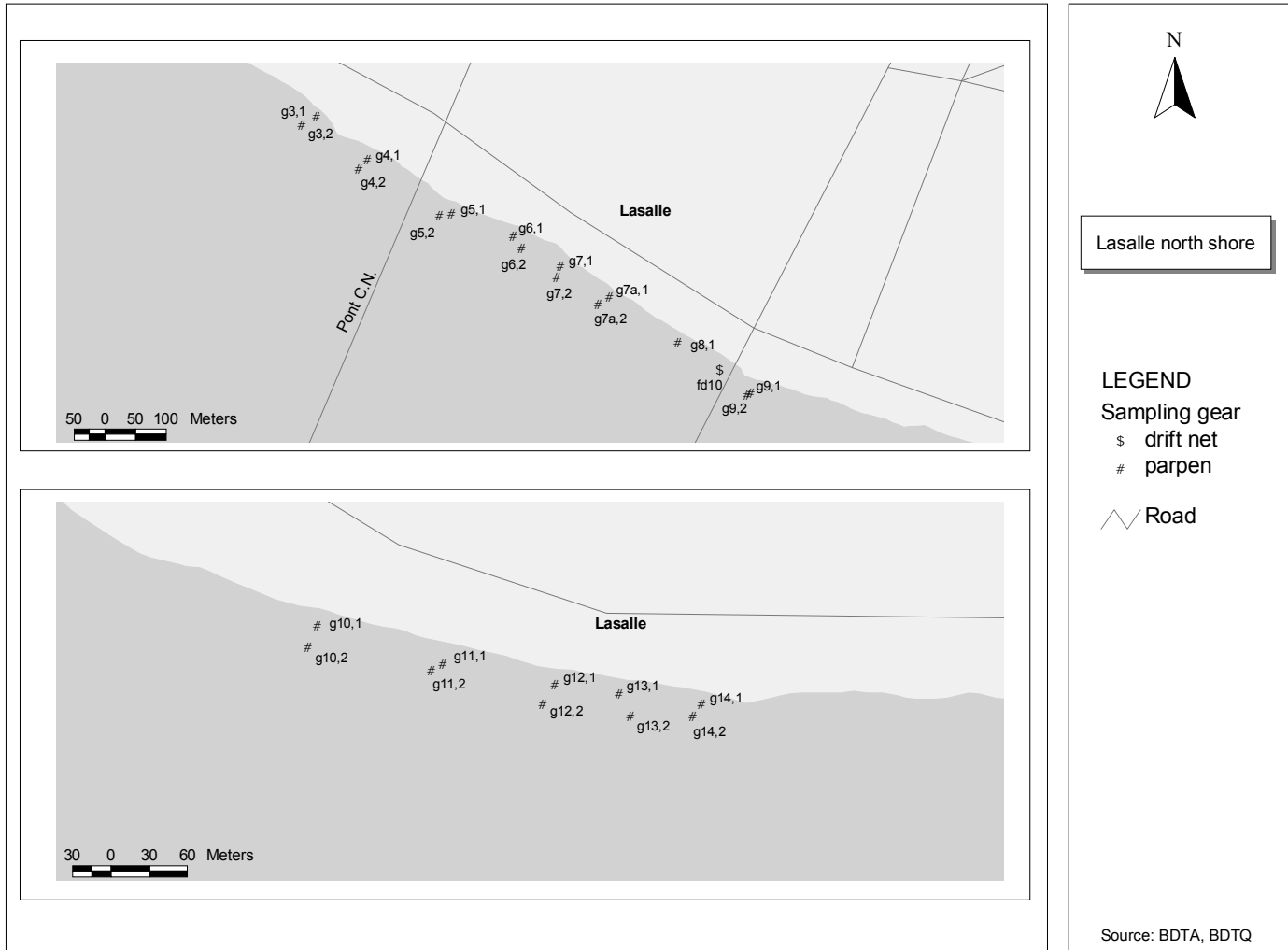
Appendix 4. Spatial coverage in the north shore dike sector using parpens, upstream portion of the Lachine Rapids, spring of 2002.



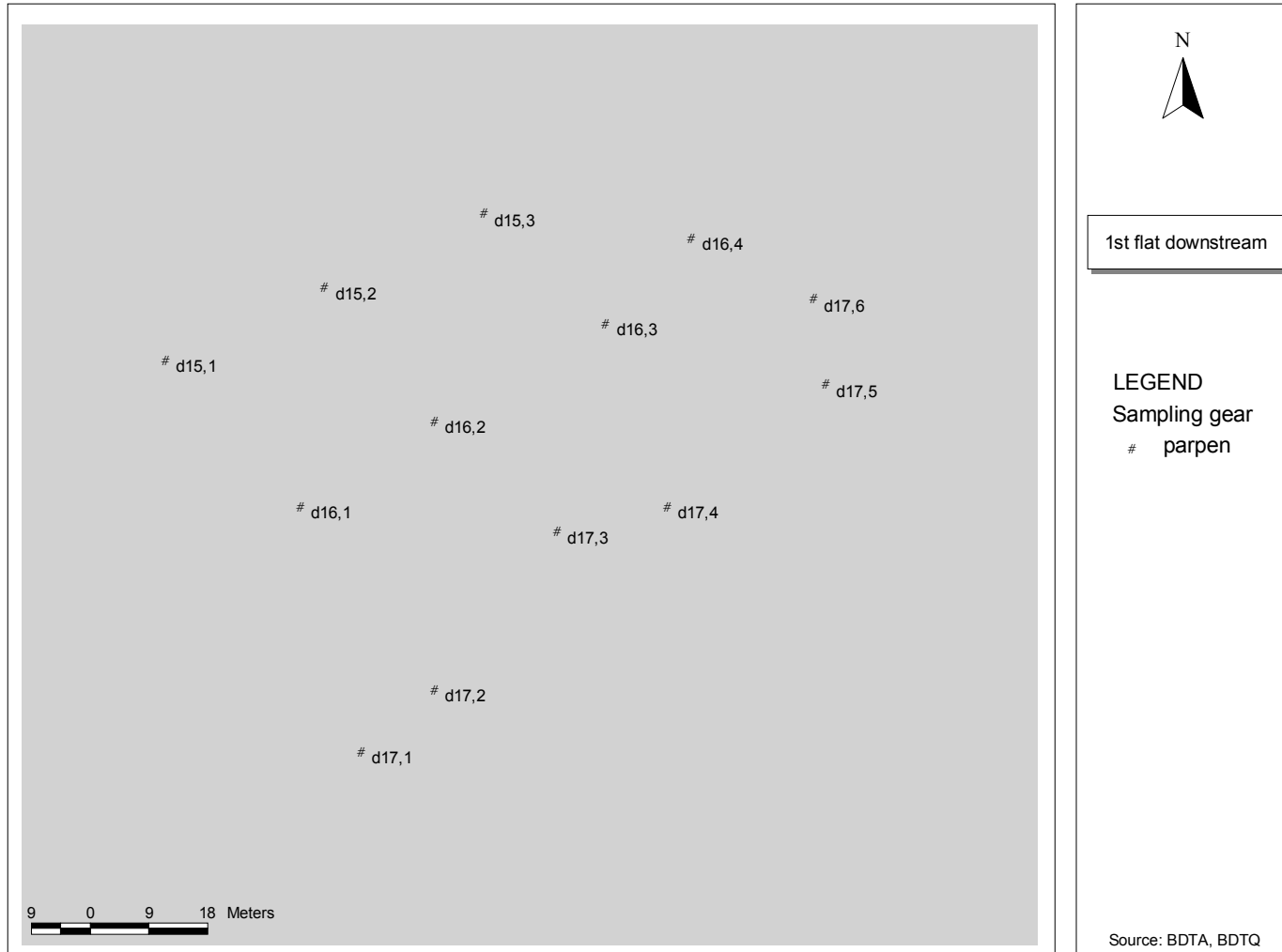
**Appendix 5. Spatial coverage upstream from iron bridge using parpens, upstream portion of the Lachine Rapids, spring of 2002.**



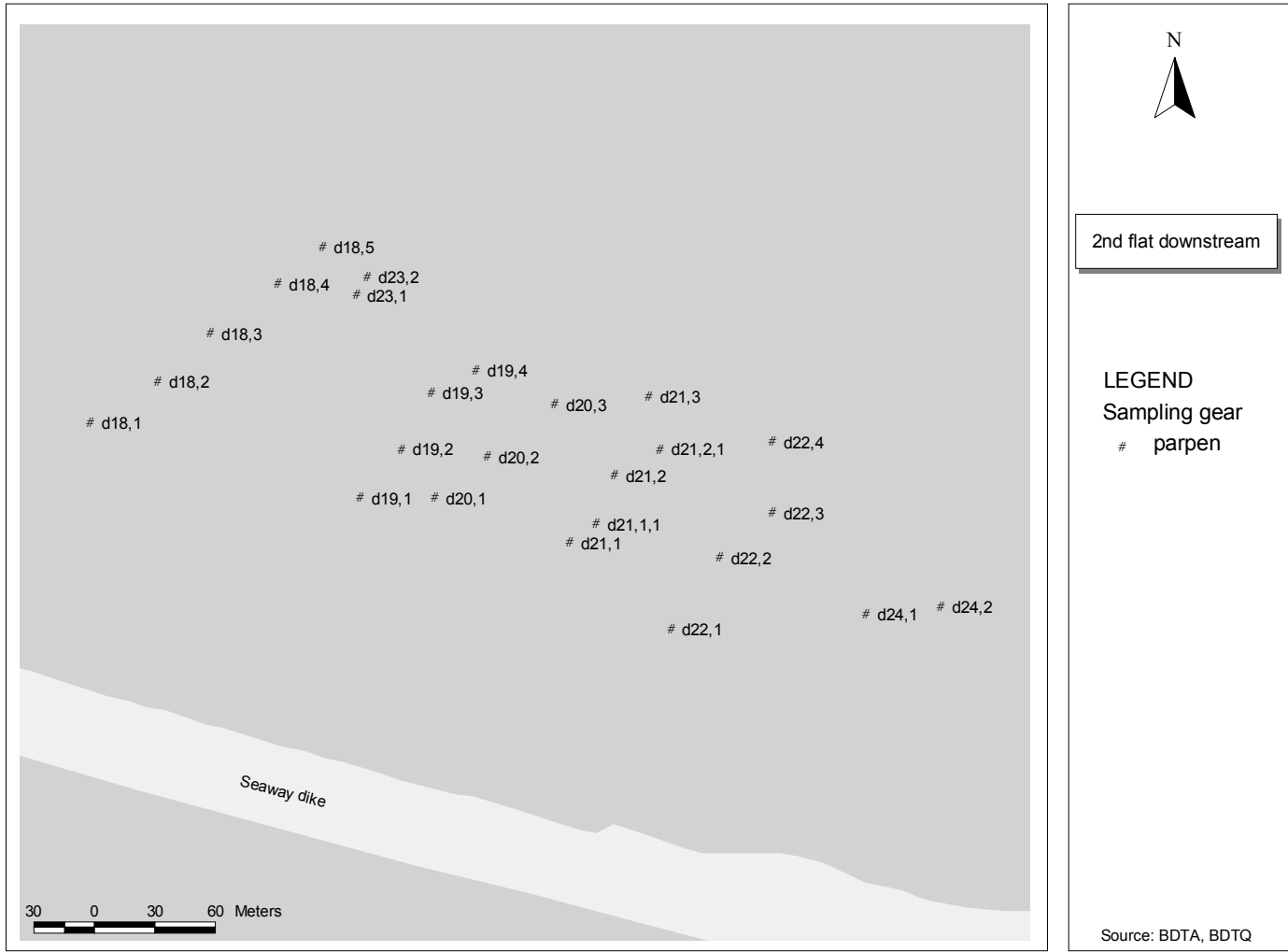
Appendix 6. Spatial coverage in the south shore 2 bridges sector using parpens, upstream portion of the Lachine Rapids, spring of 2002.



Appendix 7. Spatial coverage in the Lasalle north shore sector using parpens, upstream portion of the Lachine Rapids, spring of 2002.



Appendix 8. Spatial coverage in the 1<sup>st</sup> flat downstream sector using parpens, upstream portion of the Lachine Rapids, spring of 2002.



Appendix 9. Spatial coverage in the 2<sup>nd</sup> flat downstream sector using parpens, upstream portion of the Lachine Rapids, spring of 2002.