REGIONAL ASSESSMENT
LAKE OF TWO MOUNTAINS SECTOR

Regional Assessment
Lake of Two Mountains Sector

Priority Intervention Zone 24

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Edited by Alain Armellin and Marie-José Auclair
St. Lawrence Centre
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NOTICE TO READERS

Reports on Priority Intervention Zones (ZIPs) are published as part of the St. Lawrence Vision 2000 Action Plan by the St. Lawrence Centre, Environment Canada, in conjunction with Fisheries and Oceans Canada, Health Canada, the Ministère de la Santé et des Services Sociaux and its partners, and the Ministère de l'Environnement du Québec.

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Preface

In April 1994, the governments of Canada and Quebec agreed to carry on the work of the St. Lawrence Action Plan, approving a five-year program (SLV 2000) extended in 1998 until 2003.

The goal of St. Lawrence Vision 2000 (SLV 2000) is to conserve and protect the St. Lawrence River and the Saguenay River so that people living along their shores can reclaim use of these rivers in a manner compatible with sustainable development.

The Priority Intervention Zones program — better known by its French acronym ZIP (zones d'intervention prioritaire) *— is a major element of the Community Involvement component of the St. Lawrence Vision 2000 Action Plan.*

Through the ZIP program, riverside communities are invited to play an active part in achieving the objectives aimed at restoring the St. Lawrence and Saguenay rivers.

The program enables various community partners, non-governmental organizations and citizens committees to work together to identify common priorities for the conservation and restoration of the St. Lawrence River.

We are pleased to present this assessment report on the uses, resources and main environmental problems specific to this area. It has been prepared using all the data available from the various federal departments and provincial ministries involved in SLV 2000.

We hope it will prompt a more enlightened debate based on information that is as objective as possible, and that the debate will help the different partners involved to draw up and implement an action plan for the restoration of the area in question.

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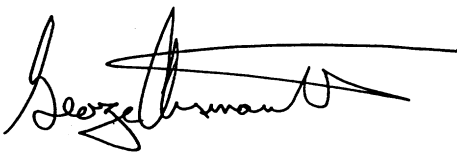

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Management Perspective

The Priority Intervention Zones (ZIP) program is a federal-provincial initiative involving stakeholders and shoreline communities in implementing measures to restore the St. Lawrence River. The program has three phases: producing a regional assessment report on the state of a specific area of the St. Lawrence, consulting shoreline partners in setting priorities for action, and developing an ecological rehabilitation action plan (ERAP).

The regional assessment is a synthesis of four technical reports on the biological, physico-chemical, socio-economic and public health aspects of the study area, prepared by the federal and provincial partners of the St. Lawrence Vision 2000 Action Plan as part of its Community Involvement component.

The process of gathering and analysing data area by area has never before been undertaken for the entire St. Lawrence. The technical reports go a step further, assessing our knowledge of the current state of a given area based on known quality criteria.

The challenge, then, is to offer a scientific opinion based on the available information. The pitfalls are numerous: the data were collected for other purposes, the geographic and temporal coverage is less than ideal, and the chemical analysis methods are not standardized, to name but a few.

The ZIP team remains nonetheless convinced that an enlightened and thoughtful overview of each study area can be presented without further delay. This initial assessment is therefore intended as a discussion paper that will serve as a starting point for the shoreline partners in each study area.

Perspective de gestion

Le programme des Zones d'intervention prioritaire (ZIP) relève le défi de la concertation entre les gouvernements fédéral et provincial et de l'implication communautaire des partenaires riverains, en vue de mettre en œuvre des mesures de réhabilitation du Saint-Laurent. Ce programme comporte trois grandes étapes, soit l'élaboration d'un bilan environnemental sur l'état du Saint-Laurent à l'échelle locale, la consultation de partenaires riverains, avec l'identification de priorités d'intervention, et l'élaboration d'un plan d'action et de réhabilitation écologique (PARE).

Un bilan régional est établi à partir d'une synthèse des quatre rapports techniques portant sur les aspects biologiques, physico-chimiques, socio-économiques et sur la santé humaine du secteur étudié. Ces rapports sont préparés par les partenaires fédéraux et provinciaux du Plan d'action Saint-Laurent Vision 2000, dans le cadre du volet Implication communautaire.

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

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.

L'équipe de travail ZIP demeure convaincue qu'il est possible de poser, sans plus attendre, un regard éclairé et prudent sur chaque secteur. Cette première évaluation constitue un point de départ et un document de base rédigé à l'intention des partenaires riverains de chaque secteur d'étude.

Abstract

The Lake of Two Mountains–Des Prairies River and Mille Iles River study area has been divided into two Priority Intervention Zones, called ZIPs 24 and 25. Although the Lake of Two Mountains sector (ZIP 24), dealt with in this assessment, is not situated on the St. Lawrence River proper, it borders the lower reaches of its primary tributary, the Ottawa River. This 162-km^2 lake near Montreal has its source in the Ottawa River, whose brown waters differ chemically from the green waters that flow from the Great Lakes into the St. Lawrence River.

The lake's natural habitats have not been altered as much by human activities as have the other water bodies near the Island of Montreal. The wetlands feature some unique and precious components, notably the flora.

Most of the land in the area is given over to agriculture. The lake, which is very well suited for pleasure boating and water-related activities, has long been a popular site for vacationers. Many municipalities in the eastern part of the lake originated as vacation spots and gradually became suburbs of Montreal. Expansion of this large urban centre has resulted in numerous encroachments on natural habitats, especially close to the water body.

In the past, water quality in the Lake of Two Mountains was impacted by forestry and agricultural activities, as well as by effluents from the pulp and paper companies operating in the Ottawa River watershed. Along the shores, local degradation of water quality could be observed around the discharge points of municipal effluents and at the mouths of tributaries which drain agricultural lands and urban areas. In the early 1950s, oxygen deficiencies in the wintertime caused mass mortalities of resident fish populations. Most of the species have since recovered, except for Lake Sturgeon, a long-lived fish species whose population still shows negative effects, in its age structure. Over the past 20 years, water quality has improved considerably. Only the phosphorus levels still occasionally exhibit exceedances of the criterion established to prevent eutrophication.

The natural habitats of the Lake of Two Mountains have not been studied to any great extent. Efforts should be made to fill the existing knowledge gaps as soon as possible, so that unique and fragile environmental components can receive suitable protection.

Résumé

Le secteur d'étude Lac des Deux Montagnes – Rivières des Prairies et des Mille Îles a été divisé en deux zones d'intérêt prioritaire, soit les ZIP 24 et 25. La portion Lac des Deux Montagnes (ZIP 24) dont traite ce bilan n'est pas située le long du fleuve Saint-Laurent même, mais dans le cours inférieur de son affluent le plus important, la rivière des Outaouais. Ce lac de 162 km^2, situé aux abords de la métropole, est alimenté par les eaux brunes de la rivière des Outaouais dont les caractéristiques chimiques diffèrent de celles des eaux vertes des Grands Lacs et du Saint-Laurent.

Les milieux naturels autour du lac ont été moins altérés par les activités humaines que ceux des autres plans d'eau qui baignent l'archipel montréalais. Les milieux humides du lac des Deux Montagnes possèdent encore des éléments d'un grand intérêt, notamment au plan floristique.

Les terres avoisinantes servent surtout à la production agricole. Le lac, particulièrement propice à la navigation de plaisance et aux activités nautiques, est depuis de nombreuses années un site très fréquenté par les estivants. Plusieurs municipalités de la partie est du lac ont d'abord été des lieux de villégiature, et sont devenues peu à peu des banlieues de Montréal. L'expansion urbaine a ouvert la voie à de nombreux empiétements sur les habitats naturels, particulièrement aux abords du plan d'eau.

La qualité des eaux du lac des Deux Montagnes a été affectée dans le passé par l'activité forestière et agricole, de même que par les effluents des papetières établies dans le bassin de la rivière des Outaouais. Le long des rives du lac, on pouvait aussi observer des dégradations locales aux points de déversements d'effluents municipaux, et à l'embouchure des affluents drainant des territoires agricoles et des zones urbaines. Au début des années 1950, un phénomène d'anoxie hivernale a causé une mortalité massive des populations de poissons résidentes. La plupart des espèces se sont rétablies depuis, sauf l'Esturgeon jaune, poisson longévif dont la population montre encore aujourd'hui, dans sa structure d'âge, les séquelles de cet événement. Au cours des vingt dernières années, la qualité de l'eau s'est considérablement

améliorée. Seules les teneurs en phosphore présentent encore, à l'occasion, des valeurs dépassant le critère établi pour éviter l'eutrophisation.

Les milieux naturels du lac des Deux Montagnes ont été relativement peu étudiés. Les lacunes, à cet égard, auraient avantage à être comblées le plus tôt possible afin que les éléments uniques ou fragiles de l'environnement puissent être adéquatement protégés.

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CHAPTER 1 The St. Lawrence, Then and Now

For the great majority of Quebecers, the mere mention of the St. Lawrence evokes a deep-rooted feeling of belonging to the land traversed by these waters on their way from the Great Lakes to the sea. The pictures that spring to mind are those of a mighty river, fertile plains on either side, shady banks, and rich wildlife.

The country was born on the banks of the river, as can still be seen today by the division of land — a vestige of the seigneurial system. In those days, people had to learn to live with the whims of the St. Lawrence, including spring flooding. In return, it provided the European settlers, still struggling with unreliable harvests, with a sure supply of fish and a crucial means of communication linking the first towns and villages that grew up along its banks.

With time, forests gave way to farmland, and then towns and cities sprang up. Until that point, the low population density and the very size of the St. Lawrence meant that human uses of the river had had virtually no impact on its resources. But things would soon change. The first major impact seems to have been caused by logging and the beginnings of industrialization, in the 19th century; this included the floating of timber down the Ottawa River and the St. Lawrence to Quebec City, the building of dams and sawmills along tributaries, and the construction and commissioning of the first hydro-electric power plants.

The pace of change accelerated in the 20th century, with the construction of major dams on the St. Lawrence, controlling its flow, shipping channels and then the St. Lawrence Seaway. More and more industries were established near towns, often right on the river. The proximity of the waterway offered several advantages: it reduced the cost of transporting raw materials, solved water supply problems and provided an easy way of getting rid of waste.

The St. Lawrence gradually succumbed to these numerous onslaughts. A few informed observers noted that some animal populations were declining and suggested that the reason was habitat degradation. Their warnings aroused little public interest, however.

Public awareness was sharply raised in the early 1970s with the realization that mercury contamination of fish was not just an abstract research topic, but a real risk to which some Native people and many sport fishers were exposed. As the list of toxic substances reported in the aquatic environment continued to grow, the general public changed its perception and put environmental quality at the top of its list of priorities. There is virtually unanimous agreement now that the comforts afforded by an industrial society have a drawback: unbridled exploitation of resources and increasing levels of contaminants will eventually threaten all forms of life, including human beings.

Most industrialized countries have now agreed to base their economies on sustainable development. The profit motive alone can no longer govern human activity. Given the fragile nature of our environment and the limitations of our planet, sustainable economic development must ensure that scarce resources are used for a variety of purposes; it must also take into account the quality of life of human beings and promote the maintenance of biological diversity.

CHAPTER 2 The ZIP Program

Starting in the 1960s, growing public awareness of the degradation of the Great Lakes and the St. Lawrence and Saguenay rivers, along with the urgency of the situation, prompted governments to take substantive joint action. This paved the way for the 1972 *Great Lakes Water Quality Agreement*. A 1987 amendment added a local use restoration program (Remedial Action Plan, RAP). In 1988, the eight American states concerned and the provinces of Ontario and Quebec signed the *Great Lakes Charter* and an agreement to control toxic discharges into the Great Lakes Basin. In response to the poor quality of the waters of the St. Lawrence and its tributaries, the Quebec government launched its wastewater treatment program (PAEQ) in 1978.

In 1989, the federal and Quebec governments decided to combine their efforts under the St. Lawrence Action Plan, which was renewed in 1994 as St. Lawrence Vision 2000 (SLV 2000). In 1998, the plan was extended until 2003 and renamed the *St. Lawrence Vision 2000 Action Plan, Phase III.* One of the objectives of this action plan is to prepare a comprehensive state-of-the-environment report on the Quebec portion of the St. Lawrence River. Under the Priority Intervention Zones Program, the St. Lawrence and two of its main tributaries — the Ottawa and Saguenay rivers — were subdivided into 25 sectors, or ZIPs, combined into 13 study areas (Figure 1). The aim is to encourage community stakeholders to work together locally to restore and protect aquatic and riparian habitats and to harmonize use of the river.

In preparation for consultations, a state-of-the-environment review is conducted by the partners for each study area, and the findings are compiled in four technical reports.[1] This report summarizes these findings to provide an overall assessment of the resources, present and potential uses, and associated constraints of the Lake of Two Mountains (ZIP 24) sector of the study area, the other being the Des Prairies River and Mille Iles River portion (ZIP 25).

[1] The technical reports deal with the physico-chemical aspects of the water and sediments (Fortin, 1999), the biological communities (Armellin and Mousseau, 1999), socio-economic aspects (Jourdain et al., 1999), and human health issues (Chartrand et al., 1999).

The document is intended above all for stakeholders of this segment of the St. Lawrence, and summarizes the main points of the available scientific and technical literature with the aim of allowing them to participate actively in the discussions and in the process of defining priorities for action.

The information presented here should provide the foundation for a common vision of the situation in the study area, thereby paving the way for concerted action by the partners.

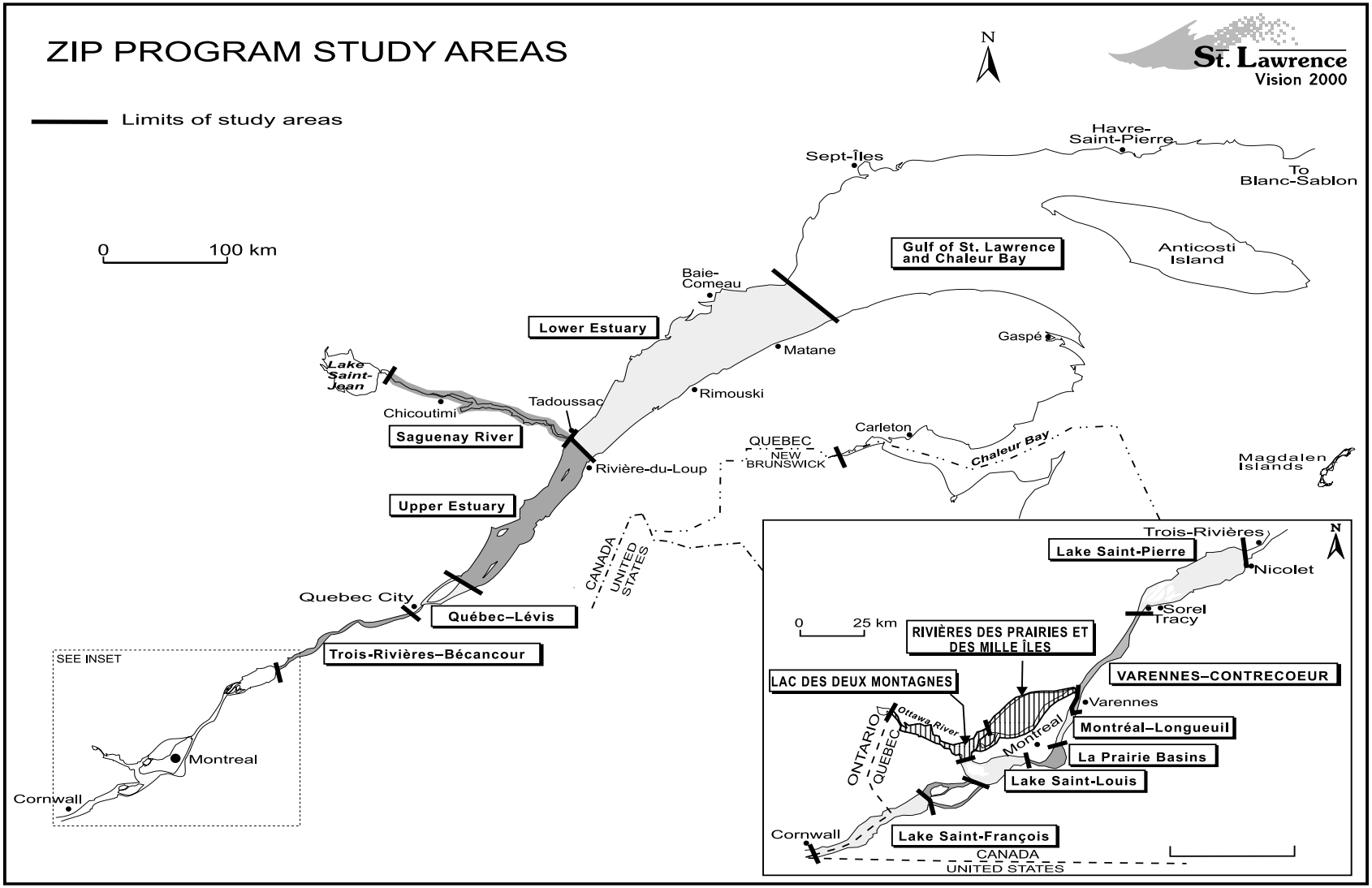

Figure 1 **ZIP Program study areas**

CHAPTER 3

Characterization of the Sector

At the end of the last ice age, several thousand years ago, southern Quebec and Ontario were covered by a major inland arm of the sea. As the ice receded, the Earth's crust gradually rebounded, exposing some land areas and isolating salt water in the huge basins that now form the Great Lakes.

Over thousands of years, the river carved out its bed in the unconsolidated deposits and clay that settled at the bottom of the former inland sea. This fertile plain, known as the St. Lawrence Lowlands, is bounded by the Canadian Shield to the north and by the Appalachian Mountains to the south.

The sector of interest here, the Lake of Two Mountains section of the study area, is not part of the St. Lawrence River proper. Instead, it is located on the lower reaches of its largest tributary, the Ottawa River. The waters of Lake of Two Mountains, which is a widening of the Ottawa River, exit through five different outlets before joining the St. Lawrence (Figure 2). Part of the flow re-enters the St. Lawrence near Lake Saint-Louis, via the Vaudreuil and Sainte-Anne-de-Bellevue canals; the rest flows through the Mille Îles River or the Des Prairies River, on either side of Ile Bizard.

The distinguishing feature of this part of the sector is undoubtedly its water mass, which differs markedly from the Great Lakes water mass that joins the upper part of the St. Lawrence (see Section 3.1). The chemical properties of this water mass have numerous repercussions on the characteristics and composition of aquatic and riparian communities (see Section 3.2).

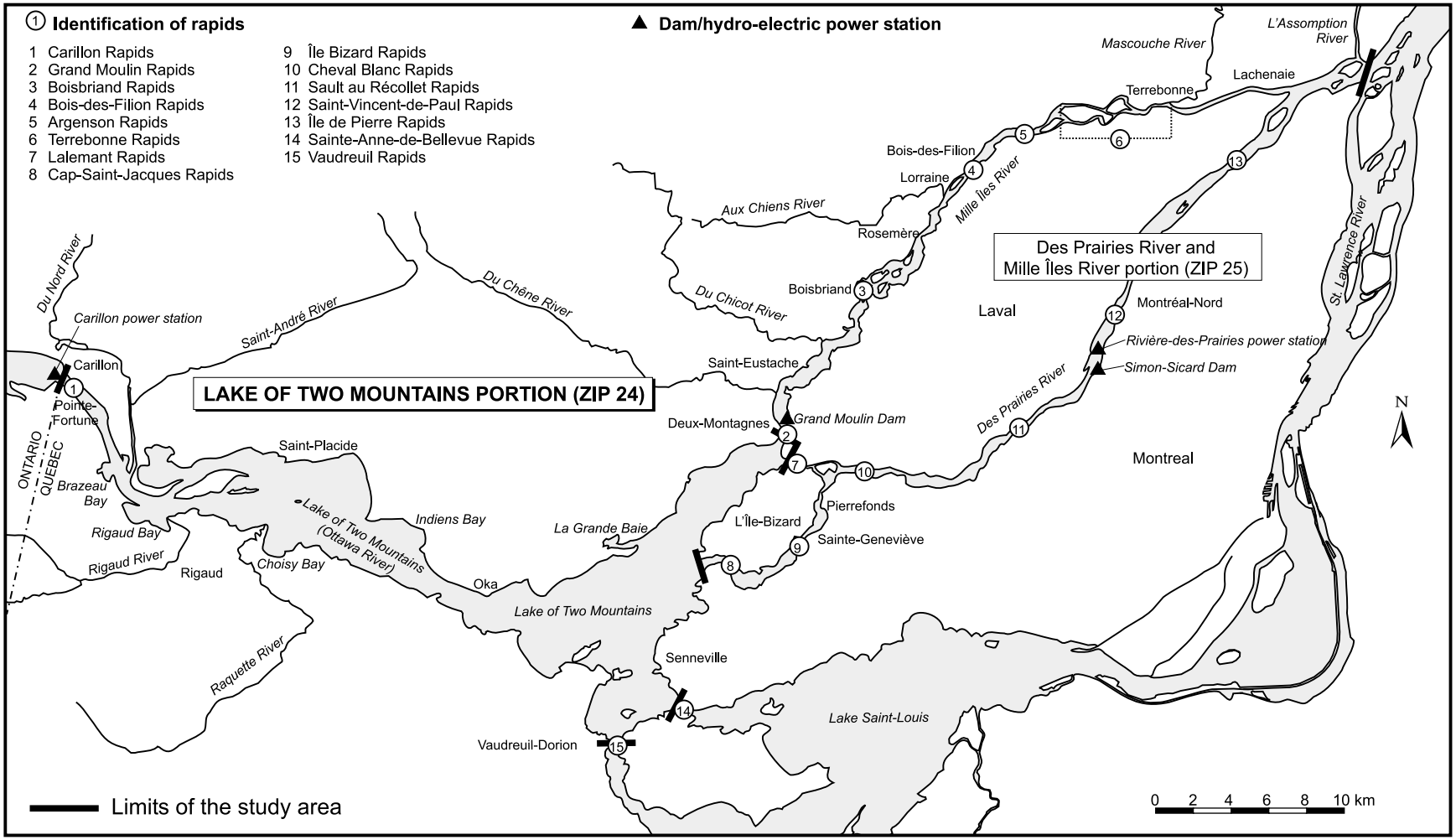

Figure 2 Lake of Two Mountains sector (ZIP 24) of the study area

3.1 Physical Environment

The Ottawa River is the main tributary of the St. Lawrence in the area between the Great Lakes and Quebec City. This tributary's mean annual discharge, 1940 m³/s at Carillon, is equal to about 16% of the discharge of the St. Lawrence near Quebec City[1].

The magnitude of the discharge from the Ottawa River is related to the surface area of its drainage basin; the waters that flow into Lake of Two Mountains are captured from an area of 146 344 km², most of which (63%) is located in Quebec[2]. This hinterland is sparsely populated; forests occupy 86% of the drainage basin and major water bodies (lakes or reservoirs) roughly 12%.

Although the Lake of Two Mountains part of the study area is situated near the St. Lawrence and likewise traverses the St. Lawrence Lowlands, it stands apart owing to the physical and chemical properties of the Ottawa River waters, which are closely linked to the drainage basin's geology. Most of the basin lies on the Canadian Shield, which is basically exposed bedrock from the Precambrian Era. These rocky formations have been covered in some areas by unconsolidated deposits transported by the glaciers of the Quaternary. The mineral particles released through the erosion of ancient rocks and glacial deposits contribute a major portion of the suspended load transported by the Ottawa River. Runoff causes leaching of organic acids (humic and fulvic acids) from the acidic soils (podzols) of the boreal forest and the extensive wetland habitats (peatland, marshes and swamps), and these acids give the watercourses of the Canadian Shield region a typical brownish tinge. Near the Montreal archipelago, the brown waters of the Ottawa River meet the green waters of the Great Lakes[3].

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1 In comparison, the inflow from the Great Lakes accounts for 61% of the mean discharge at Quebec City.

2 In Quebec, the main tributaries of the Ottawa River in terms of sub-basin area are the Gatineau (23 724 km²), Lièvre (9583 km²), Kipawa (6609 km²), Rouge (5543 km²) and Coulonge (5232 km²) rivers. The principal tributaries in Ontario are the Madawaska (8210 km²), Montreal (6605 km²) and Blanche (5115 km²) rivers.

3 The water from the Great Lakes contains more minerals and is more conductive and less turbid (cloudy) than that in the Ottawa River.

The flow of the Ottawa River is partially regulated by means of control works located within its drainage basin[4]; electricity generation during the winter provides inputs of water to the river from several reservoirs (Baskatong, Cabonga, Dozois, Decelles and a few others). During spring flood, which takes place in April, the discharge of the Ottawa River may be twice the mean annual rate, even quadrupling in exceptional cases[5]. Low water conditions (the lowest water levels) generally occur at the end of the summer.

Besides the Ottawa River, a few small tributaries empty into Lake of Two Mountains. The Rivière du Nord contributes a flow of about 42 m³/s (mean annual discharge); the other watercourses contribute less than 15 m³/s collectively.

The lake itself covers an area of about 160 km², including Vaudreuil Bay (Figure 2). While the lake is mostly shallow (2 to 6 m), its central trough reaches a depth of 14 m. Water flows out of the lake to the St. Lawrence River through five outlets. The Vaudreuil and Sainte-Anne-de-Bellevue canals discharge part of the flow into Lake Saint-Louis (335 and 550 m^3/s, respectively, on average annually); the Cap Saint-Jacques and Lalemant rapids, located on either side of Ile Bizard, drain into the Des Prairies River (1100 m^3/s); finally, the Mille Îles River (200 m^3/s), which begins at the Grand Moulin rapids, joins the Des Prairies River some 40 km farther downstream. The lake is dotted with 62 islands, comprising a total area of 662 ha; the largest is Carillon Island (397 ha).

The water's ability to transport, or entrain, particles depends essentially on current speed. Spring flood — the period of maximum runoff and erosion — has a decoupling effect on the load of suspended solids (SS) in the waters of the Ottawa River, near Carillon[6]. Nearly 600 000 tonnes of sediments enter the lake each year, with about 50 000 to 60 000 t of this total being deposited in the deepest section.

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[4] Management of control works is co-ordinated by a special committee (*Comité de Régularisation de la rivière des Outaouais*) in order to regulate flood and low water periods.

[5] The extreme discharge values recorded at Carillon between 1962 and 1989 were 8190 m^3/s for the flood period (April 4, 1976) and 306 m^3/s for the low water period (September 7, 1971).

There are few zones where fine particles accumulate on the shores of the lake[7]. In bays exposed to the wind, wave action may stir up the bottom sediments, particularly during the period when the aquatic vegetation is not well developed. Some shoreline areas undergo erosion, notably in the vicinity of Saint-Placide.

3.2 Biological Environment

At present, the sector offers a mosaic of agricultural and urban landscapes. In many spots, the natural habitats are quite intact despite their proximity to Montreal.

3.2.1 Vegetation and habitats

In southern Quebec, the plant associations that tend to become established in the clay soils of the St. Lawrence Valley in the absence of significant human activity are maple–hickory or maple–linden stands. However, since human activity has played a major role in shaping much of the study area, the plant communities have not evolved toward those associations in most of the sector.

The lands bordering the Lake of Two Mountains, which had been cleared long before to make way for crops, were impacted by Montreal's expansion, particularly during the second half of the 20th century.

Although the extensive virgin forests have long since disappeared, some islands, being less accessible than other areas, have retained remnants of their original plant communities. The shoreline vegetation has been altered by humans and in some cases displaced completely by artificial structures (wharves, retaining walls, rockfill). However, a few remnants of the original plant communities subsist, providing an indication of what the riparian habitats were like in their natural state.

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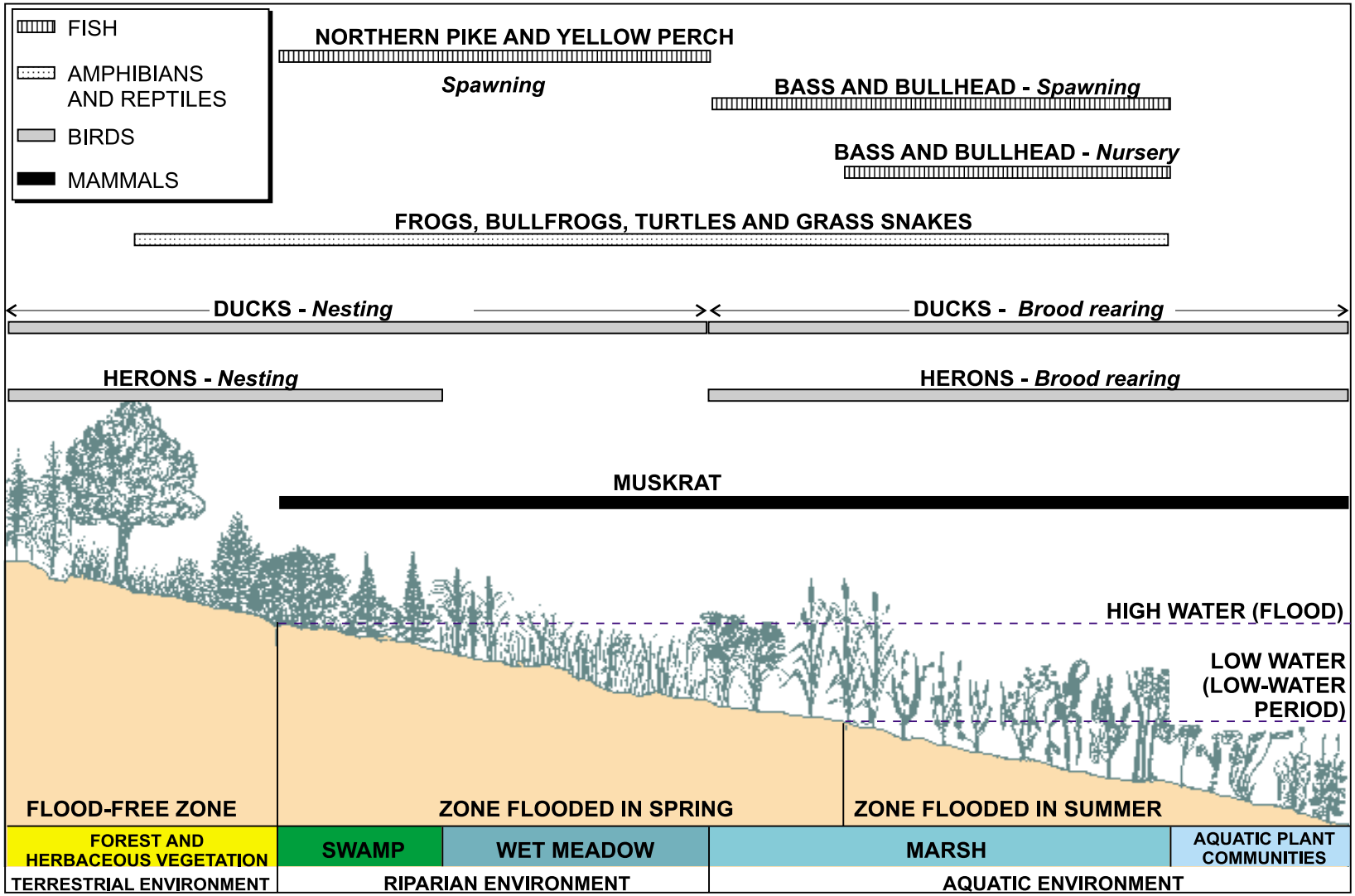
[6] SS loads of nearly 100 mg/L are sometimes recorded at Carillon in the spring (April), whereas the values obtained during the rest of the year are usually lower than 10 mg/L.

Wetlands, which border bodies of water, are crucial habitats for wildlife and plants (Figure 3). Their importance in maintaining biological diversity is widely recognized today. This term designates a variety of habitat types associated with the presence of water, each with a particular vegetation structure. *Aquatic plant communities* are dominated by submerged or floating plants; *marsh* is characterized by vegetation that emerges above the water surface. Riparian vegetation consists of emergents but these areas can be inundated occasionally, especially in the spring. It includes *wet meadow*, which consists primarily of herbaceous vegetation, and *swamp*, dominated by shrubs or trees (*shrubby* or *treed* swamp).

The sector has numerous wetlands, especially in the western part of the lake where the main marshes and wet meadows are located (Figure 4). These habitats have subsisted because this part of the lake has so far escaped much of the pressure from urban development. The aquatic vegetation (aquatic plant communities and marsh) in the lake comprises some 3600 hectares (ha), while riparian vegetation (wet meadows and swamp) make up 1700 ha (Table 1).

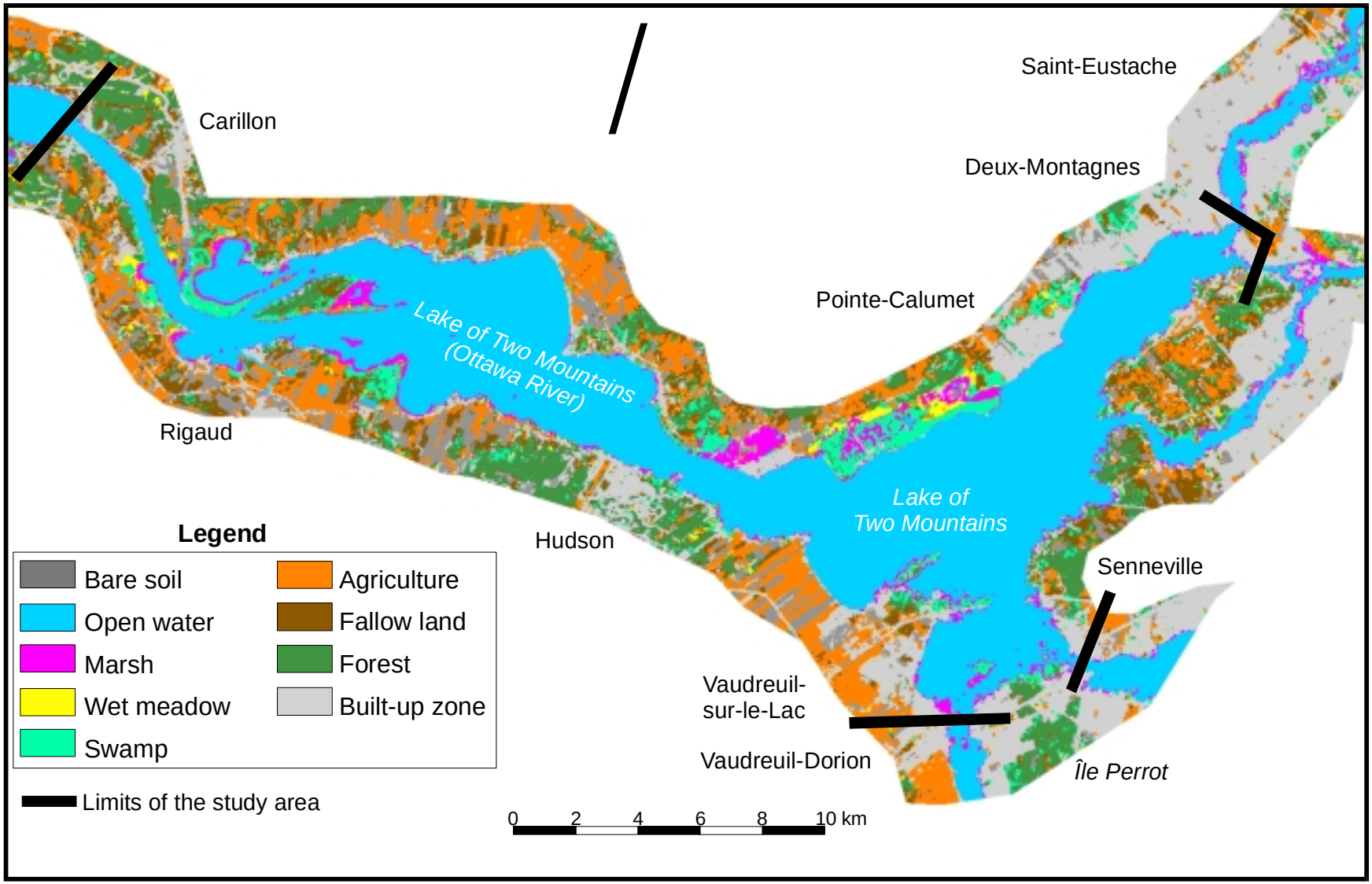
Dense groupings of aquatic plants usually harbour a diverse and abundant community of small invertebrates, which find food and shelter there. This concentration of prey in turn attracts aquatic birds and fish. Aquatic plant communities also provide important spawning grounds for a number of *stillwater* fish species, including Yellow Perch, Northern Pike and Brown Bullhead. The plants provide a support that keeps the eggs of certain fish species above the muddy bottom; after the eggs hatch, the fry can use the vegetation as a feeding and resting area. These habitats are also suitable for ducks, amphibians, certain reptiles and Muskrats.

[7] There is an area of alluvial deposits at Oka beach and another such area upstream from Grande Baie.



Source: Armellin and Mousseau, 1999, after Auger et al., 1984.

Figure 3 Typical profile of the structure of wetland vegetation and main use by wildlife



Source: Létourneau, 1998.

Figure 4 Wetlands of the Lake of Two Mountains sector (ZIP 24) of the study area

Table 1
Area occupied by different types of wetlands

Type of wetland	*Lake of Two Mountains*	*Island of Montreal*	*% of the archipelago*
	(*in hectares*)		
Aquatic plant community	3 032	12 395	24%
Marsh	555	1 518	37%
Wet meadow	183	914	20%
Swamp	1 537	2 612	59%
Total, wetlands	**5 308**	**17 439**	**30%**

Source: Armellin and Mousseau, 1999, after A. Marsan et Ass. Inc., 1986.

There are extensive communities of submergent aquatic plants in the sector, but they are not very diversified (Figure 4). They are dominated primarily by tapegrass, which is ubiquitous along the shores, and by northern water-milfoil, which is especially abundant in Carillon Bay. Floating vegetation generally covers a much smaller area than submergent plants. Floating plants are typically associated with fine bottom substrates and sectors that are sheltered from the current and waves, such as the back of Carillon Bay and Grande Baie, at Oka. The most common floating plant assemblage is dominated by tuberous water-lily. In the eastern part of the lake and in the Vaudreuil region, dense stands of filamentous algae can be seen; this is a sign of local nutrient enrichment of the waters.

The Lake of Two Mountains marshes are located in sheltered, shallow-water sites where there is no current. Most of the marshland is in the western part of the lake, notably in the Fer à Cheval, Carillon, Rigaud, Seigneurs and Brazeau bays. In the eastern section, the largest marsh is at Grande Baie. The dominant species in the marshes are wild rice, great bulrush, broad-fruited bur-reed and river bulrush.

Wet meadow and treed swamp are not well represented around the lake. In the vicinity of Carillon and Oka, there are a few expanses of herbaceous vegetation, mostly dominated by reed canary grass, and a few scrubby areas dominated by button-bush, willows or red-osier dogwood.

By contrast, treed swamp occupies large expanses of land on both sides of the lake. Silver maple dominates most of these plant communities, but this species is associated with a wide variety of plants. On the highest and best drained sites, the silver maple stands contain shagbark hickory and butternut hickory, swamp white oak and bur oak. On wetter sites, silver maple tends instead to be associated with red ash and button-bush. One association found in treed swamp, that consisting of red oak and white oak, is unique in the Island of Montreal region; this mixed oak stand is located on a small island in the ecological reserve on Avelle, Wight and Hiam islands (*Réserve écologique des Îles Avelle-Wight-et-Hiam*), located on Vaudreuil Bay.

3.2.2 Benthos

The term *benthos* comprises all organisms, both plants and animals, which live on, within or attached to the bottom. The study of benthic animals yields highly useful information for describing aquatic habitats. On the one hand, these organisms are at the base of the food chain and their abundance is a significant condition for the establishment of populations of higher organisms such as fish or birds. As well, the distribution of benthic animals in the environment is highly dependent on local conditions (presence of aquatic plant communities, nature of bottom, depth, and current speed) and individual species' requirements in this respect.

Benthos surveys were conducted in the Lake of Two Mountains primarily in the early 1980s during studies conducted under the Archipelago Project. At that time, 30 typical habitats[8] had been described in the waters around the Montreal archipelago, nine of which were represented in the Lake of Two Mountains sector (7 open-water habitats, 2 aquatic plant communities).

[8] In what is referred to as a *typical habitat*, the benthic composition is similar regardless of location.

The environmental variables that have the greatest influence on benthos composition in the area around Montreal are type of water (brown or green)[9], type of bottom substrate, current speed, the presence of vegetation, and water depth.

The benthic communities found in beds of aquatic vegetation, especially in the western part of the lake, are more dense and diversified than *open-water* communities (i.e. where there is no vegetation); certain invertebrates typically associated with aquatic plants can be 5 to 10 times more abundant in aquatic beds than in open water.

In the Lake of Two Mountains, open-water benthic habitats nonetheless occupy the largest surface area, or more than 7000 ha. They generally feature the same species as do aquatic beds, although in different proportions and smaller numbers. The benthos communities of open-water habitats that live on soft substrates (mud) have a higher density and greater diversity in shallower water (1 to 2 m).

3.2.3 Fish

In all, 73 fish species occur in the lower reaches of the Ottawa River. This species diversity is somewhat smaller than that in lakes Saint-Louis (87 species) and Saint-Pierre (80 species), but greater than the diversity observed in the fluvial stretches of the St. Lawrence. Certain physical characteristics of the habitats may influence the composition of the fish communities. For example, varied aquatic habitats and the presence of fast-flowing waters promote diversity, whereas a small floodplain area probably has an adverse effect on diversity, by limiting the spawning activity of Northern Pike, Yellow Perch, and some minnows.

The Lake of Two Mountains, the Des Prairies River and the Mille Îles River form a whole and share a number of ichthyofaunal components. However, certain fish species have a distribution that is limited to just one area in these water bodies. Muskellunge, for example, along

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[9] In the green waters of the Upper St. Lawrence, gastropods are generally the most abundant group of animals in benthic communities; in the brown waters of the Ottawa River, the dominant taxonomic gorups are, in order of importance, chironomids (midges), oligochaetes (benthic worms), nematodes and gastropods. Certain invertebrates occur solely in the brown waters: a crustacean from the order Isopoda — *Hyalella azteca*—and two members of the insect order Ephemeroptera (mayflies) — *Caenis* sp. and *Hexagenias* sp.

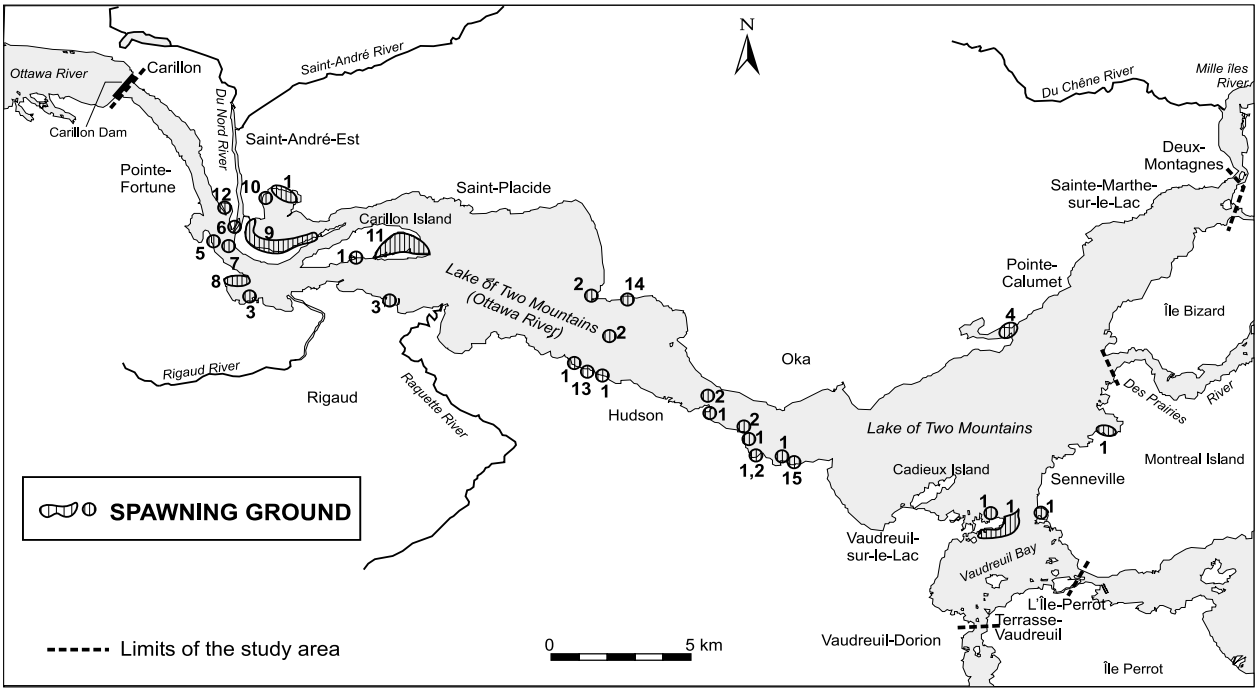
with Blackchin Shiner, Spotfin Shiner, Ninespine Stickleback, Bluegill, Freshwater Drum and Rainbow Smelt appear to be present only in the Lake of Two Mountains. By contrast, the Brook Silverside was observed solely in the two rivers. The Copper Redhorse and the Tessellated Darter were caught only in the Mille Îles River. The species with the broadest geographic range, encompassing the lake and both rivers, are Pumpkinseed and Yellow Perch, followed by Brown Bullhead, Rock Bass, White Sucker and Walleye.

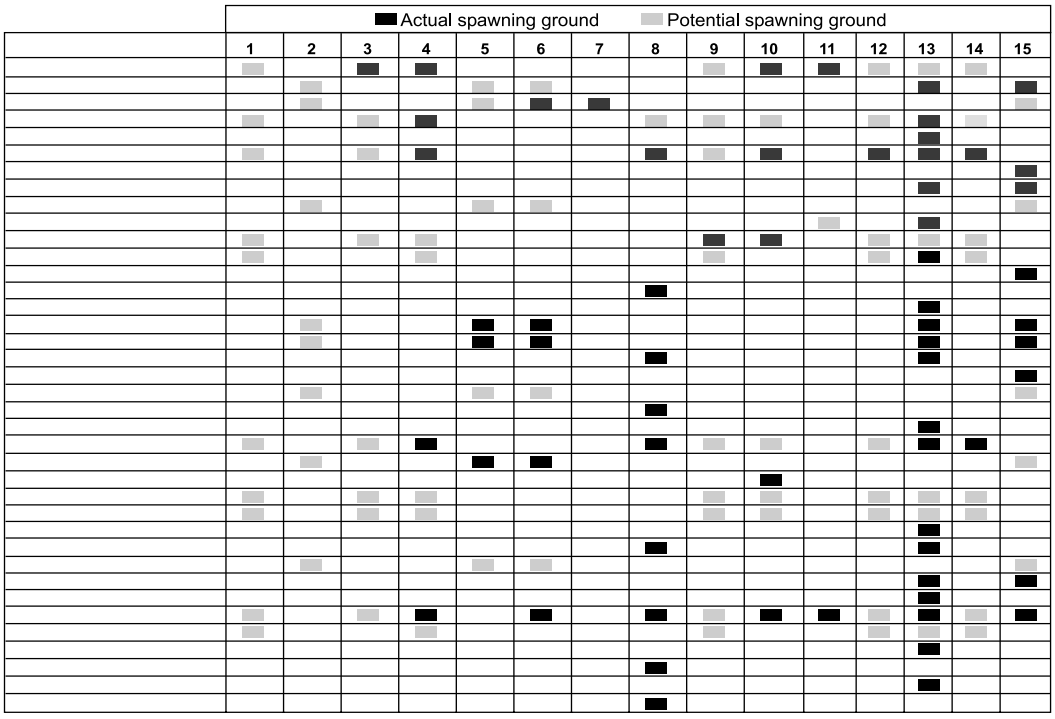
The lower reaches of the Ottawa River is a sector with especially favourable conditions for spawning by American Shad. This is an *anadromous* species, which means that it grows to maturity in salt water but needs to spawn in fresh water. American Shad sustained an important commercial fishery in the St. Lawrence River until the middle of the 20th century. The only known spawning ground still being used by shad is situated downstream from the Carillon power station, in the Lake of Two Mountains (Figure 5). To reach this spot, American Shad used to swim upriver from the ocean via one of three possible routes: the Sainte-Anne–Vaudreuil canals, the Mille Îles River and, above all, the Des Prairies River, where large numbers of shad could be caught at Gros Sault. Construction of various works on these two rivers essentially cut off this means of access, leaving only the route through Lake Saint-Louis.

The lake also has a Lake Sturgeon population that is distinct from the one that frequents the entire river corridor from Montreal to Quebec City. The sturgeons in the Lake of Two Mountains differ from those of the St. Lawrence by their growth rates, their fat content and their mortality rates; they appear to be confined to the waters of the lake and do not undertake the distant migrations that the sturgeon of the St. Lawrence do.

This population was decimated in the early 1950s by oxygen deficits in the waters of the lake, which were caused by pulp and paper mill effluents. Most other fish species have since rebuilt their numbers, but the population age structure of Lake Sturgeon, a long-lived species, still shows the impact of this earlier episode.

The spawning grounds in the lake are not well known. Some stillwater spawning sites have been found along the western shoreline, in Charrette Stream, in Raquette River and in Vaudreuil Cove, for example.





Source: Armellin and Mousseau, 1999, after Mongeau and Massé, 1976; MEF, 1998.

Figure 5 Main spawning grounds in the Lake of Two Mountains sector

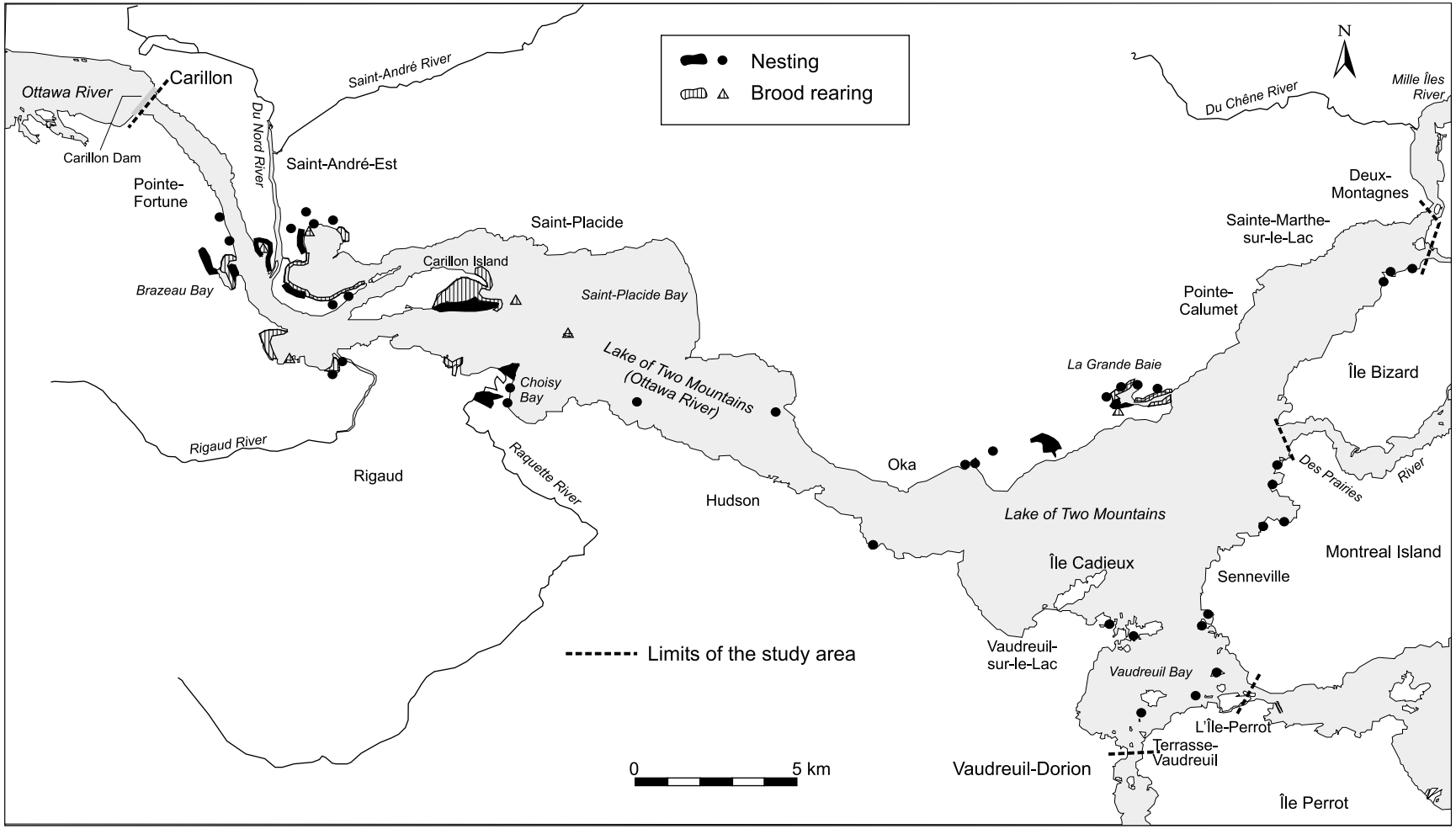
3.2.4 Birds

According to the most recent censuses, 146 bird species nest in or near the sector. The area's bird life is characterized by diversity, an abundance of nesting waterfowl and the presence of rare nesting species or infrequent visitors. However, bird colonies are essentially absent from the region, and shorebirds do not stop over during their migrations.

The many islets fringed with marsh and beds of aquatic vegetation constitute excellent sites for waterfowl nesting and brood rearing (Figure 6). Thirteen anatid species (ducks and geese) are believed to nest in the area[10]. During the migration period, especially in fall, ducks frequent the aquatic beds and the marshes, which are well developed in the western part of the lake (Figure 7).

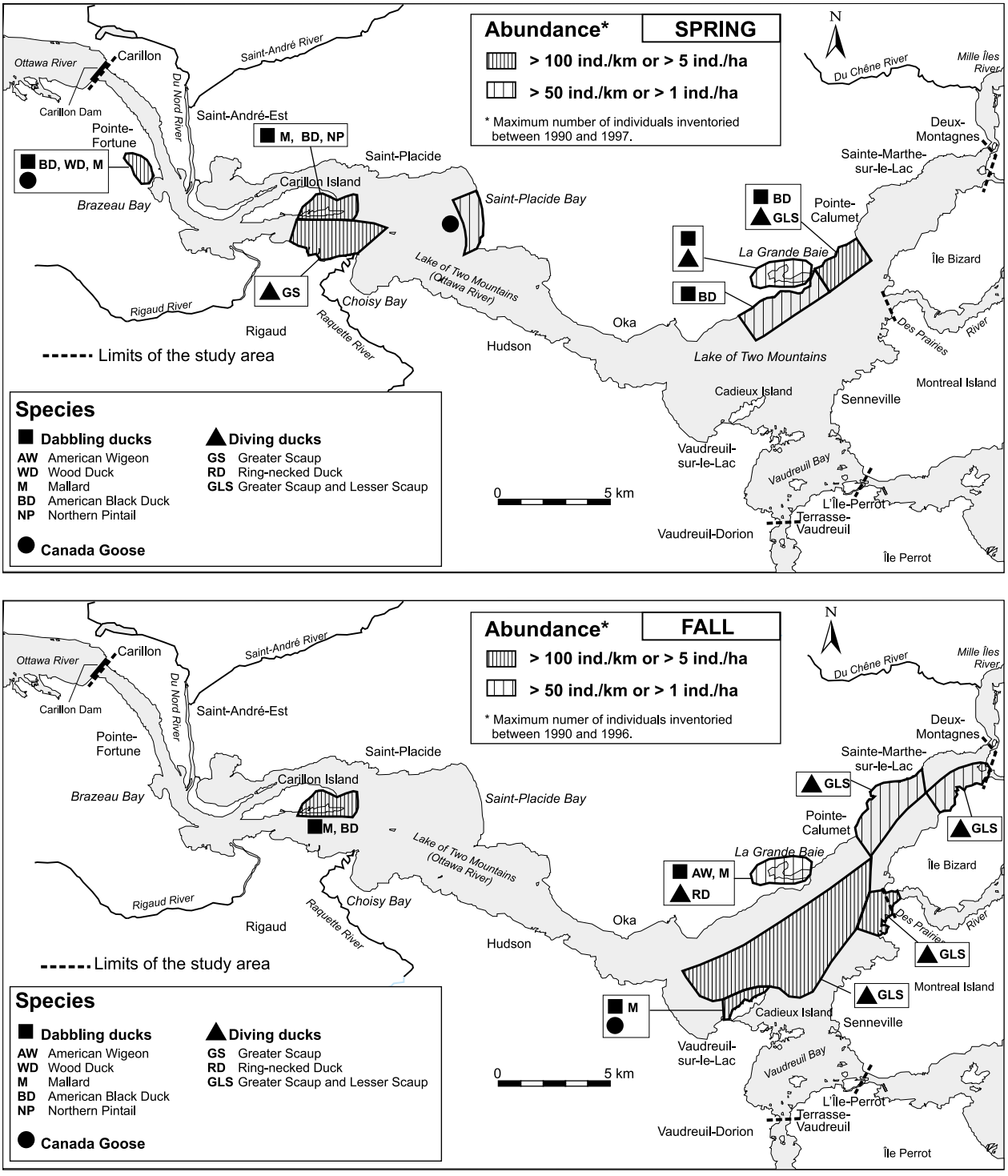
Compared with most sections of the St. Lawrence River, the lake is not a popular stopover place for migrating waterfowl in the spring migration. A few ducks gather in the area between Fer à Cheval Bay and the Carillon Island point, along Charette Stream (Brazeau Bay), off Portelance Point and in Pointe-Calumet Bay. There are more ducks in the fall, mostly diving ducks. The most abundant visitors are Lesser Scaup and Greater Scaup. Groups of ducks can be seen mostly in the eastern part of the lake, in the middle of the lake, on the north shore of Ile Cadieux and at the head of the Cap-Saint-Jacques Rapids.

[10] The main nesting species are listed below. Dabbling ducks: American Wigeon, Gadwall, Mallard, Northern Pintail, Northern Shoveler, Black Duck and Green-winged Teal. Diving ducks: Common Merganser, Hooded Merganser and Ring-necked Duck. Recently, Canada Geese have nested in adjacent areas.



Source: Léveillé, 1983; MLCP, 1984.

Figure 6 Potential waterfowl nesting and brood-rearing sites



Source: Armellin and Mousseau, 1999, after MEF, 1998.

Figure 7 Main staging areas of migrating waterfowl

There are few bird colonies on the Lake of Two Mountains. The only heronry is located at Grande Baie, in a treed swamp bordering a marsh. This colony, which was first discovered in the late 1970s, was abandoned between 1989 and 1992; nesting started up again in 1993, and the heronry contained about 50 active nests in 1997. Bank Swallows nest on a few sand, clay or gravel cliffs, near the water.

Finally, a few bird species typically associated with marshland nest in the sector: Pied-billed Grebe, American Bittern, Green-backed Heron, Virginia Rail, Common Moorhen, Common Snipe and Black Tern.

3.2.5 Other animals

We have no systematic inventory of the amphibians and reptiles of the Lake of Two Mountains sector, only a list of the species whose range encompasses this region. Nearly all of the amphibians found in southwestern Quebec (18 of 21 species) may be present in this part of the overall Lake of Two Mountains–Des Prairies River and Mille Iles River study area.

We do not have enough historical data to be able to describe changes in the abundance of most of these populations or to link any declines to specific factors. However, herpetologists all agree that these animals are strongly dependent on their preferred habitats. When these habitats disappear, the amphibians and reptiles associated with them suffer the same fate.

The Western Chorus Frog, a priority species under SLV 2000, was abundant in Vaudreuil County until mid-century, but has since undergone a marked reduction in its numbers. No specimens have been found during the inventories conducted in the county since 1988.

Most of the indigenous reptiles of Quebec occur in the Lake of Two Mountains sector. The most recent inventories show that the Map Turtle is the most common turtle species.

The Muskrat is the commonest mammal species in the aquatic and riparian habitats. This rodent was trapped intensively until the late 1980s, when falling pelt prices caused a loss of interest in this activity.

3.3 The Human Imprint

From the time the riparian lands around Lake of Two Mountains were cleared, they were used primarily for farming. Even today, all the western sector of the lake, where considerable agricultural production takes place, has mostly rural landscapes.

One of the first major events in the area's development was the expansion of navigation on the Ottawa River following the construction, in 1833, of a series of dams and locks for use by boats to reach Ottawa and then Kingston. This navigable route promoted the development of waterfront towns like Carillon.

In the early 1960s, the Carillon hydro-electric generating plant was built at the head of the lake. A lock still provides access to the Ottawa River, although commercial ships now use other routes, notably the St. Lawrence Seaway.

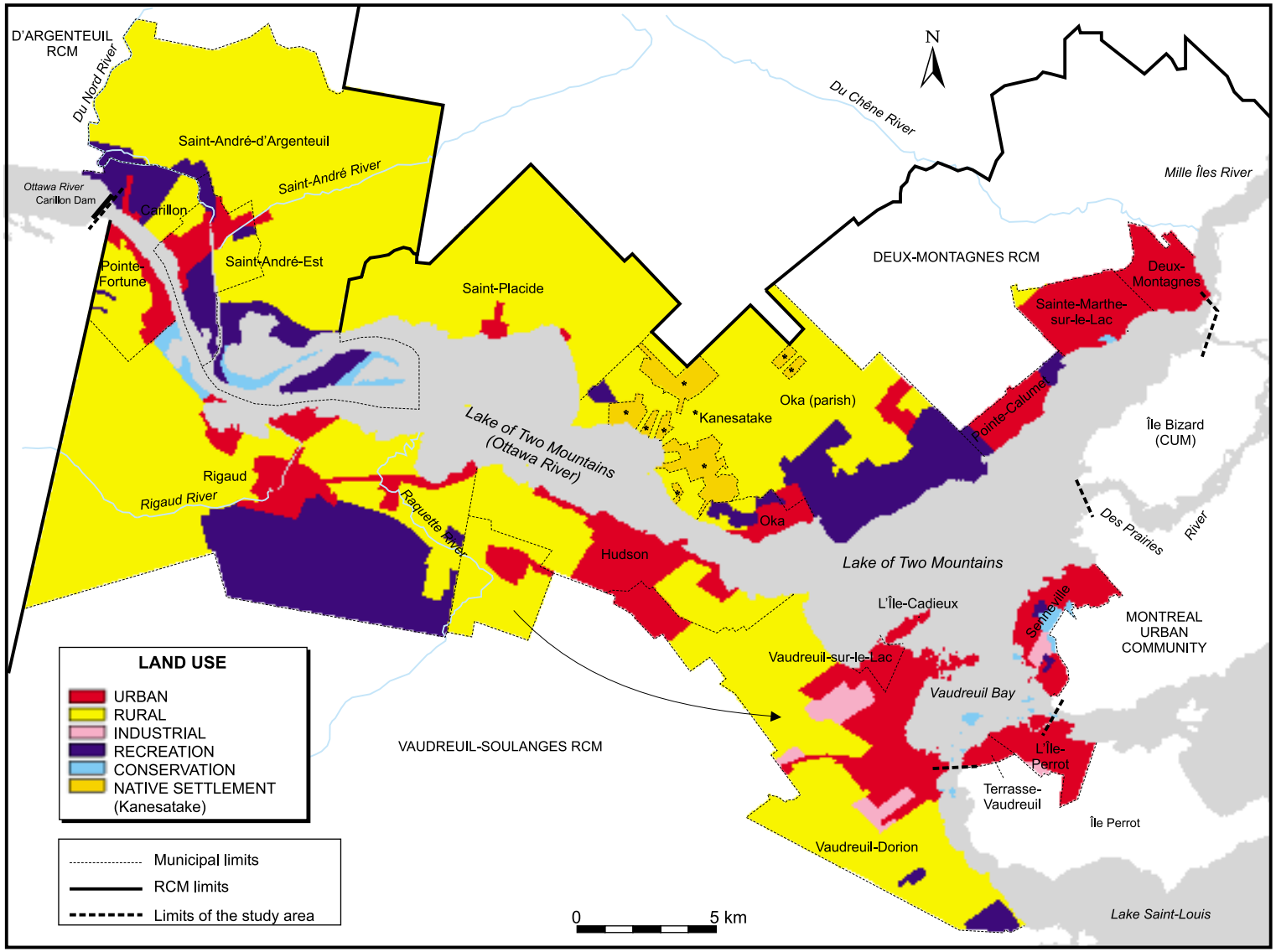
The north shore of the lake has long been a vacation spot for Montrealers, a role which, in recent decades, prompted housing developments and suburban expansion. Today, many MUC residents living on the western tip of the Island of Montreal and in the waterfront towns on the eastern part of the lake commute to work in downtown Montreal every day.

The Lake of Two Mountains part of the study area now comprises 18 municipalities and the Mohawk settlement of Kanesatake which together cover an area of 463.78 km^2; roughly 81 183 people lived there in 1996 (Table 2). In terms of planning (Figure 7), rural land use is predominant, accounting for a majority of the sector (64%), followed by urban (18%) and recreational (14%) uses. The most recent statistics show an increase in urbanization; the municipalities of Carillon and Deux-Montagnes have experienced strong population growth since 1991.

Table 2
Land area and population of the municipalities in the Lake of Two Mountains sector of the study area in 1996

Municipality	*Population (in 1996)*	*Area (km^2)*	*Population density (inhab./km^2)*
Carillon	258	6.83	37.8
Saint-André-Est	1 471	10.9	135.0
Saint-André-d'Argenteuil	1 192	80.72	14.8
Saint-Placide	1 479	41.95	35.3
Oka (town)	1 514	4.68	323.5
Oka (parish)	1 498	62.53	24.0
Kanesatake	1 200	9.58	125.3
Pointe-Calumet	5 443	4.89	1113.1
Sainte-Marthe-sur-le-Lac	8 295	9.01	920.6
Deux-Montagnes	15 953	5.94	2685.7
Pointe-Fortune	451	9.09	49.6
Rigaud*	6 057	97.15	62.3
Hudson	4 796	21.62	221.8
Vaudreuil-Dorion	18 466	73.18	252.3
L'Île-Cadieux	121	0.62	195.2
Vaudreuil-sur-le-Lac	928	1.73	536.4
Terrasse-Vaudreuil	1 977	1.08	1830.6
L'Île-Perrot	9 178	4.86	1888.5
Senneville	906	7.84	115.6
Sub-total (towns, villages, parishes)	*79 983*	*454.2*	*176.1*
Kanesatake	1 200	9.58	125.3
Total (with Kanesatake)	**81 183**	**463.78**	**175.0**

* In 1995 Sainte-Madeleine-de-Rigaud and Rigaud merged.



Source: RCM of D'Argenteuil, 1994; RCM of Deux-Montagnes, 1987; RCM of Vaudreuil-Soulanges, 1989; MUC, 1989.

Figure 8 Land use patterns in the shoreline municipalities of ZIP 24

CHAPTER 4

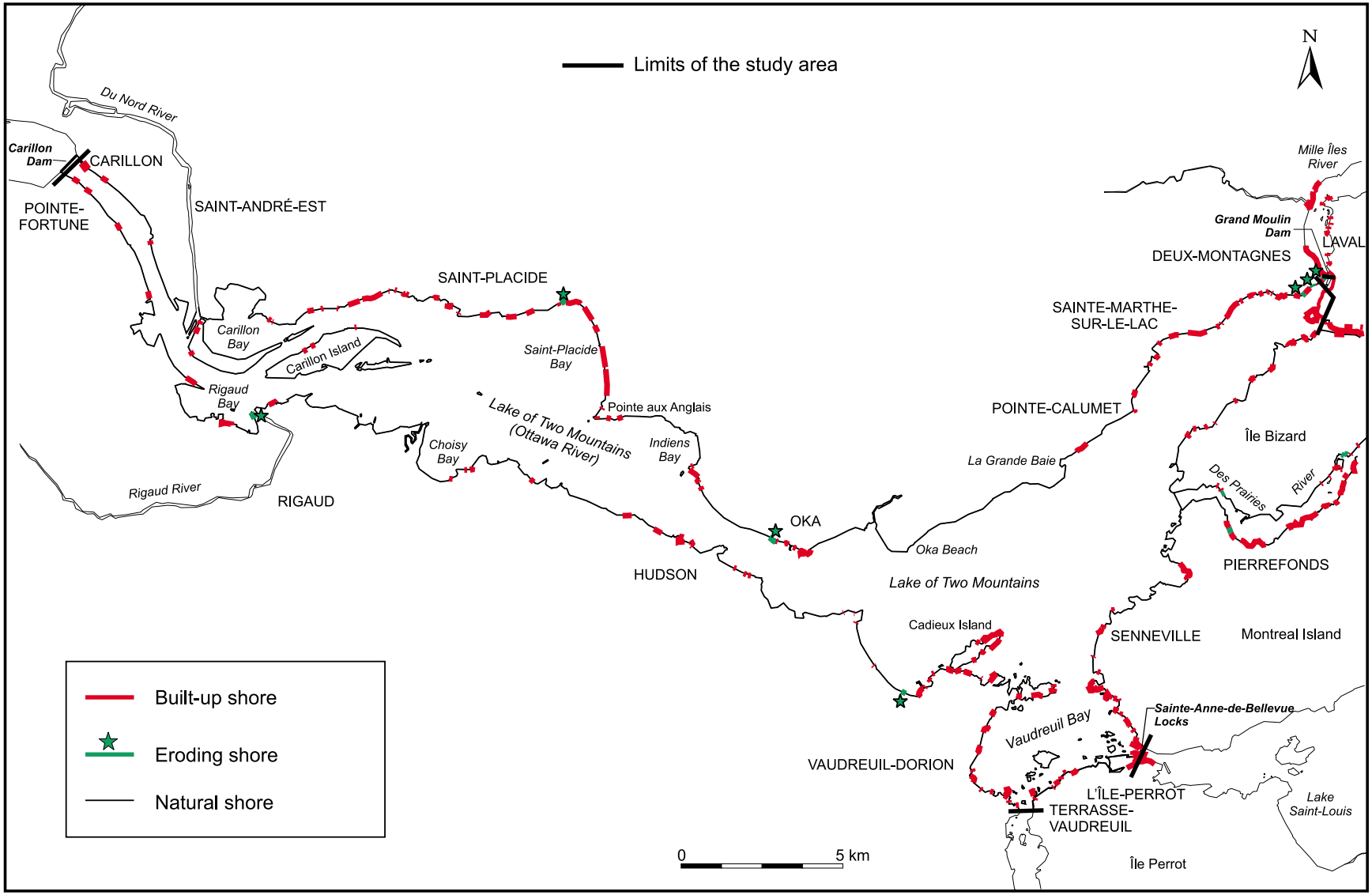
Human Activities and their Main Effects on the Environment

Human activities have resulted in many changes in the sector. The main ones are summarized below.

4.1 Habitat Modification and Encroachment

At some locations, aquatic and especially riparian habitats have been degraded or destroyed by human activities, such as filling, diking or the construction of a variety of structures (Figure 9). Such changes have the effect of reducing diversity, since the affected habitats are among the most crucial for flora and fauna. Natural riverbanks usually slope gently, with successive zones of substrates and vegetation providing a gradual transition from dry ground to the water. These shoreline fringes are very rich in fauna, providing food and shelter and a place to breed for mammals, birds, fish, amphibians and reptiles.

Filling and the construction of wharves, retaining walls and other artificial shoreline enhancements tend to destroy these habitats, since they make the slope steeper and eliminate the transition zone. Coarse fill materials interfere with the growth of vegetation. Not only do flora and fauna disappear right in the altered areas, but their abundance and diversity is diminished in adjacent terrestrial and aquatic environments. Built-up or artificial segments of shoreline are habitats with a markedly lower diversity and productivity than sections preserved in their natural state. (The term *artificial* is used to designate a shoreline that has been reworked or on which permanent structures such as walls or docks have been built).



Source: Armellin and Mousseau, 1999, after Clavet, 1983; MLCP, 1983; Tecsult Inc., 1995; SLC, 1998.

Figure 9 Physical modification of aquatic habitats and shores

The proportion of artificial shoreline in the Lake of Two Mountains part of the study area is low compared to the situation in the Island of Montreal region as a whole. The data on this topic date back to 1983: at the time, only 36 km out of the 184 km of shoreline around the Lake of Two Mountains (including the perimeter of islands) were artificial. Although the losses of natural shoreline in the sector seem minimal compared with the total loss for the Montreal area, this phenomenon must be taken seriously. Shoreline conversion is often an irreversible process engendered by urban development, as can be observed in the eastern part of the lake. This insidious erosion of riparian habitats ends up impoverishing the natural environment unless steps are taken to prevent it.

Certain flow control works, established in the sector or outside of it, have had impacts on the state of local resources. In 1964, the Carillon hydro-electric power station was built at the head of the Lake of Two Mountains. Although this new structure had a lock, as did the dam it replaced, it now forms the limit of the geographic distribution of American Shad in the St. Lawrence system. Since the station was built, there have been no reports of shad being caught in the Ottawa River upstream from this point.

The only spawning ground where shad still reproduce is located in the Lake of Two Mountains downstream from the power station. Now, the only route these fish can take to reach the spawning ground is through the Vaudreuil and Sainte-Anne-de-Bellevue canals. However, the downstream migration of spawners in June, and juveniles in August, takes place primarily via the Des Prairies River. Some of these fish end up getting killed in turbines[11].

[11] Certain operating adjustments can be made at the power station to minimize losses of adults. Opening a sluice in the spillway at the end of the afternoon facilitates the downstream passage of the shad that have congregated upstream from the power station during the day.

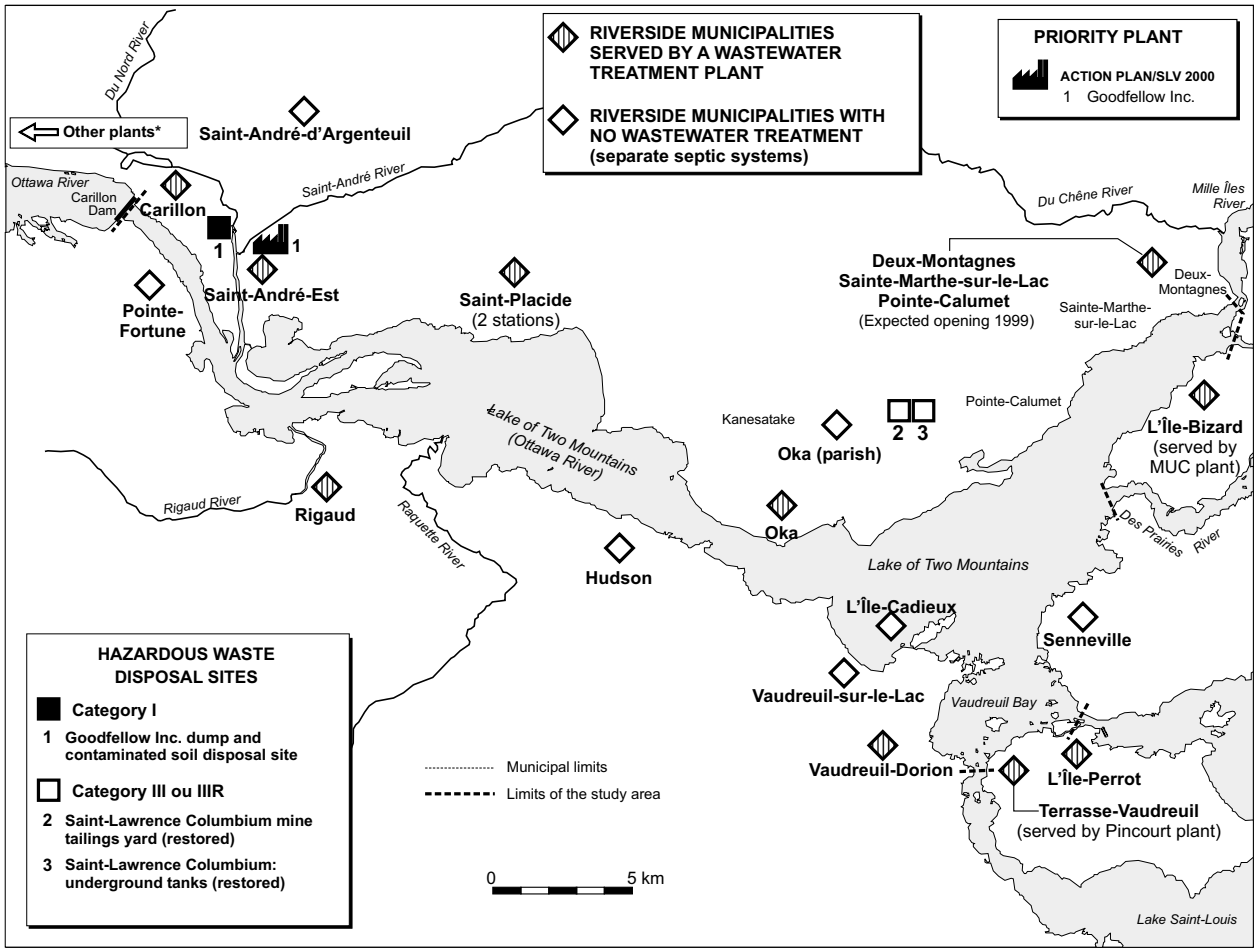
4.2 Contamination

For a long time, the St. Lawrence and its tributaries were considered a convenient and inexpensive dumpsite for wastewater. Industries, municipalities and agricultural operations discharged effluents and drainage water into the river or its tributaries untreated, until the effects of the pollution could no longer be ignored. The magnitude of the problem forced governments to monitor industrial and urban effluents and establish standards for the concentrations of substances discharged into watercourses. However, many substances have persisted in the environment and continue to be a source of contamination many years after they were originally discharged.

The volume and type of effluent determines its impact on the environment. For example, industrial plants are usually the main sources of toxic chemicals, while municipal sewage contributes to bacterial contamination and may, through nutrient enrichment, boost biological productivity considerably, which can lead to eutrophication and give water a foul odour that turns people off swimming and other recreational activities.

4.2.1 Pollution sources

The Lake of Two Mountains receives inputs of contaminants generated by human activities in the watersheds of the Ottawa River and the Rivière du Nord. Its surface waters also absorb a portion of the pollutants released into the atmosphere from distant or nearby sources, such as adjacent towns. These nonpoint sources of pollution engender an ambient level of contamination that is exacerbated locally by discharges of urban effluents and inputs from small tributaries that drain agricultural and urban land areas (Figure 10).



*** Other industrial plants near the main tributaries: Action Plan–SLV 2000–ARET** – ICI Canada Inc.; James MacLaren Industries, Kraft Pulp Div.; James MacLaren Industries, Newsprint Div.; Albright and Wilson America Limited; Sterling Chemicals; E.B. Eddy Forest Products Limited, Stone Container (Canada) Inc., Pontiac Division; Tembec Inc. **ARET** – Avenor Inc., Gatineau Plant; Armstrong World Industries; PFCP Ltd., Gatineau Plant; Scott Papers Ltd.

Source: Fortin, 1999; Jourdain et al., 1999.

Figure 10 Main local sources of contamination and treatment facilities in the study area

4.2.1.1 *Ottawa River*

Forestry is the main economic activity in the Quebec part of the Ottawa River basin; six pulp and paper plants and a number of sawmills are located there. Until 1994, timber drives were carried out on this river and several of its tributaries. Agriculture is somewhat of a marginal activity in the Quebec part of the watershed; it is much more developed in Ontario.

The data available on the water flow that reaches Carillon indicate that water quality is good, except in terms of phosphorus concentrations. The water also contains fairly high levels of arsenic and certain metals, but this situation appears to be due mainly to the chemical composition of the rocks and soils in the watershed. The contribution of human activities is believed to be minimal in this regard.

The total flux of polycyclic aromatic hydrocarbons (PAHs) at Carillon is about 1.1 tonnes per year. Certain types of PAHs may be released into the environment by natural phenomena; however, the PAH composition at Carillon suggests that an appreciable portion of the loading results from the combustion of petroleum products, with the resultant PAHs being transported by the atmosphere and eventually deposited in the aquatic environment.

In the case of polychlorinated biphenyls (PCBs), which do not occur naturally, the loading from the river at Carillon is 14.6 kg/year, which is equal to about 9% of the total quantity transported by the St. Lawrence as far as Quebec City. Most of this PCB load results from atmospheric deposition. Since the Ottawa River accounts for roughly 16% of the discharge of the St. Lawrence at this spot, it can be inferred that the Ottawa River has a low PCB load.

4.2.1.2 *Tributaries*

The *Rivière du Nord*, whose drainage basin covers 2213 km^2, empties into the Lake of Two Mountains and has a mean annual flow of 42 m^3/s. The region drained by this river is 70% forested; farmland occupies 20% of the total area. The upper basin of the river, which is characterized by wooded hills and numerous lakes, has become a popular vacation and recreation area. The lower reaches, situated on the St. Lawrence Lowlands, traverse land that is devoted mainly to agriculture. Although more than 100 000 people live year-round in the river's

watershed, the population doubles during the summer. The main urban and industrial centres are Lachute and Saint-Jérôme.

Clean-up measures have been implemented to reduce contamination of the river by urban, industrial and agricultural activities. In 1991, 21 of the 34 municipalities had a sewer system. There are 54 potentially polluting industries in the watershed[12].

The Rivière du Nord does not have an acute agricultural pollution problem. Efforts have been devoted to addressing this issue, notably the storage of animal manure and spreading of manure on cropland. A decline was noted in the quantities of nitrogen and phosphorus transported by the river toward the Lake of Two Mountains between 1979 and 1986, and this improvement was attributed to the overall cleanup measures adopted.

The *Rivière à l'Orme* discharges part of the runoff from Baie d'Urfé, Beaconsfield, Kirkland, Pierrefonds, Sainte-Anne-de-Bellevue and Senneville into Anse à l'Orme cove (Island of Montreal), in addition to draining a section of the Félix-Leclerc Highway (Highway 40). Samples collected in 1992 and 1993 revealed that the bacteriological quality of the water in this small river was poor and that it carried loads of suspended sediment, phosphorus and trace metals (Cd, Cr, Cu, Pb and Zn) to the Lake of Two Mountains.

4.2.1.3 *Industry*

The Lake of Two Mountains region, situated near Montreal, has fertile lands and a predominantly agricultural vocation in addition to being a popular vacation spot. However, there are also some industrial activities, concentrated mainly in the Oka and Vaudreuil areas.

Only one plant in the sector, the *Goodfellow Inc.* facility in Saint-André-Est, is among the 106 plants targeted by the industrial cleanup component of the SLV 2000 Action Plan. This plant treats lumber with preservatives (chromated copper arsenate [CCA] or pentachlorophenol [PCP]), and then dries it on special drainage facilities.

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[12] The number of industrial plants that actually pollute the environment is lower than this. Eight of the plants inventoried have shut down, and the effluents from 14 other plants have been deemed to be safe.

The facility has closed-loop operations, which means that the industrial effluents are filtered and channelled back to the process stream. Water extracted from the wood is stored and then reused. Domestic wastewater is evacuated into a septic tank equipped with a treatment unit. Storm water and boiler feed water are discharged into the Rivière du Nord.

4.2.1.4 *Contaminated sites*

In addition to their effluents, industrial plants generate hazardous wastes that they dispose of at landfill sites. Over the long term, these sites can also contaminate the aquatic environment because wastes may be carried in runoff or migrate to the groundwater, eventually reaching watercourses.

Contaminated sites far from the aquatic environment may pose less of a risk to water bodies, but they still impose serious constraints on how the land is used.

Given that one previously inventoried site has been restored and another delisted, the only remaining contaminated site in the Lake of Two Mountains sector is the land and dump owned by *Goodfellow Inc*. (Figure 10). When this plant first started up, some 25 years ago, the treated wood was drained outside, on the bare ground, and some of the land became heavily contaminated as a result of this practice. In addition, certain quantities of preservatives (substances left in the bottom of tanks, plus wood chips and sawdust impregnated with preservatives) were disposed of in the company's dump, located near the plant. A preliminary study confirmed that the ground is heavily contaminated with wood preservatives. The soil may also be contaminated with dioxins and furans. In view of the strong toxicity of these substances and the potential for contamination of the Rivière du Nord, the site is considered to present a high risk.

4.2.1.5 *Municipal effluent discharges*

In the past, the discharge of untreated municipal wastewater into the Lake of Two Mountains was a factor contributing to local water quality degradation. The main drawbacks of this practice are foul odours and nutrient enrichment of the water, which promotes dense algal

growth and poor bacteriological water quality, thus posing risks for recreational activities involving water contact.

However, this type of discharge has been reduced considerably as a result of the provincial wastewater treatment program. It is predicted that 69% of the waterfront population in this part of the study area will be served by wastewater treatment facilities by the year 2000 (Table 3). In the case of isolated dwellings and municipalities that are not connected to a treatment plant, sewage is stored in septic tanks, which must be emptied periodically.

Table 3
Status of municipal wastewater treatment

Treatment plant (other municipality served)	*Volume treated in 1998 (m^3/d)*	*Population served*	*Point of discharge*
Carillon	122	196	Ottawa River
Saint-André-Est	393	971	Rivière du Nord
Saint-Placide 1	250	472	Lake of Two Mountains
Saint-Placide 2	365	330	Lake of Two Mountains
Oka	789	1 514	Lake of Two Mountains
Deux-Montagnes (Sainte-Marthe-sur-le-Lac, Pointe-Calumet, Saint-Joseph-du-Lac)	15 478**p**	24 777**p**	Mille Îles River
Rigaud	2 650	3 375	Rivière Rigaud
Pincourt (Terrasse-Vaudreuil)	7 878	1 977	St. Lawrence
Vaudreuil-Dorion	11 000	13 609	Lake of Two Mountains
L'Île-Perrot	8 419	8 146	St. Lawrence
Total in 1998	31 866	30 590	
Total expected in 1999	47 344 **p**	55 367**p**	

Source: Jourdain et al., 1999.

p: projected at the end of 1999.

Note: The Pincourt plant, outside the study area, serves Terrasse-Vaudreuil.

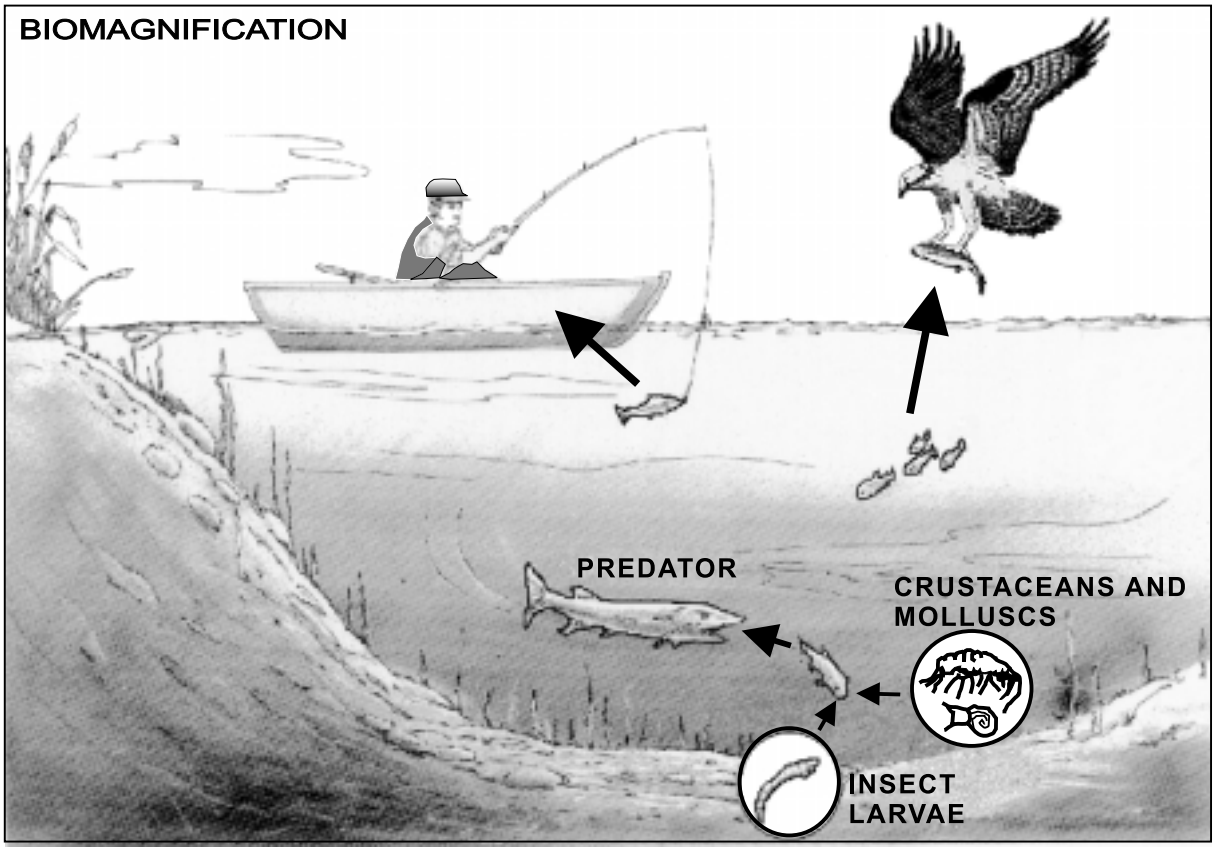
4.2.2 Effects of contamination on the aquatic environment

Whatever their origin, the pollutants found in the aquatic environment present varying degrees of risk to the normal functioning of living organisms. Certain types of pollution have no lasting effects, and the quality of the environment improves rapidly as soon as the discharges stop. This is the case, for example, with bacterial pollution, nutrient enrichment of waters or highly soluble substances that are carried to the sea by the current. Some fairly insoluble pollutants that are chemically stable in their original forms or as environmental degradation products can adsorb to suspended particles and then accumulate in sediments over long periods of time. These persistent substances can be found in high concentrations in living organisms.

The concentration of a toxic substance may increase in an organism throughout its life, a phenomenon known as *bioaccumulation*. It can also increase from one link in the food chain to another by the process of *biomagnification*. Substances are thus gradually transferred to predators (fish, birds or mammals) occupying higher levels of the food web, reaching higher concentrations in these animals (Figure 11).

4.2.2.1 *Water*

During an analysis of the Lake of Two Mountains, in the early 1980s, it was noted that water quality in the central channel was similar to that in the Ottawa River. During that period, discharges of effluents from many pulp and paper mills in the watershed as well as of untreated urban effluents, coupled with fertilizer runoff from farmland, contributed to high nutrient and organic matter levels in the lake, and the water in the middle was very turbid. However, water sampled near the shores, albeit of variable quality, was more likely to be affected by local inputs. Degradation was observed around the points of discharge of municipal and agricultural effluents.



Many invertebrates such as aquatic insect larvae, molluscs and crustaceans live on the bottom of waterways. They accumulate in their tissues the toxic substances attached to the sediments or adsorbed to suspended matter. They are then eaten by organisms that occupy a higher position in the food chain, such as Yellow perch, which are in turn eaten by larger predators such as Northern pike or Walleye, by fish-eating birds such as Osprey, or by humans. From one link to the next in the food chain, toxic substances accumulate in increasingly larger concentrations.

Source: *Toxics in the St. Lawrence: An Invisible but Real Threat*. "St. Lawrence UPDATE" Series. St. Lawrence Centre, Environment Canada, Conservation Branch, Quebec Region. June 1990.

Figure 11 The phenomenon of biomagnification

As a result of the treatment measures implemented in the watershed over the past two decades, the situation has improved markedly. The data series collected from 1979 to 1994 at the lake inlet show a significant decline in nitrogen and phosphorus concentrations, although exceedances are still noted for the latter relative to the criterion aimed at preventing eutrophication. Owing to the phosphorus exceedances alone, water quality at the inlet of the lake failed to receive the classification of *very good* during the period 1979 to 1994. Surveys at the lake outlets indicate that the quality of the water mass remains stable as it passes through the middle of the lake.

Metal levels (Al, Cd, Cu, Co, Fe, Ni, Pb, Zn and Hg) in the water at the inlet are comparable to those observed in water bodies that are considered not very polluted. The same is true for PCBs and PAHs: the levels are low, and these contaminants appear to be transported to the Ottawa River basin by the atmosphere.

4.2.2.2 *Sediment*

A number of contaminants bind to suspended particles in the water, which tend to settle to the bottom in areas where the current is slower. This is how deposits of contaminated sediment form on the bottom, creating a potential source of contamination for living organisms. Depositional zones often correspond to aquatic plant beds, which are frequently home to benthic organisms occupying the base of the food chain. The presence of contaminated sediments represents a potential threat to the fish, birds and mammals that feed at these sites, and ultimately for the hunters and fishers who eat them.

Little information is available on the degree of contamination of recent sediments in the lower reaches of the Ottawa River, except for a single site, located in Vaudreuil Bay.

The most comprehensive datasets are quite old and come from a characterization of sediments in the Lake of Two Mountains done in 1976. The samples collected at that time showed trace metal levels (copper, chromium, nickel and zinc) similar to the concentrations observable in comparable sediments in the Canadian Arctic, with the exception of lead and mercury.

Lead contamination of sediments is a well-known phenomenon, and it has been documented for water bodies situated leeward of large urban centres. This contamination is associated with leaded gasoline, which was used until the 1970s. The phase-out of leaded gas resulted in a decline in atmospheric emissions of lead and in sediment contamination in the St. Lawrence River; however, a similar reduction was not observed in the areas bathed by the brown waters of the Ottawa River.

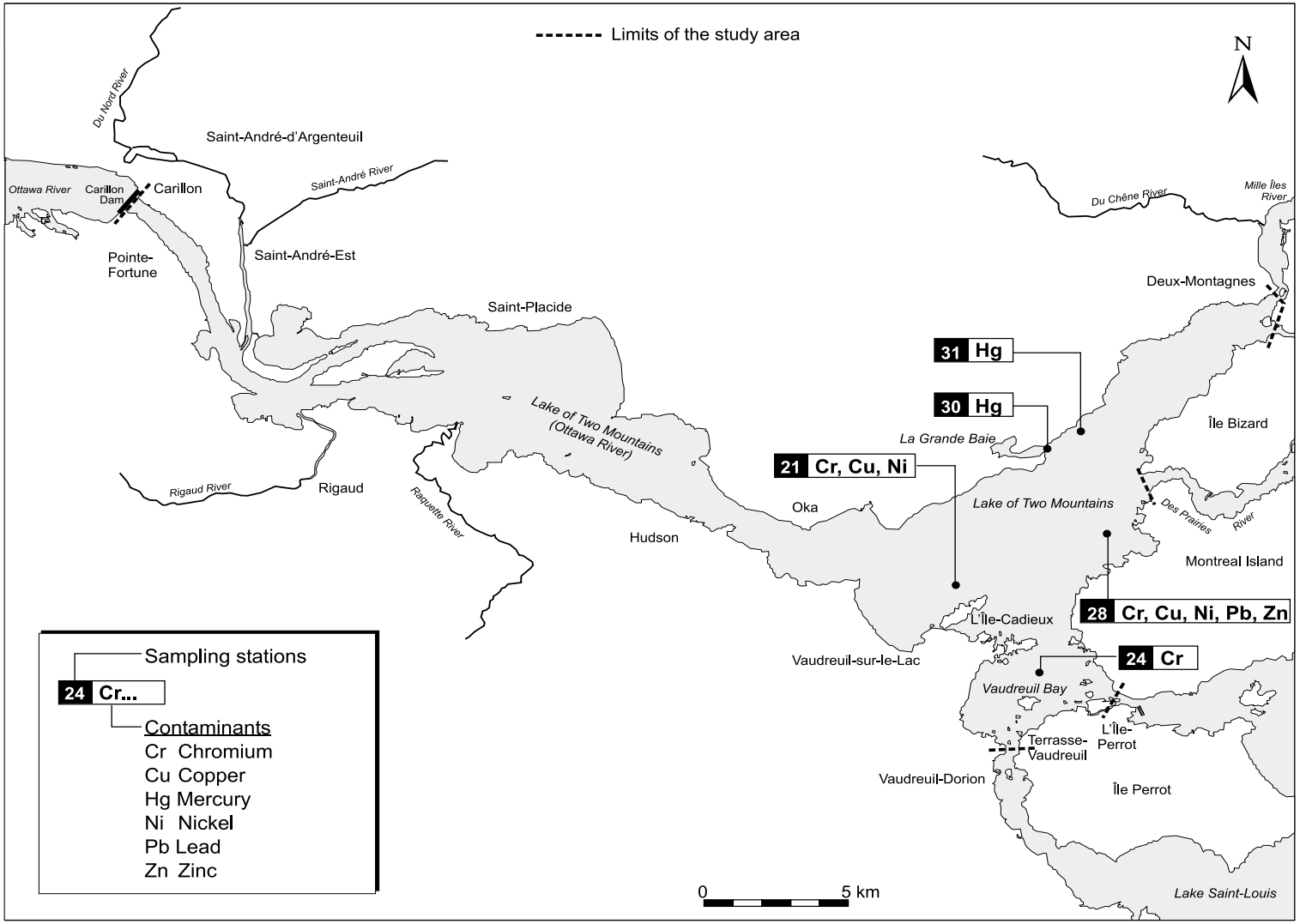
Mercury is a metal that is naturally abundant in the rocks of the Canadian Shield. The filling of hydro-electric reservoirs sometimes causes mercury to be put back into circulation in the aquatic environment. Human activities have probably increased the concentrations of mercury that are naturally present in the water and sediments, through atmospheric deposition. In addition, mercury was used as a bactericide by pulp and paper mills until 1978.

Scientists have attempted to explain the peaks in the abundance of trace metals and PCBs during the decades of the 1950s to the 1970s, as measured in sediment cores, by suggesting that an increase in the organic matter content of the water, attributable to forestry operations, may have bound up certain contaminants in the water column and caused them to be deposited with sediments.

Figure 12 shows the location of the sites sampled in 1976 and the places where the sediments exhibited contaminant levels significantly higher than the typical ambient level in the Ottawa River. Although the contamination level is low there for the most part, these localized degradation patterns often correspond to local sources of contamination, whether past or present.

4.2.2.3 Aquatic organisms

The *zoobenthos*, or animal benthos, is the group of organisms that best lends itself to an assessment of the integrity of aquatic habitats within a body of water. Since these organisms are not very mobile, their degree of contamination is a good indicator of the distribution of toxic substances in the environment. Furthermore, changes in the composition of benthic communities in disturbed habitats can also be more easily quantified than is the case for higher, more mobile, animals.



Source: Fortin, 1999, after Sérodes, 1978.

Figure 12 Localized degradation of sediment in the Lake of Two Mountains sector of the study area

According to a study done in the 1970s, most of the benthic communities in the Lake of Two Mountains were in satisfactory condition. By comparison, the communities of the Des Prairies River were heavily degraded: at several sites there was a predominance of tubificid worms (class Oligochaeta), organisms used as indicators of organic pollution.

Fish sampling during the 1970s in the waters around the Island of Montreal showed frequent exceedances of the permissible mercury concentration for marketing of fish products, especially in large piscivorous species like Northern Pike, Walleye, Sauger and Smallmouth Bass. However, in regions where the problem was most acute, mercury levels in the flesh of these species have exhibited a marked decline over the past two decades. Mercury concentrations in the flesh of fish in the Lake of Two Mountains should therefore not be a problem.

Contamination in birds has not been studied much in the sector. The organochlorine levels measured in the eggs of Great Blue Herons on Carillon Island, in the early 1980s, were the lowest found among all the heron colonies in southern Quebec. Analyses done on four ducks (a Ring-necked Duck, a Bufflehead and two Red-breasted Mergansers) taken in the downstream part of Lake of Two Mountains in the fall of 1991, revealed low levels of most contaminants in the breast muscle, except for PCBs and mercury. However, as these were migrating individuals, their degree of contamination likely does not reflect the effect of local conditions.

In summary, the information on levels of contamination in most living organisms dates back a number of years. Most of it was collected before industrial cleanup programs were instituted and before many municipal outfalls were connected to wastewater treatment plants. Hence, the picture we can get of the situation does not necessarily reflect the current state of affairs and updated information is needed.

4.2.3 Risks to human health

According to the information available, pollution currently poses little threat to human health, to the extent that the recommendations applicable to specific activities are followed.

4.2.3.1 *Water consumption*

In 1997, 66% of the population was served by water supply systems in the Lake of Two Mountains part of the study area[13] (see Section 5.3.1). Based on data collected from 1995 to 1997, the water distributed from systems that draw supplies from the lake is of good quality and meets provincial standards and federal recommendations. No epidemics linked to drinking water were reported between 1989 and 1997.

A number of municipalities have water treatment systems that include chlorination, which releases certain by-products, among them trihalomethanes (THM), substances of particular concern to public health authorities. It is believed that long-term exposure to these compounds may increase the risk of bladder cancer. No recent data are available on the THM concentrations in the water supply systems in the sector. Moreover, a number of waterfront municipalities have modified their treatment processes to minimize formation of these by-products.

4.2.3.2 *Fish and game consumption*

With regard to users of the Lake of Two Mountains, recreational fishers who consume fish are most likely to become exposed to contaminants in the aquatic environment (see Section 5.1.2). Regular consumption of large amounts of certain species of fish caught in contaminated bodies of water may pose health risks. In Quebec, mercury is often the most worrisome substance. However, the health risk associated with eating fish from the Lake of Two Mountains part of the study area may be considered negligible, provided official consumption advisories are complied with.

According to a brochure on the topic[14], recreational fishers may eat the fish they catch in the study area; however, they should limit their consumption of large piscivorous species (bass, pike, Muskellunge, Walleye) to two meals per month. However, they may eat up to four meals

[13] This percentage excludes the municipality of Pincourt, located outside the sector.

per month of bullhead, Lake Sturgeon, Rock Bass, Burbot, sucker and Yellow Perch. No restrictions apply to the other species.

As long as people abide by the recommendations concerning consumption (number of meals) and preparation of fish[15] and also avoid eating specimens with external lesions[16], the health risks are negligible, based on current knowledge.

No specific studies have been done on consumption of fish caught in the Lake of Two Mountains. However, a study involving 192 sport fishermen in the Montreal region (Lake Saint-François and Lake Saint-Louis) showed that slightly higher levels of mercury, PCB and other toxic substances can be detected in the tissues of people who eat large amounts of fish from the St. Lawrence (about 6 meals of 230 g per month) than in people who eat, say, one meal per month. People who ate fish regularly did not exhibit excessive levels of chemical contaminants.

In short, the risk of contamination from eating fish is low, provided that people abide by consumption advisories. In addition to being a good dietary source of proteins, vitamins and minerals, fish offers some protection against cardiovascular disorders. Moreover, for pregnant and nursing women, the polyunsaturated fatty acids and nutrients in fish meet essential requirements for the fetal nervous system.

With regard to waterfowl, contaminant concentrations have not been found to be high enough to warrant restrictions on consumption[17]. However, although no specific advisories exist, it appears that mergansers contain high enough mercury levels in their flesh to pose a threat if

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[14] The brochure entitled *Connaissez-vous les Oméga-3? Moi, oui…* was produced jointly by the Quebec departments of Agriculture, Fisheries and Food (MAPAQ), Environment and Wildlife (MEF) and Health and Social Services (MSSS).

[15] Since organochlorines tend to concentrate in the fatty parts of fish, it is possible to reduce the quantity ingested by not eating the skin, viscera and fatty parts. It is recommended that the cooking juices not be eaten either.

[16] Parasites and external abnormalities may sometimes be prevalent in fish taken from the St. Lawrence. Most fish parasites present no danger for humans. As a precaution, however, the flesh should be thoroughly cooked and the skin and viscera should not be eaten. It is also recommended that people not eat fish that have external abnormalities (ulcerating dermatitis, dermal growths, oral papillomas, etc.).

[17] Although contaminant concentrations may be low, as an additional precaution people should use cooking methods that remove as much fat as possible. To eliminate all risk of parasitic or microbiological contamination, meat should be well cooked.

consumed on a regular basis (i.e. more than four means per month over several years). These birds are migratory and spend only a short period of time in the study area.

It should be kept in mind also that hunting and fishing enthusiasts derive benefits from these sports, which can be relaxing and good for their well-being.

4.2.3.3 *Recreational activities*

Swimming and water-contact activities (water skiing, personal watercraft use and windsurfing) are very popular around the Lake of Two Mountains. Besides the 17 000 or so recreational boaters who frequent the lake and the 14 000 visitors who use the locks, many people flock to the public beaches in this part of the study area or the adjacent area, notably at Oka Provincial Park, Cap-Saint-Jacques or Ile Bizard. These beaches are monitored under the provincial Environment Ministry's beach water quality program during the summer season; water quality was found to be excellent at the beaches in 1998. At the Lake of Two Mountains, the number of swimmers was estimated at 32 000 in 1994, which is a highly conservative figure considering the fact that Oka Park (western part of the lake) alone received 343 000 visitors in 1996 and that Cap Saint-Jacques and Ile Bizard parks received 145 000 visitors in 1994.

There are a few other sites that are used by swimmers; however, the bacteriological quality of the water has not been evaluated there and there is no lifeguard service to ensure the safety of users. Swimming in contaminated water exposes people to such health problems as gastro-enteritis, and skin, eye and ear infections.

4.3 Other Pressures on Resources

Other processes may undoubtedly have effects on the natural environment in the sector. However, it is difficult at this time to assess their magnitude.

4.3.1 Introduced and expanding species

Today, it is known that the voluntary or accidental introduction of new species into an ecosystem can have a significant impact on the indigenous flora and fauna. Many people are familiar with the cases of the House Sparrow and the European Starling, introduced species that are now integrated with the local fauna. Some examples of fish species that have been introduced locally are Brown Trout, Rainbow Trout and carp.

With regard to some more recent invaders, the process of colonization or expansion is still ongoing and the overall consequences of their advent have not yet been assessed.

Purple loosestrife is an introduced plant species that is currently expanding. It tends to colonize marshes and wet meadows, displacing indigenous plants such as reed canary-grass, prairie cordgrass and bluejoint.

Two invertebrates, the Zebra Mussel and the Quagga Mussel, are currently invading the St. Lawrence River. It is feared that these newcomers will harm indigenous bivalves (e.g. the family Unionidae). The abundance of Zebra Mussels, reported for the first time in the Des Prairies River in 1991, has not increased since then. With regard to the Quagga Mussel, it appears to be absent from the study area. These exotic mussels probably have not yet invaded the Ottawa River basin, because of unfavourable conditions there.

Among the region's bird species, the Ring-billed Gull is the one that has expanded its range most in the Montreal region over the past 20-odd years. The gull's numbers appear, however, to be levelling off. This opportunistic species has learned to take advantage of human-induced alterations to the environment; some individuals feed on refuse (dumpsites, trash cans and public places) and groups of gulls are often seen on farms following the plough. When Ring-billed Gulls gather in large numbers, their droppings may cause local water pollution problems.

4.3.2 Environmental accidents

Many of the tracts of land located near water bodies in the sector are subject to flooding because the Ottawa River is only partially regulated.

The flood of 1974 caused substantial damage to many properties in the Montreal region and prompted the construction of control structures (e.g. at the head of the Mille Îles River). As part of the Archipelago Project, a plan was devised to harness the hydro-electric potential of the waters in the Montreal area and stop the flooding once and for all through a series of control structures. As this project was abandoned in 1985, the sector is still exposed to the floods that occur on the Ottawa River. To minimize the risk of flooding around Montreal, a special committee on regulating the Ottawa River has been mandated to manage the operations of all the works within the river's watershed.

No specific information is available on public health problems related to flooding in the sector over the past few years. However, such episodes represent a risk not only to the safety of shoreline residents, but also to their health, since victims may have to survive for some time in unhygienic conditions. The most common problem is respiratory difficulty caused by the growth of mould in recently-flooded houses. Although the residents' physical health is not affected every time the river overflows its banks, the social and psychological impacts associated with property losses and evacuations can sometimes be serious.

CHAPTER 5

Sector Resources and Assets

Despite the alterations to the natural environment caused by intensive human activities, the sector still has many amenities that are intricately associated with the proximity of the water bodies. These assets need to be factored into the overall picture, since development in the sector is partially dependent on them.

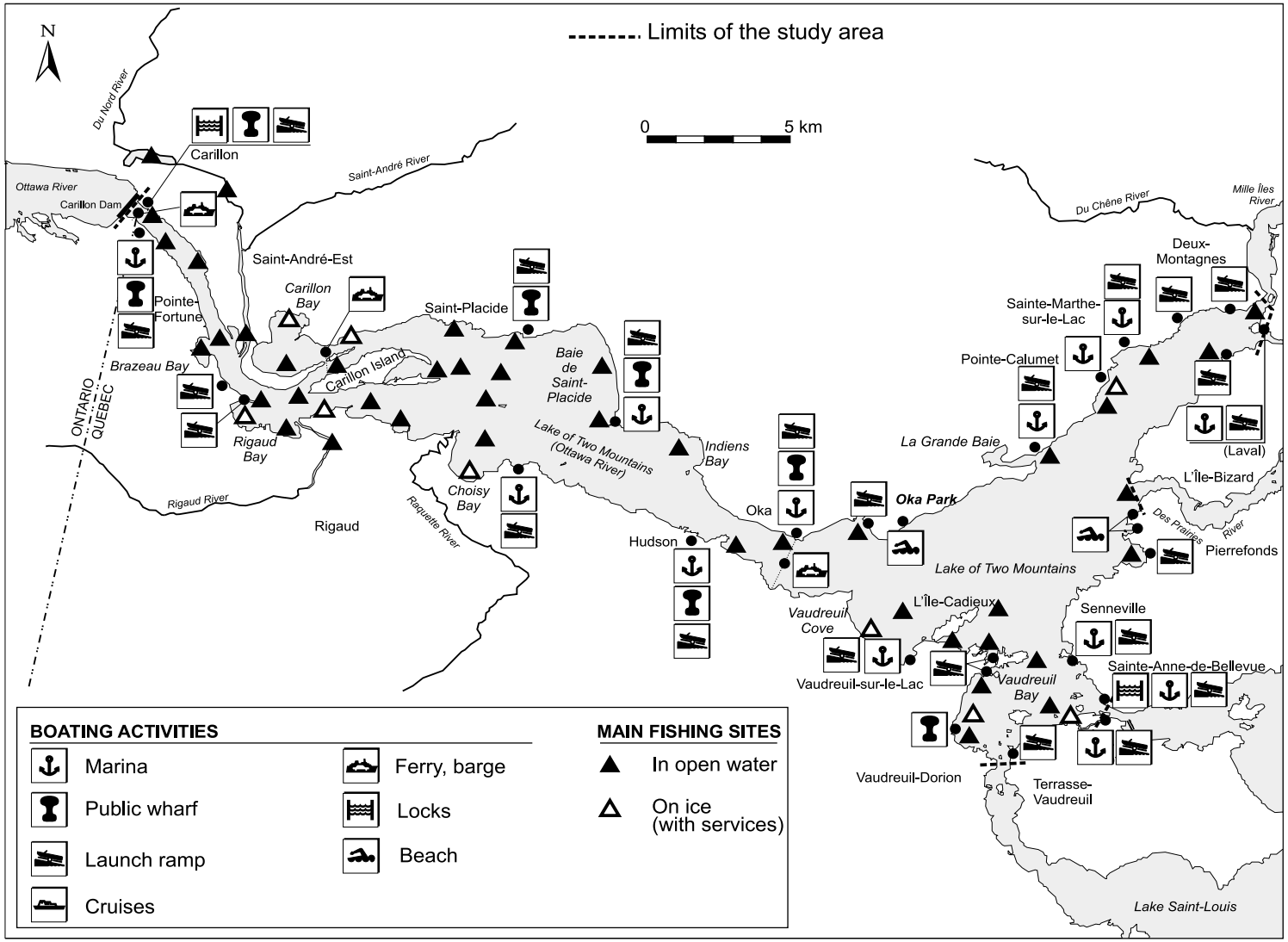
5.1 Recreation and Tourism

On account of its location near Montreal, the sector offers a wide range of recreational and tourism activities. Our interest in this case is those activities related to the presence of the water resource.

5.1.1 Pleasure boating

The Lake of Two Mountains offers pleasure boaters 118 km^2 of navigable area, which is especially suitable for sailing. Some 17 000 pleasure boaters use the lake every year. Regardless of the type of boat, this lake does not present any notable navigation hazards (currents, shoals) and, even better, commercial ships do not ply its waters. By going through the Carillon lock, boats can travel up the Ottawa River toward Ottawa, and from there they can reach Kingston via the Rideau Canal. A regional project is under way with the goal of improving the links between the different water bodies around the Island of Montreal, and even the links with upstream lakes, which could give a boost to recreational boating.

Pleasure boaters can stop off in many locations around the Lake of Two Mountains. There are some 20 wharves and marinas, providing 1315 places to dock. Figure 13 gives an overview of the recreational boating facilities available in the sector.



Source: Tecsult Inc., 1995; Office du Tourisme de Laval Inc. and Tourisme Québec, 1998; Mongeau and Massé, 1976; MLCP, 1991.

Figure 13 Boating infrastructure and main access points for fishing

Boating in these waters demands a degree of caution. In 1997, the Canadian Coast Guard was called out to deal with 108 incidents on the Lake of Two Mountains involving pleasure craft, chiefly motor boats. The most common problems were mechanical failure and grounding, usually due to negligence: ignorance or poor judgment or inebriation. Injuries, hypothermia, psychological distress and even drownings can result from such incidents. Between 1990 and 1997, three drownings were reported in connection with recreational activities in the Lake of Two Mountains part of the study area. The risk of drowning can be mitigated by the wearing of flotation devices.

5.1.2 Sport hunting and fishing

In the early 1980s, an estimated 13 700 fishers frequented the Lake of Two Mountains; however, the number has probably risen since then. Fishers have a few favourite spots: they like to practise their sport downstream from Carillon Dam, in the Carillon, Choisy, Vaudreuil and Fer à Cheval bays, in the Hudson shallows, at Parsons and Oka points, and around Cadieux Island. In 1985, seven species made up nearly all the catches made by sport fishers: they are, in descending order, Yellow Perch, Walleye, Brown Bullhead, Northern Pike, Smallmouth Bass, Pumpkinseed and Channel Catfish

Ice fishing is a popular activity on the lake. In 1985, the fishing effort in winter amounted to 255 200 fisher-days, which corresponds to a harvesting pressure of 16.4 fisher-days/ha, the highest rate in the Montreal region as a whole. Shack rentals and outfitting services are available near Carillon and Choisy bays, as well as at Vaudreuil-sur-le-Lac and Sainte-Marthe-sur-le-Lac.

Duck hunting is not as intensive on the lake as in most sections of the St. Lawrence. Between 1977 and 1981, only 13 000 ducks were taken there. Roughly 54% of the birds taken were diving ducks, mostly Common Goldeneyes, Greater Scaup and Lesser Scaup. The dabbling ducks (36% of the birds taken) consisted primarily of Mallards, Black Ducks, Wood Ducks and Blue-winged Teals. The Sainte-Anne and Cap-Saint-Jacques rapids are popular spots for hunters, especially at the start of the hunting season.

5.1.3 Sites suitable for wildlife observation and interpretation

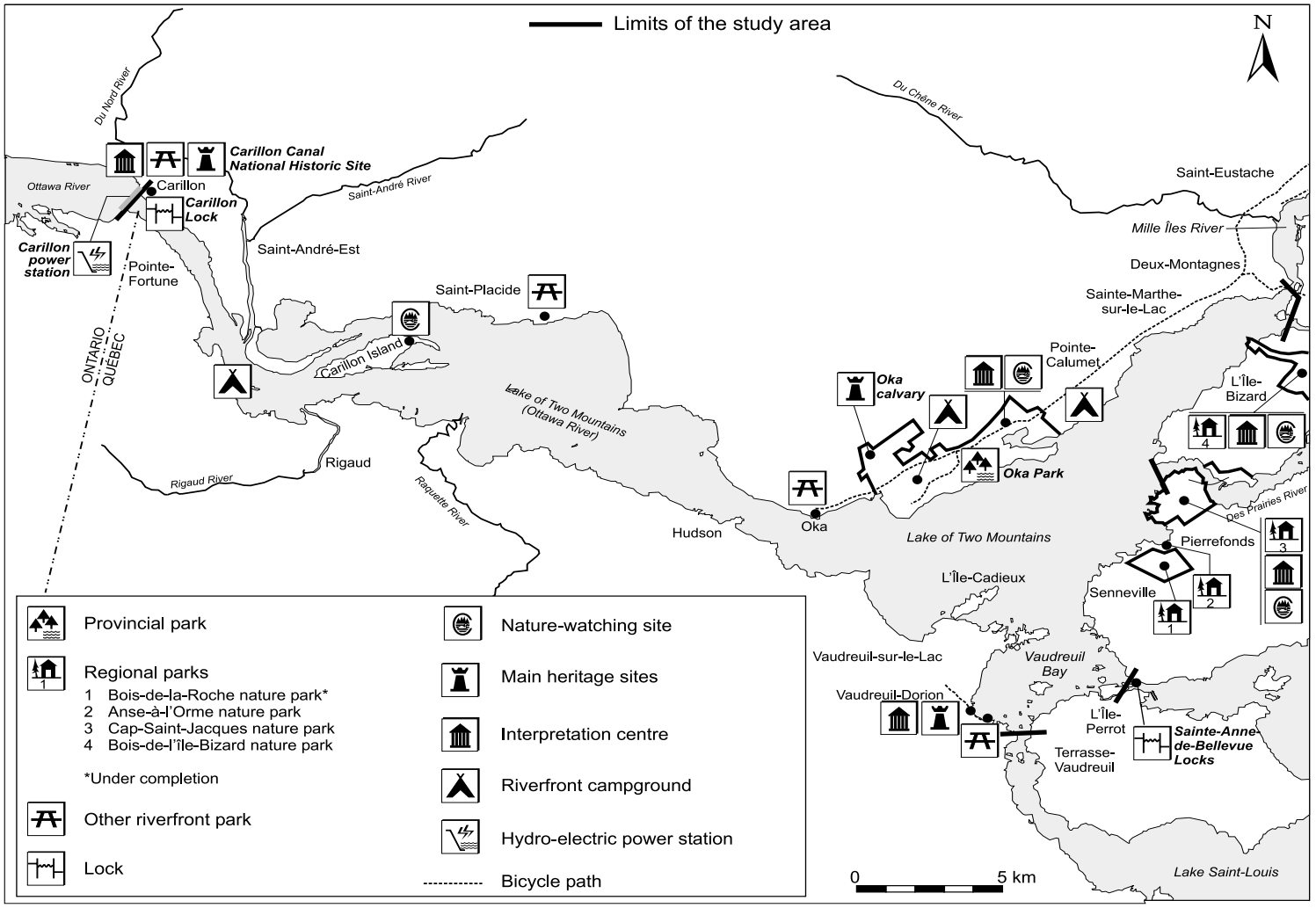
Every year the number of bird-watchers grows. The Lake of Two Mountains part of the study area includes some good spots for bird-watching: the most popular sites are the Vaudreuil rapids, Ile Claude, Oka Park, the Morgan Arboretum and the Rigaud, Saint-Lazare, Vaudreuil and Hudson areas. In 1994, a total of 24 000 nature observers and hikers visited the sector.

5.1.4 Vacation spots and tourist attractions

The Lake of Two Mountains long ago acquired the reputation as a good vacation spot near Montreal. Before the towns of Deux-Montagnes, Sainte-Marthe-sur-le-Lac and Pointe-Calumet became affected by Montreal's expansion, their pastoral charms and the clean water attracted city dwellers in search of relaxation Even today, there are some 1300 cottages around the lake, primarily at Pointe-Calumet, Saint-Placide and Vaudreuil-Dorion.

Recreational uses account for 14% of the land area. The best known and most popular places are Oka Provincial Park and Carillon Canal National Historic Site. There are also some MUC nature parks in the sector (Bois-de-la-Roche, Cap-Saint-Jacques, l'Anse-à-l'Orme and Bois-de-l'Île-Bizard) and many municipal parks bordering the lake (Figure 14). Public access to the lake consists of only two spots on the eastern shoreline (at Vaudreuil-Dorion and near Rigaud) and two places in the western part (Saint-Placide, Carillon Island). On the whole, the recreational network is not very well developed, compared with the facilities in other sectors of the St. Lawrence.

Nevertheless, in 1994 a total of 32 000 people swam in the lake, and this estimate is probably very conservative, given that 145 000 visitors used the Cap Saint-Jacques and Ile Bizard parks that same year and Oka Provincial Park alone received 343 000 visitors in 1996.



Source: Tecsult Inc., 1995; Office du Tourisme de Laval Inc. and Tourisme Québec, 1998; ATR de la Montérégie and Tourisme Québec, 1998; ATR des Laurentides and Tourisme Québec, 1998.

Figure 14 Tourist attractions and recreational facilities

5.2 Biodiversity and Conservation

Roughly 1% of the territory of the Lake of Two Mountains part of the study area is dedicated to conservation. Certain sites that are important for flora and fauna already enjoy legal protection (Figure 15). Many other sites remain unprotected, however.

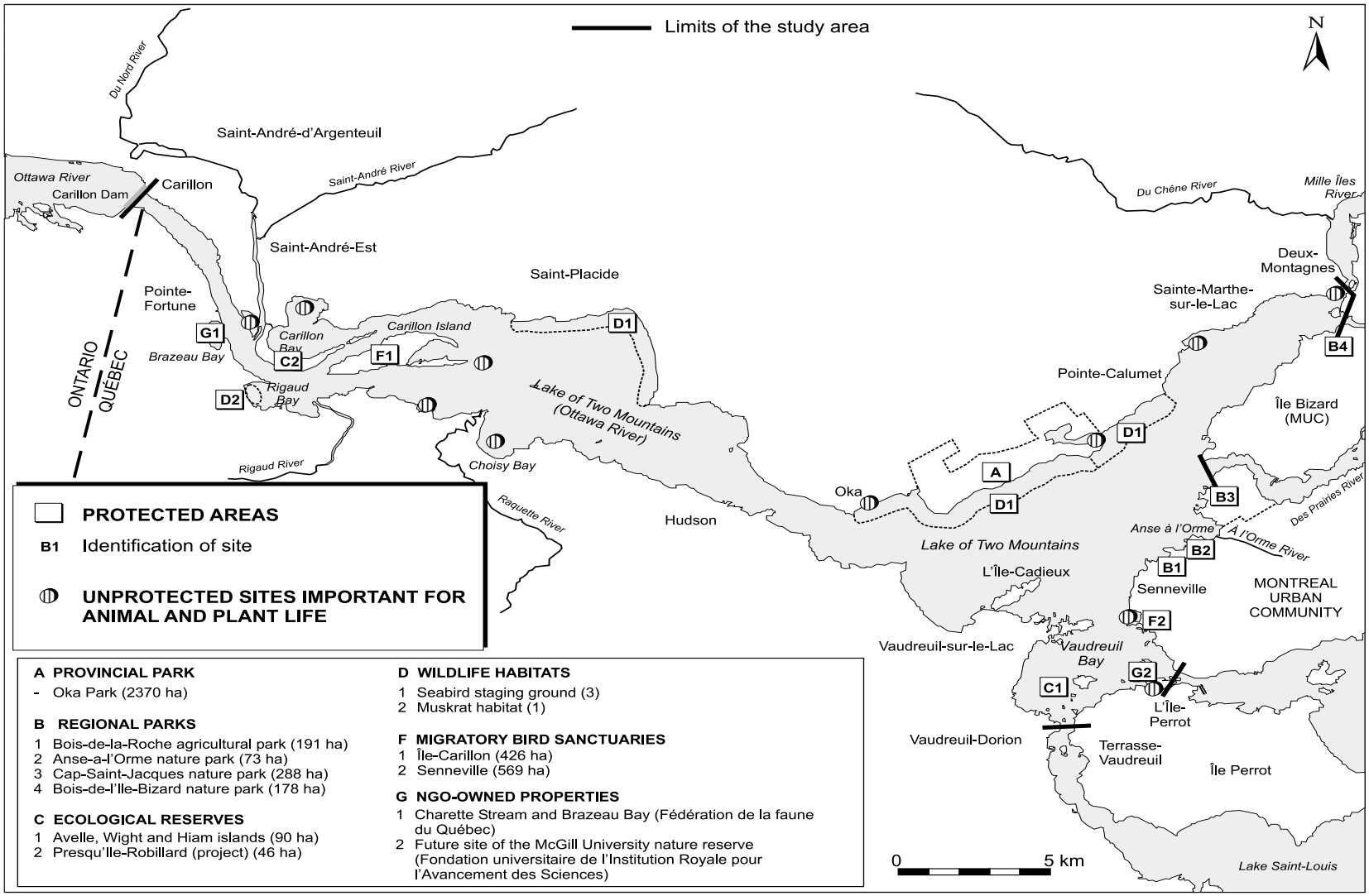
The *Carillon Island Migratory Bird Sanctuary*, created in 1931, protects nesting and staging sites for migrating waterfowl. The site covers 426 ha, including 125 ha of aquatic and riparian habitat. The sanctuary includes the islands of Carillon and Paquin, along with a marsh and a swamp. Carillon Island contained a heron colony in the 1980s.

The *Senneville Migratory Bird Sanctuary*, located on the westernmost tip of the Island of Montreal, was set up in 1936. This wooded area of 569 ha is often used by passerine birds (Indigo Bunting, American Robin, warblers), although raptors can also be observed there.

Located in Vaudreuil Bay, the ecological reserve called *Réserve écologique des Îles-Avelle-Wight-et-Hiam* was set up in 1994 to protect wetland plant communities representative of the Lake of Two Mountains region. One rare plant association is found there — white oak–red oak stands — along with a number of vascular plant species that are likely to become listed as threatened or vulnerable. The reserve comprises a group of islands covering about 90 ha and aquatic and riparian habitats of excellent quality.

Oka Park, created in 1990, is dedicated primarily to recreation, as well as to protecting the natural environment. It has an area of 23.7 km² and harbours about 40 plants that are likely to become designated as threatened or vulnerable. The park features a *floristic habitat*[18] within its boundaries.

[18] This designation arises from the *Act respecting threatened or vulnerable species*. The habitat concerned is that of late coral-root (Pringle variety), a threatened species.



Source: CWS, 1998; MUC, 1998; MEF, 1997; Bélanger et al., 1994; MLCP, 1998; Thibault, 1998; UQCN, 1993, 1998; Tanguay, 1998.

Figure 15 Protected areas and other important wildlife sites

Four Montreal Urban Community (MUC) nature parks are located in this part of the study area: the *Bois-de-la-Roche* agricultural park, and the *Anse-à-l'Orme*, *Cap-Saint-Jacques* and *Bois-de-l'Île-Bizard* nature parks. These parks have a dual role to conserve natural heritage and provide recreational opportunities.

The status of *wildlife habitat*, granted under the *Quebec Act respecting the conservation and enhancement of wildlife*, prohibits all activities likely to alter the habitat involved. At the Lake of Two Mountains, the publicly-owned sites that have this status consist of three waterfowl staging areas, a Muskrat habitat in Rigaud Bay, and the entire lake, which is protected as fish habitat.

A pilot project for *voluntary conservation* was initiated in 1994 to develop Charrette Stream and Brazeau Bay. The goal is to protect wetlands and terrestrial areas on about 40 privately-owned properties. Habitat enhancement work is to be carried out and the project also involves a development component centring on educational, recreational and commercial activities.

On Ile Perrot, west of Ile Claude, there is a group of woodlands and ponds bordering the Lake of Two Mountains, for which a McGill University foundation holds purchases options. This site is to be designated a *nature reserve* and used for research projects by McGill University students, including those at its Macdonald campus. The reserve encompasses an interesting variety of terrestrial and wetland habitats. The Northern Water Snake occurs there, a species that may eventually be listed as threatened or vulnerable.

Rare, threatened and sensitive species represent key elements of biodiversity in view of their unique character or their precarious situation. The study area is home to 18 plant species, 4 fishes, 1 amphibian, 5 reptiles and 13 bird species (including 6 nesters) which are considered priorities under the SLV 2000 Action Plan (Appendix 1).

5.3 Utilitarian Use of the Water Body

Proximity to a large water body provides human communities with numerous benefits that are too often overlooked.

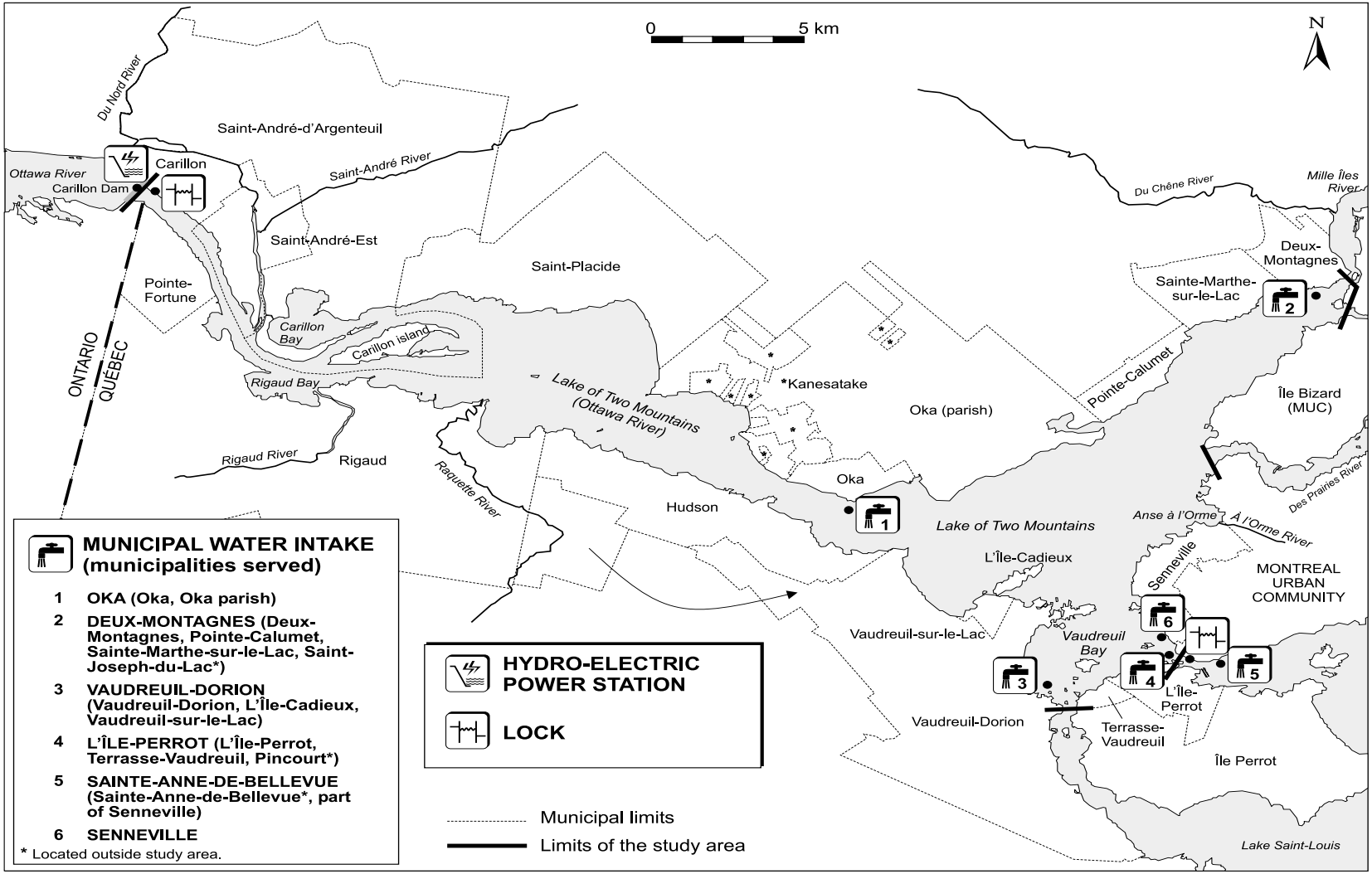
5.3.1 Water supply

An abundant supply of good-quality water is a precious resoruce. A considerable proportion of the sector's population (66%) is hooked up to water supply piped from one of four stations (Oka, Deux-Montagnes, Vaudreuil-Dorion and Ile-Perrot) (Figure 16). The volume of water drawn from the Lake of Two Mountains and the Ottawa River is some 26 000 m^3/day. Residents who are not connected to the water supply system have private wells, and their water consumption rates are not known.

5.3.2 Hydro-electricity

At several locations within its watershed, the Ottawa River offers conditions conducive to the generation of hydro-electricity. The Carillon and Rivière-des-Prairies generating stations are located on its lower reaches.

The Carillon generating station, at the head of the Lake of Two Mountains, was built in the early 1960s. It has 14 turbines (18 m head) which generate a total of 654 MW. There is a lock adjacent to the station, which enables boats to go between the Ottawa River and the Lake of Two Mountains.



Source: Jourdain et al., 1999.

Figure 16 Utilitarian uses of the water

5.3 Commercial Fishing

Commercial fishing was once intensive in the St. Lawrence River and its main tributaries, particularly between 1929 and 1939, during the Depression. Fishing has declined considerably as a result of tighter regulations, the ban on marketing of certain contaminated species, and the decreased abundance of the resource, with allocations now being granted primarily to sport fishermen.

A commercial fishery existed in the Lake of Two Mountains until the 1950s and provided work for about 30 fishers using droplines, nets or fykes. Catches consisted mainly of Lake Sturgeon, Brown Bullhead, Channel Catfish, Yellow Perch, Northern Pike, Walleye and American Shad. The fishery was closed following the mass mortalities recorded between 1949 and 1952, which decimated the fish populations.

The only commercial fishing still being conducted is for bait fish. It is difficult to gauge the actual extent of this activity because of the rapid turnover of the fish in tanks and the opportunity for underreporting catches. The demand for bait fish from sport fishers appears to have declined owing to recent restrictions imposed under fishing regulations relative to the use of live bait.

CHAPTER 6

Strategies for Sustainable Development

Sustainable development of the Lake of Two Mountains part of the study area entails protecting the remaining biodiversity and promoting a variety of water-related uses, thus enhancing the quality of life for shoreline residents.

6.1 Main Issues

In the Lake of Two Mountains (ZIP 24) sector, it is imperative that certain key issues be taken into consideration in drawing up action plans.

6.1.1 Protecting wetlands and biodiversity

The Lake of Two Mountains part of the study area has a diverse assemblage of aquatic and riparian habitats, which are of inestimable value for biodiversity conservation. A number of islands harbour plant communities that are unique not just in the Montreal region as a whole, but in the province, too. Naturalists and hikers alike still have a chance of encountering plants, amphibians, reptiles, birds and fish species that have become a rare commodity elsewhere around Montreal. In the lake, downstream from the Carillon generating station, there is an American Shad spawning ground, the only one known to still exist in Quebec.

It is imperative that steps be taken to preserve these unique components of Quebec's natural heritage for the benefit of future generations. Initially, it might seem that the main threat to the integrity of these resources is the expansion of Montreal, which extends beyond the Island of Montreal and Ile Jésus, encroaching mainly on the eastern part of the lake. Preserving wetlands from the dangers posed by continuing urban development and shoreline conversion is of paramount importance.

The relative lack of knowledge of the Lake of Two Mountains area, its habitats and resident species represents a hindrance to efforts to protect them. So far the lake has not been studied very much, and many knowledge gaps exist. Efforts should be devoted to filling these gaps and deciding what conservation measures should be implemented.

6.1.2 Reducing contamination

An essential condition for preserving some of the present uses of the lake is continuing the progress made in improving water quality. Data collected in recent years show that the condition of the lake has improved markedly. In the early 1950s, a few consecutive episodes of oxygen deficiency occurred in the deep waters of the lake in winter. Those events, which were attributed to the effluents from pulp and paper mills along the Ottawa River, decimated the populations of several fish species, including Lake Sturgeon. The latter population, which is separate from the Lake Sturgeon population in the St. Lawrence, has never really recovered.

Such events are less likely to occur today, thanks to the abatement measures that have been implemented; however, vigilance is still in order relative to water quality. Attention needs to be devoted notably to maintaining the present downtrend in phosphorus concentrations in the water.

6.1.3 Reconciling recreational and tourism development with conservation

The Lake of Two Mountains has long been a popular vacation and outdoor recreation spot, conveniently situated right beside Montreal. This advantageous situation has been a driving force for local development, which is expected to continue for the foreseeable future.

To ensure that this recreational and tourism vocation does not hinder efforts to conserve natural heritage, choices may have to be made in some cases to permit the harmonious coexistence of these two functions. Wetland enhancement activities, public education and efforts to raise awareness of the fragility of natural habitats, which are already under way, will have to consolidated. Where necessary, steps must be taken to control certain recreational activities that

are likely to have adverse effects on the environment, for example, disturbance of wildlife or the deterioration of fragile habitats.

6.2 Taking Action

To refocus planning related to the uses of this remarkable water body in accordance with sustainable development objectives, many aspects of the above-mentioned problems should be kept in mind. Besides the limitations that certain uses impose on resources, leading inevitably to conflicts among users, the permanency of certain changes that have taken place (and cannot realistically be reversed) must be taken into account. Existing roads, docks and other structures constrain planning in ways that may be considered irrevocable. However, more importance can be given to the protection of subsisting natural habitats and the restoration of degraded habitats.

To ensure that habitats are not degraded as a result of short-sighted decisions made in response to the concerns of special interest groups, it is important to weigh land development options very carefully.

These issues need to be assessed and discussed, in full knowledge of the facts, by all groups interested in conserving the lake and the local quality of life, so that the strategies that are eventually adopted suit the entire community. Table 4 provides a preliminary outline for discussing suitable development options for the sector.

Following such discussions, it should be possible to co-ordinate uses in keeping with the goal of preventing further degradation of natural habitats. Once a consensus has been reached on priorities for action, it will be easier to come up with a concrete action plan with which partners will be happy to comply.

Conservation of the remaining intact aquatic and riparian habitats and restoration of those that have been degraded constitute an exciting challenge. It is to be hoped that future generations will also be able to enjoy the rich diversity of these unique habitats, in full awareness of their fragility and with concern for preserving them.

Table 4
Main issues in the sustainable development of the Lake of Two Mountains sector (ZIP 24) of the study area

Issue	*Main effects on the water body and its resources*	*Assessment of the current situation in light of sustainable development objectives*	*Guidelines for sustainable development*
Protecting wetlands and biodiversity	The most common alterations in the sector appear to be shoreline encroachments, initially associated with cottages and then urban expansion. This phenomenon appears to be concentrated mainly in the eastern part of the lake. The construction of control works at Carillon and in the outlets of the lake may have created impediments to the passage of certain fish species, such as American Shad.	**Biodiversity:** The disappearance of natural shoreline areas spells an impoverishment of the environment. Some plant communities that are unique in Quebec have been reduced to just a few patches covering a small area. The status of a number of plant and animal species, which may be at risk, is not well known. **Uses:** Certain uses of the water body, for instance, fishing or wildlife observation, are affected by the increasing extent of artificial shorelines or by the associated impoverishment of certain resources. **Quality of life:** Artificial shorelines have a permanent effect on the landscapes accessible to lakeside residents.	**Biodiversity:** The most urgent measure consists of halting development along the shoreline and the clearing of vegetation. To ensure informed decision making about conservation of the environment, it is necessary to increase knowledge of local ecosystems and their flora and fauna. Some actions may permit an increase in diversity: restoration of degraded shoreline areas, protection against erosion, conservation of natural habitats and enhancements for wildlife. **Uses and quality of life:** Conservation and development of natural habitats along the water body can improve the quality of life for residents living nearby and all other users.

Table 4 (cont'd 1)

Issue	*Main effects on the water body and its resources*	*Assessment of the current situation in light of sustainable development objectives*	*Guidelines for sustainable development*
Reducing contamination (industrial and municipal effluents; tributaries)	In the past, the lake received inputs of contaminants from the Ottawa River due to forestry operations carried out in the watershed (log drives, effluents from paper mills, etc.) and agricultural activities. Local sources of contamination (municipal effluents, agricultural activities) had localized effects, near the shores. Abatement and cleanup measures appear to have improved the situation markedly.	The main parameter that is still a problem in terms of water quality is the total phosphorus level. At several spots in the deep part of the lake, clean surface sediments may overlie old layers of sediment that are contaminated with lead, mercury and PCBs. **Biodiversity:** Pollution can reduce the numbers of many species and alter the structure of living communities. Organisms that tolerate this degradation become predominant. This does not appear to be the case in the Lake of Two Mountains, since the communities are in good condition. **Uses:** Effluents discharged into the aquatic environment untreated have many adverse effects on certain uses (restrictions on recreational activities involving water contact and on fish consumption, etc.). **Quality of life**: Pollution jeopardizes enjoyment of the water body for local residents and has an impact on recreational potential, hindering certain activities.	Municipal, industrial and agricultural pollution abatement programs appear to have substantially reduced inputs of toxic substances and nutrients to the water. It is essential to continue these efforts and build on the progress achieved. **Biodiversity:** Disturbances caused by pollution can be reversed over varying time periods, depending on the nature of the contaminants and how long they stay in the environment or in the tissues of aquatic organisms. **Uses:** The most effective measure for curbing losses of use due to pollution is controlling discharges at source: introduction of less polluting practices, treatment of municipal and industrial effluents, etc. Even if some of these changes may appear costly a priori, they are economically advantageous in the long term, compared with the indirect costs associated with a laissez-faire approach. **Quality of life:** Controlling pollution gives communities all the benefits of their proximity to the water.

Table 4 (cont'd 2)

Issue	*Main effects on the water body and its resources*	*Assessment of the current situation in light of sustainable development objectives*	*Guidelines for sustainable development*
Harmonization of recreation and tourism with conservation of the natural environment	Anarchic development of recreation and tourism and overly intensive activities may, under certain conditions, conflict with conservation of the natural environment. (e.g. disturbance of fauna, trampling of fragile habitats, gathering of rare plants).	**Biodiversity:** In general, natural habitats and animal populations tolerate the presence of humans. A number of species are amenable to moderate sport fishing and hunting. The development of recreation and tourism infrastructure may affect certain components of natural habitats. Intensive use of the water body may have repercussions on living communities. **Uses:** The presence of a large number of boats and the noise they create can become a nuisance for other users and shoreline residents. Recreational boating is governed by safety regulations, but other rules should be established to protect the natural environment. Hunting and fishing are regulated from the standpoint of harvest levels. **Quality of life:** The opportunity to engage in water-based recreational activities contributes to the well-being of lakeside residents and attracts tourists. Recreation and tourism activities can generate substantial economic spinoffs, provided they are carefully planned.	**Biodiversity:** Wildlife habitat protection ensures that animal and plant populations and the recreational activities that depend on them will be maintained. In cases where recreation and tourism might affect natural habitats, compliance guidelines should be established and users made more aware of conservation. **Uses:** Recreational boating, hunting and fishing must be controlled to prevent conflicts with other habitat uses (disturbance of wildlife, public access to the water body and safety). Planning must take into account certain nature interpretation and observation activities, which are increasing in popularity. **Quality of life:** Various water sports, outdoor and nature-observation-related activities can further enhance tourist attractions. Recreation and tourism facilities and their locations and operating methods should be chosen wisely so as not to degrade the natural environment and areas inhabited by humans.

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Appendices

1 St. Lawrence Vision 2000 (SLV 2000) Priority Species Found in the Lake of Two Mountains–Des Prairies River and Mille Îles River Study Area (ZIPs 24 and 25)

Name	*Type of distribution or status in the study area*
Plants (18 of the 110 priority species)	
Agastache nepetoides (Yellow giant hyssop)	Peripheral, north LTM only
Allium tricoccum (Wild leek)	Peripheral, north, PR only
Arisaema dracontium (Green dragon)	Peripheral, north, PR only
Carex formosa (Handsome sedge)	Peripheral, north, LTM and MIR only
Carex lupuliformis (False hop sedge)	Peripheral, north, LTM only
Justicia americana (American water-willow)	Peripheral, north, PR and MIR only
Lycopus virginicus (Virginia waterhorehound)	Peripheral, north, MIR only
Lysimachia quadrifolia (Whorled yellow loosestrife)	Peripheral, north, LTM only
Panicum virgatum (Switchgrass)	Peripheral, north, MIR only
Podophyllum peltatum (Mayapple)	Peripheral, north, LTM only
Polanisia dodecandra (Clammyweed)	Peripheral, north, LTM only
Polygonum punctatum var. *majus* (Stout smartweed)	Peripheral, north, PR only
Pycnanthemum virginianum (Virginia mountainmint)	Peripheral, north, LTM and MIR only
Saururus cernuus (Lizard's tail)	Peripheral, north, LTM and MIR only
Sorghastrum nutans (Yellow Indiangrass)	Peripheral, north, LTM only
Taenidia integerrima (Yellow pimpernel)	Peripheral, north, LTM only
Torreyochloa pallida var. *pallida* (Pale false mannagrass)	Peripheral, north, LTM only
Wolffia borealis (Northern watermeal)	Peripheral, north, PR only
Fish (4 of the 14 priority species)	
Lake Sturgeon	Migratory, fresh water
American Shad	Migratory, anadromous
American Eel	Migratory, catadromous
Copper Redhorse	Resident, fresh water
Amphibians and reptiles (6 of the 6 priority species)	
Western Chorus Frog	Presence confirmed, current status unknown
Brown Snake	Presence confirmed, current status unknown
Wood Turtle	Presence confirmed, current status unknown
Spotted Turtle	Presence confirmed, current status unknown
Spiny Softshell Turtle	Presence confirmed, current status unknown
Map Turtle	Presence confirmed, current status unknown

Name	*Type of distribution or status in the study area*
Birds (13 of 19 priority species)	
Horned Grebe	Migrant
Least Bittern	Possible nester on LTM
Northern Pintail	Confirmed nester, except along MIR
Blue-winged Teal	Confirmed nester on LTM and along PR, probable nester along MIR
Barrot's Goldeneye	Migrant
Bald Eagle	Possible nester on LTM
Peregrine Falcon	Probable nester along PR
Common Moorhen	Confirmed nester, except along MIR
Caspian Tern	Possible nester on LTM
Red-headed Woodpecker	Confirmed nester on LTM
Sedge Wren	Probable nester on LTM
Loggerhead Shrike	Possible nester, except along MIR
Grasshopper Sparrow	Possible nester on LTM

Abbreviations: LTM: Lake of Two Mountains; PR: Des Prairies River, MIR: Mille Îles River.

2 **Environmental Quality Criteria** (for assessing loss of use)

Ecosystem Component	*Reference Criterion*	*Objective*
WATER	Raw water (untreated water taken directly from a body of water) (MENVIQ, 1990)	Protect the health of persons who may both drink water directly from a body of water and eat aquatic organisms caught there throughout their lives.
	Contamination of aquatic organisms (MENVIQ, 1990)	Protect human health from the risks associated with consumption of aquatic organisms.
	Aquatic life (chronic toxicity) (MENVIQ, 1990)	Protect aquatic organisms and their offspring and wildlife that feed on such organisms.
	Recreational activities (primary contact) (MENVIQ, 1990)	Protect human health in the context of recreational activities involving total body contact with the water (e.g. swimming and windsurfing).
SEDIMENTS	No effect threshold (NET) (SLC and MENVIQ, 1992)	Contaminant levels are below those at which any effects on benthic organisms are observed.
	Minor effect threshold (MET) (SLC and MENVIQ, 1992)	Contaminant levels exceed those at which minor but tolerable effects are observed in most benthic organisms.
	Toxic effect threshold (TET) (SLC and MENVIQ, 1992)	Contaminant levels exceed those at which harmful effects are observed in most benthic organisms.
AQUATIC ORGANISMS	Protection of aquatic life (IJC, 1987)	Protect the health of fish-eating aquatic organisms.
	Fish and poultry marketing guidelines (HWC, 1985)	Maximum acceptable contaminant levels in the tissues of fish, molluscs, crustaceans and poultry sold for consumption.
	Freshwater sport fish consumption guidelines (MSSS and MENVIQ, 1993)	Prevent harmful effects on human health from eating contaminated fish, molluscs and crustaceans.

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3 Glossary

Anthropogenic: Effect resulting from human activity that transforms the natural environment.

Benthos: All organisms living in contact with the bottom of a body of water, divided into phytobenthos (plants) and zoobenthos (animals).

Biocenosis (or biological community): All the animals and plants living in a biotope.

Biomass: Total mass of living organisms, taken either globally or in systematic groups by surface or volume unit, in a given biotope at a given moment (e.g. plant, insect, herbivore, carnivore biomass).

Biotope: A limited region characterized by certain physical and chemical characteristics that provide an environment suitable for the development of living organisms (i.e. a biocenosis).

Community: All the living organisms, both plant and animal, occupying the same biotope.

Discharge: Volume of water carried by a watercourse, conduit, etc., in a given unit of time, generally expressed in cubic metres per second (m^3/s).

Distribution – **peripheral**: Refers to a species that lives at the edge of its geographic range.

sporadic (or disjunct): Refers to species found in an area or areas remote from their main range.

endemic: Refers to a species that is confined to a particular area.

Drainage basin: The entire continental land area drained by a river system; that is, the total precipitation catchment and drainage area.

Ecosystem: An entire physical and chemical environment (biotope) and all the living organisms (biocenosis) living there and able continue doing so indefinitely by virtue of matter and energy inputs.

Effluent: Any liquid released from a source of pollution, whether a residential area (domestic outfall) or industrial plants (industrial outfall). Point-source effluents (sewers): liquid pollutants discharged at a given location.

Habitat: Ecological framework in which an organism, species, population or group of species lives.

Marsh: Wetland habitat where plants emerge above the water surface.

Minimum flow: Lowest level of water flowing in a watercourse.

Nonpoint-source pollution: Diffuse discharge of pollutants into a given environment. Agricultural runoff is nonpoint-source pollution, since fertilizers and pesticides are spread over large areas.

Nutrient: Simple substance absorbed by plants and used in photosynthesis. Basic nutrients are nitrates, phosphates and silicates.

Sediment: Particles of soil and other solids formed by the weathering of rocks and other chemical or biological processes, and transported by air, water or ice.

Sediment regime: Set of streamflow characteristics that influence sediment transport, deposition and erosion..

Spawning ground: Place where fish gather to breed.

Suspended solid: Small particles of solid matter (> 0.45 m) floating in a liquid. Also called *suspended sediments* (see *Sediment*).

Tributary: Watercourse that empties into a larger river, or into a lake.

Turbid: Refers to water containing a high concentration of suspended matter.

Turbidity: Cloudiness of a liquid due to the presence of fine suspended matter (clay, silt or micro-organisms).

Waterfowl: Collective term for ducks and geese.

Water mass: Volume of water having relatively homogeneous physical and chemical properties.

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