REGIONAL ASSESSMENT
VARENNES–CONTRECŒUR

Regional Assessment
Varennes–Contrecœur

Priority Intervention Zone 10

Jean Robitaille

Edited by Marie-José Auclair
St. Lawrence Centre
Environment Canada – Quebec Region

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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 et de la Faune.

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Production Team

St. Lawrence Centre

Design and Writing	Jean Robitaille, consultant
Editing and Co-ordination	Marie-José Auclair
ZIP Writing Team	Alain Armellin Jean-François Bibeault Guy R. Fortin Nathalie Gratton Pierre Mousseau Marc Pelletier
Cartographic Analysis and Illustrations	Marcel Houle
Linguistic Revision and Text Layout	Patricia Potvin
Quebec Public Health Centre	Josée Chartrand Jean-François Duchesne Denis Gauvin

Contributors

Ministère de l'Environnement et de la Faune du Québec

Aquatic Ecosystems Branch	Gérard Croteau Yves Lefebvre
Lanaudière Regional Branch	Pierre Fournier Marie-Josée Gauthier
Montérégie Regional Branch	Jean Hubert Pierre Dumont

Environment Canada

Environmental Protection Branch	Alain Latreille
Canadian Wildlife Service	Léo-Guy de Repentigny

Health Canada	Sylvie Coad Louis L'Arrivée
Ministère de la Santé et des Services Sociaux	Claire Laliberté
Lanaudière Public Health Branch	Suzanne Fortin
Montérégie Public Health Branch	Danielle Gaudreau

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We would also like to thank all those from the sectoral and regional offices of the departments and ministries concerned who were involved in reviewing this report.

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.*

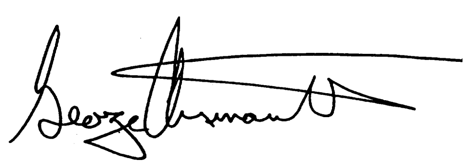
Through the ZIP program, riverside communities are invited to play an active part in achieving the objectives aimed at restoring the St. Lawrence and Saguenay rivers.

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.

Jean-Pierre Gauthier
Regional Director General
Quebec Region
Environment Canada
Co-chair, St. Lawrence Vision 2000



George Arsenault
Assistant Deputy Minister
Wildlife Resources and Parks
Ministère de l'Environnement et de la Faune
Co-chair, St. Lawrence Vision 2000

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

One of the most striking features of the Varennes–Contrecoeur study area is the number of islands found in this stretch of the St. Lawrence River. Over millennia, the alluvial deposits transported in the river accumulated slowly in certain areas, only to be reworked or carried away by the current thereafter. Interaction between the river's flow and its tractable bed has given this section of the river a look all its own, with low-lying, elongated islands, interlaced with shallow channels. The terrestrial, riparian and aquatic vegetation found on these islands, and the fact of their isolation, has produced choice habitat for birds, especially ducks. This is also where the inflow of brown water from the Canadian Shield increases considerably, chiefly from the Ottawa River, via the Des Prairies, Mille Îles and L'Assomption rivers.

Human settlement of the land adjacent to the river remained typically rural from the advent of New France right up until the 1960s and 1970s, when the Montreal suburbs were first developed. Repentigny appeared first, then neighbouring towns grew up alongside. During this same period the industrial hubs of Varennes and Contrecoeur sprang up on the south shore, strategically located to take advantage of the ease of transport.

The construction and use of the ship channel appears to have been a major cause of the disturbance of aquatic and riparian environments. Where once the river flowed through many arms, it was now reduced to a single 11-m-deep channel. The concentration of the flow in the ship channel served to increase the current velocity there, to the detriment of secondary channels, thereby promoting erosion in an area where the river bed is most subject to reworking. Boat traffic further aggravates this problem. Wake waves travel only a short distance before striking the banks of the nearest islands, which are crumbling bit by bit. Shoreline stabilization techniques are being applied in an effort to contain the losses of wildlife habitat, notably in the Contrecoeur archipelago.

The once-obvious pollution of the past has declined due to municipal and industrial cleanup efforts in the study area itself, but especially upstream, in the Great Lakes and the region of metropolitan Montreal. All Montreal districts are now connected to the Montreal Urban Community (MUC) sewer network. The industrial plants in Varennes and Contrecoeur belong to

the industrial sector whose effluents have done the most harm to the aquatic environment. Overall, however, these plants are willing to improve their environmental performances, and most have adopted cleanup measures.

The available waterfowl nesting grounds are sometimes limited by the use of certain islands for farming or pastureland. However, there exist a few proven and simple measures by which these agricultural activities can be better harmonized with the conservation of wildlife habitat.

Enhancement of the Varennes–Contrecoeur study area may be hindered by the quasi-absence, outside the islands, of green spaces devoted to recreation and conservation. Though the St. Lawrence River remains accessible to boats at a number of sites, there are few areas for people to enjoy the water. There is no integrated recreation and tourism network in the study area, and many of its best features are not being fully utilized. Lastly, some recreational activities involving contact with water (swimming, windsurfing, seadooing, etc.) cannot be practised in the central and northern areas of the river because the urban effluents discharged into the St. Lawrence by wastewater treatment plants are not disinfected, and because much of the municipal wastewater released to its tributaries (e.g. Des Prairies and Mille Îles rivers) is not treated.

Résumé

Les îles nombreuses constituent l'un des traits marquants du tronçon fluvial Varennes-Contrecoeur. Au fil des millénaires, des alluvions charriés par le fleuve se sont peu à peu accumulés à certains endroits, pour être ensuite remaniés ou emportés par le jeu du courant. Cette interaction de l'écoulement avec le lit malléable a fini par donner à cette partie du fleuve son allure typique, avec ces îles basses, allongées et entrelacées de chenaux profonds. La végétation terrestre, riveraine et aquatique de ces îles, de concert avec leur isolement, en a fait des habitats de premier choix pour la faune ailée, en particulier pour les canards. C'est aussi dans cette section du Saint-Laurent que les eaux brunes provenant du bouclier canadien accroissent notablement leur contribution à l'écoulement fluvial, avec l'apport de la rivière des Outaouais, via les rivières des Prairies et des Mille Îles, et celui de la rivière L'Assomption.

L'occupation humaine des terres adjacentes au fleuve est demeurée typiquement rurale de l'avènement de la Nouvelle-France jusqu'aux décennies de 1960 et 1970. À partir de cette période, on a assisté au développement de banlieues de Montréal en direction de Repentigny d'abord, puis des municipalités voisines. Sur la rive sud se sont formés à la même époque les pôles industriels de Varennes et Contrecoeur, à la faveur d'une localisation stratégique sur le plan des facilités de transport offertes aux compagnies.

La construction et la mise en service du chenal de navigation semblent avoir été une cause imprtant de perturbation des milieux aquatiques et riverains. Le creusage du chenal jusqu'à une profondeur de 11 mètres a entaillé ce secteur où l'écoulement s'était jusque-là réparti entre plusieurs bras. La concentration du débit dans la voie navigable a accru la vitesse à cet endroit, au détriment des chenaux secondaires, donnant plus de vigueur aux processus d'érosion dans une zone où le lit du fleuve est plus sujet à des remaniements. La circulation des bateaux contribue à aggraver ce problème. Les vagues de sillage ont peu de distance à parcourir pour venir frapper avec force les berges des îles les plus proches, qui s'affaissent peu à peu dans l'eau. Pour tenter de contenir les pertes d'habitats fauniques causées par le recul du rivage, des techniques de stabilisation ont été mises à l'essai, notamment dans l'archipel de Contrecoeur.

La pollution, dont les effets se sont fait sévèrement sentir dans le passé, tend aujourd'hui à régresser grâce aux mesures d'assainissement municipal et industriel mises en vigueur dans le zone à l'étude elle-même, mais surtout en amont, dans les Grands Lacs et la région métropolitaine de Montréal. On a complété le raccordement de tous les arrondissements de Montréal au réseau collecteur de la CUM. Les industries du secteur dont les effluents ont été les plus dommageables pour le milieu aquatique se trouvent à Varennes et à Contrecoeur. On décèle désormais chez l'ensemble des entreprises une volonté d'améliorer leurs performances à cet égard; la plupart d'entre elles ont adopté des mesures d'assainissement.

L'utilisation de plusieurs îles pour des cultures ou du pâturage limitent parfois la reproduction de la sauvagine. Cependant, les pratiques agricoles peuvent être mieux harmonisés à la conservation des habitats fauniques grâce à des mesures simples, dont l'efficacité a été démontrée.

Parmi les difficultés que peut présenter la mise en valeur du tronçon Varennes-Contrecoeur figure la quasi absence d'espaces verts voués à la récréation et à la conservation, en-dehors des îles. Bien que le fleuve soit accessible aux embarcations en de nombreux points, on trouve peu de parcs permettant au grand public de profiter du voisinage de l'eau. La région n'est pas dotée d'un réseau récréo-touristique intégré et plusieurs de ses atouts ne sont pas exploités à leur pleine valeur. Enfin, certaines activités récréatives impliquant un contact avec l'eau (baignade, planche à voile, motomarine, etc.) ne peuvent être pratiquées dans les sections centrale et nord du fleuve, parce que les eaux urbaines rejetées dans le Saint-Laurent par les stations d'épuration ne sont pas désinfectées et qu'une bonne partie des eaux usées municipales évacuées dans les affluents (par exemple, rivières des Prairies et des Mille Îles) ne sont pas épurées.

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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 nineteenth 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 twentieth 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 has been subdivided into 23 sectors, or ZIPs, combined as necessary into study areas (Figure 1). The aim is to encourage community stakeholders to work together to restore and protect the St. Lawrence, and to harmonize use of the river.

As part of the groundwork for public consultation meetings, 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 the detailed data on ZIP 10, referred to in the following pages as the *Varennes–Contrecoeur sector* or the *study area*, to provide an overall assessment of this stretch of the river, its resources, present and future uses, and the associated constraints.

[1] The technical reports deal with the physico-chemical aspects of the water and sediments (Pelletier and Fortin, 1998), the biological communities (Armellin and Mousseau, 1998), socio-economic aspects (Gratton and Bibeault, 1998) and human health issues (Duchesne et al., 1998).

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 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.

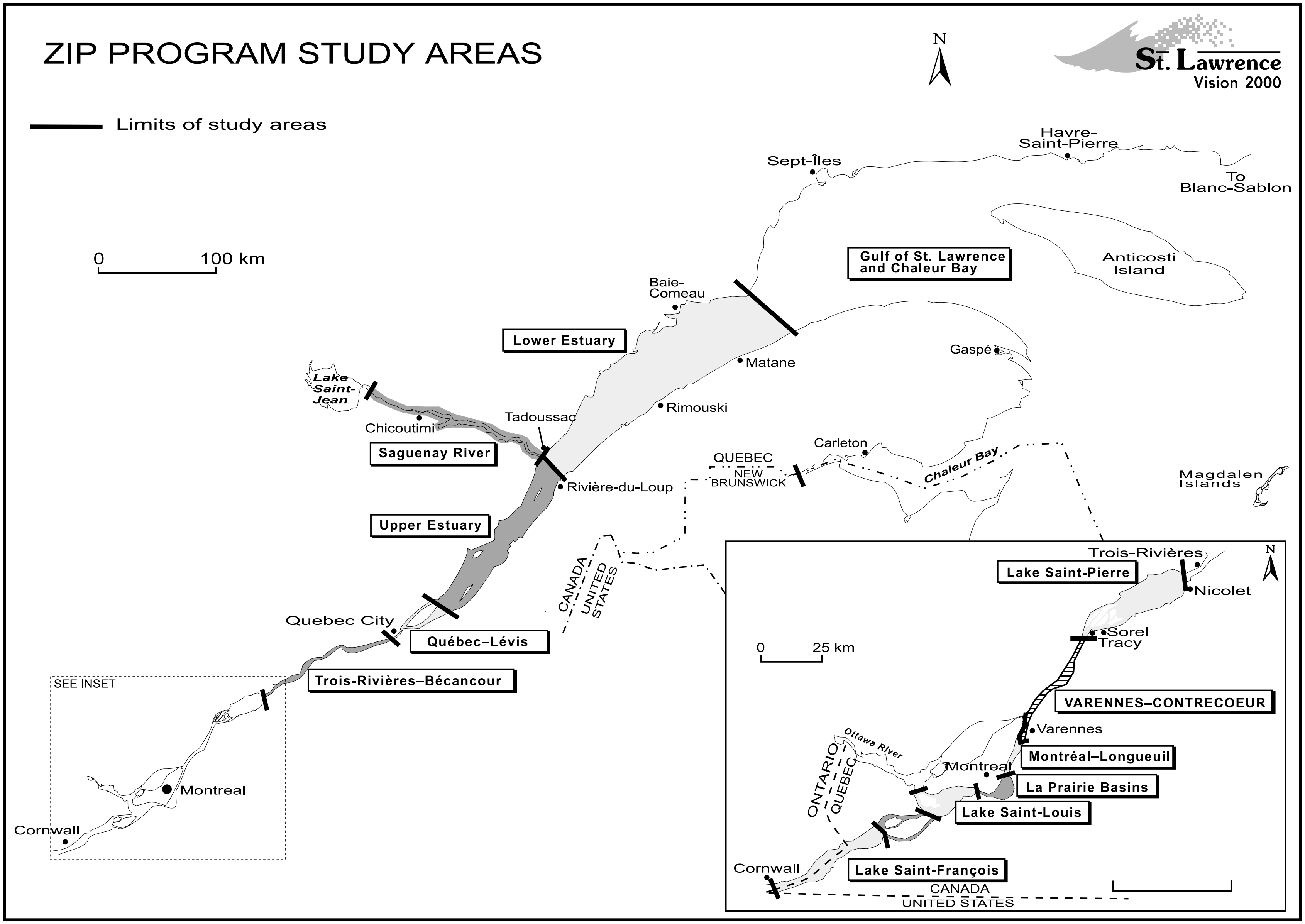

Figure 1 ZIP Program study areas

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 to us is the narrow stretch between the Montreal archipelago and the delta at Sorel (Figure 2). It starts at the Varennes islands a little way above the confluence of the Des Prairies River and runs 45 km to Lanoraie, never exceeding 4 km in width. This report also covers human activities on the lands along the shoreline, to the extent that they have an impact on the state of the river.

The defining characteristic of this part of the St. Lawrence is the many islands and the braidwork of back channels. Though the current is swift in the main channel, used by ships, along islands, bays and banks there exists a diverse mosaic of aquatic and riparian habitats, many of which have been saved from major urban and industrial development by their insular situation and inaccessibility. Some islands, however, have been farmed since the 17th century.

3.1 Physical Environment

The Great Lakes are fed by precipitation collected in a drainage basin of 1.2 million square kilometres. What they cannot hold flows to the sea by way of the St. Lawrence River, at an average rate of 6850 m^3/s as it leaves Lake Ontario.

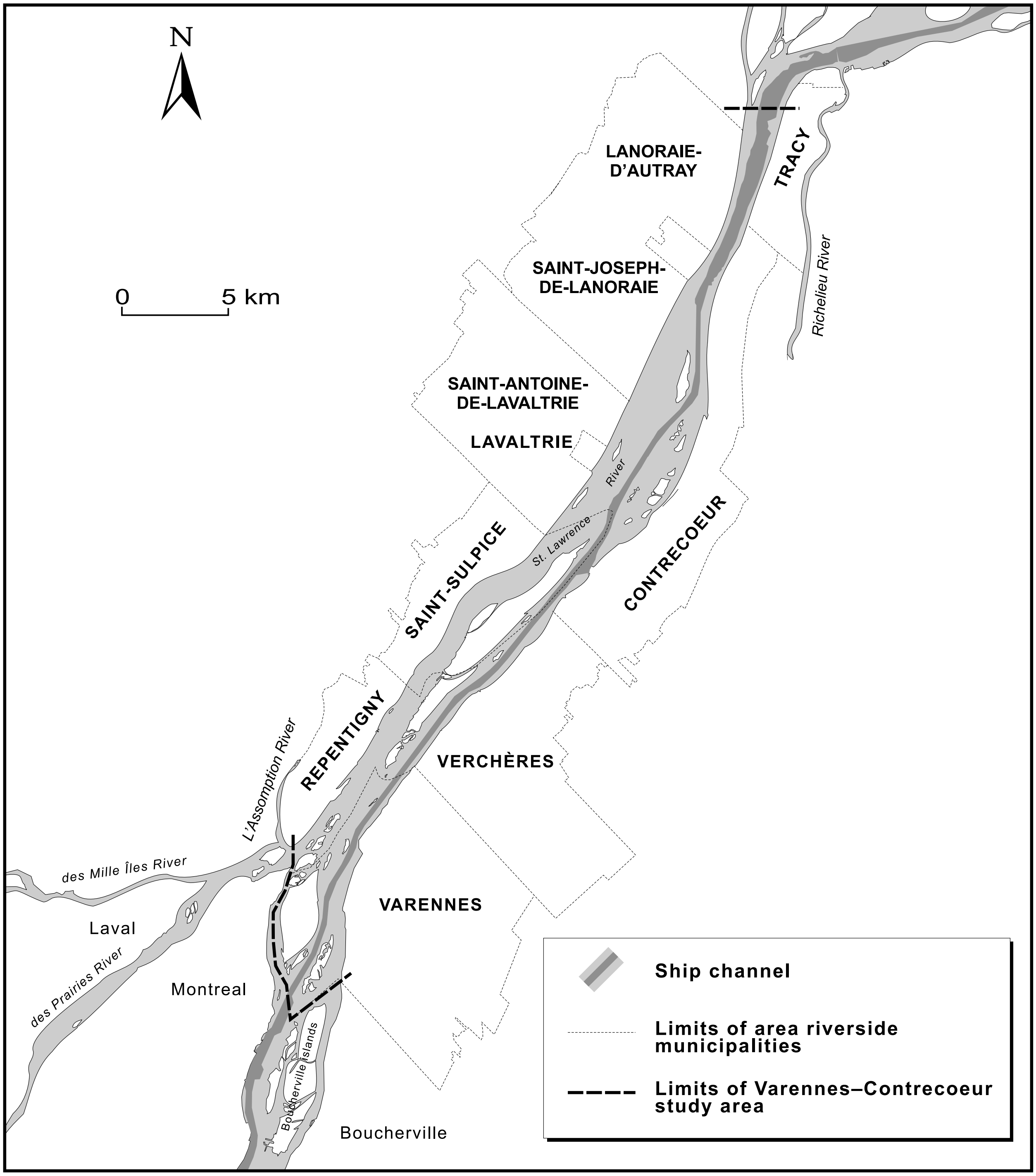

Figure 2 Varennes–Contrecœur (ZIP 10) study area

From Lake Ontario, the St. Lawrence runs for some 170 km between the province of Ontario and New York State before entering Quebec. It then flows through Lake Saint-François, the Beauharnois sector and Lake Saint-Louis to the Montreal archipelago.

3.1.1 Water masses

Though tributaries add little to the river's flow between Lake Ontario and Lake Saint-Louis, the downstream sections are characterized by major inflows, especially that of the Ottawa River. Some of this river's waters (about 45%) enters the St. Lawrence at Lake Saint-Louis through the Vaudreuil and Sainte-Anne canals, while the rest flows through the Des Prairies and Mille Îles rivers to join the St. Lawrence at the eastern end of Montreal Island.

The Ottawa River's input through these three channels is significant not only in terms of volume,[2] but also in terms of its chemical composition. Most of the Ottawa River's catchment basin is located in the Canadian Shield, giving its waters certain chemical characteristics that distinguish it from those of the Great Lakes.[3]

Once joined, these water masses of different origin may flow side by side a long way before mixing completely. At Varennes, two water masses can be distinguished: the greenish Great Lakes water along the south shore and the mixed waters (from both the Ottawa River and the Great Lakes) to the north[4] (Figure 3).

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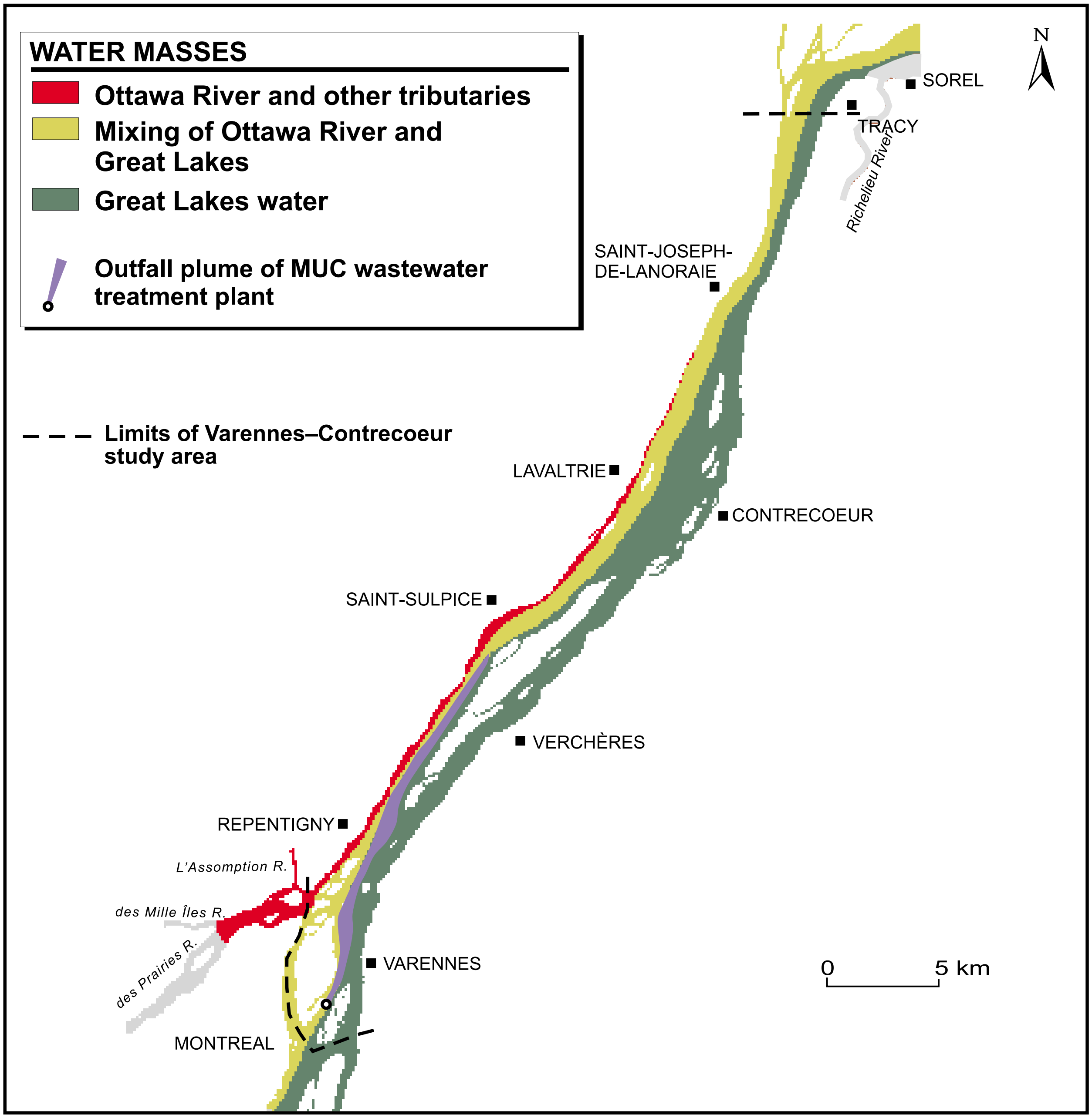
2 The average year-round discharge of the Ottawa River is some 2000 cubic metres per second, but unlike the controlled waters of the Great Lakes, it varies a great deal seasonally. It averages 800 m^3/s at low water and 6500 m^3/s in flood, but it has exceeded 9000 m^3/s in the past, almost comparable with the average discharge of the LaSalle River (8640 m^3/s).

3 The brown waters of the Ottawa River have fewer minerals, less conductivity and more turbidity than the green waters of the Great Lakes.

4 These consist of Ottawa River water entering through Lake Saint-Louis and mixing with Great Lakes waters in the Lachine Rapids.



Source: Adapted from Verrette, 1990.

Figure 3 Main water masses in the Varennes–Contrecoeur section of the river

The additional Ottawa River water entering through the Des Prairies and Mille Îles rivers can be seen at Repentigny. Under certain conditions, even the weaker flow of the L'Assomption River can be picked out within this third water mass.

At the downstream end of the study area, the waters of the St. Lawrence on the north side are well mixed with those of the Des Prairies, Mille Îles and L'Assomption rivers and other tributaries, forming a single corridor occupying nearly half the river's width; the southern flank, though, still consists of the green waters of the Great Lakes. The relative size and location of these water masses vary according to the discharge of the tributaries, especially the Ottawa River, but other factors, such as wind and the stage of development of aquatic vegetation, also play a role.

The river's mean annual discharge, about 8775 m^3/s at Varennes (Table 1), rises to 10 180 m^3/s a few kilometres further on, largely on account of the Des Prairies (1020 m^3/s), Mille Îles (210 m^3/s) and L'Assomption (76 m^3/s) rivers. These three tributaries drain farmland and urban or industrial areas. Several smaller rivers and streams empty into the river in the study area, for a total discharge of 99 m^3/s.

Table 1
Some physical characteristics of the Varennes–Contrecœur sector

Area (km^2)		98
Length (km)		45
Width (km)	Mean	2.2
	Maximum	4.0
Maximum depth (m)		12
Mean annual discharge (m^3/s)	St. Lawrence, on entering the sector	8 775
	Des Prairies	1 020
	Mille Îles	210
	L'Assomption	76
	Other tributaries, exiting sector	99
	Total	10 180
Current velocity		

Source: Pelletier and Fortin 1998, from Simoneau and Grimard, 1989; Environment Canada, 1992; Procéan et al., 1996.

3.1.2 Discharge, particle transport and sedimentation

One of the characteristics of the Varennes–Contrecœur sector is the large number of alluvial islands. These 70 low islands were formed over hundreds of years from silt carried by the river; their main axis is always aligned with the flow of the water, and they were originally in balance with its flow patterns. They form four main groups, identified in the following pages as the Varennes (here taken to include Sainte-Thérèse Island), Repentigny, Verchères and Contrecoeur archipelagos (Figure 4; Table 2).

In the study area, riverbed configuration and current speed are highly variable. Originally, the river’s flow was divided among a network of channels of varying dimensions. In the course of successive improvements to the ship channel, it has been gradually deepened to 11 m to accommodate ever larger vessels. One effect of this has been to concentrate more of the flow in that passage and to increase its speed (up to 1.2 m/s). The water in the ship channel takes about ten hours to run the 45 km of the study area, but the flow is generally slower, on the order of 0.3 to 0.6 m/s, along the banks and around the islands.

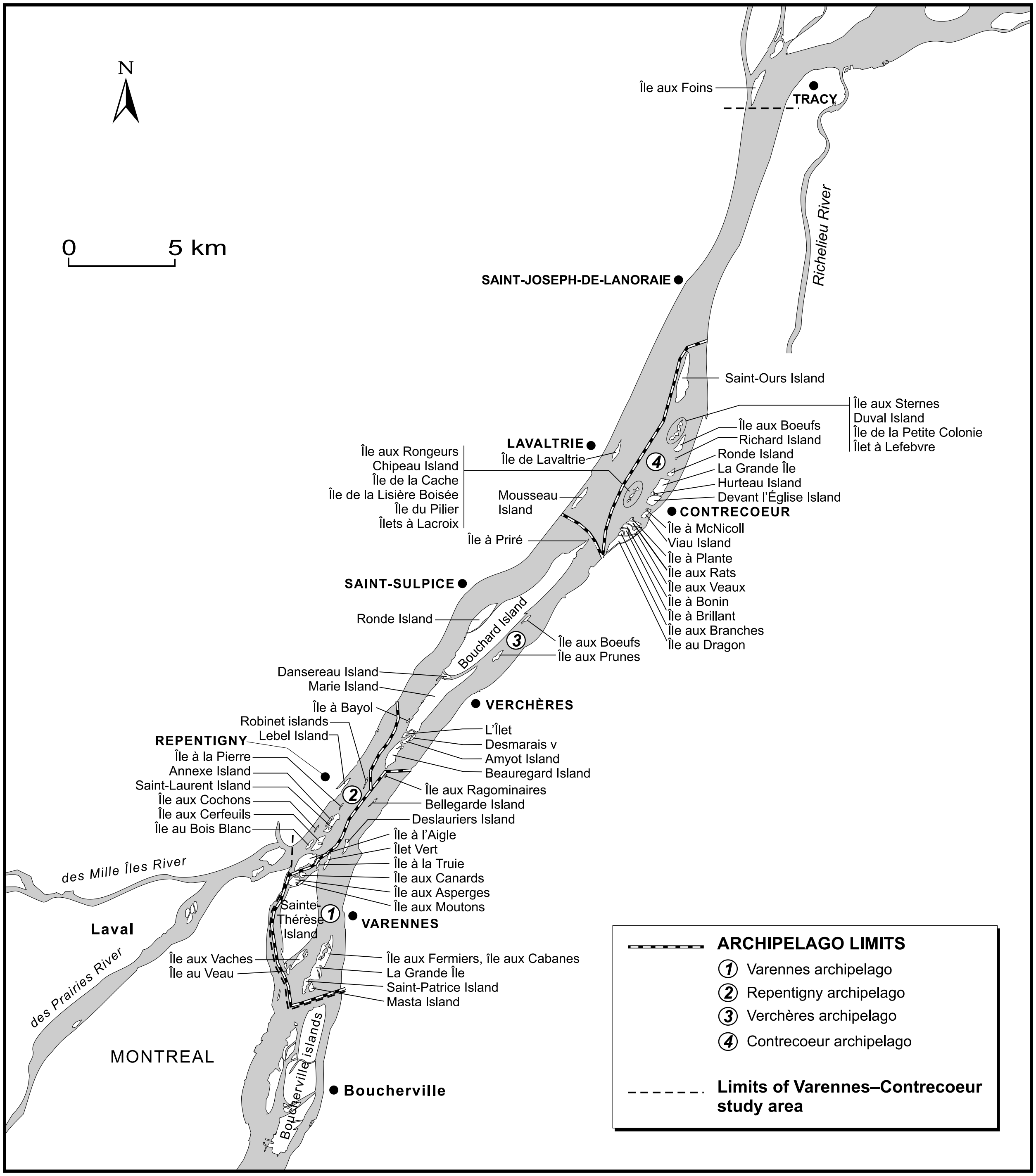
The river’s particle-carrying capacity depends on current speed; conditions favouring erosion prevail in the channel, whereas sediments tend to settle out in the slow areas, close to shore or in beds of aquatic vegetation. Wave action sometimes destabilizes sediments on the bottom, especially at times of year when water plants are poorly developed. At present, the main sedimentation areas in the sector are found on the south side of the river, in the Contrecoeur islands; particulates near the north shore are generally coarser. (At some points in the Contrecoeur islands, sediments are estimated to accumulate at a rate of between 0.8 and 1.6 cm per year).

It has been estimated that the river carries some 3.3 million tonnes of sediment each year past the Sorel delta, at the downstream end of the Varennes–Contrecœur sector.

Table 2
Area of islands and archipelagos in the Varennes–Contrecœur sector

	Area (ha)		*Area (ha)*
Varennes Islands	**809.4**	**Contrecoeur Islands**	**294.4**
Sainte-Thérèse Island	573.0	Saint-Ours Island	91.3
La Grande Île	45.9	La Grande Île	35.4
Île aux Vaches	29.3	Île aux Rats	25.8
Île aux Fermiers	23.2	Île Devant l'Église	23.3
Île aux Asperges	21.7	Richard Island	17.1
Îlet Vert	19.0	Ile aux Veaux	12.1
Deslauriers Island	15.6	Île au Dragon	11.5
Masta Island	14.1	Île aux Bœufs	10.3
Île aux Cabanes	13.7	Île à Plante	9.5
Île au Veau	11.7	Île à Bonin	9.4
Saint-Patrice Island	9.2	Ronde Island	7.4
Île de Varennes	8.2	Île à Viau	7.0
île aux Canards	6.5	Îlots de l'Île aux Rats	6.9
Île aux Moutons	4.5	Île à Brillant	5.5
Hertel Island	4.0	Îlets à Lacroix	4.5
Île à la Truie	3.8	Îlets à Lefebvre	4.2
Bellegarde Island	3.8	Île aux Branches	3.5
Île au Beurre	1.4	Hurteau Island	1.7
Île aux Ragominaires	0.8	Île de la Cache	1.3
		Île de la Petite Colonie	1.3
		Duval Island	1.2
		Île à McNicoll	0.9
		Île de la Lisière Boisée	0.9
		Île du Pilier	0.8
		Heureuse Island	0.4
		Île aux Rongeurs	0.4
		Chipeau Island	0.4
		Île aux Sternes	0.4
Repentigny Islands	**119.7**	**Verchères Islands**	**1 222.8**
Île à L'Aigle	50.2	Bouchard Island	850.0
Île aux Cerfeuils	21.0	Marie Island	109.5
Saint-Laurent Island	20.8	Ronde Island	57.8
Lebel Island	16.2	Beauregard Island	55.0
Île au Bois Blanc	6.2	Île aux Bœufs	9.9
Annexe Island	2.6	Île à Priré	9.6
Robinet Island	1.7	Île aux Prunes	8.6
Île à la Pierre	0.8	Dansereau Island	7.2
Île aux Cochons	0.2	Amyot Island	6.1
		L'Îlet	4.9
		Desmarais Island	3.0
		Île à Bayol	1.1
Other islands	**35.6**		
Île de Lavaltrie	23.0		
Mousseau Island	12.6		

Source: Adapted from De Repentigny, 1997; Bélanger, 1991; Bélanger et al. 1989; Bertrand et al., 1991; Grenier, 1993.



Source: Armellin and Mousseau, 1998.

Figure 4 Islands in the Varennes–Contrecoeur sector

3.2 Biological Environment

At present, the study area presents a varied mix of urban, agricultural and natural landscapes, changing along the way. Discounting certain human-made structures, it is easy to imagine how the area looked originally.

3.2.1 Vegetation and habitats

In southern Quebec, the plant communities that tend to dominate the rich clay soils of the St. Lawrence Valley are maple stands with hickory. For vegetation to evolve to this type of association, however, human intervention needs to be minimal, which is not the case in most of the study area. The land along the banks was cleared of trees and put to the plough under the French regime, and any virgin forest has long since disappeared. Shoreline vegetation has also been modified by humans.

However, the many islands in the St. Lawrence, being less accessible than other areas, have allowed some plant communities to survive in a near-natural state. These islands have been spared extensive development work, except here and there for work associated with the dredging of the ship channel. Farming has had the greatest impact on the islands, where they are large enough for cultivation or pasturage. Wetland fringes, between the dry prairie and aquatic environments, have generally been conserved (Figure 5). Today, the islands still harbour a great variety of habitats (Figure 6; Table 3).

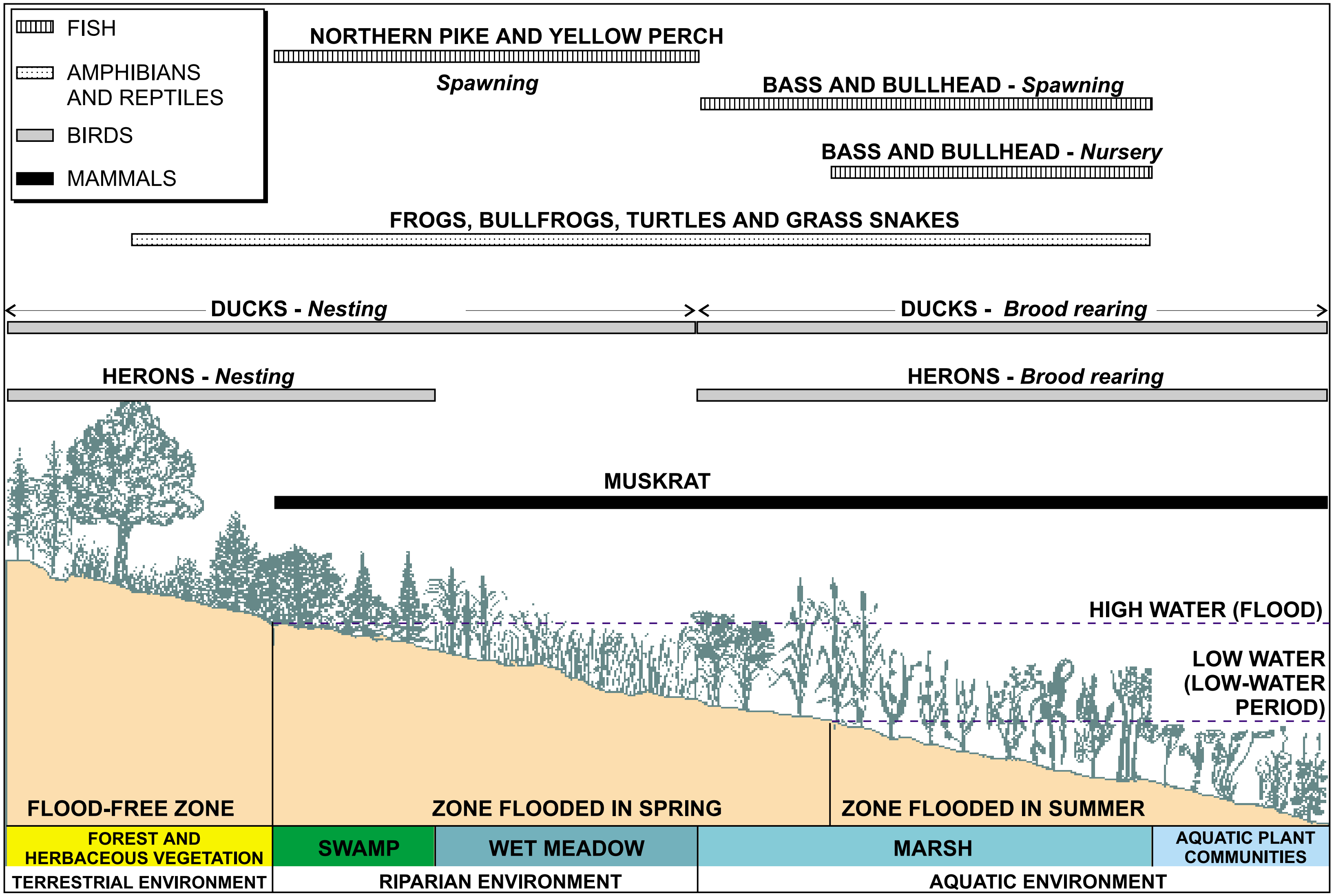
Very dense groupings of aquatic vegetation provide food and shelter to diverse and abundant communities of small invertebrates; this concentration of prey species in turn draws water birds and fish. These aquatic plant communities are also prime breeding grounds for many species of fish, among them perch, Northern pike and Brown bullhead. The plants are actually used to anchor the eggs and keep them clear of the mud; after hatching, the fry can find shelter and food. Such habitats are also well suited to amphibians, certain reptiles and Muskrat.

Source: Létourneau and Jean, 1996.

Figure 5 Wetlands in the Varennes–Contrecoeur sector in summer 1990

Source: Létourneau and Jean, 1996.

Figure 5 Wetlands in the Varennes-Contrecoeur sector in summer 1990



Source: Adapted from Auger et al., 1984.

Figure 6 Typical profile of wetland vegetation and main uses by wildlife

Table 3
Distribution and area of various wetland types in the Varennes–Contrecoeur sector

		Wetland type (ha)				
		Aquatic plant beds	*Marsh*	*Wet meadow*	*Swamp*	*Total*
Archipelagos	Varennes	111.2	35.0	119.3	4.4	269.9
	Repentigny	73.9	22.4	32.2	0.6	129.1
	Verchères	181.0	61.0	156.5	33.3	431.8
	Contrecoeur	183.7	241.1	238.6	20.6	684.0
Other islands		43.8	19.5	27.3	0.3	90.9
Total, islands		***593.6***	***379.0***	***573.9***	***59.2***	***1605.7***
Shoreline	North	126.6	55.2	24.1	3.7	209.6
	South	160.9	19.6	6.1	1.8	188.4
Total, shoreline		***287.5***	***74.8***	***30.2***	***5.5***	***398.0***
Total, sector		**881.1**	**453.8**	**604.1**	**64.7**	**2003.7**

Source: Armellin and Mousseau, 1998.

The aquatic plant communities and marshes of the Varennes–Contrecœur sector are found mainly in those places less subject to wave action. The largest such aquatic plant beds are above and below Sainte-Thérèse Island, along the south shore opposite the Varennes islands, and along the north side of the Contrecoeur islands.

The Varennes islands cover over 800 hectares. Six of them (Aux Fermiers, Masta, Saint-Patrice, De Varennes, Aux Cabanes and La Grande Île) were joined when they were raised by dumping dredged material from the ship channel in the 1950s. The highest part of the newly merged island is occupied by a prairie used to graze cattle, broken by marshes. There are also a broad sheltered bay and three enclosed lagoons.

This archipelago has little swampland, but there are wet meadows and inland marshes. Stretches of wet meadows are found on La Grande Île, Île aux Fermiers, Sainte-Thérèse Island, Île aux Asperges, Île aux Canards, Île aux Moutons and Îlet Vert. Beds of Northern water milfoil, Water plantain and Canada waterweed flourish along the eastern shores of the islands, sheltered from wave action.

The Repentigny archipelago still has some woodland. Most is occupied by tallgrass prairie with canary grass and other low-growing plants. Marshland accounts for only 22 ha of the entire archipelago. There are extensive aquatic plant communities along sheltered sections of the shoreline.

The Verchères archipelago differs from the other two groups of islands in that it has extensive swamps and a great diversity of marshland vegetation, especially in the interior and along its northwest shores. There are some wet meadows with canary grass along the edges of the larger islands. Aquatic plant beds, less developed than in the Varennes or Repentigny archipelago, occupy some depressions on Bouchard Island and the channels between the islands.

Lastly, the Contrecoeur islands have the largest expanse of wetlands in the study area. On Saint-Ours Island, there are willow and red ash swamps, as well as extensive wet meadows and marshes. The archipelago’s vast aquatic plant beds, extending out to the middle of the river, constitute the largest aquatic environment in the whole study area. They are made up essentially of groupings of Northern water milfoil, except for the portion in the middle of the river and the belts around Mousseau, Lavaltrie and Saint-Ours islands, where wild celery predominates.

3.2.2 Benthos

The term *benthos* comprises all organisms, whether plant or animal, living on the bottom or buried therein.

The study of benthic animals, especially invertebrates, yields very useful information for characterizing aquatic habitats. These organisms are at the base of the food chain, and their abundance is a major condition for the establishment of populations of higher animals, both birds and fish. Also, the distribution of benthic animals in the environment depends heavily on local conditions (presence of aquatic plant communities, type of bottom, depth) and the requirements of each species in terms of these conditions.

The benthos surveys conducted in the study area were done mainly in the Varennes and Repentigny islands. Most samples were taken in the early 1980s as part of the *Archipel* project or in connection with environmental monitoring of the MUC wastewater treatment plant, whose outfall enters the river off Île aux Vaches. The *Archipel* studies defined 30 model habitats[5] in the waters around the islands in the Montreal archipelago, ten of which are represented in the Varennes–Contrecoeur sector. The environmental variables with the greatest impact on benthos composition are water type (brown, green or mixed), type of water bottom, current speed, vegetation and depth.

In the Varennes and Repentigny archipelagos, the most common benthic animals are gastropods (snails). In the aquatic plant beds, gastropod density can reach as high as 10 000 individuals per m^2. In summer, the conditions prevailing in the aquatic plant beds change as the current is slowed by vegetation, and organic matter accumulates. The benthos is thus more abundant than in open water, though the species are the same. Each condition favours certain groups, thus altering their relative abundance within the community..[6]

In these two island groups, aquatic plant habitats, found in different types of water, account for a larger portion of the aquatic environment (77% of the total area) than does clear water (19%). Benthic communities in green water aquatic plant beds differ from those in brown water in that some groups of creatures are present in greater densities.[7]

Open-water benthic communities are typical of the green waters of the Great Lakes. They are found at greater depths and are generally characterized by a lower density of organisms and low species diversity. The most widespread of the open-water communities, dominated by gastropods and trichoptera, shows marked variation in abundance in the course of the year. Density is low in spring, averaging 1800 individuals of all species per m^2, and rising to over 107 000 per m^2 in the fall.

5 In what is referred to as *typical habitat*, the benthic composition is similar regardless of location.

6 For example, benthos in aquatic plant beds has a higher proportion of amphipods (small crustaceans) and chironomid larvae (a subgroup of flies).

7 Including *amphipods* and *pelecypods* (mussels).

3.2.3 Fish

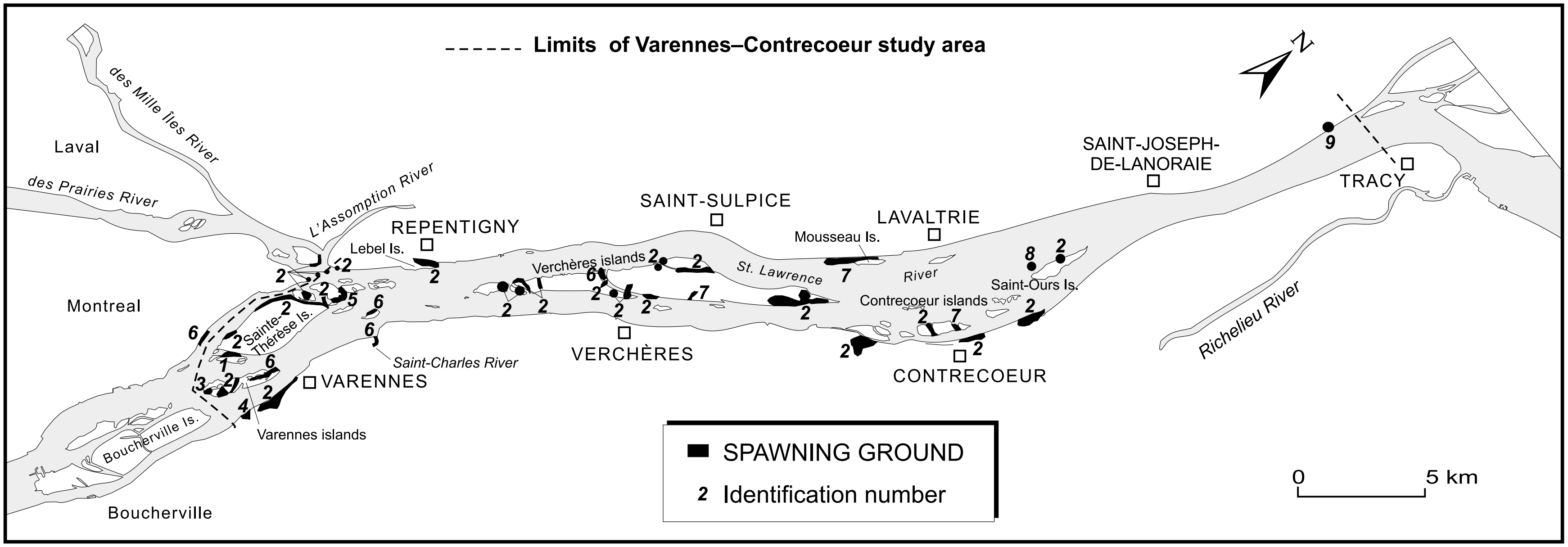
There are 54 fish species in the Varennes–Contrecœur stretch of the river; this is a little less diversified than in the sections further up and down stream, a fact which may be due to the range of habitats available. There is some information to suggest that marine traffic has also had some direct and indirect effects on fish (see Section 4.1). However, it is impossible to compare the situation today with earlier conditions because the first systematic inventories of fish were made only in the 1970s, long after the ship channel had assumed its present form.

Many biologists who are familiar with the sector surmise that the variety and abundance of fish would have been greater before certain shallow-water habitats were destroyed; these would have been originally more numerous along the banks. There are still some sites today that offer suitable conditions for eggs and fry (i.e. for the growth of young-of-the-year fish). Among these are the mouth of the Saint-Charles River, Lebel Island (Repentigny) and some of the channels in the Varennes, Verchères and Contrecoeur archipelago (Figure 7).

It should be added that the Varennes–Contrecoeur sector is also used by a number of migratory species, including the American eel, the American shad and the Lake sturgeon.

3.2.4 Birds

Bird life in the study area is quite diverse. Of the estimated 145 bird species thought to nest in Varennes–Contrecoeur, 99 are confirmed breeders. This compares favourably with the Saint-Lambert–Boucherville sector, though it is less diverse than what is reported for Lake Saint-Pierre. A great variety of birds can be seen on the islands, especially in the Varennes archipelago. Breeding birds of interest include the Pied-billed grebe, the Least bittern, the Common gallinule, the American coot, Wilson’s phalarope, the Sharp-tailed sparrow, the Northern harrier and the Short-eared owl. Occasional sightings of Ruddy duck, Great egret and Cattle egret have been reported, and there have been exceptional sightings of Long-billed curlew, American avocet and Smith’s bunting.



	SPAWNING GROUND ● Actual ○ Potential								
Species	1	2	3	4	5	6	7	8	9
Largemouth bass		●							
Brown bullhead	●	●	●	●		●	●	●	●
Channel catfish				●		●			
Carp		●	●				●		
Rock bass	●			●		●			
Pumpkinseed		●	●	●		●	●		●
Northern pike	●	●	●	●	●	●	●		●
Black crappie		●							
Golden shiner		●		●					
Yellow perch		●	●	●		●	●		●
Bowfin		●	○						
Central mudminnow		●							

Source: Adapted from MLCP, 1993a, and Therrien et al., 1991.

Figure 7 Spatial distribution of spawning grounds in the Varennes–Contrecoeur study area

However, the study area is one of the stretches of the St. Lawrence least used by migrating waterfowl (fewer than 10 000 individuals). It is thought that high spring water levels and strong hunting pressure in the fall may explain why so few ducks and geese visit.

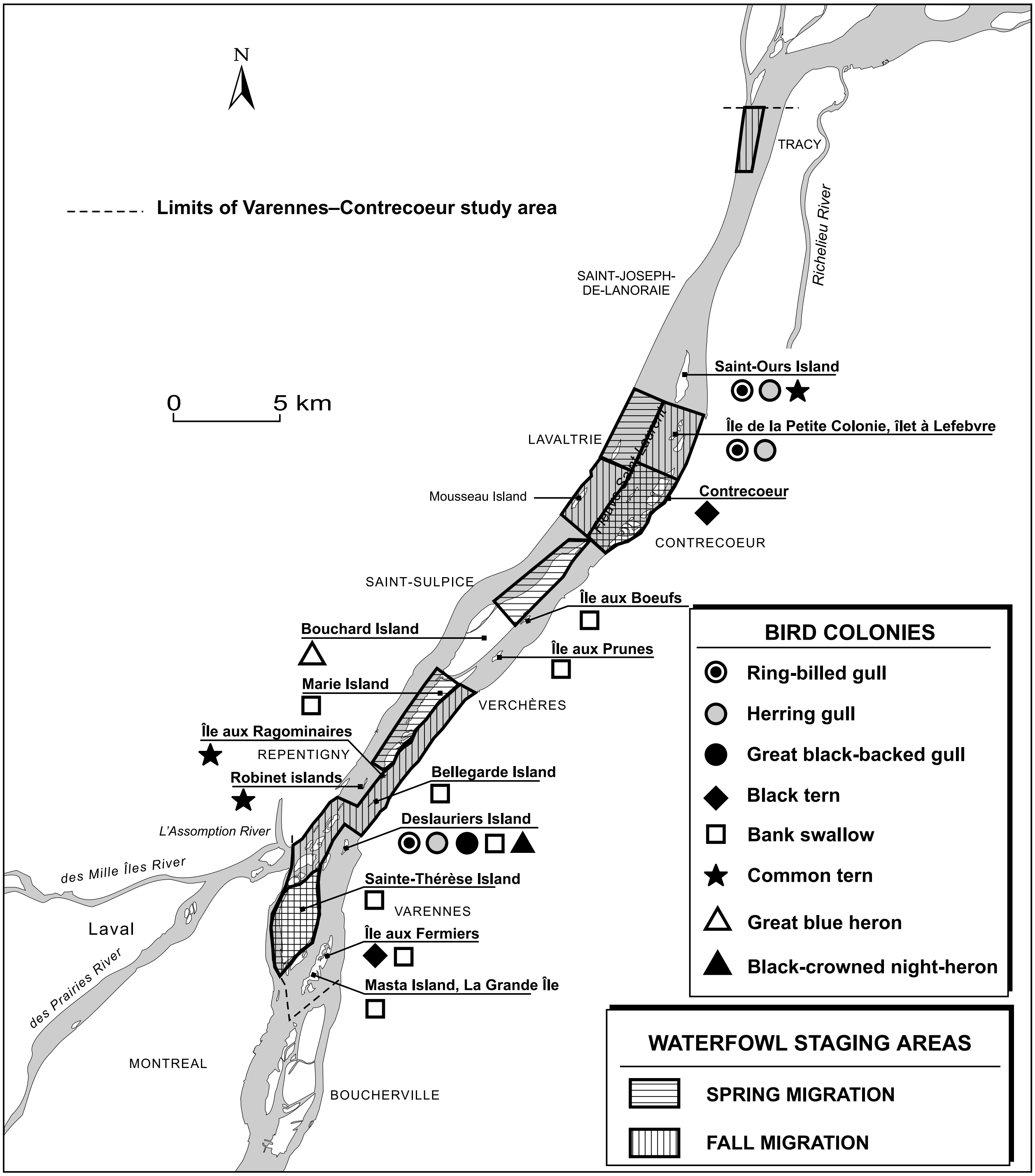
During the spring stopover, Canada geese and both dabbling and diving ducks, in roughly equal numbers, can be seen, especially near Sainte-Thérèse Island, in the upstream and downstream reaches of the Verchères islands, in the upstream islands of the Contrecoeur archipelago, and on Lavaltrie Island (Figure 8).

In the fall, there are distinctly more dabbling than diving ducks, and there are no Canada geese. The busiest places are Sainte-Thérèse Island, around the islands off Repentigny, Mousseau Island, the Contrecoeur islands with the exception of Saint-Ours Island, and the mouth of the Saint-Joseph River (upstream of Île aux Foins).

Thirteen waterfowl species breed in the Varennes–Contrecoeur sector. The two most abundant are the Gadwall and the Northern pintail, which account for 55% of the nests built.

The Varennes archipelago is especially favoured by the Shoveler, for which the small enclosed lagoons provide ideal habitat. In the Repentigny islands, the greatest concentrations of nests are on Deslauriers Island; the leading breeder is the Gadwall (43% of nests), followed by the Pintail and the American wigeon.

The Verchères islands are the one place where all breeding duck species can be found, the most common breeders being the Gadwall, the Pintail and the American wigeon. The highest nesting densities are reported on Île aux Ragominaires (2.8 nests per ha) and Robinet Island (1.4 nests per ha).



Source: Bannon 1991; Brousseau, 1997; Desrosiers, 1997; Dumas, 1997; MLCP, 1993b; Pilon et al., 1980.

Figure 8 Bird colonies and waterfowl staging areas

There is no doubt that the Contrecoeur islands constitute the most important waterfowl breeding territory, especially for the Gadwall (about half of all nests). At present, this site has the highest density of breeding pairs of this species in Quebec, though it has only recently established itself and is still steadily expanding. The other main breeding species are the Pintail and the American wigeon. For the Contrecoeur islands overall, nest density for all duck species has been calculated at 3.3 per hectare. The highest values have been reported on Île aux Rongeurs (20 nests per ha), Chipeau Island, Île de la Petite Colonie, Île de la Cache, Lefebvre Island, Duval Island, Île aux Boeufs, Saint-Ours Island and Île aux Sternes.

The Canada goose has been breeding in the study area for several years. In 1992, a few pairs started breeding on the upstream islands of the Varennes archipelago, and over the years their numbers have grown.

The main colonial species in the sector (Figure 8) are larids (gulls and terns). There are at present three active Common tern colonies: one on Saint-Ours Island, one on a neighbouring islet and one on the Robinet islands. Two other colonies have disappeared in recent years: the Île aux Sternes site has eroded away and no longer exists, and the Ring-billed gull has taken over Deslauriers Island. The Black tern has established small colonies in two marshes in the Varennes–Contrecœur sector, one in the marsh between Île aux Fermiers and La Grande Île in the Varennes group and the other on the south shore at Contrecoeur. The Ring-billed gull has four colonies on Deslauriers Island, Saint-Ours Island, Île de la Petite Colonie and the Lefebvre islets, with a total population of nearly 65 000 pairs in 1997, about half of the Quebec breeding strength of the species. On Deslauriers Island, the number of gull nests grew from 5300 in 1981 to over 48 000 in 1997.

There is a small Great blue heron colony (11 nests in 1997) in the swamps of Bouchard Island, in the Verchères archipelago. On Deslauriers Island, a Black-crowned night-heron colony has developed in a reed bed, with some 50 nests in 1997.

Another gregarious species, the Bank swallow, occupies a dozen sites on the eroded banks of the Varennes, Repentigny and Verchères islands. These birds dig burrows high in the cliff face where the banks have been sapped by wave action.

Shorebirds visit the Varennes–Contrecoeur sector during their migration. The shores of Île aux Fermiers are used by at least 28 species, though none is abundant. During the fall migration, several hundred shorebirds, chiefly Semipalmated sandpipers and Greater and Lesser yellowlegs, gather on the muddy and sandy shores of Île aux Fermiers and on the Contrecoeur shoreline opposite Saint-Ours Island.

3.2.5 Other animals

We have no systematic inventory of the amphibians and reptiles of the Varennes–Contrecoeur sector, only a list of the species whose range includes this part of the river.

In the sector, 16 amphibian species — including the Western chorus frog, a priority species under SLV 2000 — of the 19 that could live here have been confirmed. According to distribution maps for Quebec reptiles, 11 species may inhabit the Varennes–Contrecoeur sector. The status of amphibian and reptile populations in general is poorly understood; we do know that several species are scarce, even rare, in southwestern Quebec.

We have no historical data by which to gauge changes in abundance in these populations, much less to relate any declines to specific causes. There is, though, a consensus among herpetologists to the effect that these animals are heavily dependent on their preferred habitat, so that if the habitat disappears the associated amphibians and reptiles follow suit.

The Muskrat is the most common mammal species in the study area’s aquatic and riparian habitats. This rodent was widely trapped until the late 1980s, when falling pelt prices led to declining interest in this activity.

3.3 Human Occupation of the Land

The fertile lands along the St. Lawrence between Montreal and Quebec City were among the first in New France to be cleared and put to the plough. The plotting of lots at right angles to the river and the many historic villages still recall today the long rural tradition underlying life in this region.

It was only in the 1960s that the pressure of urbanization began to make itself felt through the development of major highways to serve the metropolis. Suburban residential development overflowed Montreal Island and invaded first Repentigny,[8] wiping out farming there in less than 30 years; it then spread to other municipalities, in particular Saint-Antoine-de-Lavaltrie and Contrecoeur, in the 1970s. From 1981 to 1996, demographic pressures eased overall, except in Lavaltrie, Varennes and Saint-Sulpice, where they remained strong; over the same period, Contrecoeur's population even declined slightly.

Though urbanization has proceeded on the south shore since the 1960s, it has not been as vigorous as on the north shore; residential areas are less densely inhabited. The two main industrial hubs in the study area are Varennes and Contrecœur.

In 1996, there were 112 896 people living in the ten municipalities of the 467 km^2 territory along the Varennes–Contrecoeur stretch of the river[9] (Table 4). About 63% of this population lived on the north shore, mainly in Repentigny. On the south shore, the most populous municipality is Varennes. As may be expected in an area of transition between city and country, population density varies widely; the highest (2357 inhabitants per km^2) is seen in Lavaltrie and the lowest (20 inhabitants per km^2) in Lanoraie-d'Autray.

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8 In the 1960s, demographic growth was strongest in Repentigny (114%); by comparison, south shore municipalities experienced population growth of anywhere from 5% to 34% (Verchères and Contrecoeur, respectively) in the same period.

9 These figures include Tracy, a municipality whose territory lies partly within the Varennes–Contrecoeur sector. The impact of human activity on the aquatic environment in this town has been analysed in the technical reports and regional assessment for ZIP 11 (Lake Saint-Pierre). Table 4 presents the main descriptors of human occupation in the Varennes–Contrecoeur sector with or without Tracy.

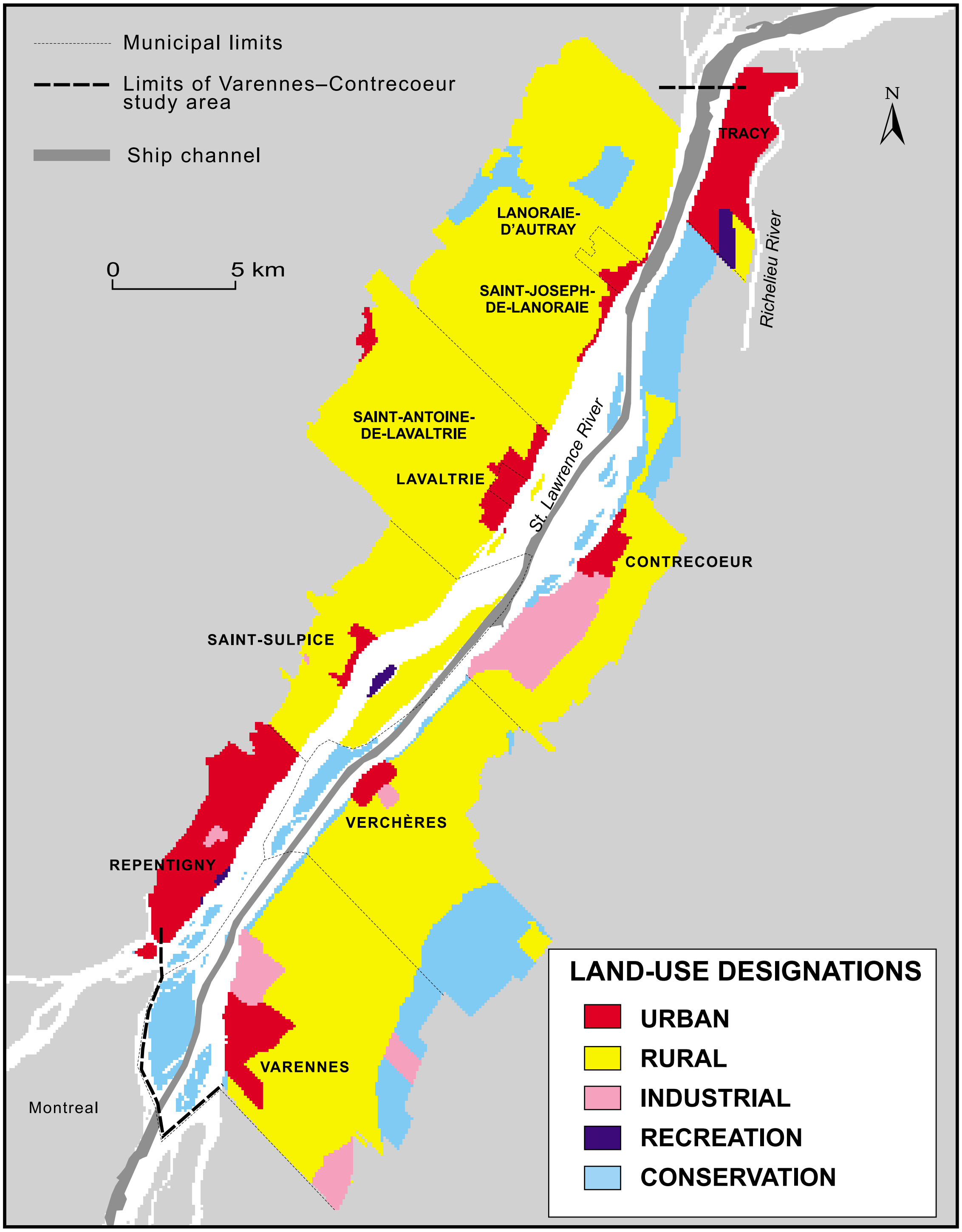
Table 4
Area and population of the municipalities in Varennes–Contrecoeur in 1996

Municipality	*Population*	*Area (km^2)*	*Density (pop./km^2)*
North Shore			
Lanoraie-d'Autray	1 904	98	20
Lavaltrie	5 821	2	2 357
Saint-Antoine-de-Lavaltrie	4 385	66	67
Saint-Joseph-de-Lanoraie	1 855	4	417
Repentigny	53 824	24	2 204
Saint-Sulpice	3 307	25	132
Subtotal	*71 096*	*220*	*323*
South Shore			
Contrecoeur	5 831	62	87
Varennes	18 842	94	201
Verchères	4 854	73	67
Subtotal	*29 027*	*228*	*127*
Sector total (excl. Tracy)	**100 123**	**448**	**223**
Tracy	12 773	19	668
Sector total (incl. Tracy)	**112 896**	**467**	**242**

Source: Statistics Canada, 1996 census databank.

Outside urban and industrial centres, land use is still essentially rural, with farming predominant. Grain and forage crops are the main crops grown in the area; there are also several sugarbush stands around Verchères. On the north shore, potatoes and tobacco are grown, especially in Lanoraie-d'Autray. The larger St. Lawrence islands are used for pasture or for a variety of crops: strawberries, corn and grain on the Verchères islands and soybeans on Sainte-Thérèse Island.

In terms of land use (Figure 9), rural activities are the most important in the study area (69%), followed by urban development and conservation (13% each by area). Industrial development accounts for a mere 5% of the territory. Less than 1% of the study area is given over to recreational use, which is very little, in view of the potential that exists.



Source: Adapted from L'Assomption RCM, 1986; d'Autray RCM, 1986; Lajemmerais RCM, 1986; Le Bas-Richelieu RCM, 1989.

Figure 9 Land use in riverside municipalities

CHAPTER 4 Human Activities and Their Main Effects on the Environment

Human activities have engendered many changes in the sector. The main ones are sumarized in this chapter.

4.1 Shipping

Among the factors responsible for the degradation of aquatic and riparian habitats in the study area, one of the most prominent appears to be ship traffic. There has been commercial navigation on the St. Lawrence for a long time, and development of the ship channel and the Seaway has only served to increase it.[10]

4.1.1 Development and maintenance of the ship channel

The problems associated with the development and maintenance of the ship channel are complex. It cannot be denied that this avenue of transportation constitutes an economic asset and has promoted industrial development along the St. Lawrence and around the Great Lakes.

Though the advantages of marine access have been amply demonstrated, the overall consequences for the environment of the repeated dredging of the channel and of shipping traffic have never been properly evaluated. We do know that the effects are multiple,[11] but we have no

[10] In shipping parlance, a distinction is made between the *ship channel* and the *Seaway*. The channel has no true water level control structures and is just a signposted route, dredged to a sufficient depth in places between Île aux Coudres in the estuary and the first Seaway lock at Saint-Lambert, whence vessels up to 233 m overall may reach the Great Lakes from Montreal through a series of locks.

[11] There are, for example, changes to certain aquatic, riparian and even land habitats due to dredging and dredged material dumping, stirred-up, sediment-bound contaminants, changes in flow patterns, and the effects of marine traffic (disturbance of biota living in the channel, waves and bank erosion, risk of accidents and spills).

full account of what conditions were like before construction work began by which we might assess the extent of the changes. However, we have accumulated, bit by bit, indicators of certain effects.

Before the ship channel assumed its present form,[12] this sector of the river flowed through a network of channels of varying depth. The current already flowed at different speeds in the deep channels and in the shallower passages, but the discrepancy was less marked than it is now. The simple act of widening and deepening the main channel to accommodate ships had the effect of concentrating the flow there. Greater current speeds increased the particle carrying capacity of the water and thus exacerbated erosion.

Dredging and the dumping of dredged material may affect the aquatic environment by stirring up and releasing sediment-bound chemicals. Excavation and dumping also disrupt habitats (Figure 10). The most significant changes occurred when the present channel was dredged between 1954 and 1959. It is estimated that since 1945 1773 ha of deep-water habitats and aquatic plant beds have been affected by these operations. Maintenance dredging of 18 000 m^3 of sediment was carried out off Contrecoeur between 1978 and 1986. A major project is being planned to dredge over 200 000 m^3 to deepen the channel to 11.3 m between Montreal and Cap à la Roche.

Dredged material may be dumped in the water, affecting the animal communities present; it may also be dumped on islands,[13] with consequences for their height, topography, drainage patterns, flora and fauna. For example, changes have been observed in the composition

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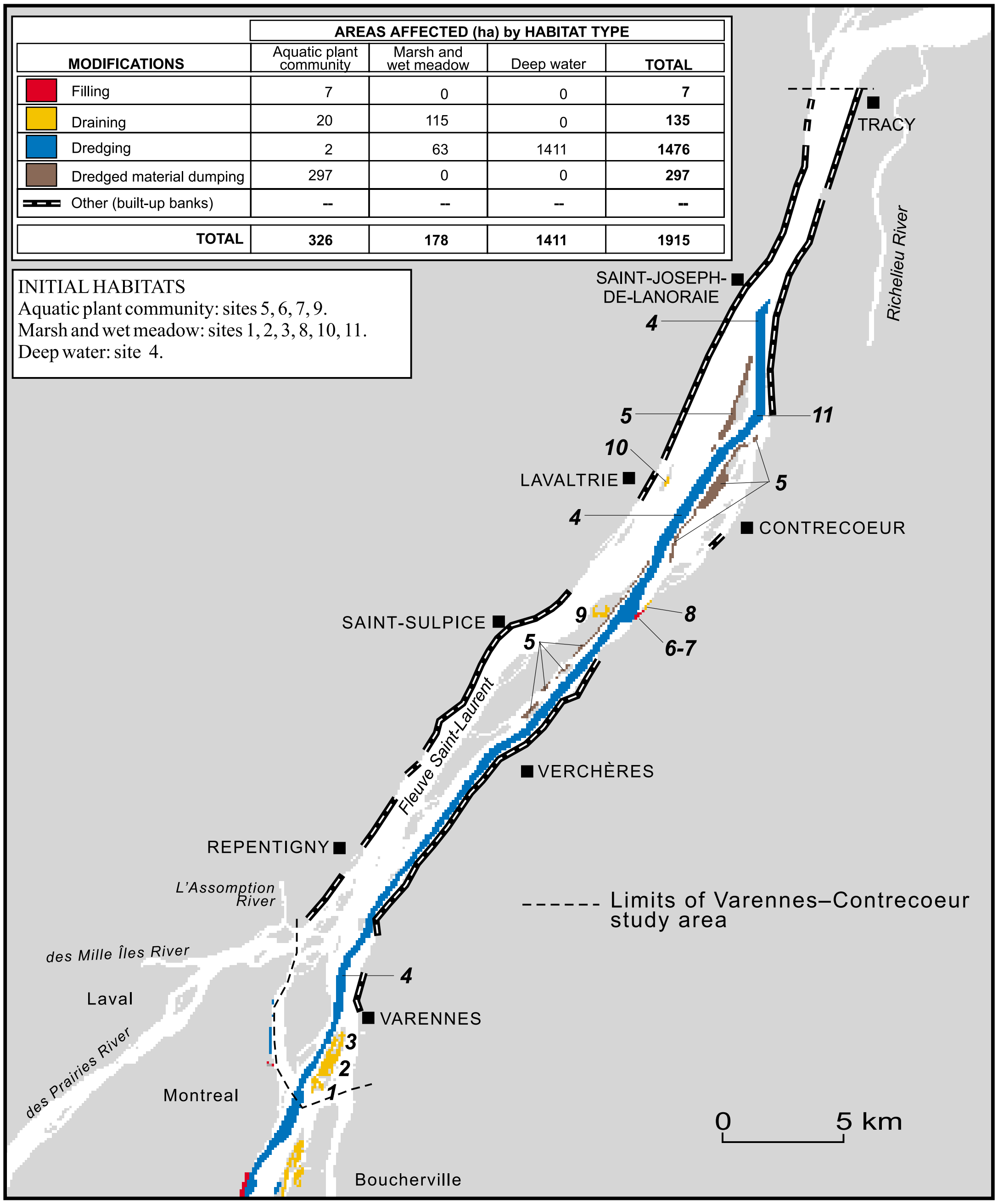
[12] The St. Lawrence ship channel has existed since the 19th century, though its dimensions were smaller then (76.2 m wide by 5 m deep in 1854). As its clearance was extended, ever-larger areas had to be dredged.

[13] In particular, the Varennes islands were affected, as were the Repentigny (Îlet Vert, Île aux Vaches, and Sainte-Thérèse and Deslauriers islands) and Verchères archipelagos (Île aux Prunes, Île aux Boeufs, and Bouchard, Bellegarde, Ragominaires, Beauregard, Amyot and Marie islands), likewise in the Contrecoeur archipelago the Lacroix islets, Île du Pilier, Île de la Cache, , Île aux Rongeurs, Île à Lefebvre, Île de la Petite Colonie, and Chipeau, Duval, Saint-Ours and Viau islands.

of the flora of certain parts of the Contrecoeur[14] island marshes attributable to dumping of dredged material.

14 South of Île aux Boeufs, Broad-fruited bur-reed and bulrushes have been gradually supplanted by the Narrow-leaved cattail. In other marshy areas, the cattail is also pushing out arrowhead.



MODIFICATIONS	AREAS AFFECTED (ha) by HABITAT TYPE: Aquatic plant community	Marsh and wet meadow	Deep water	TOTAL
Filling	7	0	0	**7**
Draining	20	115	0	**135**
Dredging	2	63	1411	**1476**
Dredged material dumping	297	0	0	**297**
Other (built-up banks)	--	--	--	**--**
TOTAL	**326**	**178**	**1411**	**1915**

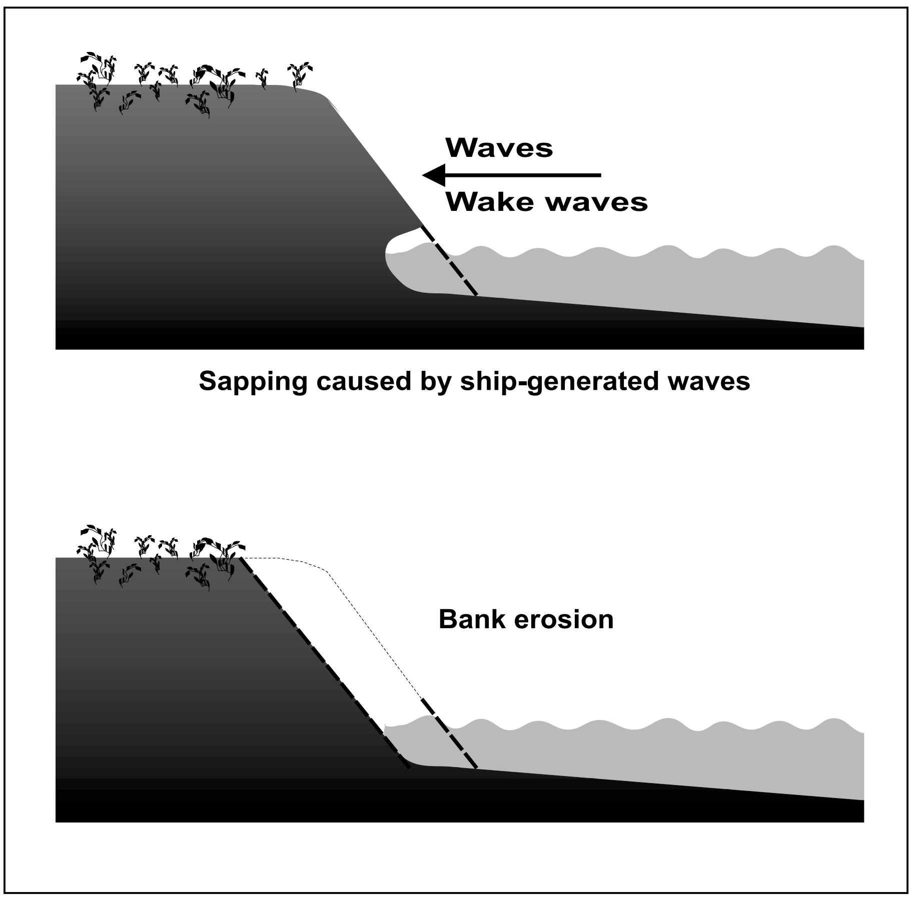
INITIAL HABITATS
Aquatic plant community: sites 5, 6, 7, 9.
Marsh and wet meadow: sites 1, 2, 3, 8, 10, 11.
Deep water: site 4.

Source: Adapted from Robitaille et al., 1988, and Les Consultants en Environnement Argus Inc., 1996.

Figure 10 Physical modifications to aquatic and riparian habitats since 1945

4.1.2 Ship traffic

One of the most visible effects of shipping results from the very passage of the vessels. The action of a ship's wake waves along the banks is damaging. Combined with other factors, like the islands' substrate type, ice abrasion and current speed in the channel, this onslaught steadily saps the banks, and the substrate slowly crumbles into the water. The eroded banks have a characteristic appearance: the top of the slope is crowned with vegetation, from which overhanging clumps finally fall off (Figure 11).



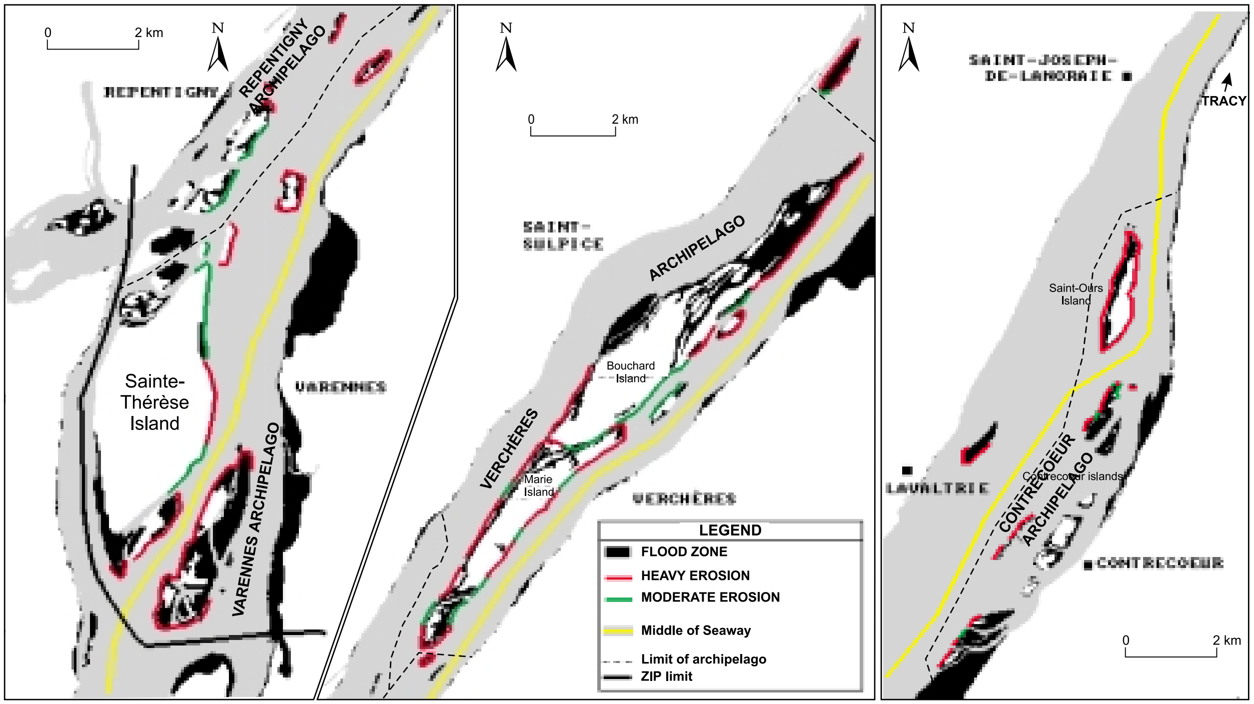
Source: SLC and Laval University, 1992.

Figure 11 Process of shoreline erosion caused by ship traffic

Together with the upper reaches of Lake Saint-Pierre, the Varennes–Contrecœur sector is the portion of the river most heavily affected by erosion. The south shore municipalities have used rock fill to arrest the retreat of the shoreline, but the islands bordering the ship channel remain exposed to the wake of commercial vessels and are suffering significant losses (Figure 12). It was recently estimated that 70 km of shoreline had been subjected to moderate to heavy erosion. This is particularly obvious on the Varennes islands closest to the ship channel (Grande Île, the north shore of Île aux Fermiers, Îlet Vert, Île au Veau, Île aux Vaches, Île aux Ragominaires, and Saint-Patrice, Sainte-Thérèse, Deslauriers, and Bellegarde islands). For example, Bellegarde island's shoreline is receding by 4.5 m per year. By far the most seriously affected, however, are the Verchères islands (especially Desmarais, Marie and Bouchard islands, along with Île aux Prunes and Île aux Boeufs),where nearly 44 km of shoreline is exposed to erosion. Other islands are suffering comparable losses, up to 10 m per year in the case of Île aux Sternes in the Contrecoeur archipelago; some islands may disappear soon unless they are protected. The island habitats lost to wave action are primarily wet meadow, marsh and woodland, some of them of great value to breeding waterfowl.

Shoreline stabilization techniques have been tried in the Contrecoeur islands. The most promising involves burying in the island soil cribs of cedar logs interlaced with willow cuttings. The willow rapidly takes root and holds the substrate in place. With some refinement, this technique holds out hope of being able to safeguard some island and riparian habitat before too long.

Wake waves also affect the abundance and distribution of fish, wiping out aquatic plant beds, which provide suitable spawning and nursing sites, and stirring up sediment in shallow waters. They are also thought to have a direct impact on the distribution of adult specimens: a number of surveys have shown that species diversity is lower in places exposed to the action of wake waves than it is in more sheltered spots. In the Varennes–Contrecoeur sector as a whole, those species with the most uniform distribution are precisely those least affected by wave action; that is, Yellow perch, White sucker and Emerald shiner.



Archipelagos of Varennes and Repentigny

Verchères archipelago

Contrecoeur archipelago

Source: Grenier, 1991; Bertrand et al., 1991.

Figure 12 Flood- and erosion-prone zones on islands in the Varennes–Contrecoeur sector

4.2 Contamination

For a long time, the St. Lawrence was considered a convenient and inexpensive dump site for wastewater. Industries, municipalities and agricultural operations discharged effluents and drainage water into the river untreated, until the effects of the pollution could no longer be ignored. The magnitude of the problem forced governments to monitor effluent and establish standards for the levels 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 determine 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 boosts biological productivity considerably, which, among other things, can lead to the rapid growth of algae and give water a foul odour that turns people off swimming and other recreational activities. Agricultural activities can degrade the aquatic environment through runoff of fine soil particles, fertilizer and pesticides.

4.2.1 Sources of pollution

In the Varennes–Contrecœur sector, it has been estimated that the most significant sources of contamination of the aquatic environment are the river itself (from further upstream) and some of its major tributaries, industrial discharges and municipal effluent. Surface runoff in urban areas and from contaminated sites, and atmospheric pollution probably also play a role in contaminating the aquatic environment, but the contribution of these nonpoint sources is hard to quantify at present.

4.2.1.1 Tributary and river inputs

Three tributaries contribute to the degradation of the river where it enters ZIP 10: the Des Prairies, Mille Îles and L’Assomption rivers (Table 5). To these may be added many smaller rivers and streams, most of them not systematically monitored for contaminant load.

Table 5
Estimated contaminant inputs to the river and its major tributaries in the Varennes–Contrecoeur sector, 1991–92

		Tributaries			
Contaminants)	*St. Lawrence (upstream)*	*Saint-Charles*	*L'Assomption*	*Mille Iles and Des Prairies*	*St. Lawrence (downstream)*
Inorganic substances (kg/year**)**					
Cadmium	4 964	0	24	661	7 217
Cobalt	49 248	7	335	7 760	80 624
Chromium	384 195	20	45	30 363	428 019
Copper	183 944	23	1 237	22 037	339 683
Iron	41 630 468	14 165	237 700	8 028 926	83 391 038
Manganese	1 629 305	513	18 630	477 381	2 672 615
Nickel	369 292	7	382	20 529	287 079
Lead	57 982	8	146	8 157	101 865
Zinc	667 337	63	1 425	68 302	579 732
Organic substances (kg/year)					
Total PCBs	31.4	0.0	0.1	3.6	54.0
Total PAHs	2 537.6	0.2	14.8	321.0	7 025.0
HCB	1.4	-	0.0	0.6	4.0
Total BHC	11.7	-	-	2.4	18.0
Chlordane	73.1	0.0	0.3	6.0	64.0
Total DDT	178.0	0.0	0.4	23.4	260.0
Tetrachloro-2,3,4,6 phenol	21.2	0.0	0.1	4.8	27.0
PCP	89.1	0.0	0.1	21.0	97.0
Atrazine	1576.0	-	-	40.2	1 855.0
Diazinon	808.0	-	-	149.4	661.0

Source: *Proulx, 1993a and b*; *Fortin, 1995.*

* Downstream load does not necessarily equal the sum of the first four columns because annual discharge estimates are inherently imprecise.

- *Load not measurable.*

Des Prairies. The Des Prairies River is the main outlet for Lake des Deux Montagnes (Lake of Two Mountains). Apart from a few streams, there are no branches adding to its flow as it runs between Jésus Island and Montreal Island.

This river undergoes a marked deterioration in water quality along its course. Nearly one million people live or work in its immediate vicinity; the area is home to some 260 industrial plants whose effluents go into municipal sewer systems, contributing about 10% of the total volume of wastewater dumped into this river.

The chief culprit in the degradation of the river's water quality is municipal sewer overflows. Since 1988, the wastewater originating from the north shore of Montreal Island has been rerouted to the MUC's regional treatment plant, but in heavy rain the collector sewer may overflow, discharging significant quantities of untreated wastewater into the Des Prairies River.

All along the north bank, numerous urban outfalls, especially those of Laval, dump wastewater into the Des Prairies River, contributing to its poor water quality. Only the Sainte-Dorothée, Duvernay and Saint-François wards provide primary treatment.

In 1990 and 1991, it was estimated that the quantities of nitrogen and phosphorus carried by the St. Lawrence increased markedly off Repentigny because of the input from the Des Prairies and Mille Îles rivers.

Mille Îles. The northern outlet of Lake of Two Mountains leads into the Mille Îles River, with a discharge equivalent to about 20% of that of the Des Prairies River. This watercourse runs north of Jésus Island and receives, on the left, the flow of the Du Chêne, Du Chicot, Aux Chiens and Mascouche rivers.

The drainage basin of the Mille Îles River is the locus of a variety of farming and industrial activities, especially in the basins of the Du Chicot and Du Chêne and on most of Jésus Island to the south. The main industrial areas are at Saint-Eustache, Sainte-Thérèse and Terrebonne.

In several local municipalities, water treatment leaves much to be desired; some facilities have been installed, but are not fully functional. Consequently, the quality of the water, quite good on leaving Lake of Two Mountains, deteriorates rapidly along the river. The water is unsafe from Rosemere to the confluence with the St. Lawrence.

The situation may have improved a little in recent years, since the population of Terrebonne, Saint-Eustache, Sainte-Rose and Auteuil is now served by a wastewater treatment plant.

L'Assomption. The upper L'Assomption drainage basin, located in the Laurentians, is largely forested and is used mainly for recreational and open-air pursuits. The river's headwaters are generally of good quality, since they receive the outfall of only a few small settlements. By contrast, the lower reaches of the river, below Joliette, pick up significant quantities of agricultural, urban and industrial waste.

In 1995, there were 1305 farms in this drainage basin, with over 60 000 hectares of land under cultivation and nearly 75 000 animal units.[15] In the early 1980s, the nitrogen and phosphorus load from all sources, at the mouth of the river, was estimated at 1777 and 262 tonnes per year, respectively; about half of this was of agricultural origin.

Local pesticide application in 1995 was almost twice the average annual rate for Quebec, and in the lower sub-basins values of three or four times the Quebec average were reported. A 1994 study showed that the water of the L'Assomption River and some of its tributaries contained high concentrations of triazine and atrazine.

4.2.1.2 *Industry*

The study area encompasses a dozen of the 106 priority industrial plants identified under the St. Lawrence Vision 2000 action plan and targeted for reducing the toxicity of their effluents (Figure 13). Seven of these plants are on the shores of the St. Lawrence and discharge waste into it. Five are in Varennes, the main industrial hub in the sector,[16] and two in Contrecoeur. These plants produce organic and inorganic chemicals, metals and petrochemicals.

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[15] An animal unit is defined as producing 75 kg of nitrogen per year. The number of head per animal unit varies by species (e.g. 1 cow, 5 hogs or 250 chickens).

[16] The Sorel–Tracy area is home to many industrial plants, but they are downstream from the study area; analysis of their effluents appears in the technical reports and assessment for the Lake Saint-Pierre sector (ZIP 11). There is an ordinance plant producing explosives and military ammunition at Le Gardeur in the L'Assomption watershed

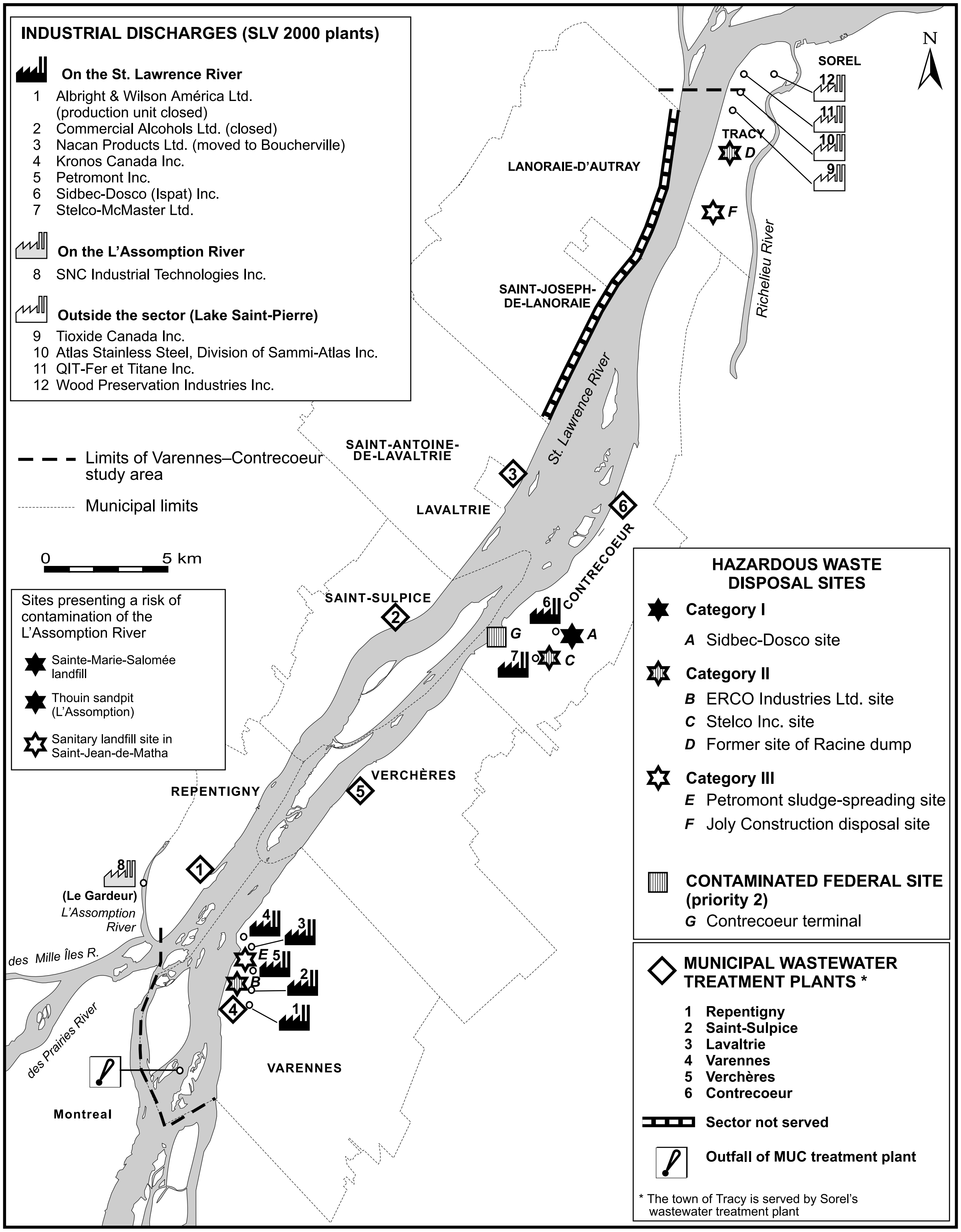
Table 6 summarizes the main products of these plants and briefly describes what they dump into the aquatic environment, according to a study conducted under the auspices of the St. Lawrence Action Plan and St. Lawrence Vision 2000 between 1989 and 1993. Three of these plants have since ceased operation.

Table 6
SLV 2000 action plan priority plants in the Varennes–Contrecoeur sector and general characteristics of their discharges

Industrial plant	*Sector*	*Product*	*Toxic substances in discharges*	*Reduction in toxicity*
Kronos Canada Inc., Varennes	Inorganic chemicals	Titanium dioxide	Acid, chromium, iron, vanadium, aluminum	94%
Albright and Wilson America, Varennes (closed 1992)	Inorganic chemicals	Phosphorus	Elemental phosphorus, total phosphorus, cyanides, arsenic	98%
Sidbec-Dosco Inc., Contrecoeur	Steel	Steel	Oils and greases, sulfur, iron, phosphorus	74%
Commercial Alcohols Ltd., Varennes (closed 1991)	Organic chemicals	Ethanol	Phthalate, phosphorus	100%
Nacan Products Ltd., Varennes (moved to Boucherville in 1993)	Organic chemicals	Polyvinyl acetate	Phthalates, oils and greases	100%
Petromont Inc., Varennes	Petrochemicals	Petroleum products	Arsenic, phosphorus, phthalates, ammonia nitrogen	74%
Stelco-McMaster Contrecoeur	Steel	Steel	Suspended matter, iron	Not available

Source: *SLV 2000 Technology and Intervention, 1996a and b, and 1997*.

(SNC Industrial Technologies Inc.); its wastewater is treated according to the production process. This plant has undertaken a clean-up and should soon be hooked up to the Le Gardeur treatment plant.



Source: *SLV 2000 Technology and Intervention, 1996a and b, and 1997; MENVIQ, 1991a and b; D'Aragon, Desbiens, Halde et Associes and Roche Ltd., 1992.*

Figure 13 Main local sources of contamination and treatment facilities

Kronos Canada Inc. produces titanium dioxide pigments, using two processes, one based on sulfate and the other on chloride. In 1991, the sulfate process created most of the contamination reaching the aquatic environment and made this plant one of the worst polluters along the St. Lawrence. Remedial work was undertaken to reduce the toxic load pursuant to an order from the provincial environment ministry (MEF). Since June 1994, acid effluent from the sulfate unit has been neutralized (1600 m^3 per day) and the dewatered sludge has been made into gypsum. This system led to a reduction in acidity, and the improvements lowered the plant's Chimiotox[17] rating by 94% from 1988 to 1995.

The *Sidbec-Dosco Inc.* plant had a nominal capacity in 1997 of 1 800 000 tonnes of steel made from either ore or scrap. The facilities comprise an ore reducing process, a steel plant and hot and cold rolling mills. Total emissions are 49 000 m^3 per day. This plant reduced the Chimiotox rating of its effluents by 74% from 1988 to 1995, largely by cutting back the load of oils and greases, iron and suspended matter.

The *Stelco-McMaster Ltd.* plant makes steel billets and sheets from scrap iron and ferrous alloys. Its nominal production capacity is 590 000 tonnes per year; in 1997, it produced some 454 000 tonnes. Its discharges, estimated at 32 700 m^3 per day, contain chiefly suspended matter and iron.

Petromont Inc. produces petroleum hydrocarbons. Process wastewater is treated before discharge into De La Commune Creek, at an average rate of 2900 m^3 per day. This company has decided to bring its Varennes plant into line with the industrial waste standards imposed by the MUC at another of its facilities, in Montreal.

Lastly, three priority plants have closed or moved in recent years: *Commercial Alcohols Ltd.* closed in 1991, *Nacan Products Ltd.* moved to Boucherville in 1993, and *Albright and Wilson America (division of Tenneco Canada Inc.)* closed its elemental phosphorus production plant in 1993, but still uses the site for distribution operations.

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[17] The *Chimiotox* index combines quantities of various contaminants in effluent into a comprehensive report of its toxicity for the receiving environment.

4.2.1.3 *Contaminated sites*

In addition to their effluents, these industries generate hazardous wastes that they dispose of at landfill sites. Over the long term, these sites can also contaminate the aquatic environment: some products may be carried in runoff or penetrate to the water table and eventually reach watercourses.

Contamination from sites far from the river and its tributaries may pose less of a risk to the aquatic environment, but it still seriously limits how the land is used.

A number of contaminated sites in the study area posing an environmental pollution or public health hazard have been inventoried by either the federal or provincial authorities (Figure 13). Ten of these sites have the potential to contaminate the St. Lawrence River or its tributaries (Table 7). Three of them are a serious threat to the aquatic environment because of the substances buried there and their proximity to a watercourse. These are the Sidbec-Dosco site in Contrecoeur, the Sainte-Marie-Salomée controlled landfill site, and the Thouin sandpit, the latter two being in the L'Assomption drainage basin.

4.2.1.4 *Municipal waste*

The proximity of Metropolitan Montreal has an impact on the quality of the water in the Varennes–Contrecoeur sector. The MUC treatment plant at the eastern end of Montreal Island accounts for almost all the municipal effluent volume released into the sector (Figure 13). In 1996, this plant processed the wastewater of 1.8 million people and some 800 industrial and commercial establishments, dumping 2.7 million cubic metres of treated water per day off Île aux Vaches. With a capacity of 7.6 million m^3 per day, the MUC's plant is the largest in the Americas using physico-chemical primary treatment. This plant alone accounts for half of all the volume of wastewater treated in Quebec.

Table 7
Contaminated sites in the Varennes–Contrecoeur sector*

Location	*Description*	*Category***	*Type of wastes*
North shore			
Sainte-Marie-Salomée	Sainte-Marie-Salomée controlled landfill	1	Various industrial wastes
L'Assomption	Thouin sandpit	1	Refinery wastes, sludges and oils
Le Gardeur	SNC Industrial Technologies Inc.	Site declassified	Various industrial wastes
Saint-Jean-de-Matha	Regional sanitary landfill	III	Household waste and tannery sludge
South shore			
Varennes	Erco Industries Ltd. site (Albright and Wilson America)	II	Various industrial wastes
	Petromont sludge-spreading site	III	Settling pond sludge
Contrecoeur	Sidbec-Dosco site	I	Dust from electric furnaces and rolling mill sludge
	Stelco-McMaster site	II	Zinc sludge, dairy waste and dust from scrubbers
Tracy	Joly Construction dump	III	Heavy metals
	Racine dump	II	Titanium dioxide sludge, metals, household waste
Federal site			
Contrecoeur	Port terminal	Priority 2	Heavy metals, coal

Source: *MENVIQ, 1991a and b; D'Aragon, Desbiens, Halde et Associés, and Roche Ltd., 1992*.

* This list includes certain sites outside the study area, but located in the drainage basins of major tributaries. Environmental risk assessment was conducted by GERLED (*Groupe d'étude et de restauration des lieux d'éliminations des déchets dangereux*, Ministère de l'Environnement) or, in the case of the site under federal government jurisdiction, by Environment Canada .

** Classification: I – high: II – moderate; III – low risk of contaminating the aquatic environment.

In terms of water quality, the connection of Metropolitan Montreal's sewers to regional treatment plants (MUC, Longueuil and Sainte-Catherine) represents an improvement for places further upstream. However, the progress made along the shores of Montreal Island and along the south shore has been at the expense of the mid-section of the river, where the Varennes–Contrecoeur sector receives the treated, but not disinfected, output of treatment plants, notably that of the MUC.

The physico-chemical treatment applied by the MUC plant is very effective in reducing suspended matter and phosphorus in wastewater: in 1996, a reduction of 83% for suspended matter and 75% for phosphorus was achieved. In spite of the quantities removed by the treatment, the MUC outfall still dumps 52 tonnes of suspended matter and over a tonne of phosphorus into the river every day.

Reducing the suspended matter in treated effluent has the effect of also reducing the quantity of certain chemicals which bind to the particles; thus, an average reduction of nearly 70% has been recorded in PCBs and PAHs in urban wastewater. Annual PCB and PAH loads dumped into the St. Lawrence River via the Île aux Vaches outfall represent 1% and 4%, respectively, of the annual flow measured off Quebec City, which is very low when one considers that the MUC plant treats over half of Quebec’s wastewater.

Compared to the effluent from the MUC treatment plant, the wastewater dumped by municipalities in the study area itself is insignificant, accounting for barely 3% of total volume, or 54 000 m^3 per day.

In 1988, only two municipalities in the sector, Varennes and Contrecœur, treated their wastewater before discharging it to the river. It was estimated at the time that the St. Lawrence was receiving, through municipal wastewater, an average daily load of 1.4 kg of copper, 5.3 kg of zinc and 2.6 kg of lead. Since 1989, four other municipalities (Repentigny, Saint-Sulpice, Lavaltrie and Verchères) have acquired wastewater treatment plants (Figure 13). In early 1998, 78% of the study area’s population was served by one or other of the functioning treatment plants.

Monitoring of the plants in Varennes, Verchères, Contrecœur and Saint-Sulpice shows that they improved their performance between 1993 and 1995. The Verchères and Varennes collector sewers experienced overflows in 1994, and the Contrecoeur plant had operating problems in 1995, when one-quarter of the effluent volume went untreated. These incidents notwithstanding, it is thought that there was little impact on river water quality, sector-wide, in view of the small quantities involved.

Late in 1997, Saint-Joseph-de-Lanoraie and Lanoraie-d'Autray still had not signed agreements to have their wastewater treated.

4.2.1.5 *Snow dumping*

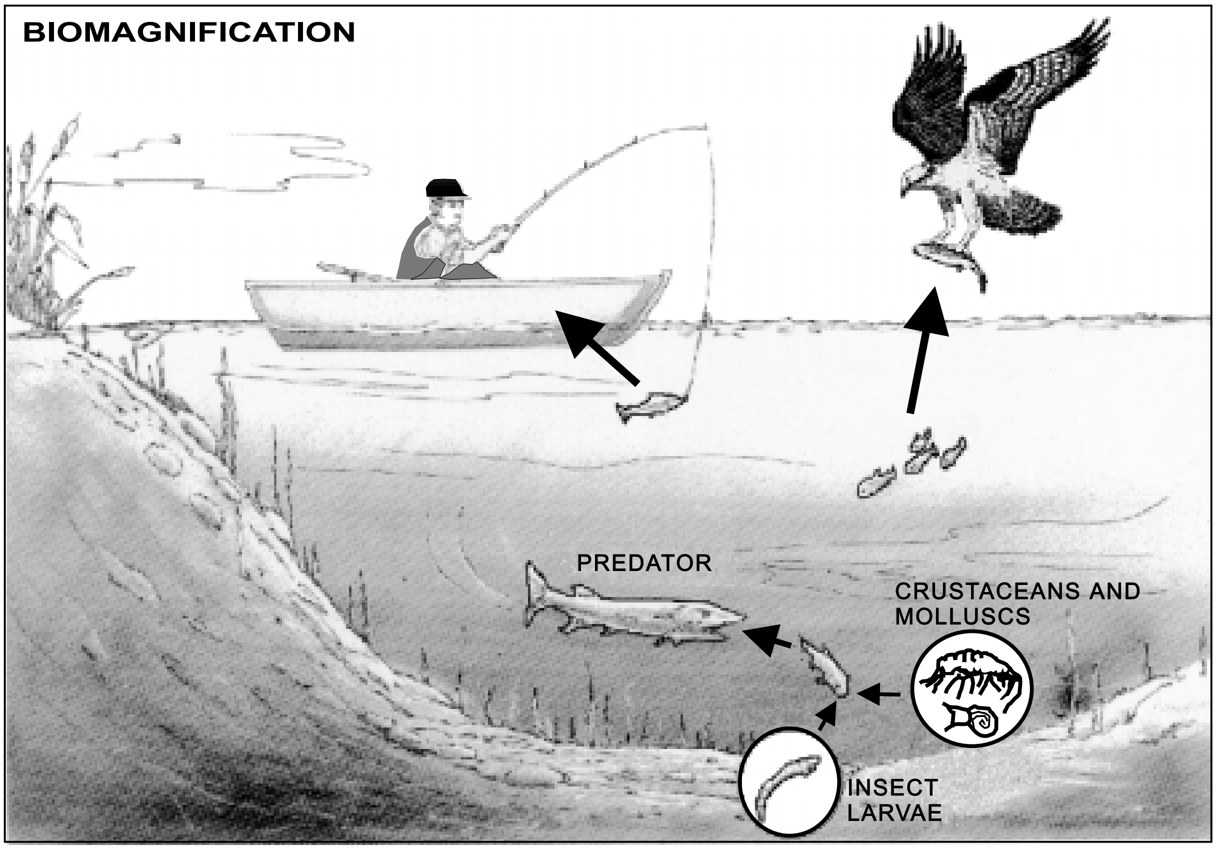
According to a study conducted in the Montreal area (LaSalle, Verdun and Lachine), snow removed from city streets after storms is too heavily contaminated with chloride ions and solid particles to be dumped directly into watercourses.

Most of the municipalities in the Varennes–Contrecœur sector still dump at least some of the snow cleared from their streets directly into the river or one of its tributaries. Provincial environment officials intend to limit this practice beginning in 2000 by imposing compensatory duties on municipalities still dumping snow directly into watercourses.

4.2.2 Impact 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 contamination 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 adsorb to particles and can accumulate in sediments over long periods. 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 high concentrations in these animals (Figure 14).



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: SLC, 1990.

Figure 14 Phenomenon of biomagnification

For researchers seeking to confirm the presence of a product in the environment, biomagnification can provide useful clues. Analyses of the flesh of predator fish or birds can sometimes reveal the presence of contaminants in quantities too small to be directly detectable in the water, even with the best analytical techniques.

Criteria such as the quality of water, sediments and aquatic organisms are used to calculate the extent of contamination of the aquatic environment and the resulting loss of use (Appendix 2).

4.2.2.1 *Water*

The available data on contamination of the water in the Varennes–Contrecoeur sector are incomplete, and therefore a cautious approach is called for in making a diagnosis. The limited number of stations, their differing sampling schedules and their positions at the two extremities of the sector mean that interpretation can easily be skewed by such factors as the flow or distribution of the water masses. Samples have been taken for analysis at these stations since the 1970s, but we are interested here only in the more recent period (1985–1990) so as to present the most up-to-date picture possible. This precaution probably will not eliminate all discrepancies between the latest available data and the situation as it is now, since a number of industrial and municipal cleanup programs have been implemented in recent years. These measures, especially the connection of Montreal Island municipalities to the MUC regional wastewater treatment plant, are very likely to have improved water quality, though this may not show up in the data presented here.

Between 1985 and 1990, contamination by inorganic toxic substances did not appear to inhibit water use in the Varennes–Contrecoeur sector, except at two points along the shore. At one sampling station near the south shore downstream from the Contrecoeur industrial area, high concentrations of chromium were recorded, often exceeding the prescribed limit for long-term protection of aquatic organisms. Data from another station, located near Pointe-aux-Trembles, showed that the brown Ottawa River water was rich in arsenic after passing Montreal’s harbour facilities. At the time, many urban and industrial collector sewers, including those serving oil refineries and a major copper smelter, emptied into Montreal harbour.

Data from the early 1990s raise concerns about the presence in the water of PCBs and DDT, all organic toxic substances. PCBs, as measured near the MUC outfall and off Les Grèves, exceeded the criteria for raw water quality[18] and contamination of aquatic organisms. DDT, as measured at Les Grèves only, also exceeded criteria. Since all these products are now banned in Canada, high PCB and DDT levels may reflect either long-range airborne pollution or past use in this country.

Concentrations of nitrites and nitrates, with due allowance for seasonal variations associated with their absorption by vegetation, show long-term increases in both the river and the Great Lakes. This rise may be attributable to greater fertilizer application on farms and increased hog and cattle production, particularly in the L'Assomption drainage basin. Phosphorus is another nutrient present in the water at high levels: in spite of a significant drop between 1990 and 1997, values recorded in the summers of 1995 and 1996 were still high enough to engender excessive growth of aquatic vegetation in some areas washed by the waters of the Des Prairies and L'Assomption rivers or in the plume of the MUC outfall. However, the current and the turbulence and turbidity of the water prevent plants from proliferating except in a few bays where there is little movement of the water.

Fecal coliform counts measured in the Varennes–Contrecoeur sector in the 1990s provide an indicator of the seriousness of bacterial contamination from urban waste in the Greater Montreal area. Generally, bacteriological contamination increases across the river from south to north and as one goes downstream. Summer bacteria counts have exceeded the criterion established for recreational activities involving contact with the water (swimming, windsurfing, sea-dooing, etc.) in the middle and northern parts of the river. Most of the counts taken along the south shore, though, respected this criterion.

[18] Raw water is untreated water taken directly from the water body for human consumption; organisms (fish, molluscs, etc.) living in the water body must also be edible without health risk.

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 river bed, contributing to the contamination of living organisms. Deposition zones often correspond to aquatic beds, which are home to benthic organisms occupying the base of the food chain. The presence of contaminated sediment represents a risk to the fish, birds and mammals that feed at these sites, and ultimately for the hunters and fishers who eat them.

There is little available information on sediment contamination in the Varennes–Contrecoeur sector. Most sediment sampling efforts have actually ignored this section of the river because it has virtually no areas of permanent sedimentation, except for a few deep trenches near the Contrecoeur islands. A sediment core taken in one of these trenches in 1990 showed low levels of nickel and chromium contamination over the past 40 or 50 years. In any case, *anthropogenic enrichment*[19] of sediment is more marked for some other metals, including lead, copper, zinc and especially cadmium.

The issue of aquatic contamination in the Varennes–Contrecoeur sector has to take into account the resuspension of old contaminated sediment that sometimes occurs further upstream. Current speeds do not favour the accumulation of significant quantities of fine, potentially polluted sediment in the sector itself, but there is probably temporary (or seasonal) sedimentation in some places, close to the banks or in aquatic plant beds. Permanent sedimentation appears to be confined to the trenches in the Contrecoeur islands already mentioned.

4.2.2.3 *Aquatic organisms*

The *zoobenthos* (animal benthos) is the group that best lends itself to an assessment of the state of aquatic habitats in various parts of the study area. Since these organisms are not very

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[19] For some metals, some of the content is natural, deriving from the geochemistry of the drainage basin, and is amplified by a contribution from human activity. The *anthropogenic enrichment factor* is the ratio of total measured content to the natural concentration.

mobile, their degree of contamination reflects local conditions of contamination by toxic substances. Changes in the composition of benthic communities in affected environments can also be more easily quantified than among higher, more mobile animals.

Samples taken in 1981 provide a basis for comparing the benthic communities in this section of the river with those that are characteristic of similar but healthy habitats. At the end of this exercise, it was established that the sector's communities were in a state ranging from acceptable to very disturbed, depending on the location. The latter label was assigned to certain communities on the eastern shore of Sainte-Thérèse Island. In 1997, varying degrees of degradation in benthos had already been reported in the Repentigny and Contrecoeur archipelago and near the municipalities of Lavaltrie, Les Grèves and Tracy. At these locations, sampling revealed a clear preponderance of tubificids and oligochaetes (up to 90% of the organisms present), a condition considered indicative of organic pollution.

Testing for metals[20] in the flesh of pelecypods (mussels) in 1983 showed that lead concentrations exceeded the limits for market seafood[21] at the stations in Boucherville, Repentigny, Sainte-Thérèse Island and its channel. The mercury limit was likewise exceeded at all stations except Deslauriers Island.

Fish sampling in the late 1970s showed mercury levels in excess of admissible limits for marketable fish, especially in the Walleye, Smallmouth bass and Northern pike.

Surveys conducted in the mid-1980s to assess the impact of the new MUC collector sewer suggest that the situation has improved. Of the metals for which fish were tested — cadmium, chromium, mercury, nickel, lead and zinc — only mercury showed up in measurable quantities, generally within the limits for marketable fishing. Only the Smallmouth bass was found to exceed this criterion. Mercury concentrations in several species nonetheless exceeded the threshold established for the protection of aquatic life. Fish in the study area were tested for

[20] Mussels were tested for lead, mercury, beryllium, cadmium, chromium, cobalt, nickel, silica, titanium and vanadium.

[21] These mussels are neither marketed nor eaten locally.

organic substances like PCBs and DDT between 1978 and 1992, but all results were below the criteria set for marketable fish.

The available data on contamination in birds are mostly dated (1978 and 1979) and relate to certain organic pollutants in the Ring-billed gull. Analyses had shown high levels of hexachlorobenzene, PCBs and DDT in eggs. Given the time that has elapsed since sampling, these results can not be used to adequately assess the present degree of contamination in these birds.

According to a recent study (1989–1996) of contamination in Black tern colonies in southern Quebec and Ontario, the level of organic substances in eggs has declined markedly since the early 1980s. Eggshell thinning due to DDT is much less pronounced in Quebec (3%) than in Ontario (9%), and it is thought that this factor no longer has any perceptible impact on breeding. Moreover, contamination in these birds is not solely of local origin, as they are migrants, spending eight to nine months of the year in more southerly climes.

Contamination levels in fish thus pose no threat to human health, though they remain of concern for the state of animal populations, especially fish-eating birds and fish. Most predators of fish swallow their catch whole and are thus more exposed to the effects of chemical compounds, which may accumulate in certain tissues and organs like the liver in greater concentrations than in the muscles.

4.2.3 Risks to human health

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

4.2.3.1 *Water consumption*

A water distribution system serves 94% of the population (see Section 5.3.1). This water is of good quality and meets provincial standards and federal recommendations. No epidemics linked to drinking water were reported between 1989 and 1997.

In all cases, water treatment includes chlorination, which releases certain byproducts, among them *trihalomethanes* (THMs), substances of particular concern to public health authorities. It has been suggested that long-term exposure to such compounds may increase the risk of bladder cancer. We have no recent data on THM concentrations in the water supplies of the study area, but all local plants except that at Lavaltrie have modified their treatment process to minimize formation of these byproducts.

4.2.3.2 *Consumption of fish and game*

Riverside residents are primarily exposed to the contaminants present in the aquatic environment when they eat fish. No studies have been carried out in the sector on the consumption of St. Lawrence River fish and the potential consequences for human health. However, research conducted in other regions (sport fishers in the Montreal and Lake Saint-Pierre regions and commercial fishers of the Lower North Shore) suggests that the health risk associated with eating fish from the St. Lawrence is negligible under current conditions of exposure (contamination level of specimens, ingested quantities and species concerned).

Nevertheless, regular consumption of large amounts of fish caught in the study area may pose health hazards, particularly from mercury. According to the guide prepared by the MEF and the Ministère de la Santé et des Services Sociaux, sport fishers may eat the fish they catch in the study area. However, moderation is advised, especially with regard to the largest specimens of predatory fish. Depending on the species, fish size and catch site, the maximum number of meals that can be eaten without risk of contamination varies between one and eight per month. In the Montreal area, the most stringent restrictions apply to Northern pike, Walleye, Smallmouth bass and, above all, American eel, which young children and pregnant or nursing women are advised not to eat. As long as people abide by the recommendations concerning consumption (number of meals) and preparation of fish[22] and avoid eating fish with external abnormalities[23], the health risks are negligible based on current knowledge.

A pilot study involving 40 sport fishers in the Montreal area indicated, moreover, that people who ate a lot of fish from the St. Lawrence (about six meals of 230 g per month) had higher body burdens of mercury, PCBs and DDE (a degradation product of DDT) than individuals who ate only one meal per month. However, all of the fishers, except one, had concentrations below the guidelines recommended by Health Canada. The one exception exceeded the recommended level for PCBs.

In short, the risk of contamination from eating fish is negligible, provided that people abide by consumption advisories. Fish consumption has many advantages: in addition to providing a good source of protein, vitamins and minerals, fish offers some protection against cardiovascular disorders. Moreover, for pregnant and nursing women, the consumption of the least-contaminated species (that is, those that may safely be eaten eight times per month) are an important source of polyunsaturated fatty acids (especially omega-3s) and nutrients that are essential to the developing fetal nervous system and infants in their first few months of life.

With regard to waterfowl, contaminants have not been found at concentrations that would limit their consumption.[24] The main advisory concerns lead shot, which should be removed from the flesh before cooking. This clearly has nothing to do with environmental pollution.

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

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[22] Because 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 consumed, either.

[23] Parasites and external abnormalities may sometimes be prevalent in fish taken from the St. Lawrence. Most fish parasites are not harmful to 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 papilloma, etc.)

[24] Though contaminant content is low, it is still wise to use cooking methods which remove as much fat as possible. To eliminate any risk of parasitic or microbiological contamination, the meat should be cooked thoroughly.

4.2.3.3 *Recreational activities*

The study area has no public beaches on the St. Lawrence River included in the provincial *Environnement-Plage* program. There are a few places where people swim, including Repentigny, but they are not monitored for bacteriological water quality, nor are they supervised to ensure safety.

Water samples taken in this area have consistently yielded coliform counts far above the threshold for recreational activities involving direct contact with the water (swimming, sailboarding, sea-dooing, water skiing), and such activities are not recommended. The health hazards for those who expose themselves to contaminated water include gastro-intestinal problems and infections of the skin, eyes and ears.

4.3 Encroachment on Habitat and Conflicting Use of the Environment

Since 1945, human activity (filling, diking or erection of various structures) has degraded or eliminated 142 ha of aquatic habitat in the study area, especially along the shoreline (Figure 10). These changes may tend to reduce the richness of the environment, as the habitats affected are among the most important to fauna and flora along the river. Natural river banks usually slope gently, with a succession of substrates and vegetation, so that there is a gradual transition from dry ground to the water. These shoreline fringes are very rich in fauna, providing mammals, birds, fish, amphibians and reptiles with food, shelter and breeding grounds.

Filling and the construction of docks, retaining walls and other artificial structures destroy habitat. The slope is made abrupt, eliminating transition zones. Coarse fill, placed to withstand the current, does not allow vegetation to flourish. Not only do flora and fauna disappear where the changes occur, but abundance and diversity are reduced in adjoining terrestrial and aquatic habitats. The artificial stretches of the shoreline[25] are distinctly less rich and productive than those left in their natural state.

The proportion of artificial embankment in the Varennes–Contrecœur sector is far lower (34%) than it is on and around Montreal Island. Most riparian habitat remained in its natural state until the mid-1970s, when urban and industrial development spread to areas along the river. Urban areas like Repentigny, Lavaltrie, Varennes and Contrecoeur have suffered the largest losses of natural shoreline (Figure 15). The islands have remained relatively unscathed, with 93% of their shoreline still in a natural state.[26]

Of the different types of encroachment that have taken place in the sector, the use of riprap along the banks between Varennes and Verchères, is a special case, since it was undertaken to halt erosion due to ship wake waves and is thus related to the problem of ship traffic, dealt with in Section 4.1.

Other types of encroachment have also reduced wildlife habitat. On some of the Repentigny and Verchères islands, the entire arable surface has been ploughed for corn, leaving only a thin strip of shoreline, too narrow to accommodate nesting waterfowl. These losses, quantifiable in terms of area, are amplified by more diffuse and imperceptible disruption due to the movement of people, machinery or livestock. On those islands used for pasture, livestock trample shoreline vegetation, prevent ducks from nesting and disturb their broods. Some farmers

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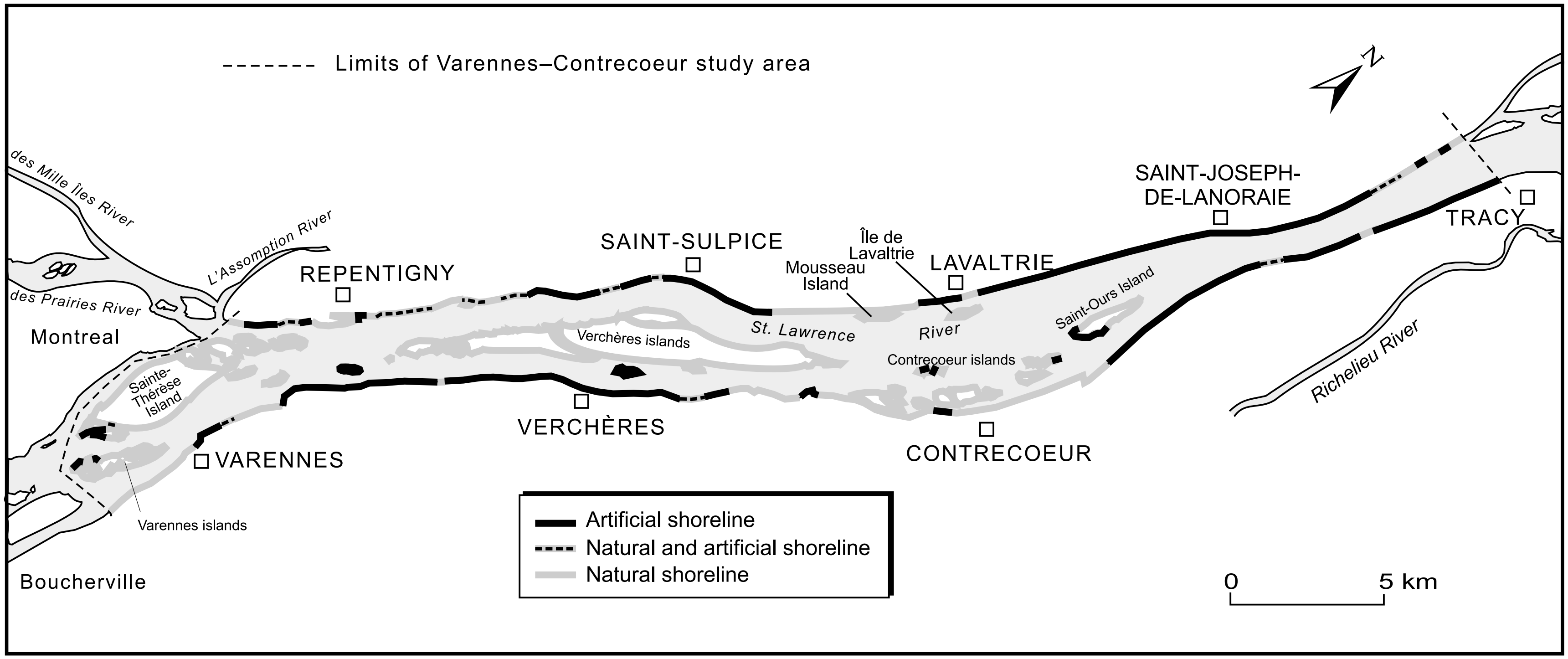
[25] *Artificial* refers to any river bank whose profile has been reworked or on which permanent structures (walls, docks) have been erected.

[26] The shoreline has been modified on Île aux Vaches, Saint-Patrice and Bellegarde islands (Varennes archipelago), Île aux Prunes (Verchères), Saint-Ours and Duval islands, and Île aux Peupliers (Contrecœur).

are accompanied by their dogs, which may destroy nests. Measures have been proposed for reconciling the demands of breeding waterfowl and those of farming and pasturage.[27]

[27] These measures include choice of reaping date, rotation of mowing, seeding without ploughing, maintaining wider natural borders, sowing some wild plants and fencing to limit livestock movement and trampling.



Source: Les Consultants en Environnement Argus Inc., 1996.

Figure 15 Natural and artificial shoreline in the Varennes–Contrecoeur study area

The first trials conducted on some of the Varennes islands resulted in an immediate boost to nesting density.

Control of livestock movement, creation of dense patches of plant cover and enhancement of the leaf litter seem to have improved nesting habitat. In the long term, regrowth of abandoned pasture and creation of dense plant cover promise to attract many species of passerine birds. All this has been achieved without penalizing or interrupting farm operations.

4.4 Other Pressures on Resources

There may undoubtedly be other processes impinging on the natural environment in the study area, though they are hard to assess at present.

4.4.1 Introduced and expanding species

Today, we know that the introduction of new species into an ecosystem, a fairly widespread practice in the last century, 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 which are now integrated with the local fauna. 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. Reed grass has spread throughout Quebec since the 1970s. It multiplies from its rhizomes and colonizes reclaimed land and drainage ditches, forming dense groupings that shut out other species.

Two invertebrates, both molluscs, are currently invading the St. Lawrence. The Zebra mussel has colonized the Great Lakes and St. Lawrence from Lake St. Clair, Ontario, displacing indigenous bivalves, especially unionids. The Quagga mussel, a more recent invader, has a similar impact. The far-reaching effects on ecosystems of the arrival of these two species have yet to be fully described. One of the best known drawbacks of the overabundance of the Zebra mussel is the clogging of water intakes.

In the early 1990s, the Zebra mussel was virtually unknown in the Varennes–Contrecoeur sector. It became somewhat more abundant over the next few years, but without reaching values as high as elsewhere on the river. Between 1991 and 1996, the density of Zebra mussels attached to navigation buoys in the sector never exceeded 9.2 per m^2; by way of comparison, in the Soulanges Canal, densities of up to 3712 individuals per m^2 were reported in 1994.

Among birds in the Montreal area, the Ring-billed gull is the species that has expanded most dramatically over the last 20 years. Its numbers now seem to have levelled off, if the nest counts of the colonies on Deslauriers and Saint-Ours islands are to be trusted. This opportunistic species takes advantage of human alterations to the environment; some individuals have learned to feed on refuse from dumps and street trash cans, and flocks are often seen on farms following the plough. When they gather in large numbers, they can cause local water pollution problems.

The gulls of Deslauriers Island frequent a sanitary landfill site in Lachenaie. When they are raising their young, their numbers at this location often exceed 8000 at a time, causing considerable nuisance for the people working there.

4.4.2 Environmental accidents

Some places in the study area are subject to flooding or landslides. Portions of the municipalities of Repentigny, Saint-Sulpice, Lanoraie-d’Autray, Varennes, Verchères, Contrecoeur and Tracy are vulnerable to the cresting of the river or one of its tributaries (L’Assomption or Richelieu rivers). Ground movement is thought to be a hazard near the Saint-Charles River, in Varennes and near Jarret and Langlois creeks in Verchères.

Flooding, like the landslides that may result, represents a risk not only to the safety of riverside residents, but also to their health, since victims may have to survive for some time in unhygienic conditions. The most common problem is respiratory difficulties caused by mould growth in recently flooded houses. Though physical health is not affected at every such occurrence, the social and psychological impact of property losses or evacuation can sometimes be serious.

Incidents caused by human activities, such as the transportation or storage of hazardous products near the river, also pose a risk to health and safety.

Shipping threatens part of the river and its banks with the latent risk of ecological mishaps. The St. Lawrence ship channel is one of the most challenging navigable waterways in the world. It is narrow and winding, and wind, current and ice can sometimes complicate things further. Since 1974, over 100 incidents involving dangerous goods, chiefly petroleum products, have been reported in the Varennes–Contrecoeur sector. The biggest spills were at Varennes in 1976 and off Tracy in 1978.

To date, these events have had little impact on the health of riverside populations or the environment because most of them occurred in port during transshipment operations.

CHAPTER 5 Sector Resources and Assets

Despite the alterations of the natural environment caused by human occupation and activities, the study area still has many assets that are closely linked to the St. Lawrence River. These elements need to be factored in, since development in the sector is partially dependent on them.

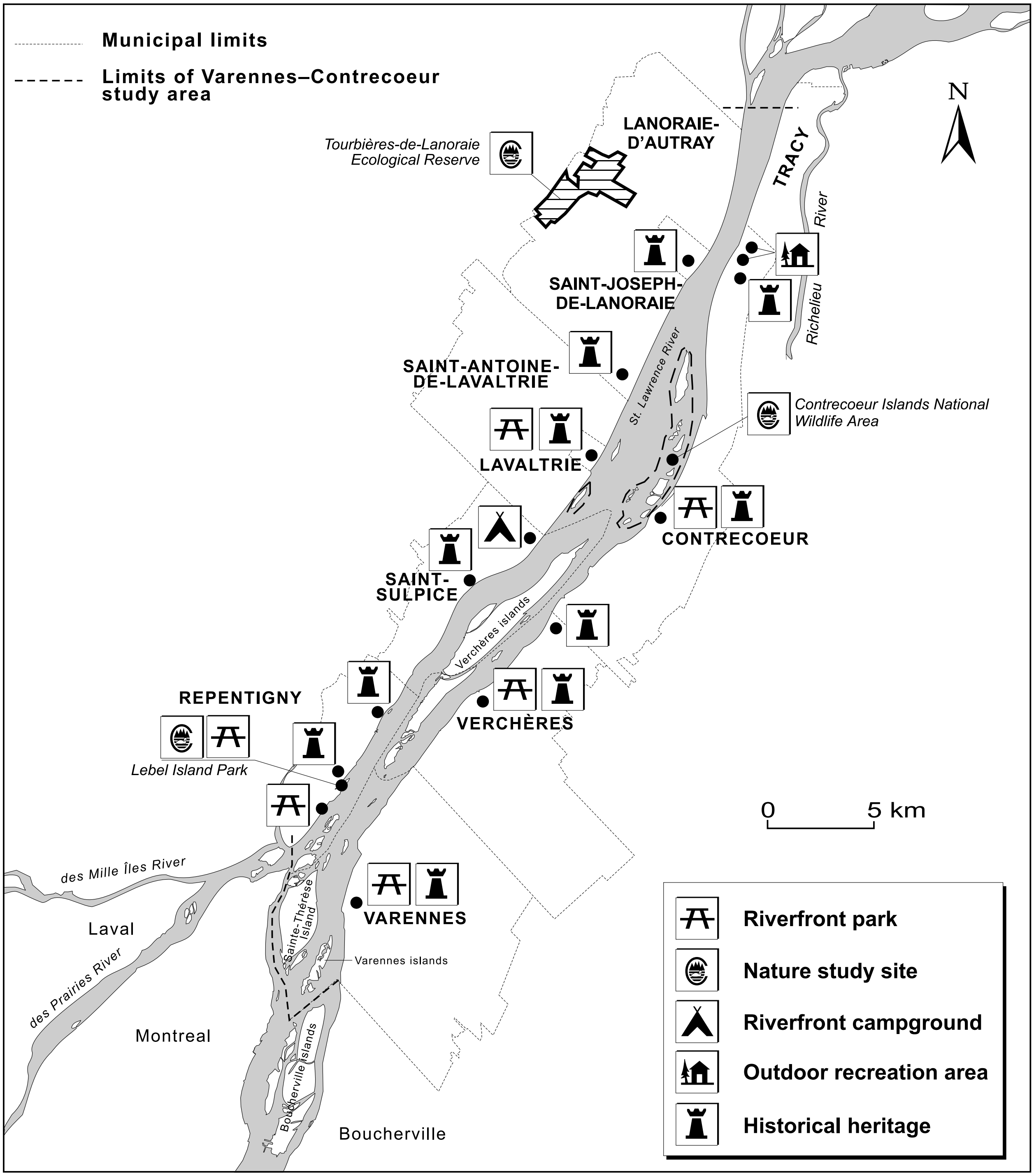
5.1 Recreation and Tourism

One of the defining features of the study area is the lack of a developed recreation and tourism industry, particularly one that would take advantage of the river. There is no real regional recreation and tourism hub around which such an industry could be organized.

5.1.1 Tourist attractions and recreational facilities

At present, there is no integrated recreation and tourism network on which a local tourism industry could be built, yet the region possesses assets (Figure 16) worth developing. Apart from attractive riverside spots, there are monuments and sites of archaeological, historical or heritage interest. A number of villages have preserved an ambience that lends them tourist appeal.

Accessible green spaces opening onto the river are almost non-existent. At the present time, this section of the river does not give the impression of being a public resource. Most of the shoreline (66%) is divided up among a host of private lots whose owners have exclusive access. There are 513 cottages, mostly concentrated in Varennes (25%) and Lanoraie-d’Autray (18%).



Source: ATR de la Montérégie, 1996; ATR de Lanaudière, 1996; Tecsult Inc., 1995.

Figure 16 **Tourist attractions and recreational facilities in the Varennes–Contrecoeur sector**

The proportion of land in the study area that is devoted to recreation is negligible (less than 1%); this amounts to a handful of municipal or regional parks (in Tracy, Repentigny and Saint-Sulpice). Except for Saint-Laurent and Lebel Island parks in Repentigny, there are few public spaces opening onto the river. There were four active beaches on the north shore (in Charlemagne and Repentigny) until the 1970s, but poor water quality led to their closure. In spite of the lack of public beaches, some people still swim off Sainte-Thérèse Island, and windsurfing is practised around Saint-Laurent Park in Repentigny and off Varennes.

Services to users of green spaces are not available or have simply been withdrawn because of costs. One such example is the water taxi that until 1985 plied a route between Pointe-aux-Trembles and Sainte-Thérèse Island, the latter a resort popular with east-end Montrealers until the 1960s.

In spite of the limited access to the river, some 131 000 people are reckoned to have taken part in various recreational activities in the fluvial section of the river running from the eastern tip of Montreal Island to the entrance to Lake Saint-Pierre, about 57 000 of them in three shoreline stretches within the Varennes–Contrecoeur sector (Table 8).

Table 8
Recreational and touristic use of three stretches of the river (Repentigny–Saint-Sulpice, Varennes, and the main channel) in 1994

Activity	*Participation (number of people)*
Hiking, observation, picnicking	28 000
Sailing	9 000
Swimming	10 000
Sport fishing	7 000
Hunting	3 000
Total	**57 000**

Source: Tecsult Inc., 1995.

5.1.2 Pleasure boating

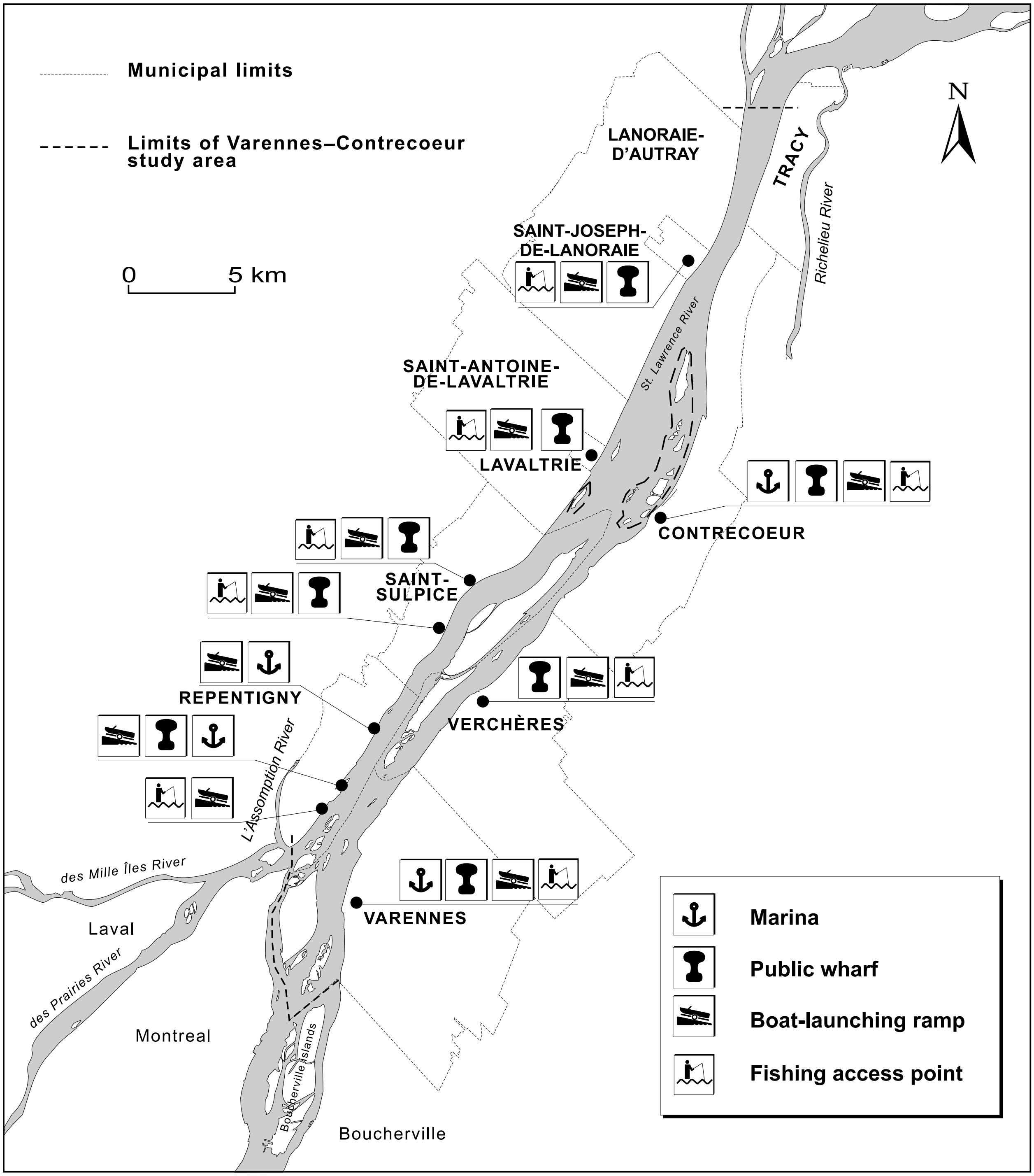
Boating in the waters of the upper reaches of the study area (Repentigny and Varennes) is limited because of currents, islands and shoals; the lower part of the sector is better suited to recreational boating craft. The study area has a number of facilities for pleasure craft (Figure 17); there are several public docks and boat launching ramps and four marinas (two in Repentigny, one in Saint-Sulpice and one in Contrecoeur) with a total of 391 berths. Boats can also be launched from many points without facilities (at Repentigny, Saint-Sulpice and Lavaltrie). In addition to pleasure craft, hunters and fishers take their boats onto the river, depending on the season, and a few cruise vessels make excursions this far from the Old Port of Montreal.

Boating in these waters demands a degree of caution. In 1995, the Coast Guard was called out to 213 incidents involving pleasure craft, usually motor boats, between the Port of Montreal and Yamachiche (Lake Saint-Pierre). The most common problems were mechanical failure and grounding, usually due to negligence: ignorance or poor judgment, inebriation or failure to carry flotation devices. In some instances, injuries, hypothermia, psychological distress and even drowning were the outcome. Between 1987 and 1993, seven drownings related to recreational activities were reported in the Varennes–Contrecoeur sector.

5.1.3 Sport hunting and fishing

We have little information on sport hunting or fishing in this section of the river. A 1994 survey estimated at about 7000 the number of fishers and hunters active in three segments of the river (Repentigny–Saint-Sulpice, Varennes, and the main channel).

If the profiles for these pursuits in the sections further upstream and downstream are any guide, the Yellow perch is likely to be the the most popular species in terms of numbers caught. Fishers seem to be mainly local people, fishing from either the shore or boats. There are no outfitters operating in the area. Ice fishing does not seem to be widely practised, though a few huts appear on the ice near Contrecoeur each winter.



Source: ATR de la Montérégie, 1996; ATR de Lanaudière, 1996; Daigle, 1997; MLCP, 1990; Tecsult Inc., 1995.

Figure 17 Boating infrastructure and main access points for fishing

In the late 1970s, it was estimated that some 52 000 ducks were shot each fall between Montreal and Sorel. According to a recent survey, the Gadwall accounts for about half the kill, followed by the American wigeon, the Blue-winged teal, the Shoveler, the Pintail, the Black scoter, the White-winged scoter and the Common merganser.

In 1979, the islands in the Varennes–Contrecœur sector were visited by over 1500 hunters. Hunting pressure appears to be very heavy in some places, especially near Île aux Cerfeuils and Saint-Laurent Island, in the Repentigny archipelago. Other popular sites are around Bouchard and Ronde islands in the Verchères archipelago and near Mousseau and Lavaltrie islands (Contrecoeur archipelago). Hunting is allowed in the Contrecoeur Islands National Wildlife Area and on Saint-Ours Island, which is now part of the archipelago.

5.1.4 Sites suitable for wildlife observation or interpretation

There is no shortage of natural landscapes in the Varennes–Contrecoeur sector, on either the islands or the mainland.

In Contrecoeur, there are woods used by a number of summer camps, but some of the south shore woodlands are threatened by heavy all-terrain vehicle traffic and unrestrained residential development.

Each year, the number of birdwatchers grows; the most popular sites are Île aux Fermiers (Varennes archipelago) and the Contrecoeur islands (including the northeast point of Bouchard Island in the Verchères archipelago). At these places, birders may be lucky enough to catch a glimpse of the Least bittern, the American bittern, the Great blue heron, the Pied-billed grebe, the Redhead, Wilson’s phalarope, the Common gallinule, the Common snipe, the Black tern, the Sharp-tailed sparrow, the Bank swallow, the Song sparrow, the Swamp sparrow, the Common yellowthroat, the Yellow warbler, the Short-eared owl, and the Peregrine falcon.

5.2 Biodiversity and Conservation

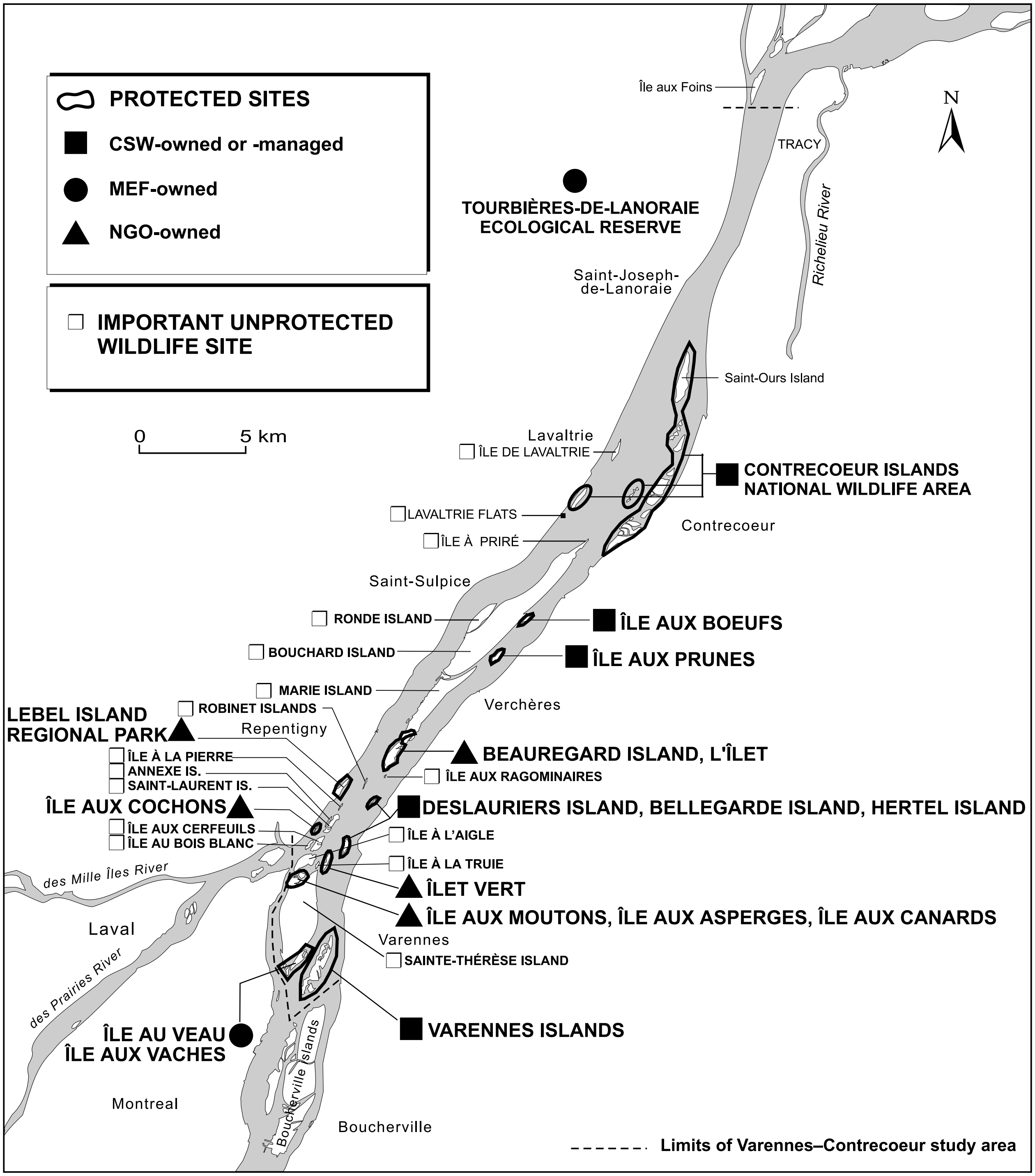
Conservation areas (13% of the territory) are located mainly on the islands, especially in the Contrecoeur archipelago (Figure 18).

The *Contrecoeur Islands National Wildlife Area* enjoys legal protected status. It was created in 1981 and subsequently extended to include 26 islands in all, with an area of over 200 hectares. It will grow to 312 ha with the addition of Mousseau and Saint-Ours islands, the latter having previously been designated as the *Île Saint-Ours Migratory Bird Refuge*. The Canadian Wildlife Service holds the title to all but five of these islands. Located at the western end of the archipelago, Île à Bonin, Île au Dragon, Île aux Branches, Île à Brillant and Île aux Veaux are owned by Sidbec-Dosco, which leases them to the National Wildlife Area.

Île Lebel Regional Park, owned by the municipality of Repentigny, includes wetlands suited to the eggs and fry of still-water fish species; there is also good waterfowl habitat (for nesting, brood-rearing and migratory stopovers).

The *Tourbières de Lanoraie Ecological Reserve* (415 ha), created in 1994, protects a sample of typical St. Lawrence Lowland peat bog.

A few of the islands are owned by the provincial or federal government or by conservation organizations, thus limiting the chances of some kinds of disturbance. The *Canadian Wildlife Service* owns or manages ten islands in the Varennes archipelago and two in Verchères. The *provincial government* owns Sainte-Thérèse Island, Île aux Vaches and Île au Veau, in the Varennes archipelago. The *Canadian Society for the Conservation of Nature* owns Île aux Asperges and Île aux Moutons (Varennes archipelago), Île aux Cochons (Repentigny) and Beauregard Island (Verchères). The *Société Québécoise de Protection des Oiseaux* holds title to Île aux Canards and Îlet Vert (Varennes). Lastly, *Ducks Unlimited Canada* owns Îlet and manages parts of Marie and Bouchard islands in the Verchères archipelago under the terms of agreements with the owners In the early 1980s, Ducks Unlimited laid out habitat to improve waterfowl breeding on Sainte-Thérèse, Marie, Bouchard and L'Îlet islands.



Source: De Repentigny, 1997; Bélanger et al., 1994; Mercier et al., 1986.

Figure 18 Major protected and unprotected sites for flora and fauna

In the early 1990s, as part of the St. Lawrence Action Plan, a number of government and private partners joined forces to purchase and protect over 1900 ha of aquatic and riparian habitat in the sector.

At present, only 19 of the 70 islands in the Varennes–Contrecoeur sector are in private hands. Fifteen of these — Lavaltrie Island, Sainte-Thérèse Island, Île à la Truie and Île aux Ragominaires (Varennes archipelago), Île à l'Aigle, Île au Bois Blanc, Île aux Cerfeuils, Saint-Laurent Island, Annexe Island, Île à la Pierre, Robinet Island (Repentigny), Marie, Bouchard, and Ronde islands, and Île à Priré (Verchères) — should be protected because they harbour threatened or vulnerable plant species, bird colonies or extensive habitat for fish, waterfowl or other animals (see Figure 18). To these islands should be added the Lavaltrie flats, one of the few surviving wildlife habitats on the north shore of the study area, with aquatic plant beds and marshes suited to the spawn and fry of still-water fish species and the foraging of aquatic birds.

Some publicly-owned sites currently enjoy the status of *wildlife habitat*, which precludes any activity likely to alter the habitat biologically, physically or chemically. At present, all sites with this status in the sector are composed of fish habitat.

Rare, threatened or sensitive species are crucial to biodiversity because of their unique character or their precarious situation. The study area is home to five plant, five fish, one amphibian, three reptile and fourteen bird species (the last including six breeders) assigned priority under the SLV 2000 action plan (Appendix 1).

5.3 Utilitarian Use of the Watercourse

Proximity to a large watercourse provides numerous benefits that are easily overlooked in an area blessed in this respect.

5.3.1 Water supply

The availability of abundant good-quality water is one of the things we often take for granted here, while most countries in the world do not have such readily accessible water resources.

Almost the entire population of the study area (94 133 people, or 94% of the population) is hooked up to a water supply system in any of eight stations, in Repentigny, Saint-Sulpice, Saint-Antoine-de-Lavaltrie, Lavaltrie, Lanoraie-d'Autray, Varennes, Verchères and Contrecœur. In 1997, the combined municipal intake averaged 73 100 m^3 per day.

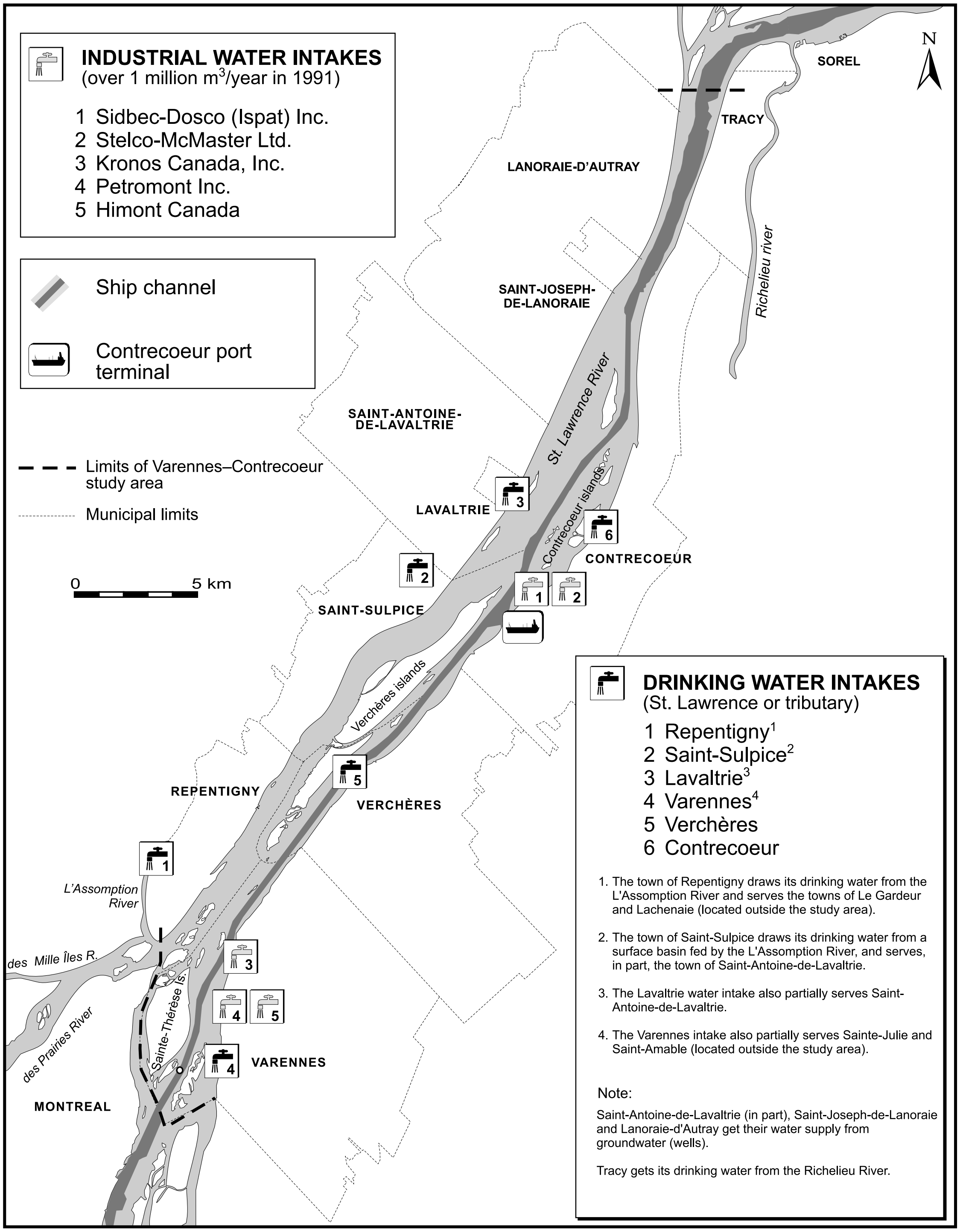
Municipal water supply sources are varied. Lavaltrie, Verchères, Varennes and Contrecœur take their water from the river, while Repentigny and Tracy draw theirs from the L'Assomption and Richelieu rivers, respectively (Figure 19). The towns of Saint-Antoine-de-Lavaltrie and Lanoraie-d'Autray rely on municipal wells, though these do not meet all the demand in summer heatwaves, and Saint-Sulpice uses an open reservoir fed by the L'Assomption River.

The very presence of certain industries depends on a steady water supply to serve a multitude of processes. In 1995, there were five industrial plants in the sector taking water either directly or through the local supply at a rate in excess of a million cubic metres a year each, for a total of 38 million m^3 per year, all of it originating from the river.

5.3.2 Ports and shipping

The creation and operation of the ship channel was not without consequences for the sector's natural environment (see Section 4.1), but the initiative did result in a major infrastructure, generating a host of long-term economic benefits all along the St. Lawrence.

In 1994, the freight carried on the river bound for the Port of Montreal, especially bulk cargoes (47% of total tonnage) and grain (34%), was estimated at 38 million tonnes. Fees and tolls generated revenues of $45 million.



Source: Gratton and Bibeault, 1998.

Figure 19 Utilitarian uses of the watercourse

The presence of the ship channel and the Contrecoeur dock has attracted industry and led to further infrastructure development (highways, rail lines and haulage companies).

The Contrecoeur dock is part of the Port of Montreal installations. When the Port of Montreal was redeveloped in 1967, coal and ore operations were transferred to Contrecoeur. Over the past decade, 1.5 to 2.5 million tonnes of cargo, mostly iron ore (about two-thirds of the tonnage), passed through this facility each year.

5.4 Commercial Fishing

The St. Lawrence used to be fished commercially on a large scale, especially between 1929 and 1939, at the time of the Depression. Today, this industry has withered almost everywhere along the river as a result of tighter regulation, bans on the marketing of contaminated species and declining resource abundance, most of the stock being now reserved for sport fishing.

Since 1994, there has been only one active commercial fishing licence in the sector, operating on the north shore. Commercial catches were about 20 tonnes in 1995. The species harvested are the Lake sturgeon, carp, American eel, Brown bullhead and a few other species disdained by sport fishers. This part of the river is considered a refuge for the Lake sturgeon, and for this reason commercial catches are restricted.

Bait fishing is marginal (some 30 kg per year). Demand from sport fishers seems to have tailed off as a result of recent regulatory restrictions on fishing with live bait.

CHAPTER 6 Strategies for Sustainable Development

The sustainable development of the Varennes–Contrecoeur sector involves protecting the existing biodiversity and promoting a variety of water-related uses, thus enhancing the quality of life of riverside residents.

6.1 Main Challenges

It is imperative that certain key issues in the sector be taken into consideration during the drafting of action plans.

6.1.1 Protecting wetlands and biodiversity

The islands scattered along the St. Lawrence between Montreal and Lake Saint-Pierre are clearly the main asset of the Varennes–Contrecoeur sector. Their relative isolation has spared them many of the disruptions to which the shorelines are prey.

The plant cover is in a near-natural state, and birds, especially ducks, breed there in considerable numbers. The shallow waters around the islands are known to be important spawning and nursing habitat for many fish. The fact that so many of these islands are dedicated to conservation is recognition of their great value in terms of biodiversity.

Some of the low-lying islands bordering the ship channel are subject to wave action from the wake of passing ships, which undermines their banks, causing them to retreat. Stabilization techniques have been tried, but it is not certain that such measures can save all the threatened habitat.

Farming and pasturage on the islands limit their nesting potential for waterfowl. Changing practices now being introduced should make for integrated management of agriculture and waterfowl conservation. Trials conducted on some of the Varennes islands are promising.

6.1.2 Reducing contamination

An essential condition for restoring the river to mixed use in the study area is improvement of water quality. Considerable progress was made along the north shore between 1990 and 1997 with the start-up of wastewater treatment plants. The connection of several Montreal Island outfalls to the MUC treatment plant means that now some 1.8 million people are served. However, the discharge into the middle of the river from this plant's outfall, located in the upstream portion of the sector at Île aux Vaches, is not disinfected, and the Mille Îles, Des Prairies and L'Assomption rivers, heavily impacted by urban, industrial and agricultural activities, still disgorge poor quality water into the St. Lawrence off Repentigny.

The potential for recreational water-contact pursuits in the middle and northern parts of the river in the Varennes–Contrecoeur sector therefore remains circumscribed. This stretch of the St. Lawrence cannot be restored to full use as long as urban wastewater dumped into the tributaries is untreated and treatment plants do not disinfect their effluent.

Along the south shore, water quality is generally acceptable; urban wastewater on this side of the river is treated at plants in Longueuil and Sainte-Catherine, and the output is discharged into the middle of the river.

In the study area itself, the system of municipal wastewater treatment plants needs to be completed, the functioning of some plants improved, the incidence of overloads reduced and the cleanup initiatives already undertaken by industry and farmers continued.

6.1.3 Improving access to the river and developing recreation and tourism

Though endowed with many touristic and recreational assets, the Varennes–Contrecoeur sector lacks an integrated system for developing them.

Such development in this section of the St. Lawrence is currently bedevilled by the limited public access to the river, which constrains development of some water-related activities.

Recreation and tourism should be developed in a way that blends with the conservation vocation of much of the area. It would be unwise to promote activities likely to disturb wildlife or degrade fragile habitat.

6.2 Time for Action

To refocus planning related to water body uses and bring it in line with the objectives of sustainable development, 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. The roads, docks and other structures already built constrain planning in ways that can be taken as irrevocable. Yet more importance can be given to protecting surviving natural environments, improving wildlife habitat and promoting farming practices that are more in tune with conservation.

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

These issues need to be assessed and discussed, in full knowledge of the facts, by all groups interested in the river and the local quality of life, so that the strategies which are eventually adopted suit the entire community. Table 9 provides a preliminary outline for discussing suitable development options for the water bodies in the sector.

Following such discussions, it should be possible to co-ordinate water uses in keeping with the goal of preventing further degradation of natural habitats and restoring certain sites. 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.

The conservation of surviving aquatic and riparian habitats and restoration of those that have been degraded constitute an exciting challenge. It is to be hoped that future generations too will be able to enjoy the natural bounty of this region’s natural environment, in full awareness of its fragility and with concern for its preservation. Collaboration remains the key to the success of this project.

Table 9
Sustainable development issues in Varennes–Contrecoeur

Issue ***Protection of habitats and resources; rehabilitation of disturbed elements:***	*Main effects on the water and its resources*	*Assessment of the current situation in light of sustainable development objectives*	*Toward sustainable development*
The most far-reaching changes in the sector appear to have affected the aquatic environment and are related to the dredging of the ship channel. Loss of natural shoreline through encroachment and filling is most prevalent in and around urban areas.	Development of the ship channel altered flow patterns. Dredging and dumping of dredged material may change the aquatic environment by stirring up chemicals in sediments or altering habitat. Wake waves generated by passing ships increase erosion and retreat of the banks. Filling for building walls, docks, ramps and other structures swallows up aquatic and riparian habitat. Farming practices limit waterfowl breeding potential on the islands.	**Biodiversity:** Alteration of aquatic, riparian and terrestrial environments through dredging and dumping of dredged material; loss of riparian habitats through wake waves and the retreat of the banks; reduced plant and animal abundance and diversity. Loss of natural shoreline through encroachment and agriculture: disappearance of the natural transition zone between land and water, lost habitat, reduced biodiversity. **Uses:** In and near the channel, current speed, passing ships and wake waves constrain certain pursuits (pleasure boating, fishing, hunting). Reduced fish abundance makes the sector less attractive to fishers. **Quality of life:** In addition to limiting some uses of the river, shipping and the port of Contrecœur represent a latent accident risk. Wake waves undermine the banks and constrain riverside residents: eroded banks are aesthetically unappealing, certain recreational pursuits are limited, shoreline property area is reduced, etc.	**Biodiversity:** The ship channel constitutes a permanent environmental change that must be accepted. However, dredging and maintenance practices must be reassessed to preclude the loss of important wildlife habitat. Contaminated sediment must be managed in a way that does not threaten the environment. Some changes to the shoreline are reversible. Measures such as restoration of degraded banks, erosion protection and habitat creation may attract more species and thus tend to enhance biodiversity. Bank consolidation techniques have been tested and promise to limit habitat loss on the islands. Changes to existing practices could lead to the integrated management of farming and waterfowl conservation. There have been attempts to reconcile waterfowl nesting with farming and pasturage on some islands in the Varennes archipelago, and they have borne fruit. **Uses and quality of life:** Stabilization does not eliminate all habitat losses and does not address other drawbacks. Speed limits still need to be imposed on ships. Restored shoreline is nicer to look at and better suited to multiple uses.

Issue ***Reducing contamination***	*Main effects on the water and its resources*	*Assessment of the current situation in the light of sustainable development objectives*	*Toward sustainable development*
In the past, the study area was severely affected by untreated municipal and industrial wastewater from the Greater Montreal area. Tributaries drain agricultural and urban areas.	Contamination by untreated discharges results in a whole series of adverse effects on the aquatic environment. Untreated municipal wastewater contributes to chemical and microbial pollution and boosts the input of nutrients to the water. Industrial plants in Varennes and Contrecœur have also contributed to polluting the St. Lawrence by releasing toxic substances to it. Agricultural activities have contaminated the aquatic environment with bacteria, fertilizers and pesticides. Chemical contaminants are being detected in the water, and coliform bacteria limit water-contact activities. Mercury has reached high levels in some fish species.	**Biodiversity:** Pollution contributes to reducing the population numbers of many species and alters the structure of living communities. Organisms that are tolerant of environmental degradation become predominant. **Uses:** Contamination contributes to restricting the use of the environment (i.e. fish consumption and health risks associated with swimming and other water-related activities). **Quality of life:** Pollution reduces enjoyment of the water for riverside residents and has an impact on recreational potential, inhibiting the practice of certain activities.	In recent years, industrial and municipal cleanup programs in the Montreal area and around the Great Lakes, and in the study area, have reduced the input of toxic substances into the environment. The Des Prairies, Mille Îles and L'Assomption rivers, however, are still pouring large amounts of contaminants into the St. Lawrence off Repentigny, and treatment plants are still not disinfecting their effluent. The bacteriological quality of the water in the middle and northern reaches of the river is affected, and recreational pursuits involving contact with the water are to be avoided. The initiatives begun must be continued if full recreational use is to be restored. **Biodiversity:** The disruptive effects of pollution can be reversed over the relatively long term, depending on the nature of the contaminants discharged and their residence time in the environment or in the tissues of aquatic organisms. The sector does not seem prone to long-term accumulation of contaminated sediments. **Uses:** The most effective measure for limiting loss of use caused by pollution is control of all forms of dumping (industrial, residential and commercial) at source. Effective treatment processes for handling municipal waste and controlling overflows are indispensable to cleaning up and restoring full use of the environment. Improved farming practices foster soil conservation and reduce the input of contaminants to the water. **Quality of life:** Controlling pollution restores to communities all the benefits of their proximity to the water. .

Issue ***Reconciling recreation and touristic development with the natural environment***	*Main effects on the water and its resources*	*Assessment of the current situation in light of sustainable development objectives*	*Toward sustainable development*
The sector is suited to certain pursuits carried out on or near the water, such as fishing, hunting, pleasure boating, hiking, and birdwatching. All of these activities are restricted by the current state of the environment: bacterial contamination, low fish diversity, limited access to the river, etc. The sector has plenty of potential, but there is no integrated tourism infrastructure or co-ordination mechanism.	Building infrastructure for some recreational activities may lead to the destruction of aquatic and riparian habitat. Unrestrained recreational development could be hazardous for fragile habitats or animal populations apt to be disturbed at critical times, e.g. when breeding. Pleasure craft may cause bacterial or chemical pollution and disrupt the peace of local residents.	**Biodiversity:** In the Varennes–Contrecoeur sector at the present time, there does not appear to be any overt clash between recreation/tourism and conservation of biodiversity. **Uses:** Pleasure boating, hunting and fishing are subject to regulation to limit inconvenience to other users of the river and shoreline residents. At present, use by the general public is constrained by the small number of parks and limited access to the river. **Quality of life:** The well-being of residents and the ability to attract tourists depend, in part, on being able to enjoy the river. Recreation and tourism may spawn significant local economic benefits.	**Biodiversity:** Prior development of guidance structures may help reconcile recreation/tourism with conservation. **Uses:** Pleasure boating, hunting and fishing must be controlled to preclude conflicts with other uses (disturbance of wildlife, public access to the water, safety). The growing popularity of nature observation and interpretation pursuits needs to be taken into account. **Quality of life:** Various water-borne, outdoor and nature-observation activities may foster development of tourist attractions. These activities, and the facilities they require, should be judiciously chosen and located so as not to degrade the natural surroundings and way of life. Hence, application of a variety of integrated land-use planning mechanisms is essential: dedication of some areas to conservation or recreation, specification of planning documents (land-use maps and plans) and enforcement of existing shoreline protection regulations.

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Appendices

1 St. Lawrence Vision 2000 (SLV 2000) Priority Species Found in the Varennes-Contrecœur Sector

Name	*Type of distribution or status in the sector*
Plants (5 of 110 priority species)	
Arisaema dracontium (Green dragon)	Peripheral North
Justicia americana (American water willow)	Peripheral North
Lycopus virginicus (Virginia water horehound)	Peripheral North
Panicum virgatum (Switchgrass)	Peripheral North
Podophyllum peltatum (May apple)	Peripheral North
Fish (5 of 14 priority species)	
American eel	Migratory, catadromous
American shad	Migratory, anadromous
Copper redhorse	Resident, fresh water
Lake sturgeon	Migratory, fresh water
Redfin pickerel	Resident, fresh water
Amphibians and reptiles (4 of 6 priority species)	
Brown snake	Presence confirmed
Spotted turtle	Presence confirmed
Western chorus frog	Presence confirmed
Wood turtle	Presence confirmed
Birds (14 of 19 priority species)	
Bald eagle	Migratory
Barrow’s goldeneye	Migratory
Blue-winged teal	Probable breeder
Caspian tern	Visitor
Cerulean warbler	Breeds outside study area
Common gallinule	Confirmed breeder
Grasshopper sparrow	Breeds outside study area
Least bittern	Confirmed breeder
Loggerhead shrike	Confirmed breeder
Peregrine falcon	Breeds outside study area
Pintail	Confirmed breeder
Red-headed woodpecker	Breeds outside study area
Short-billed marsh wren	Confirmed breeder
Slavonian grebe	Migratory

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, rev 1992)	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, rev 1992)	Protect human health from the risks associated with consumption of aquatic organisms.
	Aquatic life (chronic toxicity) (MENVIQ, 1990, rev 1992)	Protect aquatic organisms and their offspring and wildlife that feed on such organisms.
	Recreational activities (direct contact) (MENVIQ, 1990, rev 1992)	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.

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) or, in small drainage basins, as litres per second (L/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.

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

Nonpoint-source pollution: Diffuse discharge of pollutants into a given environment. Agricultural run-off 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 solids: 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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