REGIONAL ASSESSMENT
LAKE SAINT-LOUIS

Regional Assessment
Lake Saint-Louis (ZIPs 5 and 6)

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Reports on Priority Intervention Zones (known as *ZIP*s for their French acronym) are produced by the St. Lawrence Centre of Environment Canada as part of the St. Lawrence Action Plan, in collaboration with the ministère du Loisir, Chasse et Pêche du Québec (MLCP) and the ministère de l'Environnement du Québec (MENVIQ). Readers should note that, following a Québec government decision, these two ministries no longer exist as separate entities but have merged to form the ministère de l'Environnement et de la Faune (MEF). Since this report was prepared prior to this reorganization, references to MLCP and MENVIQ will be found throughout the text.

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Management Perspective

The Priority Intervention Zones program (or ZIP program) is an innovative approach to the processing of scientific data for management purposes. The technical reports produced by the ZIP working group of the St. Lawrence Centre constitute the cornerstone of this work.

The process of gathering and analysing data on a local scale has never before been undertaken for the St. Lawrence River in its entirety. The technical reports go even further, proposing an assessment of the current state of these priority intervention zones based on objective and recognized quality criteria.

The challenge, then, consists of advancing a scientific opinion based on the available information. The pitfalls are numerous: the data were collected for other purposes; the spatial and temporal cover is not the most ideal; the chemical analysis methods are not standardized, etc.

Despite all this, the ZIP working group is convinced that an enlightened and thoughtful overview of each zone can be advanced without further delay. This first assessment thereby constitutes a starting point and a base document for the riverside partners of each priority intervention zone.

Perspective de gestion

Le programme Zone d'intervention prioritaire (ZIP) représente une approche innovatrice en matière de traitement de l'information scientifique à des fins de gestion. La réalisation des rapports techniques par les membres du Groupe de travail ZIP du Centre Saint-Laurent constitue la pierre angulaire de cette démarche.

La méthode de la cueillette et de l'analyse des données existantes à l'échelle locale est une première pour l'ensemble du fleuve Saint-Laurent. Les rapports techniques vont plus loin encore, en proposant un bilan des connaissances sur l'état actuel d'une ZIP à partir de critères de qualité objectifs et reconnus.

Le défi consiste donc à poser un jugement scientifique fondé sur l'information disponible. Les embûches sont nombreuses : les données ont été recueillies à d'autres fins, la couverture spatiale ou temporelle n'est pas idéale, les méthodes d'analyses chimiques ne sont pas uniformes, etc.

Malgré cela, le Groupe de travail ZIP est convaincu qu'il est possible de poser, sans plus attendre, un regard éclairé et prudent sur chaque ZIP. Cette première évaluation constitue donc un point de départ et un document de base rédigé à l'intention des partenaires riverains de chaque zone d'intervention prioritaire.

Abstract

This document aims to provide an environmental assessment of the Lake Saint-Louis Priority Intervention Zones (ZIPs 5 and 6), based on three technical reports on the area's physico-chemical, biological and socio-economic aspects.

In combining the results of multiple studies, difficulties may be created at the scientific level due to the spatial and temporal distribution of these studies. Caution should thus be exercised in the interpretation of certain information that is meant to be purely indicative.

The Lake Saint-Louis Priority Intervention Zones are strongly influenced by Montréal and dominated by urbanization, especially on the north shore. Human activities are intense and diversified. The lake perimeter is characterized by a high level of privatization and shoreline degradation. Major industrial centres and numerous regional recreation and tourist attractions are also to be found. Little emphasis is placed on the conservation of natural heritage, which is concentrated on island environments.

Located at the confluence of large waterways, Lake Saint-Louis offers a wide variety of habitats favourable to many plant and animal species. However, physical modifications to the environment, added to the pollution associated with urbanization, have severely altered these habitats. Toxic substances have been identified in all trophic levels of the ecosystem and frequently exceed allowable concentrations set for the protection of some of the environment's uses and resources. Finally, some biological resources are subject to heavy exploitation and are threatened by habitat destruction.

Résumé

Ce document a pour but de présenter un bilan environnemental des Zones d'intervention prioritaire du lac Saint-Louis (ZIP 5 et 6) établi à partir de trois rapports techniques sur les aspects physico-chimiques, biologiques et socio-économiques.

Le regroupement de résultats d'études multiples, répartis dans le temps et dans l'espace, présente des difficultés sur le plan scientifique. La prudence s'impose donc lors de l'interprétation car certaines informations sont présentées à titre purement indicatif.

Les ZIP du lac Saint-Louis sont fortement influencées par la proximité de Montréal et dominées par l'emprise de l'urbanisation, surtout sur la rive nord. Les activités humaines sont intenses et diversifiées. Le périmètre du lac est caractérisé par un niveau élevé de privatisation et d'artificialisation des rives. On y observe des pôles industriels importants et de nombreux attraits récréo-touristiques d'intérêt régional. La vocation de conservation du patrimoine naturel est peu importante et elle est concentrée dans les milieux insulaires.

Situé au confluent de grandes voies d'eau, le lac Saint-Louis offre une large variété d'habitats propices à de nombreuses espèces végétales et animales. Les modifications physiques du milieu et la pollution associée à l'urbanisation ont cependant sévèrement altéré ces habitats. Des substances toxiques ont été identifiées dans tous les niveaux trophiques de l'écosystème et dépassent fréquemment les teneurs admissibles fixées pour la protection de certains usages et ressources du milieu. Enfin, certaines ressources biologiques subissent une forte exploitation et sont menacées par la destruction de leur habitat.

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Acknowledgments

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CHAPTER 1 Introduction

Faced with the degradation of the St. Lawrence River, the loss of its habitats and the generalized pollution of its ecosystems, and in response to growing public concern, the governments of Canada and Québec agreed to pay special attention to the St. Lawrence and to harmonize their initiatives under the St. Lawrence Action Plan.

1.1 ZIP Program

The Priority Intervention Zones (ZIPs) created under the *St. Lawrence Action Plan* are in keeping with the sustainable development of the river and its banks. This program is also part of the *St. Lawrence Pollution Prevention Plan* under *Canada's Green Plan*. The ZIP program is also an element of the *Stratégies Saint-Laurent* program, under which various non-governmental organizations work cooperatively to involve local communities in recovering the use of the St. Lawrence. At Lake Saint-Louis, the Haut-Saint-Laurent ZIP committee is already at work organizing regional consultations on the ecological rehabilitation of this sector of the river.

The river corridor has been broken down into 23 sections (ZIPs) to facilitate understanding of the relationship between human activities carried out in a given ZIP and their effects on the area's characteristic uses and biological resources. The ZIP program is made up of three phases: *1)* determining the state of knowledge, which includes publication of *a)* technical reports, and *b)* the integration document; *2)* the consultation of riverside partners; and lastly, *3)* monitoring.

In order to assess the state of knowledge, existing physico-chemical, biological and socio-economic data must first be collected and analysed. The actual quality of the area must then be characterized in terms of recognized criteria, and a sectoral report on the state of the environment must be arrived at. This first phase of the ZIP program has resulted in the production of three technical reports on Lake Saint-Louis (Armellin et al., 1994; Fortin et al., 1994; Jourdain et al., 1994). The second or integration stage of this assessment brings together

in this document the main elements of the technical reports and identifies the problems specific to the ZIPs which make up the Lake Saint-Louis area. The integration document will be submitted for consultation with riverside partners.

The second phase of the ZIP program begins with public hearings under the *Stratégies Saint-Laurent* program, during which local partners are invited to contribute, as necessary, to the knowledge assessment report and to participate in defining priority actions. Based on these priorities, the principal socio-economic stakeholders will be called upon during the third phase of the ZIP program to develop pollution-prevention strategies and to implement plans for ecological rehabilitation.

The Lake Saint-Louis area is made up of ZIPs 5 and 6 and is the second series of ZIP program studies, the first being Lake Saint-Pierre (ZIP 11). Signatories to the federal-provincial Action Plan harmonization agreement undertook to work together on the program for ZIPs 5 and 6 and to participate jointly in assessing the present state of the area. By synthesizing and analysing current knowledge in this way, the objective is to provide the various riverside partners with scientific data that is both accessible and objective. Action plans can then be drawn up and implemented locally and regionally, with riverside partners each acting within their area of responsibility, but in a cooperative manner.

1.2 Integration Document

1.2.1 Objectives

The purpose of this document is to combine the knowledge assessments presented in the three technical reports so as to come up with a list of environmental problems and assets specific to ZIPs 5 and 6. This list will be submitted to representatives of riverside community groups for consideration and comment.

1.2.2 Methodology

We will be assessing the effects of the development of human communities on the environment, on biological resources and on associated uses from the perspective of the sustainable development of the St. Lawrence River and its banks. Our analysis focuses on two

themes: the human activities carried out in the ZIP(s) in question, and the uses and resources found there. The relationship between these two sets of themes will be established to the best of our knowledge and based on a scientific opinion supported by the available information. We have decided to look at changes to the environment as related to human actions, putting aside natural phenomena and their effects for the moment.

The integration process involves several stages (Burton, 1991a) which form the various chapters of this document: determining spatial and temporal limits for data, analysing human activity and the pressures on the ecosystem, identifying uses and resources, determining the links between these two sets of themes and identifying the specific problems of the ZIPs under study.

Temporal limitations. Information analysed in the technical reports was based on historical publications while optimizing the most recent data. Data selected for the river water quality span from 1985 to 1990 (NAQUADAT database; Rondeau, 1993), from 1986 to 1992 (Environment Canada and MENVIQ) for the tributaries, from 1986 to 1992 for industrial discharges (St. Lawrence Action Team, 1992a), and from 1989 to 1991 for municipal discharges (Asseau-INRS, 1992; MENVIQ, 1992a and b). Data on sediments were taken from various studies carried out between 1984 and 1991.

Information on biological resources was mainly taken from studies conducted during the 1980s as part of the Archipel Project (Roche et Associés Ltd., 1985a and b; MLCP, 1984b). Information on habitat losses was provided in a recent study (Marquis et al., 1991) on the physical changes to fish habitats between 1945 and 1988 — information also analysed by remote sensing in 1991 at the St. Lawrence Centre. Due to a lack of information, the status report on physical changes does not cover changes related to the diversion of the river in 1929.

The socio-economic data were taken from various sources. Statistics Canada databases enabled us to compare changes between 1981 and 1986 and, where possible, 1991, the date of the last census. The various regional and local planning documents (first-generation development plans and urban plans) were all prepared after 1985, following adoption of the Québec *Act respecting land use planning and development.*

Certain problems of a scientific nature were encountered due to the lack of data uniformity. We nevertheless retained all relevant information so that we might draw up a report on the state of the environment which will serve as a basis for consultation.

Spatial limitations. ZIP boundaries were established with a number of factors in mind: hydrodynamic conditions, biogeographic zones and riverside communities. In all, 23 ZIPs were defined for the St. Lawrence River, Gulf and Estuary, and these will be combined to form 13 study areas.

Method of analysis. Although arbitrary, this breakdown of the river does allow us to consider more carefully regional specifics — something a more global approach would not. Bear in mind, however, that this waterway has a complex hydrodynamic regime, influenced by the Great Lakes and many tributaries.

This report will look at drainage basin inputs into the St. Lawrence using two approaches. Inputs from upstream will be documented through assessed loadings at the entrance to ZIPs 5 and 6 (the Beauharnois Canal and the St. Lawrence River). Data obtained at the mouths of the main tributaries (the Ottawa, Châteauguay and Saint-Louis rivers) will be included. This approximation of drainage basin inputs should enable us to distinguish between the effects of human activity in these ZIPs and those related to activities outside these areas.

An initial approximation of these inputs comes from an analysis by Asseau-INRS (1992). At present, the St. Lawrence Centre is collecting more detailed data and preparing a report on toxic substances in the St. Lawrence.

The cartographic analysis of aspects of the aquatic and shoreline environment was carried out using a geographic information system, SPANS. The relevant information was digitized and mapping is proceeding using a single base map, with pre-established ZIP boundaries.

1.3 Presentation of ZIPs 5 and 6

As already mentioned, ZIPs 5 and 6 together form the Lake Saint-Louis region (see Figure 1). The Ottawa River to the north, the St. Lawrence River and Beauharnois Canal to the west, and the Lachine Rapids to the east form the main hydrographic boundaries of these ZIPs. The boundaries of riverside municipalities considered in the socio-economic analysis correspond to regional county municipality (RCM) development plans.

1.3.1 Physico-chemical aspects

Lake Saint-Louis is a natural widening of the St. Lawrence River and bathes part of the Montréal archipelago. It is the third largest body of water after lakes Saint-Pierre and Saint-François.

Lake Saint-Louis covers a surface area of 148 km^2 and measures 23 km in length. Its depth is less than an average three metres for over half of its surface area; maximum depth is 30 m. The lake receives the waters of Lake Saint-François, which flow mainly through the Beauharnois Canal (84%), and the St. Lawrence River (16%), along with water from the Ottawa, Châteauguay and Saint-Louis rivers. Because of the regulated water flow of the Great Lakes, fluctuations in the flow and level of Lake Saint-Louis are slight and mainly influenced by high levels in the Ottawa River.

Lake Saint-Louis has two main water masses: *green waters* from the Great Lakes, which are found in the south and along the St. Lawrence Seaway, characterized by low turbidity, heavy mineralization and low nutrient content; and *brown waters* from the Canadian Shield (Ottawa River), which flow along the north shore and are characterized by heavy turbidity and low mineralization.

Although the average concentration of suspended solids (SS) is relatively low (4 to 5 mg/L) at the entrance to the lake, Lake Saint-Louis still receives significant quantities of SS because of heavy flows from the Great Lakes and the Ottawa River. Sedimentary processes, particularly on the south shore, have contributed to the formation of shallows and island environments that are prime wildlife habitats.

1.3.2 Biological aspects

Lake Saint-Louis is characterized by its biological riches and diversity. Located at the confluence of major waterways, it provides a wide variety of prime habitats for many plant and animal species. An estimated 450 taxons are associated with the wetlands of Lake Saint-Louis.

Wetlands occupy close to 5000 ha here, where they form choice habitats. Seventy-eight of the 116 freshwater fish species in Québec are found in Lake Saint-Louis. The area's natural riches are the result of great habitat diversity and the fact that several flyways intersect here. Large concentrations of up to 50 000 waterfowl can be seen during the autumnal migration period. Colonies of Great Blue Heron, Ring-billed Gull and Black Tern are also found, along with high densities of Muskrat.

The habitats of Lake Saint-Louis have been significantly altered by urban development, which has considerably reduced the flood plain. Forests bordering the lake have been affected by the heavy hydraulicity of the past few decades. The main remaining springtime flood zones are threatened; they are found mainly in the archipelago of the De la Paix islands, in the Châteauguay area, and on Saint-Bernard and Dowker islands. The first three zones are subject to special protective measures because they are part of the Îles-de-la-Paix National Wildlife Area; Saint-Bernard Island and the Châteauguay Commons are both part of the Marguerite-d'Youville Wildlife Reserve.

1.3.3 Socio-economic aspects

Twenty riverside municipalities make up ZIPs 5 and 6. Twelve of them are divided into three regional county municipalities (RCMs), seven are part of the Montréal Urban Community (MUC), and the twentieth is the Kahnawake Mohawk reserve.

In 1991, 97% of the 209 311 residents of ZIPs 5 and 6 lived in urban centres. The workforce distribution in 1981 was similar to that of the province as a whole: 71% in the service sector, 25% in the manufacturing sector and one percent in the primary sector. This breakdown has not varied significantly since 1981.

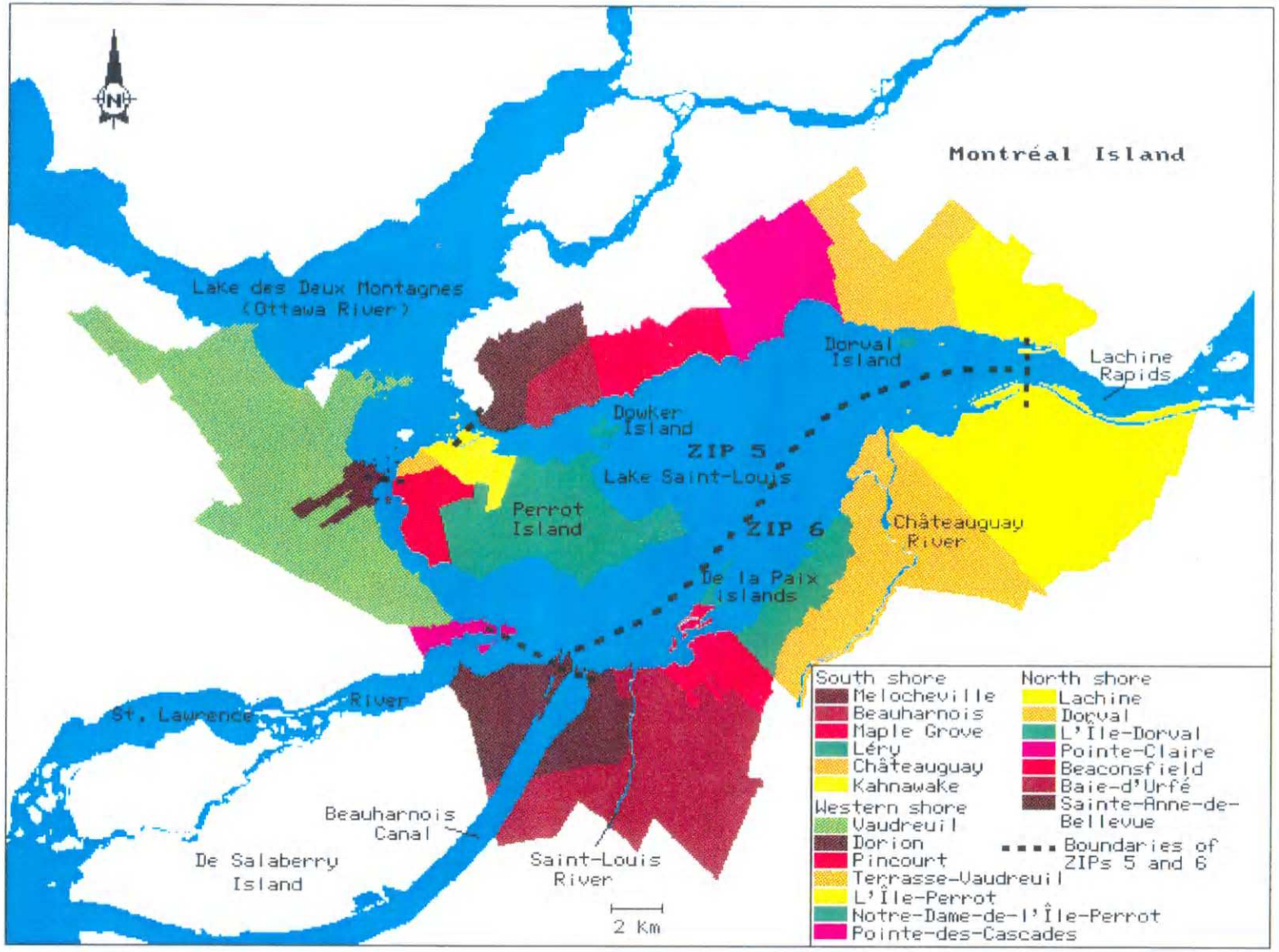


Figure 1 Lake Saint-Louis ZIPs: Boundaries, municipalities and main tributaries

From a socio-economic viewpoint, the Lake Saint-Louis region is part of the economic development axis of Québec, whose centre is Montréal. The area is dominated by urbanization and marked by residential use. The lakefront is characterized by a high level of privatization and degraded shoreline. There are major industrial centres and many contaminated sites. The transportation system is extensive and the region has many recreational and tourist attractions of regional interest. Conservation of natural heritage remains poorly developed and confined to island environments.

Commercial fishing and trapping are marginal activities and in decline. Recreational activities on Lake Saint-Louis focus mainly on boating and sport fishing. The greatest sport fishing pressure in the province is felt here, and winter fishing is particularly heavy. In the fall, Lake Saint-Louis comes under heavy pressure from hunters, who take an average of 15 000 waterfowl every year in this sector.

CHAPTER 2 Human Activity

The human activities referred to here are those which cause changes to the ecological components of ZIPs 5 and 6. These activities are sources of chemical or microbial contamination or can physically alter the environment.

These activities are generally common to the river as a whole: flow control, dredging, shipping and industry, municipal, agricultural, and recreational and tourist activities. Each one is briefly described and, based on available information, the extent of the stress placed on ecosystems is determined according to the pollutant loading or the areas affected.

2.1 Control of Water Flow

2.1.1 Water level management

Because more than half the waters of the St. Lawrence issue from the Great Lakes, the river is sensitive to water level fluctuations throughout the Great Lakes system (Great Lakes Foundation, 1989). A regulatory plan approved by the International Joint Commission (IJC) in 1954 controls water flow from the Great Lakes into the St. Lawrence. More recently, in 1985, the governments of Québec, Ontario and the eight American states bordering the Great Lakes signed the *Great Lakes Charter* to develop a joint management program for the waters of the Great Lakes/St. Lawrence basin and to deal with use of the water resource in the future.

Stress. The management of water levels flowing out of the Great Lakes has economic benefits related to flood control and ensures a constant water depth in the St. Lawrence Seaway. Combined with the heavy hydraulicity of the 1970s and 1980s, and particularly in 1972 and 1976, such management has nevertheless caused increases in water levels in Lake Saint-Louis, resulting in changes to wetlands and the loss of riparian forest.

2.1.2 Control structures

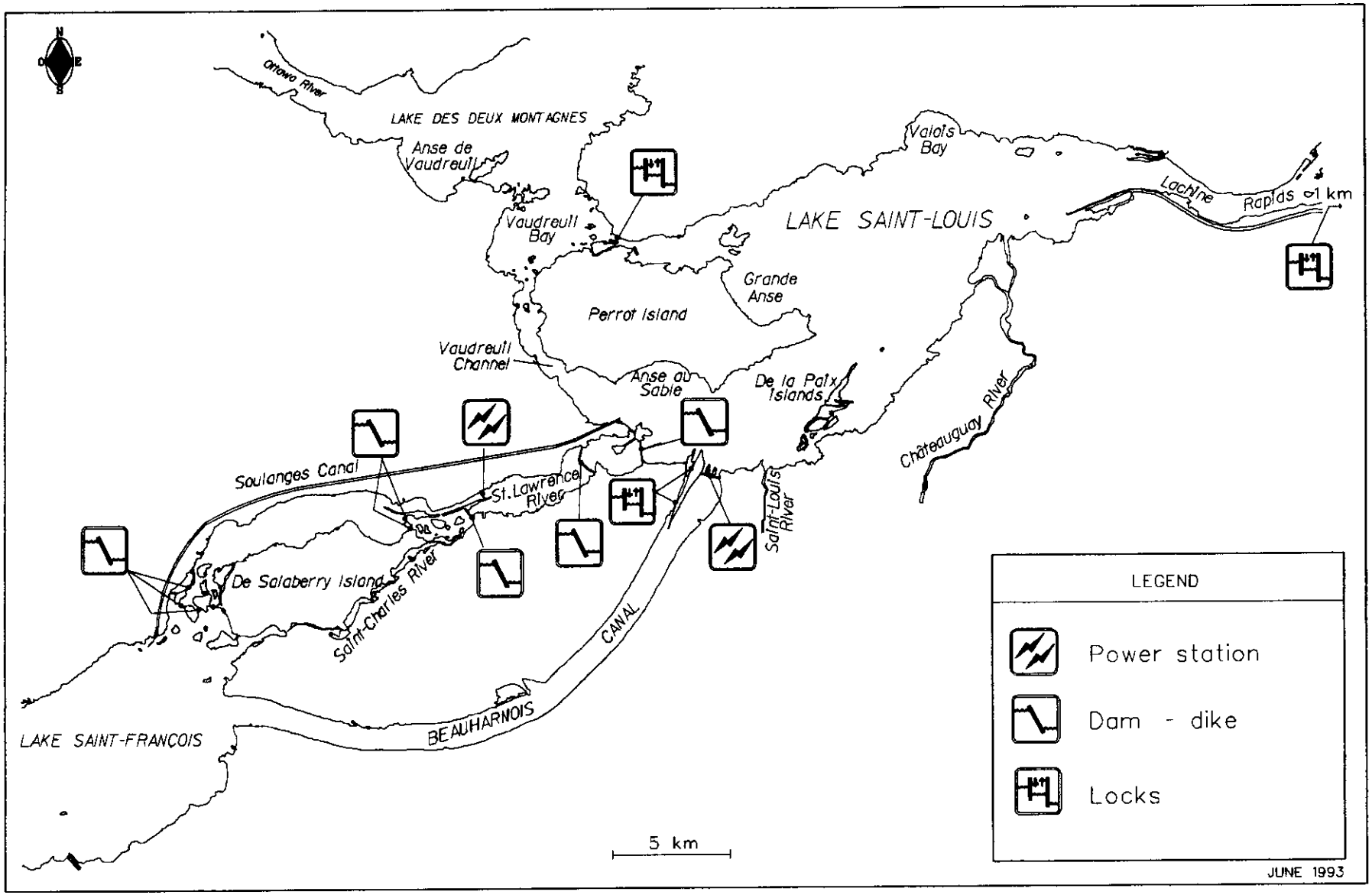
The main hydro-electric facilities on the St. Lawrence are located in the Beauharnois-Les Cèdres area west of Montréal (see Figure 2), and include two power stations and several compensating structures.

Diverting a major portion (84%) of the flow of the St. Lawrence River into the Beauharnois Canal has completely modified the physical characteristics of the river between lakes Saint-François and Saint-Louis. Compensating structures have been constructed to re-establish the previous water levels, and Hydro-Québec has been studying the operation of this system in order to limit the impact on fish and enhance the various recreational uses of basins (Environnement Illimité, 1987). Two of these structures, at Pointe-du-Buisson and Pointe-des-Cascades, are located at the border between ZIPs 5 and 6 (Lake Saint-Louis) and ZIPs 3 and 4 (Beauharnois Canal and St. Lawrence River).

Stress. Hydro-electric structures and control structures were accompanied by the flow-modifying diversion of the river in 1929. These major changes to the environment, together with backfilling, led to the loss of some 30 ha of deepwater habitats in Lake Saint-Louis (Table 1). These control structures also modified the conditions under which migratory fish (particularly Lake sturgeon and American eel) move between their breeding and feeding areas, probably contributing to their reduced numbers.

2.2 Dredging

During construction of the St. Lawrence Seaway, dredging and the dumping of dredged material affected 130 ha and 138 ha, respectively, of prime fish habitat located mainly in deep water (Table 1). Since the opening of the St. Lawrence Seaway in 1959, no sediment dredging has been required in Lake Saint-Louis. The Canadian Coast Guard takes regular soundings to detect rocks which might interfere with navigation.



Sources: Energy, Mines and Resources Canada. Topographic maps 1:50 000, Nos. 05 31G1 (1983), 31G8 (1984), 31H5 (1988).
Hydro-Québec (1991).

Figure 2 Control structures: Beauharnois-Les Cèdres region

Stress. Dredging changes the topography of the river bed (bathymetry) and thus affects currents. It may also destroy aquatic habitats. Fine sediments and re-suspended nutrients can choke spawning grounds and promote the proliferation of aquatic plants. In Lake Saint-Louis, the dumping of dredged material in open waters during construction of the Seaway changed the nature of the lake bed (substrate) and disturbed major fish habitats, including those frequented by Lake sturgeon, Walleye and sucker species (Gravel and Pageau, 1976).

Table 1
Changes to fish habitats in ZIPs 5 and 6 (Lake Saint-Louis), 1945-1988

	Area affected, by type (ha)				
Modification	*Swamp*	*Deep water*	*Marsh*	*Aquatic plant community*	*Total*
Filling	1	65	10	47	123
Drainage	2	<1	4	11	17
Dumping of dredged spoil*	0	138	0	0	138
Dredging*	0	130	0	0	130
Changes in flow	0	8	0	0	8
Encroachment	0	1	0	0	1
Modifications + fill	0	18	0	0	18
Total	**3**	**360**	**14**	**58**	**435**

* During construction of the St. Lawrence Seaway.

Source: Data from Marquis et al. (1991) digitized for the St. Lawrence Centre.

2.3 Shipping

The 300 km separating the Saint-Lambert locks from Lake Ontario are crossed by the St. Lawrence Seaway, which ensures vessels a minimum water depth of 8.2 m. Since its opening in 1959, over 1.2 billion tonnes of merchandise has moved through these facilities (Société de Développement Économique du Saint-Laurent, 1991). During the 1970s, annual traffic on the Seaway reached record levels. A record 57 million tonnes of cargo was moved through here in 1977.

Stress. The possible effects of shipping on Lake Saint-Louis include chemical pollution, bacterial contamination, wave action and disturbance of the environment by infrastructures.

Chemical pollution can result from accidental chemical spills. No accident of this type has been reported to date in Lake Saint-Louis; however, the risks are always present and are associated with the intensity of shipping and with navigational problems on this waterway. Up to 3.2 million tonnes of petroleum products are transported annually on the Montréal-Lake Ontario section, requiring 300 to 400 trips (Brander-Smith, 1990). For safety reasons, the Public Review Panel on Tanker Safety and Marine Spills Response Capability has recommended the adoption of strict regulations governing the opening and closing dates of the St. Lawrence Seaway.

A bird cleaning centre was set up at MacDonald College in Sainte-Anne-de-Bellevue because of the high concentrations of migratory birds in the St. Lawrence lakes upstream of Montréal. The centre's mandate covers the St. Lawrence River from Lake Saint-François up to Sorel, and centre personnel are ready to go into action in the event of an oil spill.

Bacterial contamination is associated with the discharge of wastewater from ships. It is difficult to detect this type of discharge in the environment and its effects combine with those of municipal and agricultural discharge. Upstream of the Saint-Lambert locks, however, shipping is subject to the *Great Lakes Sewage Pollution Prevention Regulations* under the *Canada Shipping Act,* which prohibits ships from discharging sewage.

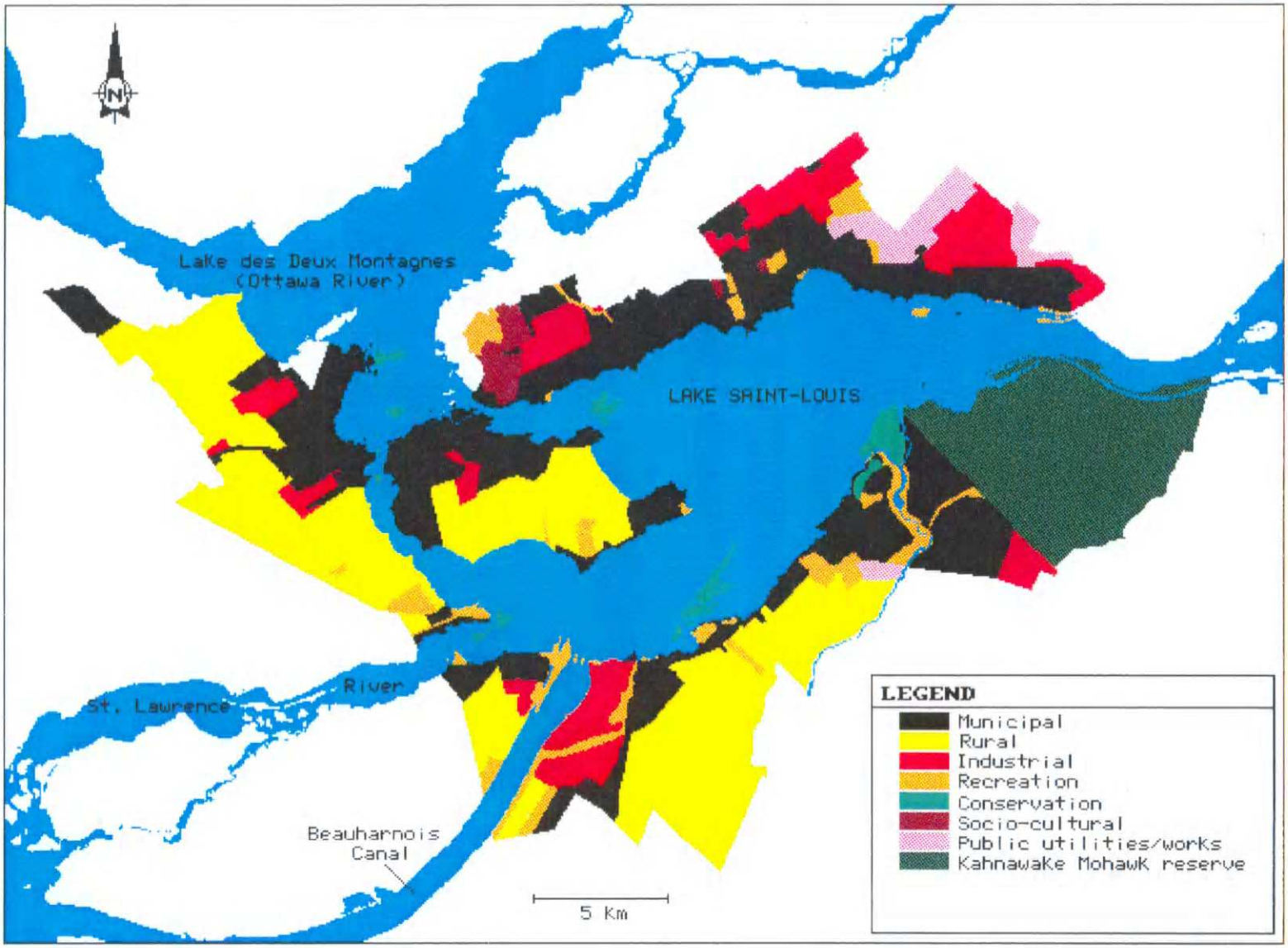
Wave action is the swell caused by the movement of large ships. This swell acts on aquatic plant communities and affects the stability of banks. Wave action has eroded the north shore of the De la Paix islands, according to Ducks Unlimited Canada (1985). These waves disturb the fish communities living in shallow habitats.

Infrastructures are mainly limited to navigational aids and occupy very small areas. Certain structures built in the form of small rocky islands were placed along the edges of the channel to maintain ice cover. This keeps the ice from breaking up (the leading cause of ice jams during spring thaw) and hastens the re-opening of shipping.

Emptying ballast tanks in shipping zones can lead to the introduction of exotic species. The Zebra mussel, which has now spread throughout the Great Lakes and has been sighted recently in Lake Saint-Louis, was introduced by vessels from Europe. Because they proliferate rapidly, Zebra mussels can block municipal and industrial water intake pipes. Moreover, because they attach themselves to hard surfaces, they cause equipment corrosion. Once established in ecosystems, they may interfere with native species (O'Neil and MacNeill, 1989).

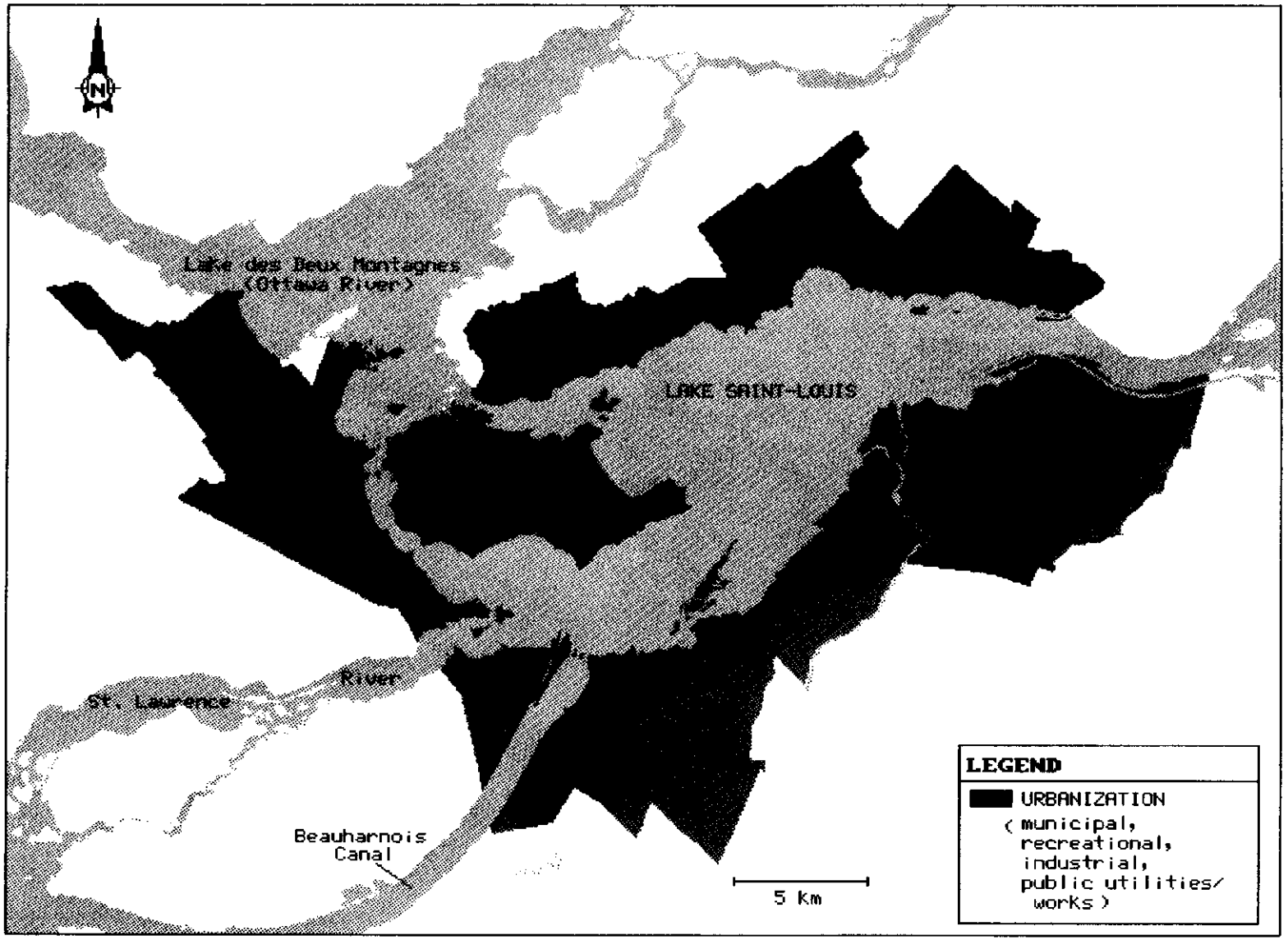
2.4 Urbanization

The area under study is strongly influenced by the proximity of Montréal, and two organizational profiles can be distinguished. The first, an extension of Montréal's urban fabric, is the densely urbanized area on the north shore of Lake Saint-Louis and the northwest part of Perrot Island where residential use dominates. The other includes the south and west shores of Lake Saint-Louis and the southern part of Perrot Island, where land use is more diversified and secondary urbanization centres are found (Figure 3). On Lake Saint-Louis the degree of urbanization, or the extent of areas allocated to municipal, industrial and recreational purposes and services, in terms of total area, is 54% (Figure 4). From 1986 to 1991, the population of these ZIPs increased by six percent.



Source: Jourdain et al. (1994).

Figure 3 Broad land use designations of ZIPs 5 and 6 (Lake Saint-Louis)



Source: Jourdain et al. (1994).

Figure 4 Urbanization map of ZIPs 5 and 6

Approximately 68% of the Lake Saint-Louis shoreline has been designated for urban use, and in 1981 at least 80% of the population lived close to the shoreline. Residential construction clearly predominates, representing 48% of the riverside perimeter (Jourdain et al., 1994). In four municipalities, a large proportion of the lakefront environment is occupied by recreational ribbon parks. The type of land use that has prevailed for the past 50 years has thus brought about permanent changes to the environment and the degradation of shorelines.

Eleven percent of the area has been designated for industrial use. That portion of shoreline used for industrial activity is nonetheless relatively modest (one percent of the lakefront area) and is concentrated in Beauharnois and Melocheville.

2.4.1 Municipal effluent

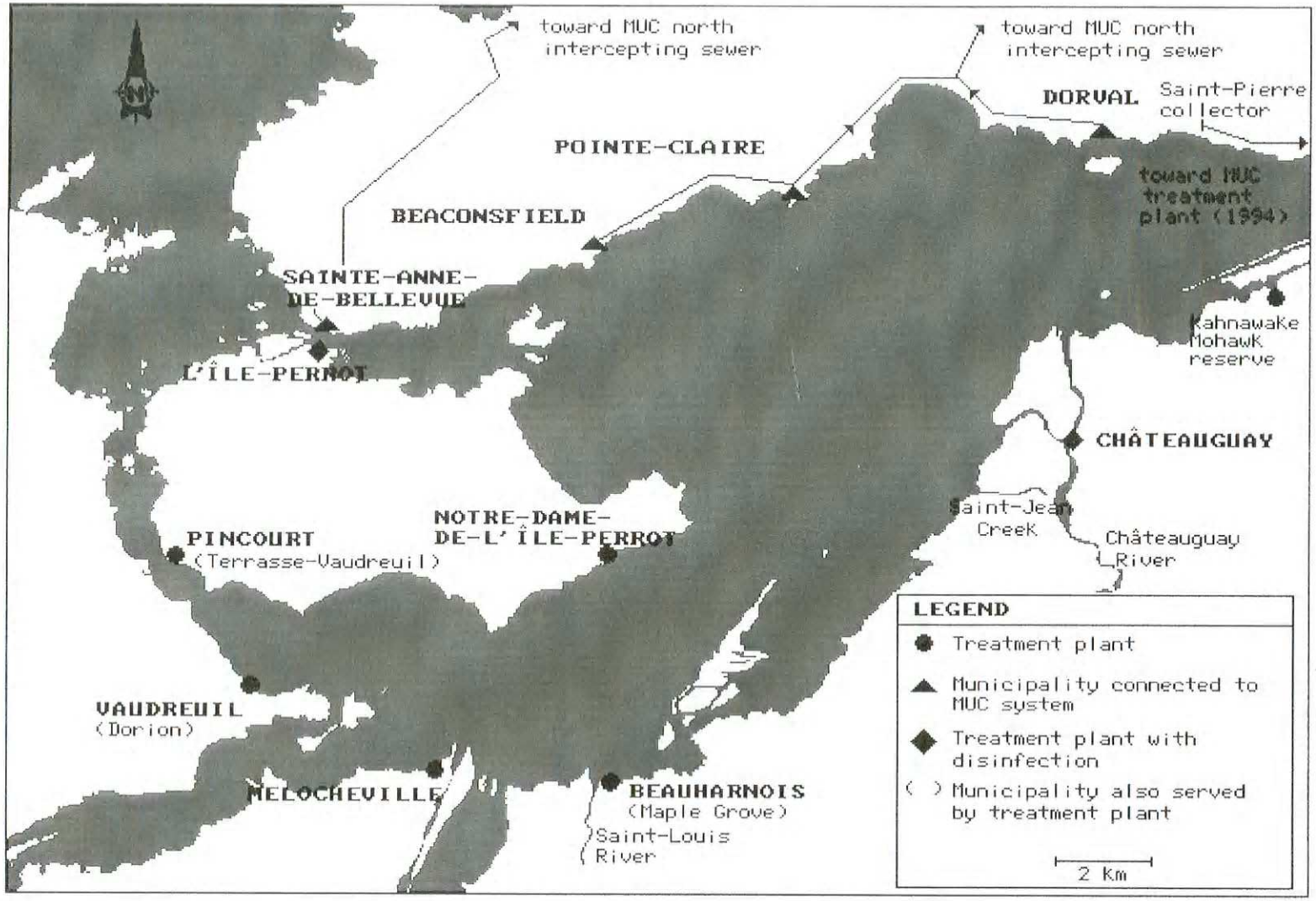
This chapter deals with the discharge of wastewater into the aquatic environment.

Thirteen of the 20 municipalities located within ZIPs 5 and 6 discharge their effluent into Lake Saint-Louis (including the Vaudreuil and Sainte-Anne channels), while four are connected to the Montréal Urban Community (MUC) intercepting sewer; the outfall sewer of the municipality of Lachine discharges downstream of Lake Saint-Louis. Two other municipalities are mainly served by septic tanks.

In 1992, eight treatment plants served the 11 municipalities discharging their effluent into Lake Saint-Louis (Figure 5), or approximately 45% of the population of ZIPs 5 and 6. As well, four municipalities representing 33% of the population were connected to the MUC system. In 1992, an estimated 76% of the population of these ZIPs was served by a sewage treatment plant. This number should exceed 95% in 1994, when the sewers of Lachine and Baie-d'Urfé are connected to the MUC's south intercepting sewer.

An estimated two percent of the population uses septic tanks.

Stress. The discharge of municipal wastewater is a major source of organic and microbial pollution, and also contains toxic substances such as metals. Treatment does, however, remove a significant proportion of the pollutants found in wastewater.



Adapted from Jourdain et al. (1994)

Figure 5 Municipal water treatment in ZIPs 5 and 6 (in 1992)

2.4.1.1 *Suspended solids*

Suspended solids (SS) in municipal effluent contribute to increased turbidity at the discharge point. Organic matter can cause the oxygen content of the water to drop by increasing the chemical and biochemical oxygen demand (COD and BOD_5). Table 2 shows discharges of SS and BOD_5 values for four treatment plants serving seven municipalities along Lake Saint-Louis. Based on this data, these plants annually discharge an estimated minimum of 120 tonnes of SS and 130 tonnes of BOD_5.

Table 2
Daily SS and BOD_5 loads in discharges of four sewage treatment plants on Lake Saint-Louis

	1990		*1991*	
Treatment plant	*SS (kg/d)*	*BOD_5 (kg/d)*	*SS (kg/d)*	*BOD_5 (kg/d)*
Pincourt	-	-	165	99
Beauharnois	75	32	85	40
Vaudreuil	78	201	-	-
Melocheville	-	14	-	-

Note: kg/d= kilograms per day.

Source: MENVIQ, 1992a and b.

The average rate of removal of these substances by the four sewage treatment plants was approximately 90% for BOD_5 and SS in 1990 and 1991 (MENVIQ, 1992a and b). The other treatment plants were not considered due to the lack of accurate information. The outfall sewer

of the MUC treatment plant discharges at Aux Vaches Island, and does not therefore affect the water quality of Lake Saint-Louis.

2.4.1.2 *Nutrients*

Domestic wastewater contains nutrients such as nitrogen and phosphorus. Discharged in large quantities, these substances encourage the proliferation of aquatic plants, amplifying the decomposition process and creating detrimental conditions for a number of plant and animal species. These conditions also interfere with recreational activities. Phosphorus input has decreased in the Great Lakes/St. Lawrence basin as a whole due to federal regulations on detergents, and also in Lake Saint-Louis following clean-up operations. However, concentrations of nitrites and nitrates appear to be on the rise. The only accurate data on discharges of these substances into Lake Saint-Louis are from the Pincourt sewage treatment plant, which was discharging approximately four tonnes of phosphorus annually in 1991, with a removal rate of 36% (MENVIQ, 1992b).

2.4.1.3 *Microbial contamination*

The discharge of non-disinfected human sewage results in the appearance of microorganisms in the water (bacteria and viruses), some of which can cause illness in humans and other mammals. These microorganisms contribute to the propagation of infectious diseases, leading to the closure of beaches and interfering with recreational activities involving water contact. Most of the municipalities on Lake Saint-Louis treat their sewage, which reduces the discharge of microorganisms into the water; the municipalities of Châteauguay and L'Île-Perrot apply a disinfection process, and municipal sewage discharges on the north shore of the lake have been halted.

2.4.1.4 *Other contaminants*

Municipal wastewater may also contain other contaminants such as phenols, pesticides and metals. Discharges of copper, zinc and lead were estimated for the main Lake Saint-Louis communities in 1989 (Table 3).

As we will see later, municipal discharges of metals in 1989 were not as significant as those of industrial plants. Moreover, ever since metals discharges were assessed in 1989, Pincourt, Terrasse-Vaudreuil, L'Île-Perrot and Châteauguay have been treating their wastewater, which no doubt decreases the input of contaminants in the environment. Residues in discharges may, however, have a local effect. Some of these substances are toxic and when found above certain levels pose a threat to aquatic life.

Table 3
Daily loadings of copper, zinc and lead
by municipalities along Lake Saint-Louis in 1989

Municipality	*Population (1989)*	*Treatment (in 1989)*	*Flow (m^3/s)*	*Cu (kg/d)*	*Zn (kg/d)*	*Pb (kg/d)*
Notre-Dame-de-L'Île-Perrot	3 447	Yes	0.020	0.017	0.043	0.021
Pincourt + Terrasse-Vaudreuil	9 088	No	0.087	0.15	0.38	0.19
L'Île-Perrot	7 700	No	0.074	0.13	0.32	0.16
Beauharnois + Maple Grove	8 750	Yes	0.074	0.064	0.16	0.080
Châteauguay	38 500	No	0.370	1.2	4.9	2.4
Melocheville	1 950	Yes	0.017	0.015	0.038	0.019
Total	**69 435**		**0.642**	**1.576**	**5.841**	**2.87**
kg/year				**575.2**	**2132.0**	**1048.0**

Note: kg/d = kilograms per day.
Loads shown in this table may be inaccurate by 40% to 50%.

Source: Asseau - INRS (1992).

2.4.2 Industrial effluent

The majority of industrial plants are located on the north shore of Lake Saint-Louis and discharge their wastewater into the MUC collector (except for those in Lachine, which discharge downstream of Lake Saint-Louis). A second industrial centre is concentrated on the southwest shore in Beauharnois and Melocheville, and industrial effluents (treated and untreated) are either discharged directly into Lake Saint-Louis or into the Saint-Louis River. These plants operate mainly in the chemical and metallurgy sectors. The Beauharnois industrial zone also poses a threat to the environment because of fuel and chemical storage sites and waste dumping sites, which are likely sources of pollution for the river.

Four of the 50 St. Lawrence Action Plan priority plants are located in the Beauharnois-Melocheville area, namely:

- Domtar Inc., Fine Papers Division
- PPG Canada Inc.
- Elkem Metals Canada Inc. (closed since 1991)
- Alcan Smelters and Chemicals Ltd. (AS & C)

These plants are also found on the short-term priority list of the *Program de réduction des rejets industriels du gouvernement du Québec* (industrial waste reduction program) or PRRI, which includes six other plants in this sector:

- Timminco Metals - Div. of Timminco Ltd. (Beauharnois) (closed since 1991)
- BGR Chemicals Inc. (Pointe-Claire)
- Timminco Ltd., Industrial Adhesives Div. (Pointe-Claire)
- Domtar Inc., R.C.I. Div. (Lachine)
- Swift Adhesives, Div. of Reichhold Ltd. (Pointe-Claire)
- Texall Inc. (Pointe-Claire).

Stress. The manufacturing sector generates waste containing suspended solids, nutrients, and organic and inorganic contaminants. Discharges of these substances from plants targeted by the Action Plan are examined in Table 4. Most of the plants targeted by the PRRI are connected to the MUC's north intercepting sewer.

2.4.2.1 *Suspended solids*

Plants located in ZIPs 5 and 6 and targeted under the Action Plan discharge approximately 55 tonnes of suspended solids each year. These discharges cause a local increase in the turbidity of water near industrial outfalls and, if organic matter is involved, may decrease oxygen content.

2.4.2.2 *Nutrients*

Discharges from these plants contain nutrients. The Domtar Inc., Fine Papers Division plant annually discharges 205 kg of nitrites and nitrates and 530 kg of phosphorus; Alcan Smelters and Chemicals Ltd. (AS & C) discharges 226 kg of nitrites and nitrates yearly; PPG Canada Inc. annually releases 1011 kg of nitrites and nitrates and 212 kg of phosphorus; and, before it closed in 1991, Elkem Metals Canada Inc. discharged 3650 kg of phosphorus annually.

2.4.2.3 *Other contaminants*

Shown in Table 4 is an estimate of the main toxic substance loads measured recently in effluents from Action Plan priority plants. In the past, these plants discharged considerable quantities of metals and organic products. Some of these substances persist in the environment and are very toxic. They may accumulate in ecosystems and contaminate links in the food chain.

The loads shown in Table 4 are taken from recent Action Plan characterization studies (except for Elkem Metals Canada Inc.) which were used to calculate the **Chimiotox Index**. This index takes into account the relative toxicity of each contaminant and of the load at final discharge, thus allowing us to rank each Action Plan plant **based on the toxic load** discharged into the receiving environment. Another indicator, the **PEEP** (Potential Ecotoxic Effects Probe) provides information on the reaction of living organisms to the toxic substances contained in plant effluent. This indicator allows us to compare plants **based on the toxic potential** of their discharge. The ranking assigned to each plant is shown in Table 4.

Table 4
Estimated daily loads (kg/d) of main toxic substances discharged by the four Action Plan priority industrial plants located in ZIPs 5 and 6

Parameter	*AS & C (1991)*	*AS & C (1992)*	*DOMTAR (1990)*	*PPG (1991)*	*ELKEM (1986)*
Conventional					
BOD_5	13.9		759	35.3	
COD			1572	212.4	630
SS	31.0		73	45.7	1000
Total solids	145.5		2907	30 425.3	
Toxic inorganics					
Heavy metals					
Zinc			1.21		130
Lead					13
Cadmium					2
Mercury				0.017	
Other metals					
Aluminum	5.29	0.180	10.27		
Iron	0.4		0.250		
Manganese					230
Anions and others					
Ammoniacal nitrogen			0.52	3.80	
Nitrites-nitrates	0.62		0.56	2.77	
Fluorides	9.0	0.95			
Total phosphorus			1.45	0.58	
Total chlorine				18.0	4
Toxic inorganics					
Total PAHs	0.751	0.003	0.0011		
Oils and greases	4.6			27.0	
Phthalates	0.123	0.064		0.003	
Total fatty acids			0.226		
Total resin acids			12.54		
Dioxins and furans[a]			$3.63(10^{-9})$		
Total halogenated VOCs			0.039	0.745	
Chimiotox ranking (/46)	18	40	37	24	n.a.
PEEP ranking (/49)	43	n.a.	18	30	n.a.

[a] Quantity expressed in terms of a reference dioxin: 2,3,6,7-tetrachlorodibenzodioxin, the most toxic isomer.
n.a.: Data not available.

Sources: St. Lawrence Action Team (1992a; 1992b).

In 1991, Alcan Smelters and Chemicals Ltd. (AS & C) discharged large quantities of PAHs in wash water from its anodic pulp briquette warehouse. In 1992, better management of wash water reduced the company's PAH discharge by 99%. At Domtar Inc., Fine Papers Division, the toxic load is mainly made up of resin acids, dioxins and furans. It should be noted that dioxins and furans are highly toxic, even in small quantities. By 1995, Domtar Inc. will have to comply with new federal and provincial regulations on pulp and paper mill effluents which limit discharges of dioxins and furans, leading to a major reduction in the BOD_5 and COD of wastewater and lowering suspended solids content.

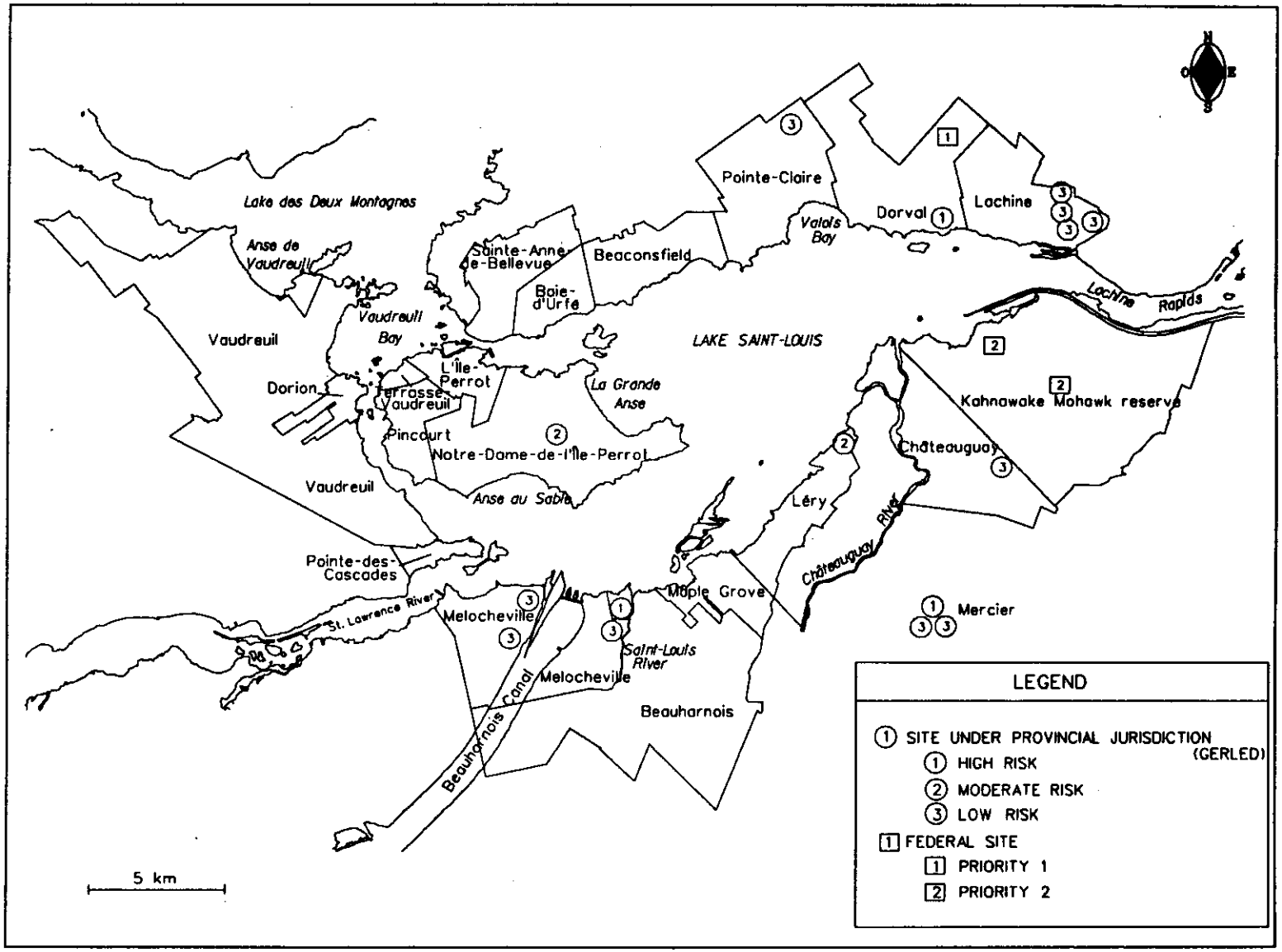
The main contaminants discharged by PPG Canada Inc. are chlorine, mercury, oils and greases. Although the average estimated mercury load dropped from 50 kg/year in 1986 to 6.2 kg/year in 1991 following technological changes, in 1976 PPG Canada discharged the equivalent of 200 kg/year of mercury into Lake Saint-Louis. At that time, in addition to being the major source of mercury for the region, discharges from PPG Canada contained other heavy metals (cadmium, copper, lead and zinc). Before the plant closed in 1991, Elkem Metals Canada Inc. discharged mainly zinc, lead, cadmium and manganese.

2.4.3 Hazardous waste sites

The presence of 19 hazardous waste disposal sites well reflects the urban and industrial character of the area. These sites could be sources of nonpoint-source pollution. They can contaminate groundwater which can migrate to the river (Figure 6). Seven of these sites are found on the north shore, 11 on the south shore and one is on Perrot Island. Three of the sites are on federal lands.

2.5 Agriculture

Lands given over to farming cover 35% of the total surface area around Lake Saint-Louis and occupy 10% of the lakeshore. They are concentrated on the western and southern sides of the lake, in the municipalities of Vaudreuil, Notre-Dame-de-L'Île-Perrot, Beauharnois and Châteauguay.



Sources: MENVIQ (1990b and c) (GERLED).
D'Aragon et al. (1992).

GERLED = Groupe d'étude et de restauration des lieux d'élimination des déchets (MENVIQ).

Figure 6 Hazardous waste sites under federal and provincial jurisdiction in ZIPs 5 and 6

The number of farms has remained constant over the past decade. In 1991, about 80% of these lands were cultivated (Table 5). Grain and dairy production and market gardening occupy the largest areas, particularly in Vaudreuil and Beauharnois. Also, tributaries of Lake Saint-Louis, the Châteauguay River in particular, flow through major farming areas.

Although agricultural activities remained stable in ZIPs 5 and 6, the 1988 review of agricultural zoning brought about a 12% reduction in the agricultural zone, and led to its complete disappearance from Pointe-des-Cascades.

Stress. Farming operations contribute in various ways to the contamination and degradation of the environment. These operations are particularly intensive in the St. Lawrence Lowlands, where more than half of Québec's prime farmland is located. The decrease of pasture land in favour of cropland normally leads to an increased use of chemical fertilizers and pesticides, and to soil erosion. These sources of agricultural pollution are spread by groundwater flow and by runoff.

2.5.1 Soil erosion

Intensive farming methods contribute to soil erosion and to the transport of large quantities of sediments into rivers and into the St. Lawrence. These sediments come from all tributary drainage basins, and not just those in ZIPs 5 and 6. An estimated 130 000 tonnes of suspended solids enters Lake Saint-Louis from its tributaries every year (Fortin et al., 1994). Eighty-eight farmers in ZIPs 5 and 6, or 38% of the total, employ soil-conservation techniques.

2.5.2 Nutrients

Nutrients of agricultural origin normally come from two sources: waste from livestock operations and the application of fertilizer. There is little livestock raising in the Lake Saint-Louis area, so nutrients here result primarily from fertilizers. Composed of nitrogen and phosphorus, these substances lead to the enrichment of the aquatic environment and the proliferation of plants which, on decomposing, reduce the oxygen content of the water, causing unpleasant odours and affecting visual quality.

Table 5
Agricultural statistics for ZIPs 5 and 6*

	1981	*1986*	*1991*
Farming operations			
Total number of farms	232	261	232
Surface area			
Average per farm (ha)	51.5	51.2	54.9
Area in proportion of total in ZIP	33%	37%	35.2%
Cultivated land			
Cultivated lands/farming	79.4%	80.9%	78.9%
Soil enrichment			
Fertilized/cultivated land	54.1%	65.2%	71.3%
Lands with manure/under cultivation	n.a.	n.a.	12.7%
Fertilizer used (tonnes/year)**	1 089	767	-
Chemical control agents			
Lands + herbicides/cultivated	35.2%	46.7%	55.6%
Land + insecticides/cultivated and fungicides	6.3%	8.9%	12.9%
Soil conservation			
Farms with crop rotation	n.a.	n.a.	88
Irrigation			
Irrigation/cultivated land	n.a.	0.7%	1.3%
Financial situation of farms			
Average surplus per farm ($)	13 870	12 864	16 424

* For purposes of comparison, the municipalities of Mercier and Châteauguay were combined as in the 1991 census, even though there is more farming activity in Mercier. The other municipalities surveyed are Beauharnois, Notre-Dame-de-L'Île-Perrot and Vaudreuil.

** On cultivated lands in the municipalities of Vaudreuil, Notre-Dame-de-L'Île-Perrot, Beauharnois and Châteauguay.

*** There are other methods for controlling erosion, but crop rotation is currently the most common practice, according to farmers.

Sources: Statistics Canada (1981; 1986; 1991).

Since 1981, the proportion of cultivated lands treated with chemical fertilizers has increased by over 30%. However, the quantity of fertilizer (tonnes/hectare) decreased by almost 30% between 1981 and 1986, indicating a more rational use of these products.

We have no information on fertilizer losses due to wind erosion, runoff, surface or groundwater flow to the river. As such, it is impossible to determine the real pressure of these fertilizers on the river environment.

Lastly, mention must be made of the organic fertilizers used in ZIPs 5 and 6; in 1991, over 12% of farms used a solid- or liquid-based manure fertilizer.

2.5.3 Pesticides

The use of chemical control agents (herbicides, insecticides, fungicides) is likely to increase the quantities of organic compounds flowing into the river. These compounds do impact on the aquatic environment since some of them are toxic, even as trace elements; they may cause physiological disorders in organisms which consume them and as they accumulate along the food chain.

Since 1981 there has been a marked increase (over 50%) in areas being treated with herbicides. In 1991, herbicides were applied to over half of the land under cultivation. Insecticides and fungicides were used on just over 15% of cultivated lands, which is twice the area treated in 1981.

2.5.4 Microorganisms

In areas where intensive livestock raising is practised, organisms like bacteria and viruses can result from animal waste. Microorganisms interfere with recreational activities, and they may even endanger the quality of drinking water in water supply areas. Leaching from pasture land and from inadequate spreading and storage of manure are all nonpoint sources of bacterial contamination. On Lake Saint-Louis, however, livestock raising is a minor activity limited mainly to the municipalities of Beauharnois, Vaudreuil and Châteauguay. In 1992, four farmers in the Lake Saint-Louis ZIPs took advantage of the MENVIQ *Program d'aide à la gestion des fumiers* (manure management assistance program).

2.6 Recreation and Tourism

Recreational and tourism activities can impact on the bacteriological quality of water, while the infrastructures associated with marinas, parks and cottage areas can physically disturb the environment.

2.6.1 Boating

Boating is the main recreational activity practised on Lake Saint-Louis. The presence of shallows and aquatic plant communities, however, make certain areas of the lake inaccessible to boats with a draught of more than 1.2 m, thus forming a major obstacle to pleasure boating. The Lachine Rapids downstream from this sector also form an obstacle to navigation because of the strong currents they generate. Most boating activity takes place south of the St. Lawrence Seaway near the De la Paix islands and Anse au Sable Bay, as well as in the centre of the lake in Grande Anse Bay and at Pointe-du-Moulin, and in Lachine and Dorval, on the north shore.

Stress. The environmental pressures exerted by boating take several forms. Marina construction often leads to the destruction of aquatic and shoreline habitats. Boating facilities are primarily privately-operated, and as such access to the water by the public is restricted to members only. Bacteriological contamination can be added to the various types of contamination already present, although it is not possible to determine its extent. No existing regulations apply to the St. Lawrence and there are few pumping facilities for septic tanks. Gas leaks and the use of antifouling paints may also cause chemical water pollution. This problem is specific to areas where boats are concentrated, such as marinas. Boating near marshes and swamps also threatens habitats because wave action causes bank erosion.

2.6.2 Other activities

Land reserved for recreation covers 20 km^2, or 6% of the total area of Lake Saint-Louis (Figure 3). Approximately 30 km of shoreline (30% of the perimeter of ZIPs 5 and 6) is given over to parks and cottages.

Ribbon parks occupy a large part of the shoreline in a number of municipalities, including Lachine, Châteauguay, Pointe-Claire and Beauharnois. These parks, generally grassy

areas situated close to urban zones, required backfilling. Despite their urban nature, these parks allow access to the river, which is very limited on Lake Saint-Louis due to shoreline privatization. Access to approximately 63% of the shoreline is either privately-owned or restricted.

In 1991, there were 725 cottages in lakefront municipalities: cottaging seems to have declined in recent years. The main cottaging areas are Notre-Dame-de-L'Île-Perrot, Léry, Vaudreuil, Pincourt and L'Île-Dorval. An estimated 2900 cottagers frequent the area; campers are accommodated at three campgrounds with a total of 175 campsites.

Stress. The creation of municipal parks generally required some backfilling work that encroached on the aquatic environment, as was the case in the northern part of Lake Saint-Louis. The septic tanks of isolated houses can be a source of bacterial contamination when such installations are inadequate. It is difficult to assess the extent of the area occupied by cottages since these concentrations are not always identified in development plans. However, L'Île-Dorval, Vaudreuil and Maple Grove have designated cottaging areas in their urban plans.

Cottages are rarely connected to water supply and sewer systems. However, the increased density of cottages and the conversion of second residences to principal residences have led municipalities to install service infrastructures, thus creating secondary development axes.

CHAPTER 3 Uses and Biological Resources

This chapter will deal with the various uses and biological resources of Lake Saint-Louis from the perspective of three main principles of sustainable development: *1)* maintenance of natural capital (habitats, exploitation, populations); *2)* diversity of uses (multiplicity, sport and commercial species); *3)* integrity and biological diversity (rare or threatened species).

Uses and resources are important considerations of ZIPs 5 and 6. They were documented from technical reports, taking into account those elements which generate the most interest.

3.1 Uses

We tried to look at trends over time where data permitted, and also at gains and losses. The data collected are sometimes quantitative (volumes of water drawn or discharged, number of beaches, participation rate, number of fishing licences, length of natural or degraded shorelines), but this type of information does not necessarily measure the quality of the use per se. The intensity of use of a historic site thus gives us information only on the number of visitors, not on their degree of satisfaction. This type of information requires costly studies, which are rarely carried out.

3.1.1 Water supply

Uses considered under this heading deal with water taken directly from the river to supply municipalities, industrial plants and farmers.

3.1.1.1 *Municipalities*

There are ten water filtration plants on Lake Saint-Louis supplying drinking water to 14 municipalities. In 1992, these plants served 91% of the population (Table 6), representing close to 200 000 people. The municipalities of Melocheville, Léry and Dorion (4%) draw their water from underground wells independent of Lake Saint-Louis. The rest of the population (about 5%) relies on sources located upstream (Beauharnois and Soulanges canals) or on artesian wells.

As well, a number of Montréal Island and south shore municipalities (not included in ZIPs 5 and 6) take their water from Lake Saint-Louis. In 1992, Montréal Island alone daily drew nearly 1.7 million m^3 of water to supply 1.5 million residents.

Table 6
Annual volume of water drawn from Lake Saint-Louis sector

	Volume drawn (m^3/year)	*Notes*
Municipalities (1992)	60 586 715**	10 treatment plants 14 municipalities 91% of the population
Industries* (1986)	19 407 143	4 industries 90% surface water 84% of surface water comes from Lake Saint-Louis
Industries* (1992)	13 238 802	4 industries

* Estimated volume for plants drawing over one million m^3 of water per year.
** This volume excludes water drawn by the Kahnawake Mohawk reserve and the island of Montréal.

Note: The domestic water requirements of plants are supplied by the municipal water system.

Source: Jourdain et al.(1994).

3.1.1.2 *Industry*

The four plants found in ZIPs 5 and 6 each drew more than one million m^3 of water per year. Three of these plants are targeted under the St. Lawrence Action Plan: PPG Canada Inc., Alcan Smelters and Chemicals Ltd. (AS & C), and Domtar Inc., Fine Papers Division; Stelfil Ltd. is also located here. Using their own systems, these plants drew surface water almost exclusively, mainly from Lake Saint-Louis. Their annual use represented close to 20 million m^3

of water in 1986. Since then, technological changes at these plants have reduced the water requirement by approximately 30% (Table 6).

The water drawn by these four plants requires only minimal treatment before being used and serves mainly for cooling, dissolving raw materials, gas purification and various manufacturing processes.

3.1.1.3 *Agriculture*

The river plays only a minimal role in supplying water for agricultural purposes. Only nine of the 261 farms in ZIPs 5 and 6 irrigated their fields in 1986, and of these nine farms, two took their irrigation water from Lake Saint-Louis.

3.1.2 Commercial fishing

Commercial fishing takes place in the intertidal zone, near the De la Paix islands, in the deep water on either side of the St. Lawrence Seaway, and on the south shore of the lake. Fishermen generally use gill nets.

In 1945, there were 106 holders of commercial fishing licences on Lake Saint-Louis. In the early 1960s, there were over 65 and their numbers have since decreased steadily: there were nine in 1984 and only five in 1989. This sharp drop was due to a number of factors: decrease in certain stocks, contamination of fish, conflicts between sport and commercial fishermen, and adoption of an urban lifestyle that does not include freshwater fishing. From 1987 to 1992, commercial catches amounted to an average of 55 000 kg per year. Four main species were fished: Lake sturgeon (which made up about 90% of catches by weight), Sunfish, Carp and Brown bullhead. The total landed value of fish (before processing) was $215 462 in 1989. Gross earnings per fisherman were estimated at $43 000.

Censuses show that populations of Brown bullhead and Sunfish are abundant and balanced. These two species can withstand the current rate of fishing. Lake sturgeon, on the other hand, display late sexual maturity and a low recruitment rate, and are heavily fished. The high total mortality of this species indicates a population exposed to hostile environmental conditions and heavy fishing pressure.

The use and possession of live fish for bait is prohibited in all regions of Québec except in the southwest and in the St. Lawrence (Mongeau, 1985). In 1981 there were 15 holders of bait-fish licences for Lake Saint-Louis. The fish catch here is greater than the average calculated for the entire Montréal region. Over 60% of the harvest takes place in the fall when several thousand individuals swarm the waters of the lake, and the fish are sold during the winter to ice-fishing enthusiasts. Most of the annual harvest is made up of Golden shiner, followed by Silver minnow, Emerald shiner and Spottail shiner. In 1979, the sale of bait fish yielded gross annual revenues of some $50 000.

3.1.3 Trapping

In the 1970s, the trapping of semi-aquatic mammals was a major economic activity for some 50-odd trappers. Over the past decade, there has been a marked decline in this activity. Between the 1986-1987 and 1989-1990 seasons, the number of trappers fell from 62 to 15, and the harvest from 6459 to 488 skins. Muskrat accounts for 95% of the animals trapped, other species being the Raccoon, Beaver and Mink. In 1989-1990, the total value of raw skins was only $2331, whereas it was $32 950 in 1986-1987. Campaigns against trapping, fur farming and the state of the economy are all factors responsible for the decline of this activity.

Most of the animals were caught on the south shore of Lake Saint-Louis; 50% were taken in the area of the De la Paix islands. The Muskrat population does not appear to have been affected by trapping. This species can withstand a high rate of harvesting among the young without jeopardizing species survival.

3.1.4 Shipping

In 1977, annual traffic on the St. Lawrence Seaway reached a record 57 million tonnes of cargo. The number of vessels passing through the Seaway nonetheless decreased between 1983 and 1990, falling from 3800 to 2770, with an average of 40 million tonnes of cargo.

3.1.5 Recreation and tourism

Activities considered in this section are those practised both on shore and in the water. There are several types, depending upon whether or not direct contact with the water is involved. Issues of aesthetics and accessibility to the recreational uses were also considered.

The proximity of Lake Saint-Louis to Montréal and its suburbs makes this body of water ideal for meeting the recreational demands of locals and tourists alike. From a tourism standpoint, however, the lake's potential remains underexploited (MLCP, 1984a). There are no integrated tours and no comprehensive policy on developing the most promising tourist products, most notably boating and cruises.

Table 7 shows public participation in various recreational activities on Lake Saint-Louis. These data were taken from a survey carried out by the MLCP in 1981. They show that the main activities practised on Lake Saint-Louis were boating, sport fishing and nature watching.

3.1.5.1 *Recreational activities with contact*

Swimming, windsurfing, kayaking and water skiing are recreational activities which involve direct contact with water. The *MENVIQ Environnement-Plage* (beach environment) program regulates swimming by monitoring the bacteriological quality of water at public beaches; however, parts of the lake where other water sports such as windsurfing are practised remain unregulated.

Swimming is a popular activity in the Montréal archipelago. In 1978, there were seven public beaches on Lake Saint-Louis, but in 1992 none of them were registered with the MENVIQ Environnement-Plage program. Ever since the inauguration in 1988 of the MUC's north intercepting sewer, the bacteriological quality of the water on the north shore of Lake Saint-Louis has improved considerably and the data collected now meet the criteria established for swimming (Figure 15). Beaconsfield Beach has remained closed, however, although there are signs of improvement.

Water skiing is also a popular activity on Lake Saint-Louis. According to a 1981 MLCP survey, this sport attracted 37% of all those who practised one or another activity in the Montréal archipelago as a whole.

Table 7
Recreational activities on Lake Saint-Louis in the early 1980s[a]

Activity	*Participation[b] (number of people)*	*Activities (%[c])*
Swimming	13 604	9.5
Hiking	9 764	6.8
Nature watching	20 475	14.3
Picnicking	15 026	10.5
Cycling	17 549	12.3
Boating	29 044	20.3
Cross-country skiing	4 401	3.1
Fishing	24 656	17.3
Snow-shoeing	761	0.5
Water skiing	6 513	4.6
Hunting	609	0.5
Diving	326	0.3
Total	**142 728**	**100**

a Refers to a survey-based study (MLCP, 1982, in Marsan et al., 1984) and as such these data must be considered as indications only.

b Participation in an activity was determined on the basis of a survey, and reflects the number of people who participated in a given activity (MLCP, 1982, in Marsan et al., 1984).

c Relative importance of this activity for all of Lake Saint-Louis.

3.1.5.2 *Recreational activities without contact*

Activities in this category are practised from motor boats, dinghies, keelboats, canoes, rowboats, or pedal-boats. Contact with water is rare.

Boating. Recreational activities on Lake Saint-Louis focus primarily on boating. In 1981, participation was estimated at 254 149 activity-days, or 26% of all boating activity in the Montréal archipelago (Secrétariat Archipel, 1984). The lake's popularity for boating is based on its proximity to Montréal — which supplies a large share of boaters — on the strategic location of the lake as part of a regional pleasure-boating system, and on its large navigable areas.

In 1981, it was estimated that 7383 boats plied the lake, representing 80% of the crafts reported in the Montréal archipelago (Cournoyer, 1982). This fleet was mainly composed of motorboats and sailboats.

Boating is one of the lake's best developed attractions, particularly on certain parts of the north shore. In 1984, this area had the greatest concentration of boating facilities (21 of the 31 clubs listed around Lake Saint-Louis), accounting for approximately 65% of the available mooring. Despite this well-organized network, public access to Lake Saint-Louis remained very limited since only 2% of the accommodation capacity was available to the general public (apart from private clubs or associations). As well, the demand for moorings was more than double the capacity.

Pleasure-boat operators in the Montréal archipelago spent an estimated $11 million in 1982 in direct costs and over $26 million in indirect costs.

Sport fishing. Sport fishing is the most popular activity on Lake Saint-Louis after boating. The catch rate is good; the area experiences the strongest fishing pressure in Québec (Gratton, 1989). In 1985, 609 000 fisher-days were spent on this activity: 63% for fishing in open waters and 37% for ice fishing.

In 1985, a survey of fishermen showed that 7413 of them had caught 23 739 fish. Three species make up most of the catch: Yellow perch (65%), Northern pike (17%) and Walleye (7%). The populations of these three species do not appear to be affected by this heavy fishing.

Yellow perch fishing in Lake Saint-Louis is currently more intense than on Lake Saint-Pierre; however, considering the age structure and the fishing rate, Yellow perch is not overfished in Lake Saint-Louis. The Yellow perch population of the south shore of the lake has a lower growth rate than the north shore population. A number of environmental and human factors might account for this difference, such as the existence of two distinctive populations, and fish flesh contamination.

The most heavily fished areas in open waters are the north, east and southeast shores of Perrot Island and the De la Paix islands. Fishing from boats takes place mainly on the south shore, in the De la Paix islands, and in the southwest of Perrot Island and Pointe du Moulin. Other secondary sites are Lachine, Baie-d'Urfé and the Beauharnois dam. Shoreline fishing attracts fewer enthusiasts, but is nevertheless a very popular activity. It is practised mainly at the Beauharnois dam and the southwestern part of Perrot Island.

These fishing activities are supported by a network of service suppliers and access points concentrated primarily on the south shore. In 1990, there were 10 service suppliers and over 20 access points.

Ice fishing is growing in popularity in the Montréal archipelago. In 1985, a telephone survey indicated that some 50 000 fishermen practised this activity in Lake Saint-Louis and Lake des Deux Montagnes (Tremblay and Dumont, 1990). Most of the fishermen came from Montréal (53%) and from around these two lakes (41%). During this same year, 225 900 fisher-days were spent on this activity on Lake Saint-Louis, representing 37% of the total fishing effort.

In all the water bodies of the Montréal archipelago, Yellow perch is by far the most commonly caught species in winter, making up 90% of catches, followed by Northern pike (5%). The area around Perrot Island and the southwestern shore of Lake Saint-Louis are the most popular with fishermen. In 1985, 28 ice fishing sites were found around Lake Saint-Louis, with six outfitters renting shacks and selling bait for this activity.

In 1985, sport fishing-related spending in Québec amounted to an average $495 per fisher or $35 per fishing day. Winter fishing generated between $20 and $30 per fishing day (Tremblay and Dumont, 1990).

Since 1950, restocking has been employed as a wildlife management tool in the Montréal area to maintain the quality of sport fishing. On Lake Saint-Louis, the MLCP stocks Muskellunge, whose natural reproduction rate could not support current sport fishing levels, along with Brown trout and Rainbow trout. The MLCP has been closely monitoring the salmonid fishery since 1983 in order to assess the progress of these non-native fish populations in the river corridor. The main fishing sites for salmonid species are Pointe du Moulin, the Beauharnois dam and the Cascades dam. Brown trout is the most commonly caught species in the waters of the Montréal Plain, even though a larger number of Rainbow trout fry are introduced. This variance is due to the more sedentary behaviour of Brown trout, its greater longevity and its resistance to high temperatures.

Waterfowl hunting. Lake Saint-Louis is a prime environment for waterfowl due to the quality of its habitats. It is also located on the main waterfowl migration route, the Atlantic Flyway. Every autumn, Lake Saint-Louis comes under heavy pressure from hunters, even though it ranks ninth in the St. Lawrence sector for total birds shot. Between 1977 and 1981, an average of 15 000 birds from 25 different species were bagged annually in this sector. Dabbling ducks dominate with 44% of birds taken, followed by diving ducks (38%). The remainder are made up of sea ducks, Canada geese and Snow geese.

Diving ducks are taken mainly at the southwestern tip of the lake (Vaudreuil), on the Léry-Châteauguay shores, in the centre of the lake east of Pointe du Moulin, on the shores of Beaconsfield and in Valois Bay. Dabbling ducks are hunted in the vicinity of the De la Paix islands, which are rich in aquatic plant communities.

Hunters frequent the shoreline aquatic plant communities that are the preferred habitats of dabbling ducks, along with the broad stretches of water sought by diving ducks. Around the Montréal archipelago, the Deux Montagnes and Saint-Louis lakes come under heavy pressure from hunters, followed by the St. Lawrence River south of Montréal.

Heritage sites. A number of historic, cultural or heritage sites are major tourist attractions for the region, notably the Pointe-du-Moulin Historic Park, the Sainte-Anne-de-Bellevue locks and the archaeological site at Pointe-du-Buisson.

The 168 500 visitors who registered at the Pointe-du-Moulin park in 1983 represented an 84% increase in the number of visitors compared to 1982.

Outdoors/nature. The Pointe-des-Cascades municipal park is one of the main centres of attraction for outdoor activities, particularly camping, swimming in pools and sight-seeing/picnicking. Annual participation in these activities in 1984 was 18 400 person-days. MacDonald College and the Morgan Arboretum in Sainte-Anne-de-Bellevue form a second regional attraction, particularly for nature interpretation. Located in Châteauguay, on the south shore, is the Fernand-Seguin ecological centre, as well as a number of nature-watching sites and a boating centre.

Cycling paths, ski trails and boat cruises are found here. Three companies offer cruises on Lake Saint-Louis: Croisières Bellevue Ltd., with excursions leaving from the Sainte-Anne-de-Bellevue Locks; Croisières Maritimes de l'Archipel Inc., and Les Tours Saint-Louis, both of which are based in Lachine. According to the company's tour operator, Les Tours Saint-Louis carried an estimated 8000 passengers in July and August of 1985.

Despite extensive urbanization, the shores and islands of Lake Saint-Louis contain natural green spaces which support a rich and diversified plant and animal life, and which constitute the last traces of the region's ecological heritage. Of the many sites available to nature lovers, most are concentrated on the south and west shores of the lake. The best known are Saint-Bernard Island and the Châteauguay Commons, the Maple Grove swamp, Pointe du Moulin, Kahnawake Point, Vaudreuil Bay and the Beauharnois dam.

3.1.5.3 *Cottaging*

As mentioned in Section 2.6.2, there are 725 cottages in the Lake Saint-Louis area, located mainly in Notre-Dame-de-L'Île-Perrot, Léry, Vaudreuil, Pincourt and L'Île-Dorval. An estimated 2900 cottagers use the area. Cottaging is not a major activity here compared to lakes Saint-Pierre and Saint-François.

Table 8
Lake Saint-Louis shoreline landscape

Type of landscape	*Uses*[a]	*Shoreline (km)*	*Total %*
Urban	Residential, commercial	49.1	
	Industrial	0.5	
	Recreational, institutional	21.4	68
	Urban[b]	4.5	
Rural	Farming	9.8	
	Cottaging	11.7	29
	Kahnawake Mohawk reserve	10.0	
Natural	Conservation, nature reserve	3.4	3
	Total	**110.4**	**100**
Island environment			
Natural	Conservation	43.6	79
	Undetermined	11.8	21
	Total	**55.4**	**100**

a Compilation of data based on combined designations (after 1985).
b Designation classification taken from development plan for municipalities with no urban plan.

Source: Jourdain et al. (1994).

3.1.5.4 *Shoreline quality*

The notion of shoreline environment quality in this area has to do with the degree of shoreline degradation and the visual quality of the landscape. This influences the attraction of the area for visitors and interferes in the lifestyle of residents.

The shoreline descriptions were taken from development and urban plans; they do not necessarily reflect the actual use being made of the land, rather its designated use, and thereby offer a glimpse of future development.

Certain designated uses cause generally irreversible degradation of banks: residential, commercial and industrial use, as well as cottaging reflect intense development and urban sprawl. These uses take up at least 60% of the shoreline (Table 8) showing that, coupled with high shoreline occupation densities, development is heaviest along the shore.

The lakescape was classified according to shoreline use in order that urban, rural and natural shoreline environments might be identified.

Shores categorized as natural are marginal (3.4 km of shoreline, occupying 3% of the perimeter) (Table 8). This type of landscape is rare because of development trends and the limited area of legally protected shoreline in ZIPs 5 and 6. The intensity of development is low in these environments. Islands, on the other hand, hold significant areas of natural shores (79%) and are given over mainly to conservation activities.

Rural shoreline occupies 29% of the perimeter of the lake (31.5 km of shoreline). This reflects the agricultural function and cottaging activity in Vaudreuil, Maple Grove and L'Île-Dorval. Such uses involve the degradation of the natural environment, since they are often accompanied by deforestation and shoreline development.

The urban landscape dominates, covering 68% of the Lake Saint-Louis perimeter (75.5 km of shoreline), especially on the north shore and on Perrot Island. Environmental degradation and development have been considerable, and divided among residential, industrial, commercial and intense recreational uses.

The area bordering Lake Saint-Louis is thus highly structured according to urban functions, particularly on the north shore of the lake and on Perrot Island. The presence of permanent infrastructures leaves little possibility of changing the area. In light of this, natural spaces such as the De la Paix islands, Saint-Bernard Island and Saint-Jean Creek take on even more importance since they are unique attractions of both ecological and social value.

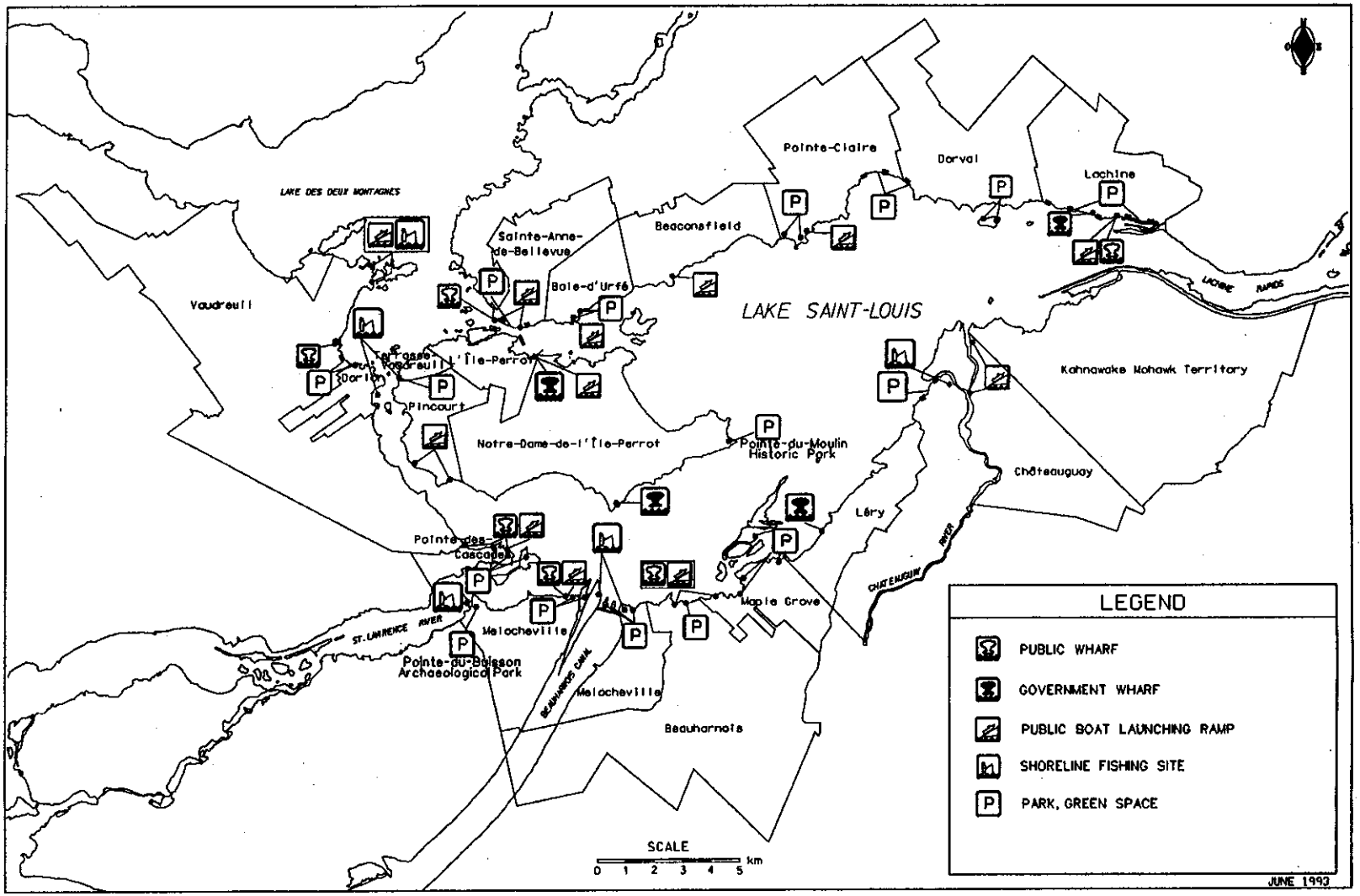
3.1.5.5 *Accessibility*

The intense urbanization of ZIPs 5 and 6, particularly shoreline residential construction, involves a high degree of privatization and forms a major barrier to public access to the Lake Saint-Louis area.

In a number of south and west lakeshore municipalities and on Perrot Island, shoreline urbanization continues and few sites are reserved for the public. At least 60% of the Lake Saint-Louis shoreline is reserved for private use (Jourdain et al., 1994).

We can nonetheless see a trend developing in the creation of so-called "windows on the river." The north shore stands out in this sense due to the development of a number of shoreline ribbon parks (Figure 7). In general, access conditions are based on the existence of a network of local parks and on service infrastructures mainly serving boating and sport fishing. Only 2% of the total capacity of marinas was accessible to the public in 1984; the rest were reserved for members. There are also several public sites of regional or provincial interest.

The creation and maintenance of public parks or green spaces along the river should be encouraged, both from the perspective of conservation and for their contribution to quality of life.



Sources: MLCP (1987; 1990).
Fisheries and Oceans (1990).

Figure 7 Main sites of public access to Lake Saint-Louis

3.2 Biological Resources

It is often difficult to assess biological resources in terms of changes to habitats and populations due to a lack of data. This is true even when we confine ourselves to species of sport or commercial interest or those species designated rare or threatened. We will nevertheless attempt to determine the essential elements of the Lake Saint-Louis ecosystems based on distribution maps of animal and plant communities.

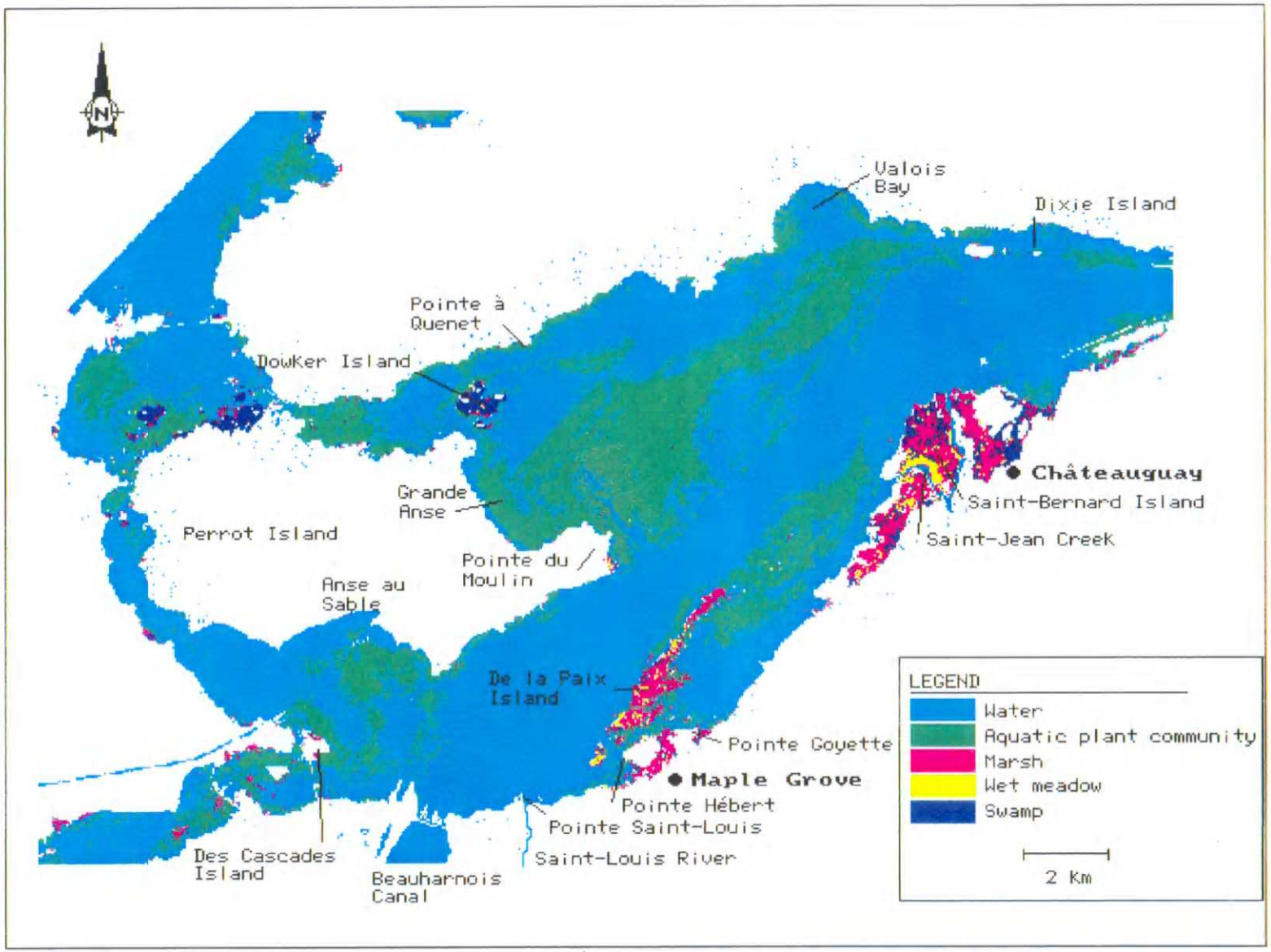
3.2.1 Habitats

Despite the many changes it has undergone, Lake Saint-Louis remains one of the richest sectors of the river in terms of flora and fauna. The clement weather conditions, the presence of low-lying islands and shallows, and areas of fast-moving currents have given rise to these exceptional riches and to the great diversity of habitats.

Lake Saint-Louis is also one of the richest sites in the Montréal archipelago for aquatic plant communities and marshes. Although it covers 33% of the archipelago, the lake area contains only 15% of the flood plain habitats here, the result of the near-total degradation of the northern lakeshore and Perrot Island.

During the breeding season, the flood plain is a favourite site for many bird, fish, amphibian and invertebrate species. Wet meadows and flooded marshes offer abundant food and shelter to fish fry and larvae during the early weeks of growth and serve as nesting and nursery areas for dabbling ducks (Figure 8).

The De la Paix islands have a special ecological value. Human disturbance is practically non-existent and parts of the south shore offer the long shoreline strips favoured by many animal species.



Source: Aménatech (1992).

Figure 8 Main types of wetlands on Lake Saint-Louis in 1990

3.2.1.1 *Plant communities*

Wetlands form a transition between the terrestrial and aquatic environments and are essential to all wildlife species (Figure 8). Around Lake Saint-Louis, wetlands covered 4769 ha in 1990, distributed between shoreline vegetation (7%) and aquatic vegetation (93%)(Table 9).

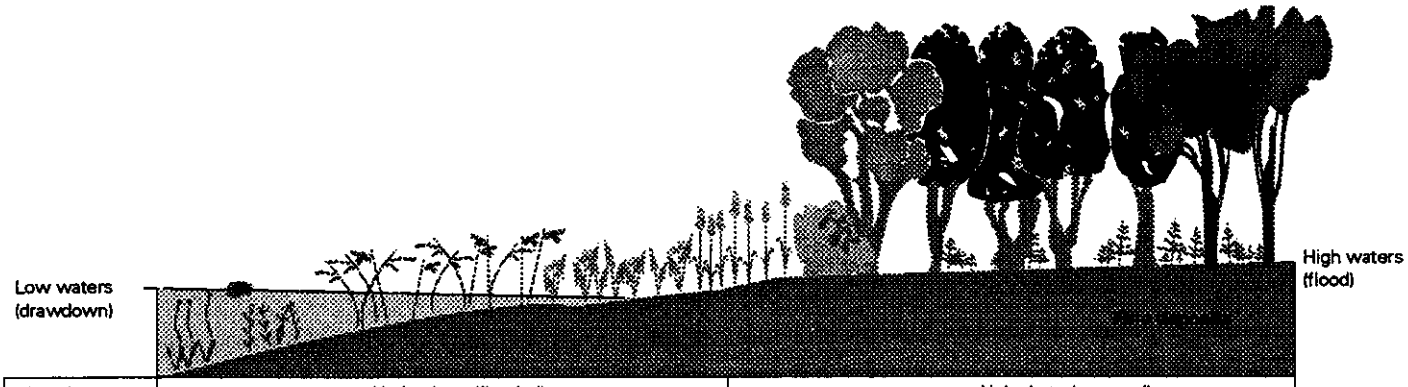
Table 9
Surface area of main types of wetlands
on Lake Saint-Louis in 1990

Type of habitat	*Area (ha)*	*%*
Aquatic vegetation		
Aquatic plant community	3919	82
Marsh	508	11
Shoreline vegetation		
Wet meadow	97	2
Swamp	245	5
Total	4769	100

Source: St. Lawrence Centre (1992).

Figure 9 shows the placement of the plant communities characteristic of Lake Saint- Louis. Moving from land to water, four main types of characteristic wetland habitats can be distinguished.

Semi-aquatic mammals	Area used by Muskrat and Mink			
Amphibians and reptiles	Area used by turtles, frogs and salamanders			
Fish	Feeding area for fish (Walleye, Yellow perch, Northern pike, Smallmouth bass and Brown bullhead Spingtime spawning ground of Northern pike and Yellow perch Spawning ground of Largemouth bass and Brown bullhead			
Birds	Migrating diving ducks, dabbling ducks, Great Blue Heron, Pied-billed Grebe (feeding)	Dabbling ducks (feeding and nursery), Great Blue Heron, Marsh Wren (feeding), Black Tern, Swamp Sparrow, Virginia Rail (nesting)	Dabbling ducks, Swamp Sparrow (nesting)	Great Blue Heron (nesting), Wood Duck (nesting), Willow Flycatcher, Yellow Warbler



Level	Hydrophyte (flooded)			Helophyte (exposed)				
Habitat	Aquatic plant community	Marsh		Wet meadow	Swamp			
Plant community	Submerged and floating herbaceous vegetation (Wild celery, Water-milfoil)	Herbaceous vegetation with Broadfruited Burreed	Herbaceous vegetation (Cattail, Arrowhead, Bulrush	Grasses (Reed phalaris)	Willow shrub stands	Willow tree stands	Silver maple stands	Cotton-wood and ash stands

Sources: Gratton and Dubreuil (1990).
St. Lawrence Centre and Université Laval (1992).

Figure 9 Main wetland habitats characteristic of Lake Saint-Louis

Swamps are treed wetlands where surface water is stagnant or flows very slowly. This type of habitat is very important for spawning Northern pike and Yellow perch. Fish feed here in spring, and some dabbling ducks use the area as a nesting site, as do several other bird species associated with wetlands. Treed swampland occupies 184 ha (4% of wetlands) and is dominated by Silver maple stands. The treed swamps of De la Paix and Saint-Bernard islands and of Saint-Jean Creek were severely affected by the exceptionally heavy flooding of 1972 and 1976. Shrubby swamp, made up mainly of Buttonbush, covers less than one percent of the area, or 61 ha.

Wet meadow occupies 97 ha or 2% of the wetland area, and is dominated by Reed phalaris communities. This environment is a highly productive one. When flooded in spring, it is an important nesting ground for dabblers. Fish spawn and feed in this habitat, which is also a rearing ground for amphibians and reptiles.

Marshes stretch over 508 ha, making up 11% of wetlands. Main plant communities are dominated by Broad-fruited bur-reed, Narrow-leaved cattail and Broad-leaved arrowhead. This zone of emergent-leaved herbaceous vegetation is generally permanently flooded, and is a habitat for Muskrat as well as for reptiles and amphibians. Invertebrates living here are food for fish, ducks, ducklings and other bird species. Marshes serve as a spawning ground for Largemouth bass and Brown bullhead, as a nursery area for dabbling ducks, and as a feeding area for Great Blue Heron.

The *aquatic plant* zone covers 3919 ha, or 82% of wetlands, and is made up of floating and submergent-leaved vegetation. These plant communities are found in four main areas: the De la Paix islands, the centre of the lake, the shoreline between Pointe Saint-Louis and the Beauharnois dam, and between Maple Grove and Saint-Bernard Island. American eel-grass, associated locally with filamentous algae, is the species most commonly found in the brown waters of the lake's north shore. In the green waters of the south shore, American eel-grass is again found, together with Canada waterweed, Water-stargrass and Northern water-milfoil. In the fast-moving waters of the lake's eastern section, Pectinate pondweed dominates. The aquatic plant

zone is a prime area for developing aquatic invertebrates, and is therefore frequented by diving ducks and fish for feeding and resting.

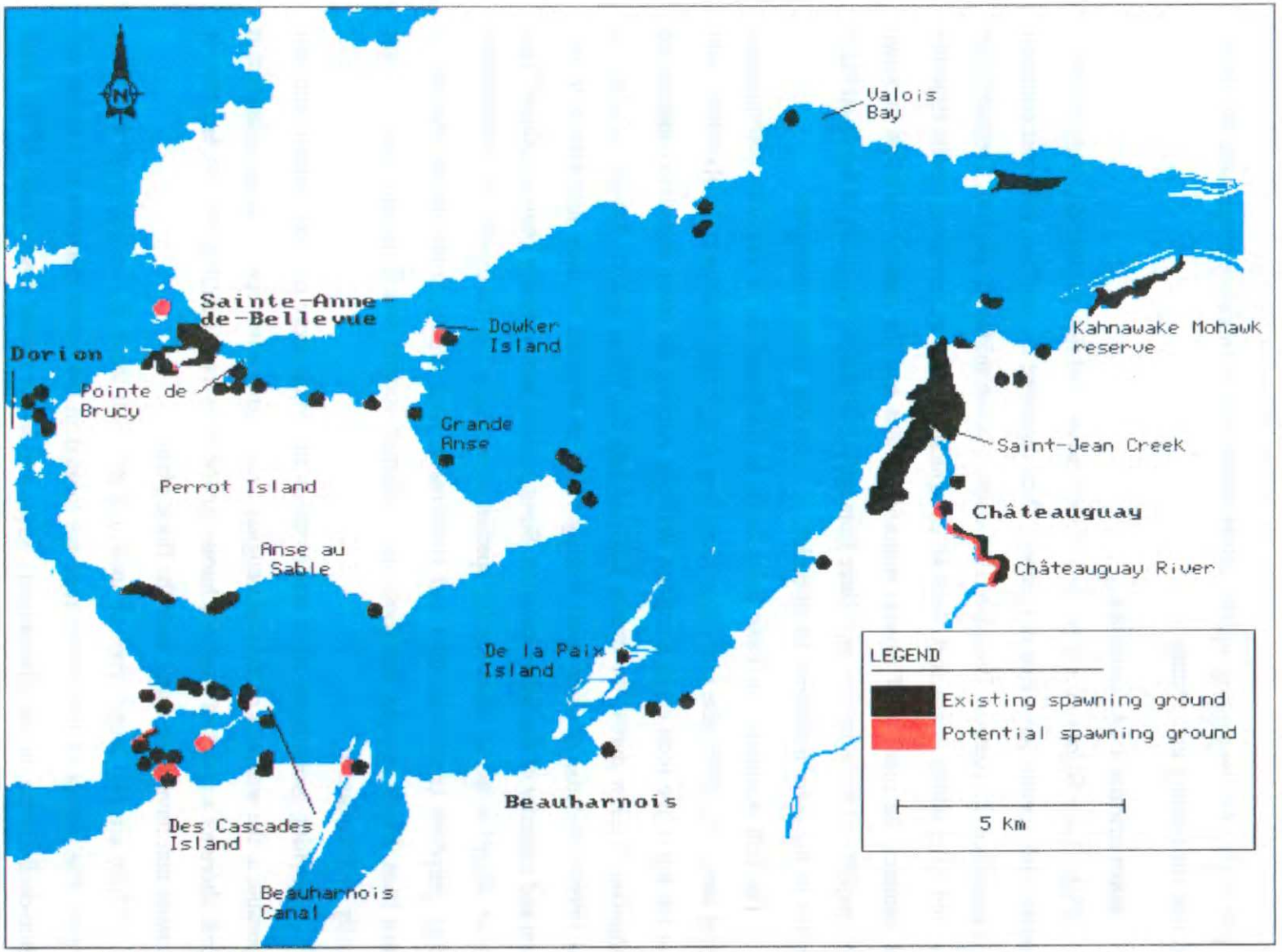
3.2.1.2 *Main animal communities*

Fish. Lake Saint-Louis is home to a very diversified fish population, with 78 of the 116 freshwater fish species identified in Québec. They represent 24 families, the most common being the Cyprinidae (21 species), Percidae (10 species), Catostomidae (8 species), Centrarchidae (5 species) and Salmonidae (5 species). Such an exceptional wealth of resources results from the variety of habitats, the meeting of several migration routes and the natural variation in water levels. The majority of these species reproduce from spring until early summer, in the flood plain at the mouths of the main tributaries or in outlets of Lake des Deux Montagnes.

The fish population of Lake Saint-Louis is characteristic of Percidae communities of the boreal forest. Northern pike is a major ecosystem component because of its abundance and its place at the top of the food chain alongside Walleye. Among the other associated species are the still-abundant Yellow perch, the Brown bullhead and the White sucker. Several species are of special interest because of their sport fishing value or because of their importance to the equilibrium and integrity of the fish population. Some species have recently been introduced here (Brown trout, Rainbow trout); other marine species have adapted to the freshwater environment for breeding purposes (American shad and Gaspereau). And finally, some native species — Largemouth bass, Black crappie, Longnose dace, Mottled sculpin and Common carp — are found locally in abundance.

Spawning grounds are most numerous on the south shore of Lake Saint-Louis, but most favourable in the wetlands of the Châteauguay sector. Only a few spawning grounds remain on the north shore as a result of repeated human action such as backfilling and the erection of retaining walls that have done away with the flood plain.

There are two broad types of spawning grounds: those in running water and those in still water. The largest of the former type are located in the outlet channels of Dorion and Sainte-Anne-de-Bellevue, in the Châteauguay River and in the rapids downstream of the dams on either side of Des Cascades Island. Fishing seasons have been defined so as to protect



Sources: Therrien et al. (1991).
MLCP (1993).

Figure 10 Spawning grounds of main fish species of Lake Saint-Louis

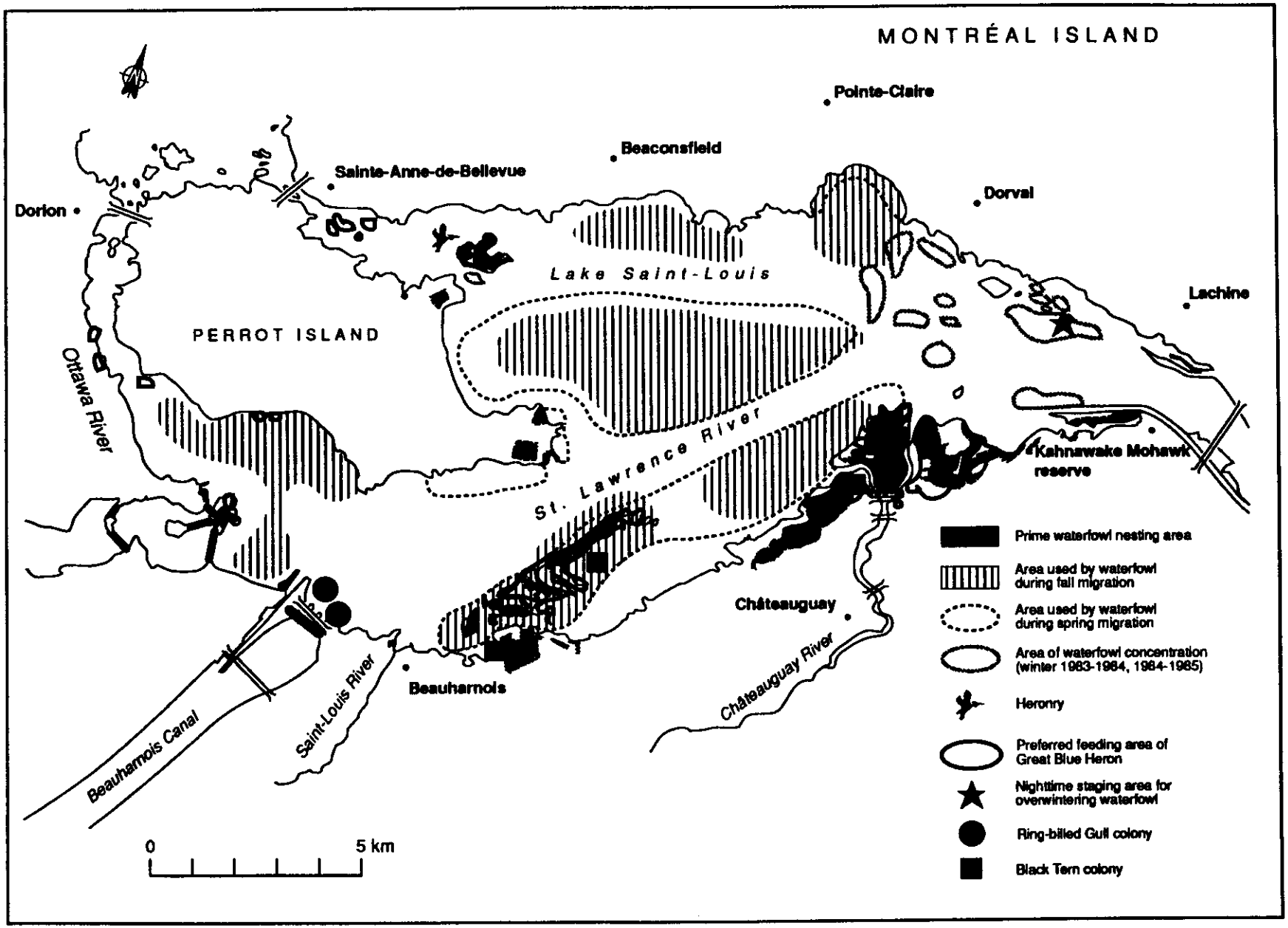
spawners in the first three spawning grounds. Most stillwater spawning grounds are located on the south shore of the lake and on the north shore of Perrot Island: the main ones are located in the Commons and Pelletier Park in Châteauguay, Grande Anse, the bay south of Pointe de Brucy on Perrot Island, in Kahnawake Bay and the Saint-Jean Creek (Figure 10).

Birds. Lake Saint-Louis is a prime environment because of the quality of its waterfowl habitats and the diversity of avifauna in general (Figure 11). After lakes Saint-Pierre and Saint-François, this is one of the areas most heavily used by migrating waterfowl in southern Québec. Several sites are excellent for birds: the De la Paix islands (Îles-de-la-Paix National Wildlife Area), Saint-Bernard Island with part of the Châteauguay Commons (wildlife reserve status), Saint-Jean Creek, Dowker Island and Goyette and Hébert points.

In the fall, some 32 000 waterfowl, mainly Scaup, stop over on Lake Saint-Louis to regain their strength.

During the winter, ice-free waters and submerged aquatic plants offer shelter to 3300 waterfowl, mainly diving ducks. The most abundant species are Common goldeneye and Common merganser.

In the spring, close to 5000 ducks stop at Lake Saint-Louis. Diving ducks are the most common of the 24 waterfowl species, with Greater and Lesser scaup making up most of the population. Lake Saint-Louis also serves as a resting and feeding area for a few groups of Canada geese. During the nesting season, eight species of dabbling ducks stay mainly in the swamp and dry meadow. The main brood-rearing site is found on the De la Paix islands. Nesting and brood production is lower on Lake Saint-Louis than on other water bodies in the region; shoreline degradation and the human presence explain the lake's low value as a nesting and rearing ground for waterfowl. The lake is also home to several bird colonies. There is a colony of Great blue herons on Dowker Island which, in 1992, experienced an unexplained drop in its breeding population. The colony on Saint-Bernard Island has been abandoned since 1980. Black terns nest in small colonies bordering the Châteauguay Commons, on Aux Plaines Island in the De la Paix islands, and in the marshes extending from Pointe Hébert to Maple Grove. A large colony of



Sources: Roche et Associés Ltd. (1985b); Lanois and LeSauteur (1985); Mousseau and Beaumont (1982).

Figure 11 Waterfowl use of Lake Saint-Louis

Ring-billed gulls occupies two small islands at the foot of the Beauharnois power station. Other flocks of gulls can be seen on the shores of Lake Saint-Louis: these immature gulls use the grassy shoreline parks as resting areas. Certain municipalities, aware that the growth of these gull populations is linked to the availability of food and garbage in urban centres, impose a fine on anyone found feeding these birds.

Muskrat. Lake Saint-Louis has a multitude of sites that attract this species. Their habitats are concentrated on the south shore (Figure 12), since the north shore is severely degraded. The De la Paix islands remain the most favourable sector for Muskrat, as confirmed by the fact that most are trapped there.

3.2.3 Threatened, rare and vulnerable species

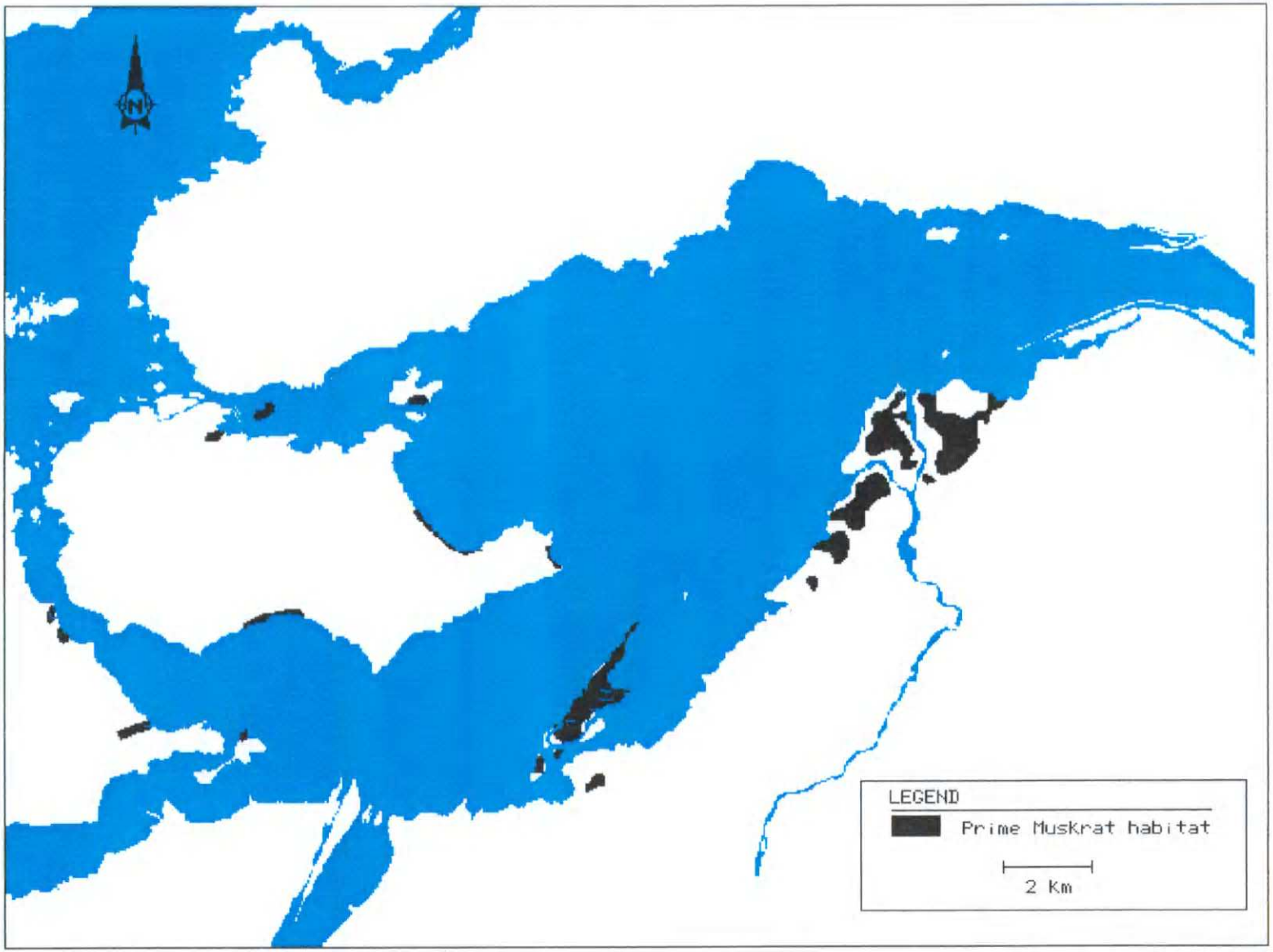
3.2.3.1 *Plants*

Forty plant species likely to be designated threatened or vulnerable are found in the wetlands of Lake Saint-Louis (Lavoie, 1992). Eight are considered rare in Canada (Argus and Pryer, 1990), and 28 have been deemed protection priorities along the St. Lawrence (Gratton and Dubreuil, 1990). None of these species is endemic; that is, exclusive to Québec.

One rare plant community, *Bromus pubescens*, is also found on Lake Saint-Louis.

3.2.3.2 *Fish*

Three fish species found in Lake Saint-Louis are in a precarious situation: American shad, Lake sturgeon and American eel. The declining numbers of American shad and Lake sturgeon are largely the result of reduced access to their breeding grounds. The biology of the American eel and the factors responsible for observed changes in this species are poorly understood. Its precarious situation is linked to a number of environmental and human-source factors, including pollution and artificial barriers that limit migration (Robitaille and Choinière, 1989). Moreover, Lake sturgeon face heavy fishing pressure from commercial fishermen, in addition to being fished illegally (Dumont et al., 1987). Two other species found in ZIPs 5 and 6 are on the list of endangered species in Canada: the Copper redhorse, a species endemic to Québec (threatened) and the River redhorse (vulnerable) (COSEWIC, 1993); four species are included on the list of priority species under the St. Lawrence Action Plan (Bouchard and Millet, 1993) (Table 17).



Sources: Roche et Associés Ltd. (1985b).
Mousseau and Beaumont (1981).

Figure 12 Prime Muskrat habitats of Lake Saint-Louis

3.2.3.3 *Birds*

Ten bird species of Lake Saint-Louis are found on the list of threatened birds in Québec (Robert, 1989) (Table 17). Seven are deemed vulnerable species, one is threatened and two endangered. Seven are on the list of Action Plan priority species (Bouchard and Millet, 1993). These species are not unique to Lake Saint-Louis. Two of them, the Least bittern and the Sedge wren, may nest on Lake Saint-Louis.

The Great blue heron colony on Dowker Island requires special protection because the species is very sensitive to disturbance during the breeding season, and the sites it favours for nesting are becoming increasingly rare in southwestern Québec.

3.2.3.4 *Amphibians and reptiles*

The Northern chorus frog and the Pickerel frog are the amphibian species found on the list of Action Plan priority species (Bouchard and Millet, 1993).

Four species of reptiles found in Lake Saint-Louis are also on this list. The Map turtles found in Lake des Deux Montagnes and its outlets make up one of the few recognized populations in Québec. Perrot Island is the most important site for Northern water snake in Québec; a population of Spiny softshell is also found here. On Perrot Island, a number of Brown snake habitats have disappeared.

CHAPTER 4 Links Between Human Activities, Uses and Biological Resources

4.1 Methodology

To determine the links between the human activities described in Chapter 2 and the uses and biological resources discussed in Chapter 3, two complementary approaches will be employed: matrix analysis and mapping.

The matrix shows the relationships between the two types of information. Maps help quantify some of these relationships, at least insofar as the modified surface areas are concerned, and to illustrate their spatial location.

4.1.1 Matrix analysis

The matrix shows direct primary relationships between human activities and the environment (Table 10). Human activities and the sources of stress associated with them are placed across the top of the matrix. The left-hand column lists the various ecosystem components: water, sediment and habitats are the first to be affected by human activity. For example, sources of chemical contamination such as industry, municipalities or ships first affect the chemical quality of water before having an impact on water resources (fish, birds) or uses (fish consumption).

The information is organized so that the various human activities affecting a given component of the ecosystem can be identified by reading across. Reading down shows the effects of the same human activity on each component of the ecosystem.

4.1.2 Map analysis

A special geographic analysis system (SPANS) can be used to illustrate land use, distribution of primary habitats and physical changes in the environment. Surface areas can also be calculated and connections made between activities, uses and resources.

Table 10
Matrix of primary relationships between human activities and ecosystem components

COMPONENTS OF ECOSYSTEM	*HUMAN ACTIVITIES*																													
	CONTROL STRUCTURES	*DREDGING*	*- Volume (m3)*	*- Contaminants*	*COMMERCIAL SHIPPING*	*- Wave action*	*- Contaminants*	*- Bacteria and viruses*	*- Infrastructures*	*INDUSTRIES*	*- SS*	*- Nutrients*	*- Contaminants*	*- Infrastructures*	*MUNICIPALITIES*	*- SS*	*- Nutrients*	*- Contaminants*	*- Bacteria and viruses*	*- Infrastructures*	*AGRICULTURE*	*- Soil erosion*	*- Nutrients*	*- Contaminants*	*- Bacteria and viruses*	*- Dikes*	*RECREATION AND TOURISM*	*- Recreation*	*- Tourism and infrastructures*	*LAND USE*
Water quantity																														
Levels	●		-	-		-	-	-	-		-	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-	-
Flow and current	●		●	-		-	-	-	●		-	-	-	●		-	-	-	-	●		-	-	-	-	●		-	-	-
Water quality																														
Physical	-		●	-		●	-	-	-		●	-	-	-		●	-	-	-	-		●	-	-	-	-		-	-	-
Contamination	-		-	●		-	●	-	-		-	-	●	-		-	-	●	-	-		-	-	●	-	-		●	-	-
Eutrophication	-		-	-		-	-	-	-		-	●	-	-		-	●	-	-	-		-	●	-	-	-		-	-	-
Bacteriological	-		-	-		-	-	●	-		-	-	-	-		-	-	-	●	-		-	-	-	●	-		●	●	-
Sediment																														
Dynamics	-		●	-		●	-	-	-		●	-	-	-		●	-	-	-	-		●	-	-	-	-		-	-	-
Contamination	-		-	●		-	●	-	-		-	-	●	-		-	-	●	-	-		-	-	●	-	-		-	-	-
Habitats																														
Aquatic plant communities	-		●	-		●	●	-	●		-	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-	-
Marshes	-		●	-		●	●	-	●		-	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-	-
Flood plains	-		●	-		●	●	-	●		-	-	-	●		-	-	-	-	●		-	-	-	-	●		-	-	●
Banks	-		●	-		●	●	-	●		-	-	-	●		-	-	-	-	●		-	-	-	-	-		●	●	●
Land and islands	-		●	-		●	●	-	●		-	-	-	●		-	-	-	-	●		●	-	-	-	-		-	●	●

Source: Adapted from Burton (1991a).

4.1.3 Presentation of results

The matrix identifies the real or potential relationships between human activities and ecosystem components, which in turn influence all the uses and resources of the ZIP.

We first describe the components of the ecosystem (water, sediment, habitats) by presenting the sources of stress that affect them and by defining their current condition in terms of quality criteria. We then assess the impacts on uses and resources, in terms of loss or limitation of use.

Ecosystem stress is approached from two angles: contamination and human modification. The first approach is based on contaminant loadings, represented by the quantities of contaminants discharged or transported as a mass per unit of time (kg or tonne per year). Loads indicate the relative importance of sources of contamination; they allow the inputs of toxic substances from upstream to be compared with local sources of contamination. The second involves attacks on habitats, assessed in terms of surface area (ha) affected or modified by human activity.

To define the quality of an ecosystem component and a use or resource, quality criteria based on concentrations must be used (mass of a substance per unit of volume, or mg/L). These criteria define a threshold (concentration) above which the use or resource is considered to be limited or threatened. There are only a limited number of measurements spread out in space (a few sampling stations) and time (a few samples per year).

4.2 Ecosystem Components

4.2.1 Water quantity

A number of hydraulic structures regulate the flow of the St. Lawrence River between the canals connecting Lake Saint-François and Lake Saint-Louis. This distribution may vary, however, depending on outflows from Lake Ontario. These outflows are determined by a water regulation plan for Lake Ontario drawn up by the International Joint Commission (IJC), which has jurisdiction over boundary and transboundary waters between Canada and the United States. The purpose of regulating flow in this way is to ensure a constant water level for shipping

in Québec, a safe current speed and sustained hydro-electric production, and to limit flooding along riverside land of the Great Lakes-St. Lawrence drainage basin.

4.2.1.1 *Water levels*

In years of heavy hydraulicity, and especially in 1972 and 1976, surplus water from the Great Lakes was drained into the St. Lawrence, causing the water level of Lake Saint-Louis to rise. The resulting flood contributed to erosion of the banks and seriously disturbed the riparian forests of De la Paix and Saint-Bernard islands, and of Châteauguay.

The progressive encroachment of residential development and cottages upon the flood plain, as well as the introduction of public facilities increases the risk of flood damage, and hence the amount of money needed for flood compensation. Since 1987, however, a federal-provincial agreement has existed respecting protection of flood-risk areas. In Québec, the agreement is applied under the *Politique de protection des rives du littoral et des plaines inondables* (shoreline and flood plain protection policy), which sets out standards for limiting development and activities in flood-prone areas, and also under the Québec *Environment Quality Act*. At Lake Saint-Louis, 12 municipalities located in the Perrot Island flood plain and on the west and south shores were designated flood-risk zones in 1992 in order to limit development. No flood-risk zones have yet been designated on the north shore.

4.2.1.2 *Flow and current*

In Lake Saint-Louis, floods with an average amplitude of 0.8 m are influenced mainly by surplus water from the Ottawa River, the main tributary of the St. Lawrence, whose flow varies more than does that of the Great Lakes. The flood plain at Lake Saint-Louis covers approximately 12 km^2. The lake behaves like a river at its centre, with a strong flow and current and a very short retention time (12 h). Along the shore, however, retention time is longer and more typically lacustrine, rendering it thus more susceptible to the effects of pollution from local sources and from tributaries.

Some 30 ha of deepwater habitats (Table 1) have been disturbed by backfilling and by the lake's different flow patterns, the result of control structures built upstream. These

activities, along with the construction of the St. Lawrence Seaway, have considerably changed the hydrodynamic conditions of Lake Saint-Louis since 1959. Shoreline infrastructures (docks and marinas) are less extensive and affect only adjacent areas.

4.2.2 Water quality

4.2.2.1 *Physical quality*

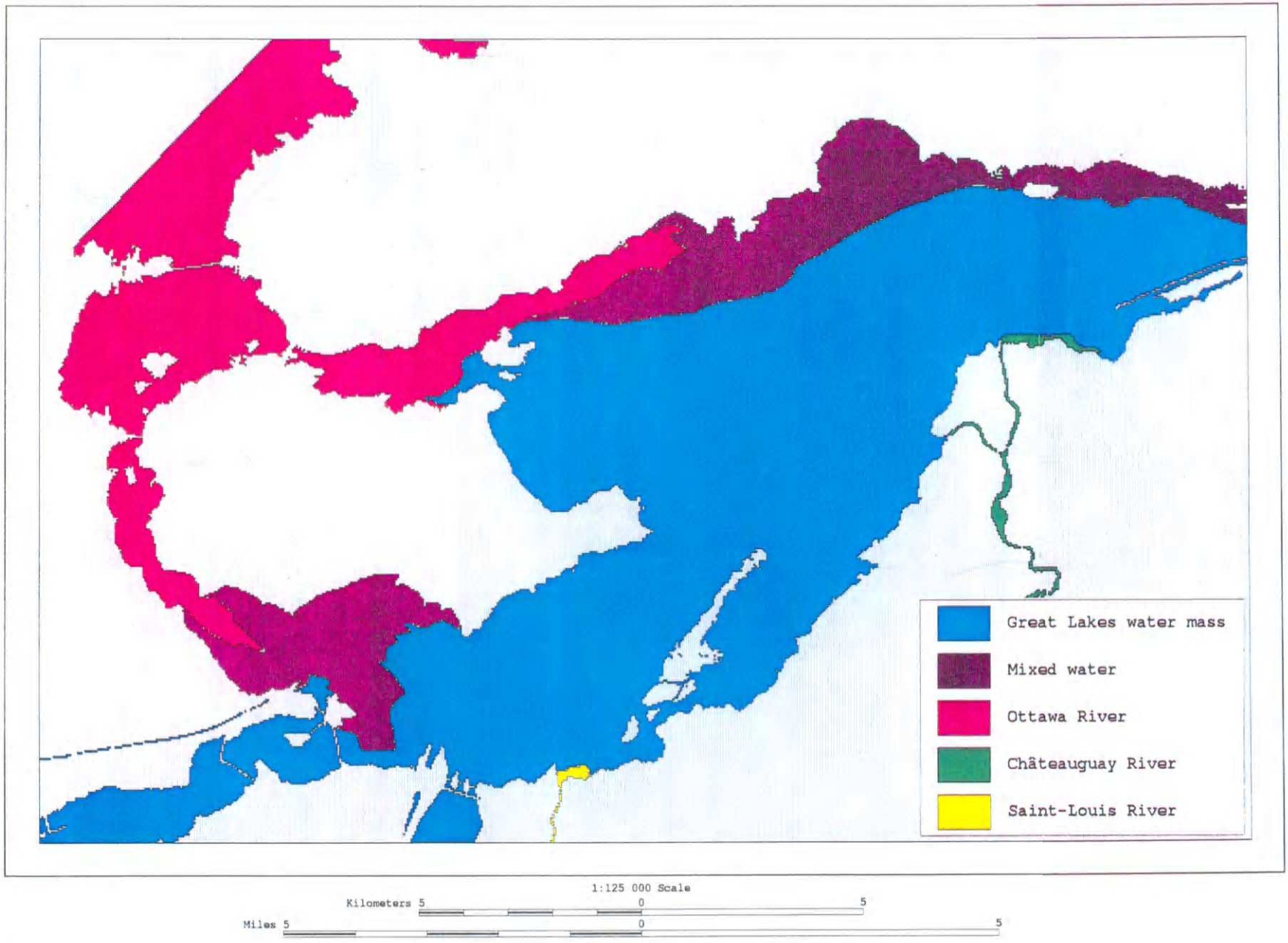
The St. Lawrence carries significant amounts of suspended solids: 1 210 000 t of SS enter Lake Saint-Louis each year. The lake's tributaries are also sources of SS, transporting approximately 130 000 t annually. At the entrance and outlet of the lake, average concentrations of suspended solids do not exceed 5 mg/L. Concentrations of suspended solids at the mouths of the tributaries vary considerably from season to season. In the spring of 1992, the SS concentration exceeded 33 mg/L in the Ottawa River, 26 mg/L at the outlet of the Saint-Louis River, and 12 mg/L at the mouth of the Châteauguay River, whereas the previous summer, these values were 1.8, 17 and 2.2 mg/L, respectively. Figure 13 illustrates the plumes of Lake Saint-Louis' main tributaries in 1990, based on a visual interpretation of digital airborne images.

Actual suspended solids discharge levels from industries targeted by the St. Lawrence Action Plan are estimated at 55 t/year, while those of four municipal wastewater treatment plants are estimated at a minimum 120 t/year.

Farming practices and drainage contribute significantly to the input of suspended solids in the St. Lawrence and tributaries through soil erosion. The wave action caused by ships also changes the physical quality of the water.

4.2.2.2 *Eutrophication*

The eutrophication of a water body occurs when its organic productivity increases in response to higher levels of dissolved nutrients, mainly nitrogen and phosphorus. The body of water goes from the *oligotrophic* (not very productive) stage to the *mesotrophic* stage, and then to the *eutrophic* (very productive) stage. Human activities may speed up this rather slow natural process. An overabundance of nutrients in the environment causes a proliferation of aquatic plants, thus magnifying the process of organic decomposition. Intense biochemical



Source: SOGEAM Inc. (1992).

Figure 13 Plumes of main tributaries of Lake Saint-Louis in 1990

activity leads to a significant variation in the water's oxygen content, with nightly reductions that affect animal communities (invertebrates and fish).

Several chemical and biological indicators can be used to determine the trophic level of a body of water. These indicators are generally applied to lake environments, and are not necessarily representative of flowing-water environments like the St. Lawrence. They must therefore be interpreted with some caution: all the more since the data are not recent.

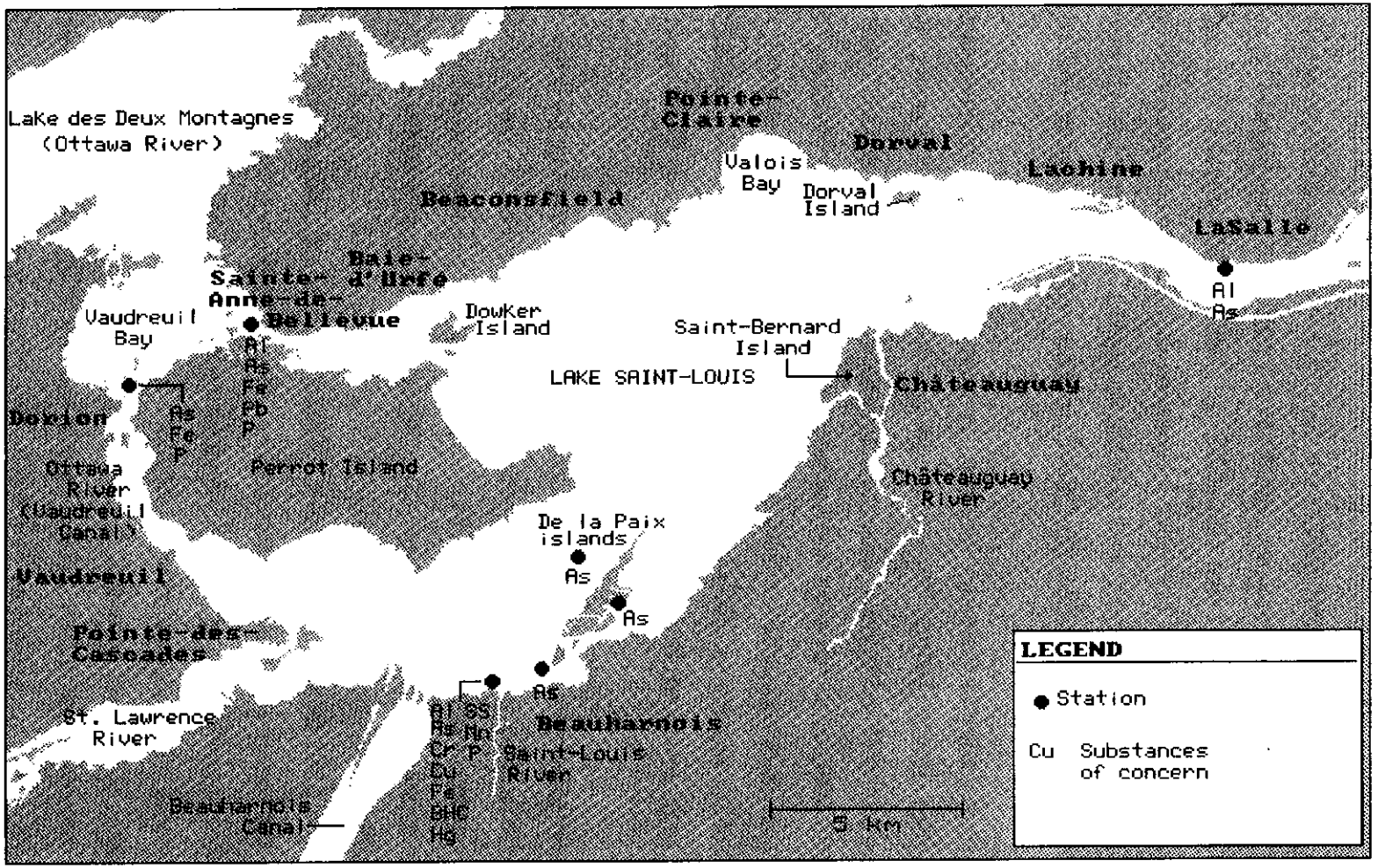
Lake Saint-Louis can be considered mesotrophic in terms of the fish communities that it sustains. In 1977, the quantity of chlorophyll *a* and phytoplankton biomass also made the lake mesotrophic as a whole. Some sections of the north shore near Sainte-Anne-de-Bellevue and Perrot Island are still eutrophic, however.

Aquatic plants are very abundant and occupy approximately 25% of the surface area of Lake Saint-Louis. The abundance of aquatic plant communities reflects the fact that the water is very clear and shallow, containing large quantities of nutrients. Over the last decade, total phosphorus levels have exceeded the water quality criteria in the Ottawa and Saint-Louis rivers (Figure 14). Phosphorus inputs have decreased in the Great Lakes-St. Lawrence drainage basin overall, however, as a result of federal regulations on detergents and due to the action taken since 1988 under the *Programme d'assaisissement des eaux du Québec* (Québec wastewater treatment program), or PAEQ. Nitrites and nitrates increased significantly throughout the Great Lakes-St. Lawrence drainage basin between 1978 and 1986. The increased use of fertilizers in farming and the intensive feedlot operations in the drainage basins of all tributaries seem to be major sources of inputs.

When aquatic plant communities become too large, they hinder pleasure craft and inhibit the practice of other recreational activities like windsurfing and swimming. Filamentous algae and plant debris clog commercial fishing gear. They also affect water supplies by clogging water intake pipes.

4.2.2.3 *Chemical quality*

In 1989, industries and municipalities were the chief local sources of toxic substances in Lake Saint-Louis. The lake's tributaries were also major sources of metals, especially lead and



Source: Fortin et al. (1994).

* Frequency of excedent levels greater than 40%.

Figure 14 Substances frequently* exceeding the water quality criteria at NAQUADAT stations on Lake Saint-Louis from 1985 to 1990

zinc (Tables 11 and 12), due to the industrial activities in their drainage basins. Upstream sources contributed considerable loads of metals, however, constituting a large percentage of total inputs: 83% of copper, 71% of zinc and 37% of lead (Table 11). In 1989, it was estimated that more than 95% of metals in inputs from the St. Lawrence (originating at the upper end of Lake Saint-Louis) came from the Great Lakes and the Cornwall-Massena region. The remaining 5% came from tributaries, municipalities and industries on Lake Saint-François and its outlets (Asseau-INRS, 1992).

The chemical quality of the water (pollution by toxic substances) is analysed using MENVIQ's water quality criteria (1990a). The aim of the *raw water criterion* is to protect the health of a person who may both drink water taken directly from a body of water and eat aquatic organisms (usually fish) taken from the same body of water throughout his or her lifetime. The aim of the *aquatic organism contamination criterion* is to protect human health, which could be threatened by eating aquatic organisms. The aim of the *chronic toxicity criterion* for aquatic life is to protect aquatic organisms and their offspring, as well as wildlife that eat these aquatic organisms.

Analysis of criteria-excedent levels. Analysis of criteria-excedent levels helps to identify substances of concern in the environment; that is, those which should be given special attention because they pose a potential risk to human health, to aquatic organisms or to associated wildlife. A substance is deemed to be of concern when the frequency of such excess levels is greater than 40% for the most restrictive criterion.

From 1985 to 1990 (Figure 14), high levels of aluminum and iron were found mainly on the north shore in the brown waters of the Ottawa River. This water body is naturally rich in aluminum and iron, the major elements of the rock which forms its drainage basin. It is therefore possible that a fraction of the total concentration of these metals is not available to aquatic organisms, thus reducing their toxic potential. On the other hand, iron and aluminum clearly exceeded the criteria for raw water quality and for chronic toxicity of aquatic life in the Saint-Louis River, thereby reflecting contamination by these metals. Manganese concentrations in the water were also slightly higher than the criterion for raw water. An organoleptic (taste and smell)

Table 11
Summary of the four main sources of contamination of Lake Saint-Louis for three reference metals in 1989

	Annual load (kg/year)		
Contaminant sources	*Copper*	*Zinc*	*Lead*
Industrial inputs	801	3 204	3 303
Municipal inputs	584	2 117	1 058
Inputs from tributaries	52 779	362 518	95 338
Inputs from river (Cornwall and sources downstream)	262 894	919 997	58 392
Total inputs	**317 058**	**1 287 836**	**158 098**

* Undetectable concentrations were not used in calculating annual loads.
Note: Loads shown in this table may be inaccurate by as much as 30% for industries, 25% to 45% for tributaries, at least 25% for the St. Lawrence River and 30% to 50% for municipalities.

Source: Asseau-INRS (1992).

Table 12
Estimated inputs of metals from main tributaries of Lake Saint-Louis in 1989

			Inputs (kg/d)					
Tributaries	*Flow (m^3/s)*		*Cu*	*Ni*	*Zn*	*Pb*	*Fe*	*Mn*
Sainte-Anne Canal	433	(1986)	58.6	35.5	109	36	11 032	616
Vaudreuil Canal	393	(1985)	73	41	853	29	13 725	867
Châteauguay R.	34	(1985)	13	15	30	196	931	89
Saint-Louis R.	2.35	(1988)	0.6	0.5	1.2	0.2	202	13
Total (kg/year)			**52 779**	**33 398**	**362 518**	**95 338**	**9 449 850**	**578 525**

Note: Loads shown in this table may be inaccurate by 25% to 35%.

Source: Asseau-INRS (1992).

problem may be signalled if the criterion for iron is exceeded in raw water, whereas the criterion for manganese is aesthetic. Toxicity for humans is not an issue where these substances are concerned.

Arsenic systematically exceeded the allowable level according to the criteria for raw water and contamination of aquatic organisms (Figure 14). It appears, however, that measured values represent levels that are largely spread throughout the Great Lakes-St. Lawrence drainage basin. Moreover, the criteria for arsenic are being reviewed in light of findings on its carcinogenicity.

Lead frequently exceeded the chronic toxicity criterion for aquatic life at a measuring station on the Ottawa River. Chromium and copper also exceeded this criterion several times at the mouth of the Saint-Louis River between 1985 and 1990 (Figure 14). All mercury values measured at the mouth of the Saint-Louis River between 1987 and 1990 exceeded the criterion for contamination of aquatic organisms.

We did not use the results of PCB tests on water obtained at National Water Quality Data Bank (NAQUADAT) monitoring stations on Lake Saint-Louis. These data differ from the concentrations measured recently elsewhere along the St. Lawrence using new analytic methods (Houle et al., 1994), which are being validated at the St. Lawrence Centre. Recent data (1991 and 1992), although very scant, nonetheless indicate that the raw water criterion is occasionally exceeded in the Ottawa, Saint-Louis and Châteauguay rivers (St. Lawrence Centre, 1993).

Organochlorine pesticides do not seem to be a cause for concern at the stations on Lake Saint-Louis, except for benzene hexachloride (BHC) at the mouth of the Saint-Louis River, which exceeded the criteria for raw water and for contamination of aquatic organisms.

Generally speaking, the water of Lake Saint-Louis did not exceed the water quality criteria in any significant way for the substances studied from 1985 to 1990. In addition, sediment fairly faithfully represents the levels of pollutants transported in the water of the St. Lawrence. Thus, suspended sediment that has settled over the last decade reflected yet another degree of contamination of the water. Some metals (lead, copper, zinc and cadmium) showed levels at least three to seven times higher than preindustrial levels. Others, however, such as

chromium and nickel in sediment, approached background levels. Core sampling in Lake Saint-Louis found a clear overall improvement in the chemical quality of suspended sediment since the early 1970s.

The fact that the criteria were frequently exceeded at the mouth of the Saint-Louis River indicates the poor water quality of this tributary during the 1985-1990 period. This further justifies efforts to reduce the discharge of pollutants by means of various cleanup programs.

It should be remembered, however, that the data cover a limited space and time and do not necessarily reflect current reality. As a result of measures taken to clean up the St. Lawrence and Great Lakes in recent years, the deterioration of water quality due to municipal and industrial inputs has doubtless been attenuated.

For some bioaccumulable substances such as arsenic and PCBs, the raw water quality criterion combines the effects on health of ingesting water taken directly from a water body and those of consuming aquatic organisms taken from the same water. Thus, even though arsenic levels measured in Lake Saint-Louis and PCB levels in the tributaries exceeded the raw water criterion, they still met the standards for drinking water. In such a case, it is deemed safe to drink the water, although eating the aquatic organisms may be a health risk. Furthermore, aluminum, iron and manganese exceeded the raw water criterion at the mouth of the Saint-Louis River. When the raw water criterion for non-bioaccumulable substances such as aluminum, iron and manganese is exceeded, water should be treated prior to consumption to ensure its quality.

Local sources of contamination. Toxic substances, whether metals or organics (including pesticides), can be of industrial, municipal or agricultural origin. Although it is impossible to trace the exact origin of pollutants, some substances measured in the water may be associated with point sources of pollution in Lake Saint-Louis (Asseau-INRS, 1992).

Domtar's Fine Papers Division plant contributes to the aluminum pollution of the Saint-Louis River. Alcan Smelters and Chemicals Ltd. discharged PAHs, aluminum and fluorides up until 1991. Elkem Metals Canada Inc. was associated with the presence of large amounts of metals, such as cadmium, lead and zinc. PPG Canada Inc. contributed considerably to mercury contamination. The high copper levels reported on the south shore are probably associated with

industries in the Beauharnois-Valleyfield area. The hazardous waste disposal sites in the Beauharnois-Melocheville area are potential sources of contamination by metals (mercury, aluminum, chromium, copper, lead and zinc) and organic substances for the water of Lake Saint-Louis.

Effects on uses and resources. Contaminants in the water may affect a whole range of uses and resources.

As far as municipal water supplies are concerned, the raw water criterion (drinking water) was frequently exceeded for aluminum and iron at the mouth of the Saint-Louis River. These excedent levels led to increased monitoring of the water quality and to the implementation of treatment for water destined for human consumption. There is no water intake pipe for domestic purposes at this location, however.

The presence of toxic substances in aquatic plants is cause for concern, given the large areas colonized by aquatic vegetation and its role in the food chain. Nonetheless, knowledge of contamination of aquatic plants in the St. Lawrence is fragmentary and studies on the effects of bioaccumulation on food chains are under way at the St. Lawrence Centre.

Metals (lead and mercury) have been detected at levels higher than the marketing standards for fish (Health and Welfare Canada, 1985) in the flesh of bivalve organisms; and in the case of mercury, the criterion for protection of fish-eating wildlife has been exceeded (IJC, 1987). The highest concentrations have been observed on the south shore, at the mouth of the Saint-Louis River and in the De la Paix islands. The heavy environmental contamination around Beauharnois is probably also responsible for the more frequent malformations of Chironomidae larvae (insects) in the area (Warwick, 1990).

Metals and halogenated organic compounds were seen in all fish caught in 1989. Mercury levels measured in fish flesh systematically exceeded the criterion for the protection of fish-eating wildlife (IJC, 1987). PCBs also exceeded the criterion in all specimens of Lake sturgeon. Given the affinity of certain metals and organic compounds for tissues rather than for flesh, and the fact that fish-eating organisms ingest the whole fish, this contamination could have

a deleterious effect on the vital functions of fish-eating wildlife, including reproduction and development.

In 1989, the same tests found mercury at levels higher than the fish marketing standard in some specimens of sport fish in Lake Saint-Louis, and particularly around the De la Paix islands (Health and Welfare Canada, 1985). Mercury levels were particularly high in large fish, especially specimens of Northern pike and Walleye caught in the area. Only the flesh of small and medium-sized Yellow perch met the marketing standards for mercury. The situation is all the more disturbing since most sport fishers on Lake Saint-Louis eat what they catch, and these are the three species most often fished (Fournier et al., 1987; Institut Québécois d'Opinion Publique, 1985). Furthermore, PCB levels observed in 1989 in the flesh of various sport species were lower than the fish marketing standard. Recent unpublished data indicate that mercury levels in the flesh of Yellow perch in 1992 were below the fish marketing standard, regardless of the size of the specimen. The same downward trend was also seen in 1992 for PCBs in the flesh of several species of fish (Laliberté, 1993).

Despite these recent observations, people who regularly eat large servings of fish contaminated by these substances are exposing themselves to health problems (Paradis et al., 1989), such as neurological and liver disorders. People who like fish should therefore follow the guidelines of the *Guide de consommation du poisson de pêche sportive en eau douce* (MSSS and MENVIQ, 1993), which recommends in particular limiting consumption of fish-eating species. Risk groups were also identified, mainly small children and pregnant and lactating women. It is recommended that pregnant women eat only the less contaminated species such as Yellow perch, and no more than eight fish meals per month.

The Info-Fishermen program run by the Société pour Vaincre la Pollution (SVP) aims to make anglers more aware of fish contamination. When they bring in their catch, SVP gives them a copy of the *Guide de consommation du poisson* and a map of contaminated sites in Valleyfield, Beauharnois and the Châteauguay region. They later receive the test results for their catch.

An accumulation of DDT, chlordane and PCBs above the poultry marketing standards (Canada, 1971) has been observed in the Peking Duck, introduced experimentally into the natural environment. There is no information available on the contamination of waterfowl flesh.

The contamination of fish and other organisms (amphibians, reptiles and birds) is cause for concern because of the diversity of toxic substances, the spread and duration of their effects, and the complexity of the phenomena of synergy and biomagnification.

4.2.2.4 *Bacteriological quality*

MENVIQ quality criteria were applied in this case (1990a). They involve allowable levels of fecal coliform bacteria in terms of raw water quality and recreational activity. These bacteria originate in humans and in animals such as birds, and are an indicator of the presence of pathogenic microorganisms in the environment.

Bacteriological data need to be interpreted cautiously. A number of factors can influence the amount of fecal coliform bacteria and introduce great variability, including sewer overflows, soil leaching during heavy rains, or large bird colonies. Furthermore, the dangers inherent in using poor quality water cannot be determined precisely. We therefore speak of the risks to health of engaging in activities in areas where the number of fecal coliform (f.c.) bacteria exceeds the quality criterion.

Drinking water supply. The raw water quality criterion was exceeded at the mouth of the Châteauguay River in 1989 and 1990 (1000 f.c. bacteria/100 mL water). Exceeding the criterion where a water intake pipe is located would mean that the treatment must be adjusted for drinking water (prechlorination). There is, however, no water intake for domestic purposes at this location.

Recreational activities. As part of its monitoring of the wastewater treatment program, the MENVIQ indicated that on the south shore at the mouth of the Châteauguay River in 1989 and 1990, all values exceeded the criterion for primary-contact activities (including swimming: 200 f.c. bacteria/100 mL) just as, on several occasions, they exceeded the criterion

for secondary-contact recreational activities (1000 f.c. bacteria/100 mL). It should be noted that in the early 1980s, none of the municipalities on Lake Saint-Louis treated their wastewater. The situation is different now; since 1992 most of the municipalities on the lake have been treating their wastewater. Nonetheless, although this reduces the discharge of microorganisms into the environment, only the municipalities of Châteauguay and L'Île-Perrot disinfect their wastewater. Although not common, faulty septic tanks also deteriorate the bacteriological quality of the water.

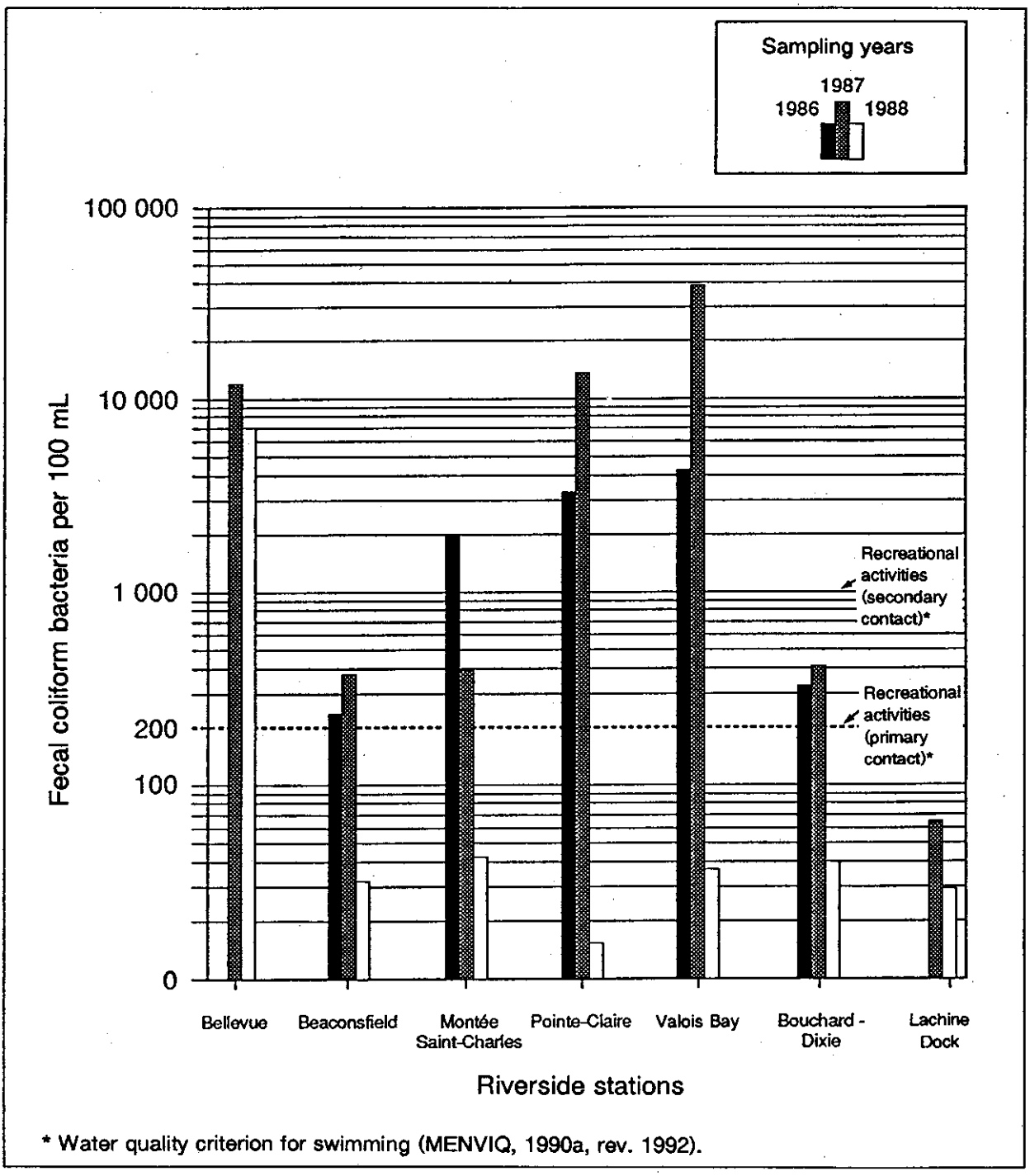
On the north shore, the Lakeshore Community Health Department reported values above the quality criterion for swimming in 1986 and 1987. In 1988, however, when the sewers of the lake's north shore municipalities were first connected to the MUC's north intercepting sewer, water quality improved and met the criterion for swimming. The MUC observed the same trend on the north shore from 1986 to 1989, except at Sainte-Anne-de-Bellevue, where some wastewater was connected to septic tanks (MUC, 1989) (Figure 15). In 1992, however, most of the wastewater from Sainte-Anne-de-Bellevue was sent to the MUC's north intercepting sewer. This is potentially a gain for the use of the water for swimming and recreational activities.

Despite the positive effect of the MUC's intercepting sewer on the quality of water on the north shore, and the treatment of wastewater by most municipalities on the south shore, the health risks associated with microorganisms in the practice of recreational activities have not completely disappeared, given the other factors that promote their growth. The bacteriological quality of water must therefore be monitored.

Cottaging and pleasure craft are other bacterial sources of water pollution, although they are not as significant.

4.2.3 Sediment

We will first look at sediment in terms of its dynamics and its contamination, two phenomena that are closely tied together. The contamination of aquatic organisms all along the food chain is partly related to the nature of sediment and to its transport mechanisms.



Source: MUC (1989).

Figure 15 Variations in concentrations of fecal coliform bacteria in Lake Saint-Louis between 1986 and 1988

4.2.3.1 *Sedimentary dynamics*

Although the suspended solids (SS) content is only 1 or 2 mg/L at the outlet of Lake Ontario, it is 3 or 4 mg/L at the entrance to Lake Saint-Louis (Fortin et al., 1994). This increase is brought about primarily by tributaries of the St. Lawrence River's international section and by the Ottawa River. Inputs from the Ottawa River have much less pronounced variations in suspended solids concentrations than those of the Great Lakes. SS inputs into Lake Saint-Louis total approximately 1 340 000 t/year (of which 90% comes from the St. Lawrence), and an almost equivalent tonnage leaves Lake Saint-Louis again. The lake is thus very active in terms of sedimentary transport.

Particle size influences sedimentation, resuspension and contaminant adsorption capacity. The hydrodynamic regime of the lake being both lacustrine and fluvial, size distribution of bottom sediment particles may differ greatly from area to area. The age of the sediment varies from between 30 and 50 years to three years and under. The middle of the lake is characterized by strong currents that inhibit sedimentation. The bottom is coarse and consists of gravel, clay and rocky outcroppings. This is the area that was excavated to make the St. Lawrence Seaway.

Zones of fine sedimentation are found along the north shore of the lake, south of the De la Paix islands and south of Perrot Island. The sedimentation rate is much higher on the south side of Lake Saint-Louis. The major deposition zone located south of the De la Paix islands is well known. The sediment is no more than three years old and accumulates at a rate of 8 cm/year. The heavy plant cover as well as the disturbance of sediment by waves and spring floods may be behind the sedimentary dynamics of this environment. In any case, serious erosion is threatening the De la Paix islands. South of Perrot Island, sediment from the St. Lawrence and Ottawa rivers is accumulating at a rate of approximately 4 cm/year. In the last 30 to 50 years, the sedimentation rate on the north side of the lake between Dowker Island and Valois Bay has been 0.5 to 0.8 cm/year. This zone, which extends over close to 28 km^2, is the site of slow, calm sedimentation of particles from the Ottawa and St. Lawrence rivers.

The sedimentary dynamics of Lake Saint-Louis are chiefly influenced by natural phenomena associated with spring floods, storm waves and the growth cycle of aquatic plants. The sediment input from the St. Lawrence is increased, however, by soil erosion in farming areas of tributary drainage basins. Fine sediment may choke spawning grounds and encourage the proliferation of aquatic plants and contaminant transport.

Industrial and municipal waste contributes to sediment loading, although it is marginal compared to the region's overall sediment load. The wave action caused by ships also contributes to sediment resuspension. These effects are limited in time and space, but may still be significant for aquatic habitats (plant communities and marshes; in the De la Paix islands, for example).

4.2.3.2 *Contamination*

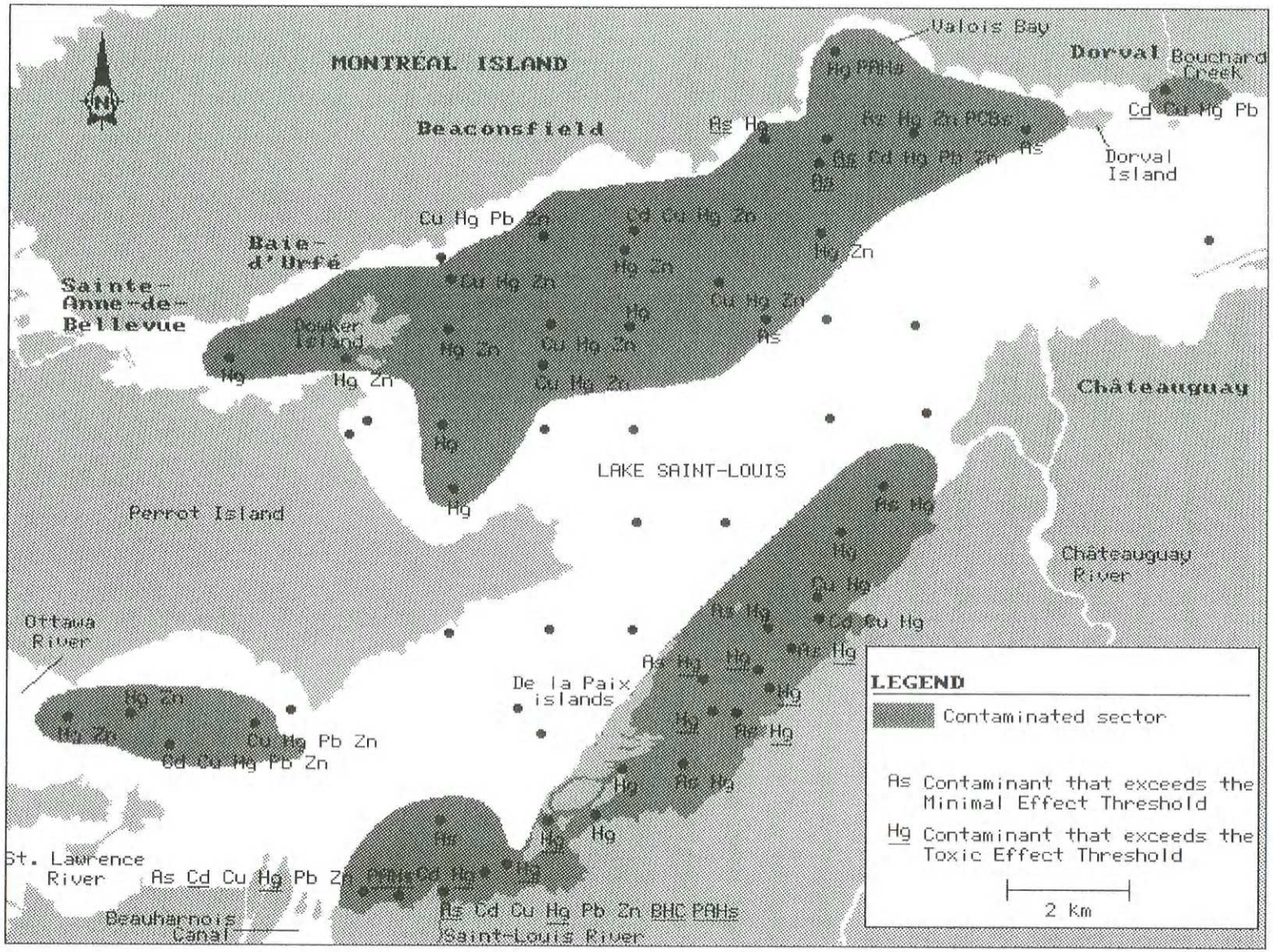
The chemical quality of sediment is determined on the basis of two levels of contamination that can potentially reduce use of the receiving environment: protection of benthic organisms and dredging. The first degree of contamination is assessed in terms of the Minimal Effect Threshold (MET) (St. Lawrence Centre and MENVIQ, 1992), which is the level above which 15% of organisms living in the sediment may be adversely affected. This threshold is exceeded in several areas of Lake Saint-Louis, i.e. the mouth of the Saint-Louis River, south of the De la Paix islands, at the mouth of Bouchard Creek, at the north end of the lake between Dowker Island and Valois Bay, and south of Perrot Island. Except for the mouth of the Saint-Louis River and Bouchard Creek, these contaminated areas are the major sedimentation zones of Lake Saint-Louis. High levels of copper, mercury, lead and zinc have been reported there (Figures 16 and 17). Other toxic substances such as arsenic, cadmium, PCBs and PAHs can also be found, but they are more localized. For methodological reasons, mercury was not measured in 1991 at the north end of Lake Saint-Louis.

The second degree of contamination is measured in terms of the Toxic Effect Threshold (TET). Above this threshold, deleterious effects are detected in most benthic organisms, and it is forbidden to dump dredged material in open water. All the major sedimentation zones of Lake Saint-Louis meet this quality criterion, except one located east of

the De la Paix islands, Valois Bay at the mouth of the Saint-Louis River and Bouchard Creek. This situation is mainly due to very high arsenic levels near Valois Bay; mercury in the southern part of the De la Paix islands; mercury, arsenic, PAHs and BHCs at the mouth of the Saint-Louis River; and very high cadmium levels at the mouth of Bouchard Creek. It should be noted, however, that no dredging has been done in Lake Saint-Louis since the Seaway was built.

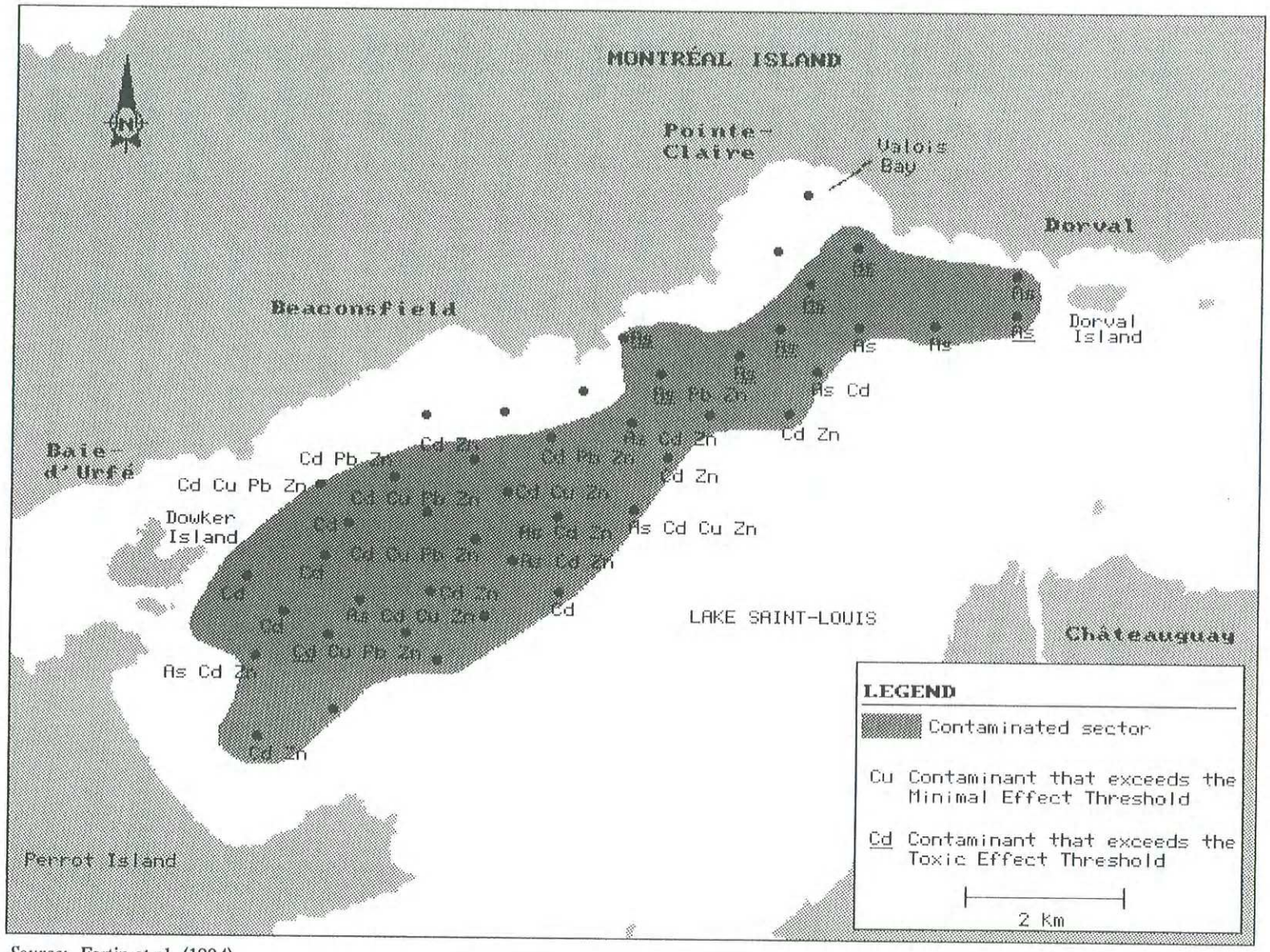
As we have seen, there are numerous sources of toxic contamination of sediment. Sources upstream contribute large loads. Locally, industries still dump metals and toxic organic substances; municipalities also discharge metals and pesticides. Tributaries primarily transport pesticides, whereas shipping is a potential oil spill source.

Sediment contamination has impacts on all levels of the ecosystem, as evidenced in organisms associated with water bottoms (benthic invertebrates and benthos-eating fish). Indirect impacts are also spread throughout the food chain by biomagnification. A number of physical, chemical and biological mechanisms act to resuspend pollutants in water, thus making them available to aquatic organisms.



Source: Fortin et al. (1994).

Figure 16 Toxic substances exceeding the quality criteria for sediment in Lake Saint-Louis in 1984, 1985 and 1988



Source: Fortin et al. (1994).

Figure 17 Toxic substances exceeding the quality criteria for sediment in the north end of Lake Saint-Louis in 1991

4.2.4 Habitats

This section looks at habitats from the perspective of changes they have undergone and the ensuing repercussions on resources and associated uses. Certain types of land use pose a threat to some important environments.

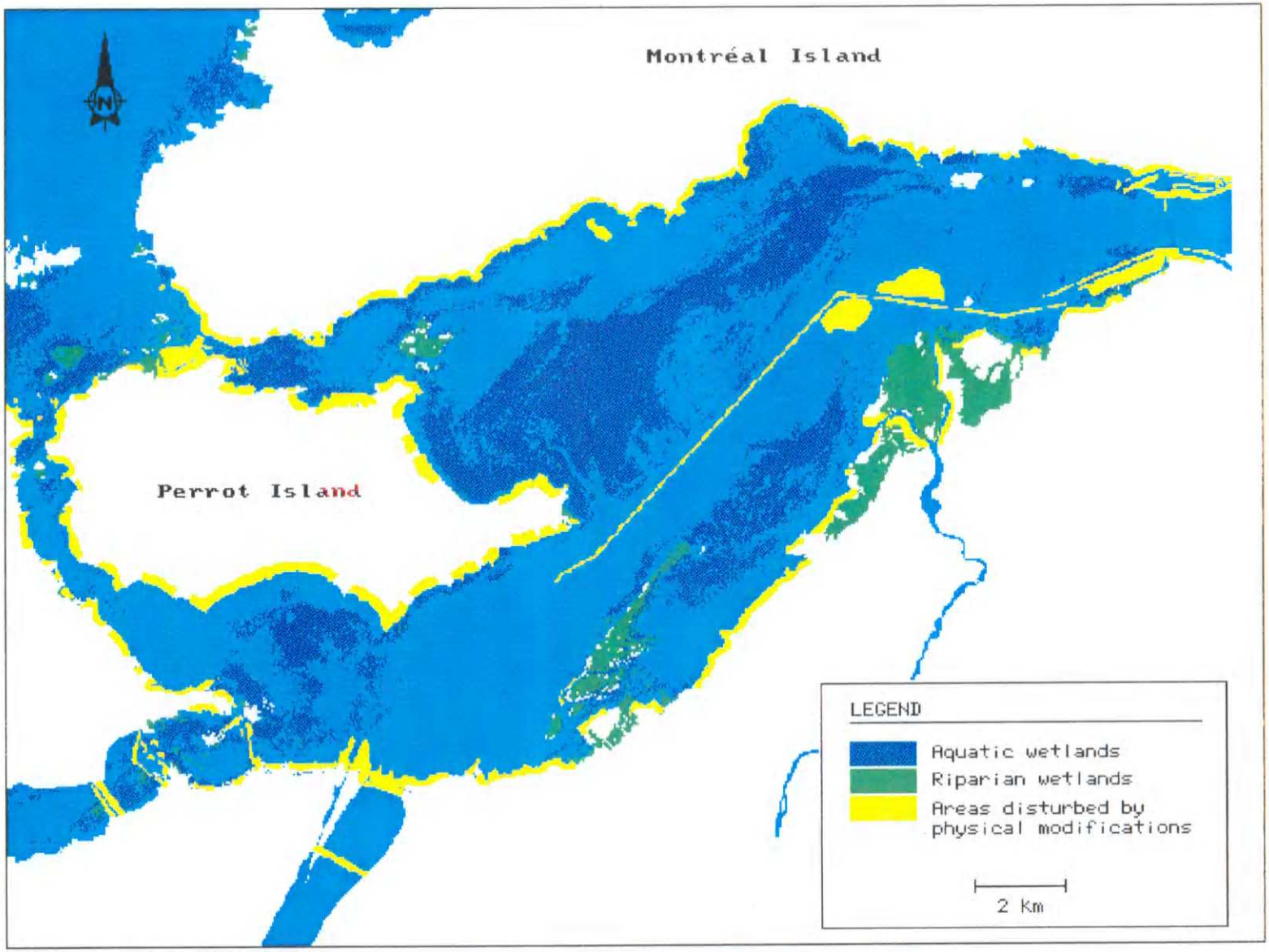
4.2.4.1 *Dredging, backfilling and changes in water flow*

Hydro-electric installations and side canals built at the upper end of Lake Saint-Louis in the 1930s changed the flow of the water. It is difficult to compare environmental conditions then with those of today due to a lack of information. The construction of the St. Lawrence Seaway in the 1950s, the expansion of the highway network and, perhaps most of all, urbanization, were factors that contributed to changing the natural environment and to its degradation, leading to the disappearance of riparian habitats.

Approximately 1770 ha of aquatic and riparian environments have undergone physical changes since the 1950s (Figure 18). Land designated for urban use now takes up 68% of the shores of Lake Saint-Louis (Jourdain et al., 1994). The north shore is an almost continuous, highly degraded urban environment. The area between Lachine and Sainte-Anne-de-Bellevue is almost completely filled in and the flood plain is practically nonexistent.

At the southwestern end of the lake, the shores are largely degraded and of little use to plants and wildlife. Suburban sprawl on the south shore is taking place at the expense of subsisting wildlife habitats, and residential construction continues to encroach on flood-risk zones.

The section of Lake Saint-Louis favoured as a fish habitat underwent three major types of changes between 1945 and 1988 (Figure 18 and Table 1). Dredging to build the Seaway affected 130 ha and the dumping of dredged material affected 138 ha in deep water; during the same period, backfilling caused an appreciable loss of habitat: 65 ha of deepwater habitats, 47 ha of aquatic plant communities and 10 ha of marshlands were lost. Changes to the water flow and backfilling resulted in the loss of approximately 150 ha. All these changes together caused a drop in fish stocks, a change in the composition of fish populations, and the filling in of troughs used by a variety of fish species, among other things. Furthermore, the flooding that occurred following the rise in the water level of Lake Saint-Louis had a severe impact on riparian forests.



Adapted from: Aménatech (1992).
MLCP (1984b).
Marquis et al. (1991).

Figure 18 Physical modifications, and riparian and aquatic wetlands of Lake Saint-Louis (since the 1950s)

In the forested areas of De la Paix and Saint-Bernard islands and in Châteauguay, 40% of the riparian forests were turned into wet meadows or marshes (Gratton, 1989). Prior to the years of heavy hydraulicity, the De la Paix islands extended over 495 ha composed solely of wetlands. Between 1958 and 1991, rising water levels transformed 163 ha of healthy forest and 37 ha of scrubland into 96 ha of marsh and wet meadows, for a net loss of 104 ha or 21% of the wetlands surface area in 1958 (Jean et al., 1992).

4.2.4.2 *Spills*

Shipping constitutes a threat to aquatic and riparian habitats. The heavy traffic and navigational difficulties presented by the St. Lawrence increase the risk of accidental chemical spills. Oil can be recovered in part, but such is not the case for more soluble chemicals, like salts and acids. No major incidents have been reported yet, but the eventuality cannot be dismissed.

4.2.4.3 *Erosion*

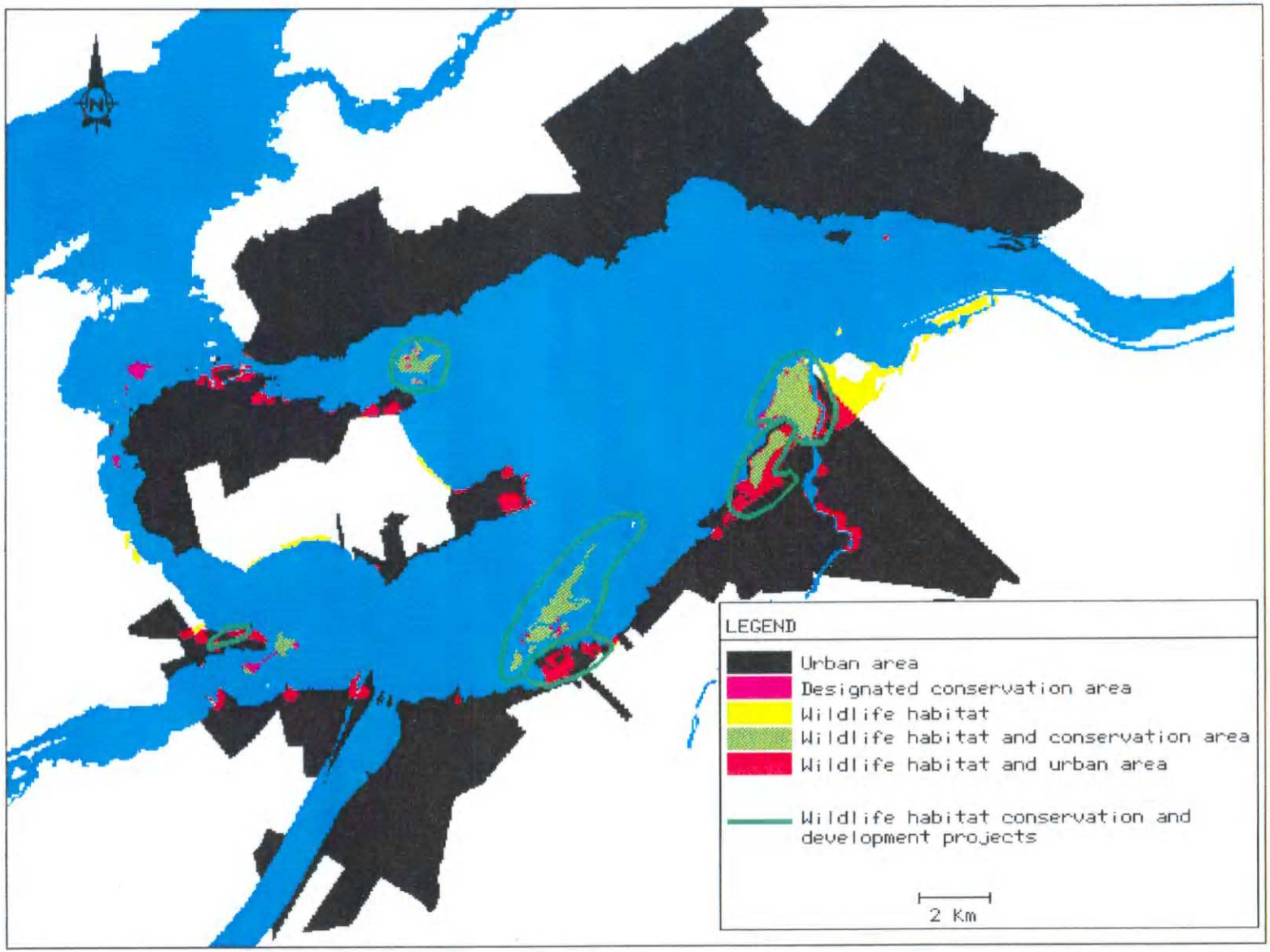
Commercial shipping and recreational boating are activities which cause the wave action that erodes the shores and aquatic plant communities of Lake Saint-Louis.

For 15 years, the northern part of the De la Paix islands have been receding by about one metre annually as a result of natural waves, ice and wave action caused by boats and ships (Ducks Unlimited Canada, 1985). Although it is an important consideration, the erosion of banks has not been mapped, due to a lack of precise information.

4.2.4.4 *Land use*

Human actions are largely responsible for the loss of natural habitats at Lake Saint-Louis. Riverside space is heavily structured according to urban functions, thereby permanently changing the area.

The area is dominated throughout by uses that characterize urban and industrial environments (Figure 3 and Table 13), followed by rural land use, located mostly in the western part of ZIPs 5 and 6. Only 2% of the territory of ZIPs 5 and 6 has been set aside for conservation and only 3% of the perimeter has been left in a natural state. More space has been set aside for recreation and conservation on the south shore: the Îles-de-la-Paix National Wildlife



Sources: Therrien et al. (1991).
Roche et Associés (1985b).
Jourdain et al. (1994).

Figure 19 Land use and wildlife breeding habitats in riparian and island environments

Table 13
Principal types of land use by area[a] for ZIPs 5 and 6

Designation	*Surface area (km²)*	*%*
Urban (residential, commercial)	116.76	33
Rural (agricultural and other)[b]	109.52	30
Industrial	40.16	11
Recreational	19.92	6
Conservation	6.01	2
Social and cultural facilities	4.62	1
Public utilities/works	10.09	3
Kahnawake Mohawk reserve	50.69	14
Lake Saint-Louis total	**357.77**	**100**

a Data obtained from analysis of first-generation development plans (late 1980s).
b In the case of ZIPs 5 and 6, "other" refers mainly to cottaging.

Table 14
Surface areas of wildlife breeding habitats* in riparian and island environments of ZIPs 5 and 6

Surface area affected by urban uses	6.2 km²
Surface area affected by conservation	4.6 km²
Other uses	3.7 km²
Total surface area in riparian and island environments	**14.5 km²**

* Spawning grounds and prime breeding habitats for birds and Muskrats.

Area, Saint-Bernard Island and part of the Châteauguay Commons are legally protected. Saint-Bernard Island and part of the Châteauguay Commons now constitute the Marguerite-d'Youville Wildlife Refuge, whose objective is habitat conservation and development. Several wildlife habitat conservation and development projects have also been proposed by the Fondation de la Faune du Québec (Quebec wildlife foundation) (Figure 19). In addition, a few sites are now officially designated as wildlife habitats under the Québec *Act respecting the conservation and development of wildlife*. This is the case for waterfowl staging grounds along the shore opposite Beauharnois, from Pointe à Quenet (Beaconsfield) to Valois Bay, in an area downstream from Dixie Island, and in the middle of the lower end of the lake (Armellin et al., 1994).

Analysis of land use development plans shows possible conflicts of use. We compared some types of land use designation with the surface areas of wildlife breeding habitats (Table 14 and Figure 19). As the land use designation referred only to shores and islands, wildlife habitats in the aquatic environment of Lake Saint-Louis had to be left out of our analysis.

Approximately 30% of major wildlife habitats located in river and island environments (chiefly concentrated in the latter) has been set aside for conservation purposes. This areas are approximations, but they do show how important RCMs consider habitat conservation to be. Figure 19 also shows conflicts in land use; approximately 40% of major wildlife habitats, particularly those in the riparian environment, are designated for urban use, and are thus threatened.

Lake Saint-Louis is one of the richest sectors of the St. Lawrence in terms of plant and animal life. To date, some development plans have emphasized conservation, especially on islands, yet natural environments have been considerably modified by human actions. Where these environments continue to subsist, they are subject to considerable pressure, especially by urban development and commercial and recreational uses: the constantly increasing needs of human society. These pressures are felt especially strongly in riverside areas, on the south shore of Lake Saint-Louis. Only by maintaining biodiversity and the natural productivity of ecosystems

can we ensure our long-term use of water and plant and animal resources. The agencies responsible for natural resources must work cooperatively with users of these resources to promote conservation and to ensure that regional development does not compromise biological diversity.

CHAPTER 5 Problems

Having described the components of the ecosystem and the stresses that affect them, and identified the current quality of uses and resources based on quality criteria, this report concludes with the main problems facing ZIPs 5 and 6 (Lake Saint-Louis), as determined on the basis of current knowledge.

This information is summarized in three tables: the first is on components of the ecosystem (Table 15), the second is on uses of the environment (Table 16), and the third has to do with biological resources (Table 17). Each table contains a brief description of the specifics of each element in the ZIPs. The next column indicates whether any uses have been lost or limited. Next come the references, standards or criteria by which the loss or limitation was assessed. The nature of the problem shows the parameters that do not meet the quality criteria, areas affected or constraints imposed on the environment or its uses. The last column indicates one of three levels of certainty of the link between the losses or limitations of uses or resources and the nature of the problem (reliability of assessment), based on the extent of available knowledge. Table 18 defines terms used in the other three tables to categorize losses and limitations and to determine the degree of certainty of the diagnosis.

Problems have been divided into three main groups, depending on whether they result from contamination of the environment, physical changes to habitats, or pressures exerted on resources.

5.1 Contamination of the Environment

Bacteriological contamination was observed on the north shore at Sainte-Anne-de-Bellevue (1986 to 1988) and on the south shore at the mouth of the Châteauguay River (1989 and 1990), where it posed a health risk to people who came in contact with water, whether by swimming or through other recreational activities. Most of these bacteriological contamination problems have gradually been resolved since 1989, with the interception of wastewater from all

municipalities on the north shore of the lake and treatment of wastewater from south shore municipalities.

The quality criteria for raw water (chronic toxicity to aquatic life and contamination of aquatic organisms) were exceeded in the water between 1985 and 1990, particularly at the mouth of the Saint-Louis River. Toxic substances, frequently found at levels above the criteria set to protect certain uses or resources of the environment, were also identified in other compartments of the ecosystem (sediment and wildlife). Levels of metals and organochlorine compounds in the flesh of fish were a cause for concern; in 1989, mercury exceeded the fish marketing standard of Health and Welfare Canada, especially for sport fish such as Northern pike and Walleye. On the other hand, levels in the flesh of Yellow perch have been below the marketing standard since 1992. The same downward trend was observed for PCBs in the flesh of several species of fish.

Lastly, the lake's overall biological productivity is average (mesotrophic). Conditions are eutrophic along some parts of the lake's north shore and on Perrot Island, however. Aquatic plants are abundant and occupy approximately 25% of the surface area of Lake Saint-Louis. Total phosphorous levels exceed water quality criteria in the Ottawa and Saint-Louis rivers, although phosphorous inputs have decreased since 1988 as a result of the PAEQ (Québec wastewater treatment) program.

5.2 Physical Modification of Habitats

The habitats of Lake Saint-Louis have been considerably degraded by the construction of a large number of hydro-electric installations upstream, by the rise in water levels, the digging of the St. Lawrence Seaway, and by backfilling for urban development. Wetlands have thus been lost and the migratory patterns of fish changed. Changes in water flow and the disappearance of riparian habitats have led to a decline in some fish stocks, to changes in the composition of fish populations and to the filling in of troughs used by several species of fish. The cumulative effects of habitat fragmentation and the disappearance of sites essential to certain species have also degraded the quality of habitats, but this is difficult to assess.

An analysis of anticipated land use according to RCM development plans reveals conflicts between conservation and urban development. Especially in the riparian environment, close to 43% of the surface area of wildlife habitats for breeding fish, birds and Muskrats is given over to urbanization.

5.3 Pressures on Biological Resources

In addition to threats to its habitat, the Lake sturgeon is showing the signs of heavy commercial fishing and poaching. Other species fished commercially can withstand the current catch rate.

Furthermore, Lake Saint-Louis has the strongest sport-fishing pressure in Québec. Populations of the main species fished, i.e., Yellow perch, Northern pike and Walleye, do not seem to be threatened by the intense fishing, but Muskellunge needs to be stocked since natural reproduction cannot keep up with the extent of sport fishing activity.

In the fall, large numbers of hunters frequent habitats favoured by waterfowl. In the area of the Montréal archipelago, Lake des Deux Montagnes and Lake Saint-Louis are subject to the greatest hunting pressure.

Table 15
Water, sediment and habitats: Assessment of present state

Ecosystem components	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
1. Water					
Quantity	Water level is regulated at the outlet of the Great Lakes.	Maybe		. A plan for regulating water levels approved by the International Joint Commission in 1954 provides control of flow from the Great Lakes into the St. Lawrence. Seasonal variations are generally not significant.	Known
	Hydraulic installations divide the flow of the St. Lawrence between the channels and canals connecting Lake Saint-François and Lake Saint-Louis.	Yes		. Backfilling and new flow patterns have disturbed approximately 30 ha of deepwater habitats.	Known
	The flow of the St. Lawrence into Lake Saint-Louis is largely concentrated in the shipping channel.	Yes		. The excavation of the St. Lawrence Seaway modified the hydrodynamic conditions of Lake Saint-Louis. The slower flow along the shores increases the surface areas affected by local sources of pollution.	Known

Table 15 (cont'd)

Ecosystem components	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
Quality					
a) Nutrients	The lake as a whole is mesotrophic, although conditions along some parts of the lake's north shore and Perrot Island are eutrophic. However, phosphorus inputs have decreased as a result of the Québec wastewater treatment program.	Yes	Aquatic life (chronic toxicity) Recreational activities (MENVIQ, 1990a)	Total phosphorus exceeds the water quality criteria in the water mass of the Ottawa and Saint-Louis rivers.	Known
	Aquatic plants are very abundant and occupy approximately 25% of the surface area of Lake Saint-Louis.		Biological indicators: . chloro-phyll *a* . fish (Armellin et al., 1994)	Phosphorus levels have dropped throughout the Great Lakes-St. Lawrence drainage basin, but nitrates and nitrites have increased. Too many nutrients cause the proliferation of aquatic plants, thus increasing organic decomposition. When too large, aquatic plant communities are a nuisance to pleasure boaters and to the practice of recreational activities.	Known
b) Bacteria	Local sources of microorganism contamination of Lake Saint-Louis are municipalities, tributaries, and possibly cottaging and pleasure craft.	Yes	Raw water (MENVIQ, 1990a)	South shore of Lake Saint-Louis: In 1989 and 1990, the criterion was exceeded several times at the mouth of the Châteauguay River. However, there is no water intake pipe for domestic purposes located here.	Possible

Table 15 (cont'd)

Ecosystem components	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
b) Bacteria (cont'd)	The situation has probably improved since the treatment plants were commissioned in the Lake Saint-Louis region, particularly the ones in Châteauguay (1991) and L'Île-Perrot (1992).		Recreational activities (primary contact) MENVIQ, 1990a)	In 1989 and 1990, the criterion for swimming (primary contact) was exceeded at the mouth of the Châteauguay River; the criterion for recreational activities (secondary contact) was occasionally exceeded.	Possible
			Recreational activities (secondary contact) (MENVIQ, 1990a)	Practising recreational activities may pose a health risk.	
	Since 1988, most of the wastewater from Sainte-Anne-de-Bellevue has been drained into the MUC's north interceptor.			<u>North shore of Lake Saint-Louis:</u>Since the sewers of north shore municipalities were connected to the MUC's north interceptor in 1988, water quality has respected the criterion for swimming, except at Sainte-Anne-de-Bellevue.	Known
c) Contaminants	Local sources of contamination of Lake Saint-Louis by toxic substances are associated with industry, disposal sites, municipalities and tributaries.	Yes	Raw water (MENVIQ, 1990a) (Drinking water and eating aquatic organisms)	<u>Criteria-excedent levels</u> PCBs in tributaries; aluminum and BHCs at the mouth of the Saint-Louis River.	Possible Known
	Measures taken in recent years to clean up the water have reduced inputs of these substances to the environment.			The ingestion of untreated water and aquatic organisms may be harmful to health.	

Table 15 (cont'd)

Ecosystem components	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
Contaminants (cont'd)			Raw water (drinking water) (MENVIQ, 1990a)	Aluminum, iron and manganese exceeded the criterion at the mouth of the Saint-Louis River. Water must be treated before drinking.	
			Aquatic life (chronic toxicity) (MENVIQ, 1990a)	Aluminum, iron, copper and chromium at the mouth of the Saint-Louis River; lead in the Ottawa River. Physiological disorders can be observed in aquatic organisms.	
			Contamination of aquatic organisms (MENVIQ, 1990a)	BHCs amd mercury at the mouth of the Saint-Louis River. The consumption of aquatic organisms may be harmful to human health.	

Table 15 (cont'd)

Ecosystem components	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
2. Sediment					
a) Dynamics	The main sources of sediment are the Great Lakes and the Ottawa River. More locally, other tributaries with soil erosion (agriculture), industries and municipalities are also sources of suspended solids that may be deposited in Lake Saint-Louis. The wave action associated with shipping causes erosion of shores and transports sediment.	Maybe		. Fine sediment can choke spawning grounds and promote the proliferation of aquatic plants as well as transport contaminants. . Loss of shoreline stability and disturbance of aquatic habitats.	Probable
b) Contamination	Several sections of Lake Saint-Louis are contaminated: the mouth of the Saint-Louis River, south of the De la Paix islands, mouth of Bouchard Creek, south of Perrot Island and the northern end of the lake between Dowker Island and Valois Bay. There are many historic sources of contamination of sediment by toxic substances: sources upstream provide large loads; locally, contaminants may originate with industries or municipalities; tributaries and maritime transport also play a role.	Yes	Minimal Effect Threshold (MET) (SLC and MENVIQ, 1992)	The MET is exceeded in several areas due to large amounts of copper, mercury, lead and zinc, and more locally arsenic, cadmium, PCBs and PAHs. Fifteen percent of sediment-dwelling organisms may be affected.	Known

Table 15 (cont'd)

Ecosystem components	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
Contamination (cont'd)			Toxic Effect Threshold (TET) (SLC and MENVIQ, 1992)	Criteria exceeded due to the following substances: arsenic in Valois Bay; mercury south of the De la Paix islands; arsenic, mercury, PAHs and BHCs at the mouth of the Saint-Louis River: a high cadmium level at the mouth of Bouchard Creek. Toxic effects have been detected in most benthic organisms.	
3. Habitats	a) Productivity of habitats has been changed by significant human interference in the water regime.	Maybe		. Implementation of infrastructures to regulate water flow. . Existence of St. Lawrence Seaway. These changes to the environment caused the loss of deepwater habitats and changed the movements of migratory fish.	Probable
	b) Favourable fish habitat zone underwent the following physical modifications: . backfilling (123 ha) . drainage (17 ha) . dredging (130 ha) . dumping of dredged material (138 ha) . modification of water flow and backfilling (approximately 30 ha)		Marquis et al., 1988	All these modifications together caused a decrease in fish stocks, changes to the composition of populations and the filling in of troughs used by several fish species.	Known

Table 15 (cont'd)

Ecosystem components	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
Habitats (cont'd)	c) Disappearance of riparian habitats due to urbanization. Since the 1950s, approximately 1770 ha of aquatic environments have been disturbed.	Yes	MLCP, 1984b Marquis et al., 1988	. The north shore is an almost uninterrupted, highly artificial urban environment.	Known
			Jourdain et al., 1994	. Designated land use along 60% of the riverside area involves the degradation of banks. . Land use over 68% of the banks is urban.	
	d) Some riparian habitats have been disturbed:	Yes		Due to increased water levels in recent decades.	Probable
	. Forty percent of riparian forests in the De la Paix islands, in Châteauguay and on Saint-Bernard Island have been transformed into wet meadows or marshes.		Gratton, 1989		
	. In the De la Paix islands, 163 ha of healthy forests and 37 ha of scrubland have been lost and replaced by 96 ha of marshes and wet meadows.		Jean et al., 1992	In the De la Paix islands, the net loss of wetlands has been 104 ha, or 21% of the total surface area.	
	e) The De la Paix islands are receding at a rate of approximately one metre per year.		Ducks Unlimited, 1985	The northern part of the De la Paix islands is being eroded by waves, ice and wave action caused by ships.	Possible

Table 15 (cont'd)

Ecosystem components	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
Habitats (cont'd)		Yes	Toxic Effect Threshold (TET) SLC and MENVIQ, 1992	In sediment, several metals, PAHs and BHCs exceed the criteria in places. Metals and organochlorines can be seen in aquatic organisms, especially around the De la Paix islands and in Beauharnois.	
		Yes	Protection of aquatic life, (IJC, 1987)	Mercury in the flesh of fish and PCBs in the flesh of Lake sturgeon exceed the criteria. Mercury in molluscs exceeds the criterion.	
		Yes	Poultry marketing standards (Government of Canada, 1971)	DDT, chlordane and PCBs in Peking Duck exceed standards.	

Table 15 (cont'd)

Ecosystem components	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
Habitats (cont'd)	f) Several islands are already protected, but other natural riparian spaces are threatened by urban development.		RCM development plans	Land use designations do not always acknowledge the importance of habitats.	Known
			Armellin et al., 1994 Jourdain et al., 1994	. Thirty percent of the total area of important wildlife habitats is set aside for conservation and is concentrated on islands. . Forty percent of the total surface area of important wildlife habitats is slated for urbanization.	
	g) All wildlife habitats are threatened.	Maybe		Risk of accidental oil or chemical spills from ships or storage sites in the Beauharnois industrial zone.	Possible
	h) Toxic substances are found throughout the ecosystem.	Yes	Aquatic life (chronic toxicity) MENVIQ, 1990a	In water, copper, iron, aluminum, chromium and lead exceed the criteria in places.	Known

Table 16
Uses: Assessment of present state

Uses	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
1. Water supply					
a) Municipalities	Ten filtration plants supply 14 municipalities (some 200 000 people).	Yes	Raw water (MENVIQ, 1990)	Aluminum at the mouth of the Saint-Louis River (health); fecal coliform bacteria (treatment costs). Iron and manganese at the mouth of the Saint-Louis River (aesthetic). There is no water intake for domestic purposes at this location.	Known
		Maybe		The Zebra mussel now found in Lake Saint-Louis may damage water pipes.	Probable
2. Commercial fishing	Between 1960 and 1986, the number of licence holders dropped from 65 to 5. Landings: 55 962 kg in 1989. Average value of catch increased by 26% between 1986 and 1988. Value of landings: $215 462 in 1989.	Yes	Contamination of aquatic organisms (MENVIQ, 1990a)	In water, BHCs and mercury exceed the criteria at the mouth of the Saint-Louis River.	Known

Table 16 (cont'd)

Uses	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
Commercial fishing (cont'd)	In 1981, 15 bait-fishing holders.		Protection of aquatic life (IJC, 1987)	Mercury levels measured in 1989 in the flesh of fish exceeded the criterion. PCB levels in the flesh of Lake sturgeon exceeded the criterion.	
			Fish marketing standards (Health and Welfare Canada, 1985)	In 1989, mercury contamination was seen in all species of sport fish. The standard was exceeded in large specimens, especially Northern pike and Walleye caught around the De la Paix islands. In 1992, mercury levels in the flesh of Yellow perch were below the standard.	Known
3. Trapping	In the 1970s, there were about 50 trappers. 1986-1987: 62 trappers, 6459 skins. 1989-1990: 15 trappers, 488 skins.	No		The amount of trapping done depends on the price of fur, which is in turn influenced by anti-trapping campaigns, the farming of fur-bearing animals and the state of the economy.	Known

Table 16 (cont'd)

Uses	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
4. Commercial shipping	Since the St. Lawrence Seaway opened in 1959, over 1.2 billion tonnes of freight has passed through it. Each year, 3.2 million tonnes of petroleum products transit between Montréal and Lake Ontario.	Maybe		The intensity of traffic and navigational difficulties of the river heighten the risks associated with accidental chemical spills.	Known
5. Recreation and tourism					
a) Swimming	In 1978, there were seven public beaches. In 1992, none of the beaches was registered under MENVIQ'S Environnement-plage program. Swimming is still popular at Lake Saint-Louis. The bacteriological quality of the water has probably improved since the water treatment plants opened on Lake Saint-Louis, especially those in Châteauguay (1991) and L'Île-Perrot (1992).	Yes	Recreational activities (primary contact) (MENVIQ, 1990a)	<u>South shore (1989-1990)</u> At the mouth of the Châteauguay River, the health criterion was exceeded on a number of occasions (200 f.c./100 mL). <u>North shore</u> The quality of swimming water on the north shore of Lake Saint-Louis has improved since 1988, when sewers of north shore municipalities were connected to the MUC's north interceptor. Water meets the health criterion, except off Sainte-Anne-de-Bellevue (1986 to 1988).	Possible

Table 16 (cont'd)

Uses	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
b) Boating	Main recreational activity on Lake Saint-Louis. In 1981, 7383 motor and sail boats counted represented 80% of the fleet in the Montréal archipelago. In 1984, 65% of boating facilities were located on the north shore.	Yes	Recreational activities (secondary contact) (MENVIQ, 1990a)	The health criterion (1000 f.c.bacteria/100 mL of water) was exceeded at some stations: Sainte-Anne-de-Bellevue (1986 to 1988) and at the mouth of the Châteauguay River (1989 and 1990).	Possible
			Jourdain et al., 1994	Restrictions on access to water . Two percent of the accommodation capacity accessible to the general public in 1984. . Polarization of infra-structures on the north shore.	
c) Sport fishing	Lake Saint-Louis has the greatest fishing pressure in Québec: in 1985, 609 000 fisher/days. Approximately 63% of fishing effort is expended on fishing in open water and 37% on ice fishing.	Yes	Contamination of aquatic organisms (MENVIQ, 1990a)	In the water, BHCs and mercury exceeded the criteria at the mouth of the Saint-Louis River.	Known
			Protection of aquatic life (IJC, 1987)	Mercury levels measured in 1989 in the flesh of fish exceeded the criterion. PCB levels in Lake sturgeon flesh exceeded the criterion.	Known

Table 16 (cont'd)

Uses	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
Sport fishing (cont'd)	Ice fishing is very popular: 50 000 fishers on Lake Saint-Louis and Lake des Deux Montagnes in 1985. Value of expenditures: $495 per fisher; $35 per fishing day.		Fish marketing standards (Health and Welfare Canada, 1985)	In 1989, mercury contamination was observed in all species of sport fish. The standard was exceeded among large specimens, mainly Northern pike and Walleye caught around the De la Paix islands. In 1992, mercury levels in the flesh of Yellow perch were below the standard.	Known
			Guide de consommation du poisson de pêche sportive en eau douce (MSSS and MENVIQ, 1993)	Consumption restrictions depending on species and specimen size. Special measures should be taken by people in risk groups. <u>Recommended consumption</u> - Most consumers: Two to eight meals per month, depending on species and size. - Pregnant women: Only the least contaminated species, such as Yellow perch, and a maximum of eight meals per month.	

Table 16 (cont'd)

Uses	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
d) Waterfowl hunting	In the Montréal region, Lake Saint-Louis and Lake des Deux Montagnes are subject to the greatest hunting pressures. Lake Saint-Louis is rated ninth in terms of the St. Lawrence as a whole: 15 000 birds taken on average each year (1977 to 1981).	Maybe	Poultry marketing standards, (Government of Canada, 1971)	Accumulation of DDT, chlordane and PCBs in the muscles of Peking Duck. Concentrations above standards.	Possible
e) Natural heritage and outdoor recreation	A few sites of interest to tourists. Excursions/cruises: 3 tours Growing interest in bird-watching.	Yes	MLCP, 1984a	. Tourism potential is under-developed and there is no integrated system. . Bird-watching sites are concentrated on the south and west shores.	Known
f) Cottaging	On Lake Saint-Louis, cottaging is decreasing as second residences are becoming permanent residences.	Maybe	RCM development plans Urban development plans	This conversion has been the cause of secondary development axes.	Possible
g) Quality of riparian environment	The "natural" landscapes that contribute to the quality of life of riverside residents and visitors to the area are not very common.	Yes	Shoreline degradation (Jourdain et al., 1994)	. Some 60% of riverside land use leads to the degradation of banks, especially along the north shore (residential, industrial, commercial and cottaging areas).	Known

Table 16 (cont'd)

Uses	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
Quality of riparian environment (cont'd)	Landscape types: . 3% natural shoreline . 29% rural shoreline . 68% urban shoreline.		Visual quality of riparian landscape (Jourdain et al., 1994)	. Deteriorating quality of the riparian environment by pollution, causing unsightly mess and unpleasant smells.	Known
h) Accessibility	Limited public access: A few ribbon parks or service infrastructures along the river.	Yes	Privatization index (Jourdain et al., 1994)	Privatization (60% of shores) is a major obstacle to public access to the water.	Known

Table 17
Biological resources: Assessment of present state

Biological resources	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
1. Fish					
a) Commercial interest	Main species commercially fished: Lake sturgeon (90%), Carp, Sunfish and Brown bullhead.	Yes	Marquis et al., 1991	Lake sturgeon: Subjected to unfavourable environmental conditions.	Probable
			Dumont et al., 1987	Lake sturgeon is heavily fished and poached.	Known
	Bait fish: Fishing at Lake Saint-Louis is above the average recorded in the Montréal area.				
b) Sport interest	Sport fish catches are good. Species fished for are Yellow perch (65%), Northern pike (17%) and Walleye (7%). Yellow perch is also the fish caught most often in winter.	No		The populations of these three species can withstand the pressure of intense fishing.	Known
	Muskellunge needs to be stocked.	Yes		Natural reproduction cannot withstand the level of sport fishing.	Known

Table 17 (cont'd)

Biological resources	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
2. Other species					
Great Blue Heron	Large colony on Dowker Island.	Yes		. Drop in the numbers of breeding pairs in 1992 which may be the result of human disturbance. . The Saint-Bernard Island colony has been abandoned since 1980.	Probable
Ring-billed Gull	Large colony at the base of the Beauharnois power station and other flocks along the lakeshore.	No	Environment Canada, CWS, 1992	The availability of food and garbage in urban centres causes the proliferation of gulls.	Known
Zebra mussel	The Zebra mussel has been seen in Lake Saint-Louis since 1990.	No	O'Neil and MacNeill, 1989	The dumping of ballast water by a European ship in shipping waters introduced the Zebra mussel into the Great Lakes; it is now found in Lake Saint-Louis. Because of its rapid proliferation, the Zebra mussel can clog water pipes and upset the balance of ecosystems.	Probable

Table 17 (cont'd)

Biological resources	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
3. Rare and threatened species					
a) Plants	Forty species of plants are considered to be vulnerable or threatened.	Yes	Lavoie, 1992		Known
			Argus and Pryer, 1990	Eight species are rare in Canada.	
			Gratton and Dubreuil, 1990	Twenty-eight species have been targeted for protection along the St. Lawrence.	
	Rare plant community.	Yes	Gratton and Dubreuil, 1990	*Bromus pubescens* community.	
b) Fish	Two species of fish have been designated as vulnerable in Canada.	Yes	COSEWIC, 1993	River redhorse*: Vulnerable. Copper redhorse: Threatened.	Known
	Three species have been designated as at risk.	Yes	Robitaille and Choinière, 1989	Lake sturgeon*, American shad*, American eel, because of reduced accessibility to breeding grounds. Contaminants found in organisms.	Known
			Dumont et al., 1987	Lake sturgeon is heavily fished and poached.	Known

Table 17 (cont'd)

Biological resources	*Description*	*Limitations*	*Reference criteria*	*Nature of problem and stresses*	*Diagnosis*
c) Birds	Ten species are on the list of birds threatened in Québec.	Yes	Robert, 1989	Vulnerable: Grasshopper Sparrow, Least Bittern*, Cooper's Hawk, Peregrine Falcon*, Horned Grebe*, Sedge Wren*, Yellow Rail*. Endangered: Caspian Tern*, Loggerhead Shrike. Threatened: Bald Eagle*.	Known
d) Reptiles	Four species are on the list of species targeted under the Action Plan.	Yes	Bouchard and Millet, 1993	Map turtle, Northern watersnake, Spiny softshell, Brown snake.	Known

* Species also included on the Action Plan list of target species (Bouchard and Millet, 1993).

Table 18
Definitions of terms used to assess the problems of a ZIP

A. Losses or limitations (third column)

Yes:	— The applicable criterion has been exceeded. — Losses or limitations have already been observed.
Maybe:	— The loss or limitation has not been measured in the ZIP but analogous situations have been documented elsewhere along the river.
No:	— The applicable criterion has been met. — No loss or limitation has been observed.

B. Diagnosis (far right-hand column)

Known:	— Existing information on the nature of the problem allows us to determine a link between the nature of the problem and the loss or limitation observed.
Probable:	— Existing information on the nature of the problem does not allow us to determine a link with the loss or limitation observed. Studies on the subject are under way.
Possible:	— What little information is available on the nature of the problem does not allow us to determine a link with the loss or limitation.

CHAPTER 6 Conclusion

The problems particular to ZIPs 5 and 6 (Lake Saint-Louis) were identified on the basis of available knowledge. Unpublished data gathered under a number of St. Lawrence Action Plan intervention programs will complete the assessment.

The results of this analysis therefore represent the shared vision of Action Plan partners: the ministère de l'Environnement du Québec (MENVIQ), the ministère du Loisir, de la Chasse et de la Pêche (MLCP), and Environment Canada worked closely together to exchange information and to develop this paper.

The list of problems will be submitted for consultation with the people living along the river, first to verify and, as needed, add to this summary of knowledge, then to prioritize the problems on the list that require special attention. This exercise should lead to the development and implementation of local action plans. This report is being submitted as a discussion paper and as a contribution of the Action Plan to the public process of local-level co-operation.

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