REGIONAL ASSESSMENT
VALLEYFIELD–BEAUHARNOIS

Regional Assessment
Valleyfield–Beauharnois

Priority Intervention Zones 3 and 4

Jean Robitaille

Edited by Marie-José Auclair
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NOTICE TO READERS

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Preface

In April 1994, the governments of Canada and Quebec approved a four-year action plan to carry on the work of the St. Lawrence Action Plan.

The goal of St. Lawrence Vision 2000 (SLV 2000) is to conserve and protect the St. Lawrence River, including its marine section and the Saguenay River, so that people 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 St. Lawrence Vision 2000 action plan.*

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

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

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

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

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Management Perspective

The Priority Intervention Zone (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 to be 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

This report deals with Priority Intervention Zones (ZIP) 3-4, which extends from Valleyfield to Beauharnois, Quebec, and encompasses all of the connecting channels through which waters flow from Lake Saint-François to Lake Saint-Louis and the adjacent area. This stretch of the St. Lawrence River is characterized by a sharp drop in elevation, formerly accompanied by major rapids.

Indians were the first to occupy the riverbanks, coming to this region to fish and establishing seasonal camps here. The Europeans who eventually settled on neighbouring lands saw the rapids as an obstacle to ship traffic, the primary means of communication at the time. The region's history and heritage are closely tied to the structures that were built to circumvent the rapids.

The 19th century saw the construction of numerous watermills, followed by several hydro-electric generating stations designed to harness the power of the tumultuous waters. The Beauharnois power station, built in 1929, and the associated canal are the cornerstone of the control structures. This plant, which at its inception received 15% of the river's flow volume, underwent expansions which increased the flow volume diverted from the St. Lawrence to the present-day level of 84%.

Water-level control structures were built in the original channel of the St. Lawrence to ensure a constant supply of water for the generating plants at Beauharnois and Les Cedres. Artificial basins were subsequently created to raise the water level for aesthetic or recreational purposes. Since some of these impounding basins freeze over in winter, they are drained in the fall, a situation which hinders the development of plant communities and aquatic fauna and also degrades the riverside landscape. Furthermore, the recurring water-level fluctuations in many of these basins constitute an impediment to many leisure activities. Most of the riverbank areas in the region have become urbanized, except for the perimeters of islands.

Few data are available to describe the state of the natural environment as it existed before the control structures were built, thus limiting comparisons with the present situation. However, it is now agreed that the loss of zones of rapids and associated habitats had repercussions on the populations of various animals, especially fish. Those species that lived or spawned in white water areas were affected. As well, fish species that migrate long distances were prevented from making their way up or down river or were, at the very least, seriously hindered in this regard. No structures have been built in the sector to facilitate the passage of fish. Nonetheless, the protection of existing species is now being taken into consideration increasingly in managing the basins located in the original channel of the St. Lawrence.

The abundant power supply available near generating plants has attracted many industrial plants to the area, making Valleyfield's economy fairly independent of Montreal's. The region was home to the first industrial centre and the first cities along the Quebec part of the St. Lawrence River. From the standpoint of pollutant loads, the first major discharges of urban and industrial effluents into the river also occurred here.

Local industries comprise textile mills and metallurgical and chemical plants. Under the St. Lawrence Action Plan and its successor, St. Lawrence Vision 2000, four industrial plants, including one that shut down in 1992, were identified as priorities owing to the toxicity of their effluents. Discharges of contaminants to the aquatic environment appear to be declining as a result of clean-up measures and the closure of several plants. The connection of municipal sewer networks to local treatment plants is nearing completion.

The area's economy has been hit hard by slowdowns in industrial activity and plant closings. Local authorities are looking to recreation and tourism activities to help bolster the region's economy, as evidenced by several recent developments and by other projects currently in the works.

Résumé

Le secteur du fleuve Saint-Laurent à l'étude dans ce bilan correspond aux Zones d'intervention prioritaire (ZIP) 3 et 4. Il s'étend de Valleyfield à Beauharnois et correspond à l'ensemble des voies d'écoulement des eaux du lac Saint-François vers le lac Saint-Louis et au territoire adjacent. Cette portion du fleuve est caractérisée par une forte dénivellation du lit et la présence, à l'origine, de grands rapides.

Les premiers occupants des rives ont été les amérindiens, qui venaient spécialement à cet endroit pour pêcher et y établissaient des campements saisonniers. Dès l'établissement de colons sur les terres avoisinantes, la présence des rapides a été reconnue comme un obstacle à la circulation des embarcations, qui constituaient alors le principal moyen de communication. L'histoire et le patrimoine de cette région sont émaillés d'ouvrages qui ont d'abord visé à permettre le contournement des rapides.

Au 19^{e} siècle, on a érigé plusieurs moulins mécaniques, puis des centrales hydroélectriques au fil de l'eau pour domestiquer l'énergie de ces eaux tumultueuses. L'œuvre maîtresse de cette série d'ouvrages est la centrale de Beauharnois, construite en 1929, et le canal qui la dessert. Alimentée à ses débuts par 15 p. 100 du débit fluvial, les phases successives d'agrandissement font qu'aujourd'hui 84 p. 100 des eaux du Saint-Laurent sont détournées vers cette centrale.

Dans le lit originel du fleuve ont été implantés des ouvrages de contrôle des niveaux, pour assurer l'alimentation des centrales de Beauharnois et des Cèdres. Par la suite se sont ajoutés des bassins artificiels servant à rehausser le niveau de l'eau à des fins esthétiques ou récréatives. Plusieurs des ouvrages de retenue ne peuvent toutefois résister aux glaces et doivent être vidangés à l'automne, ce qui limite le développement de la végétation et de la faune aquatiques et dégrade aussi le paysage qui s'offre aux riverains. Les variations de niveau qui persistent dans plusieurs de ces bassins constituent également une contrainte pour plusieurs types d'activités de loisir. À l'exception du pourtour des îles, la plupart des rives sont maintenant artificielles.

On possède peu de données pour décrire l'état du milieu naturel avant que l'écoulement du fleuve soit contrôlé et faire des comparaisons avec la situation actuelle. Cependant, on admet aujourd'hui que la disparition de zones de rapides et des habitats qu'ils recelaient ont eu un impact sur les populations animales, en particulier les poissons. Les espèces qui vivaient ou se reproduisaient en eau vive auraient été touchées. Des migrateurs de longue distance voient désormais leurs déplacements bloqués, ou du moins sérieusement entravés. Aucune structure destinée à faciliter leur passage n'existe dans le secteur. Par contre, les modalités de gestion des bassins du lit résiduel prennent maintenant davantage en considération la protection des espèces présentes.

L'énergie disponible en abondance à proximité des centrales a incité plusieurs industries à s'implanter dans ce secteur, contribuant à la relative autonomie, au plan économique, de Valleyfield par rapport à Montréal. Cette région recèle le premier foyer industriel et les premières agglomérations riveraines établies dans la partie québécoise du cours du Saint-Laurent. C'est là que se déversent dans le fleuve les premiers effluents urbains et industriels de quelque importance en termes de charge polluante.

Les industries locales œuvrent dans les textiles, la métallurgie et la chimie. Dans le cadre du plan d'action Saint-Laurent (PASL) et de SLV 2000 qui lui fait suite, quatre établissements, dont un a fermé ses portes en 1992, ont été identifiés prioritaires en raison de la toxicité de leurs effluents. Les rejets de contaminants dans le milieu aquatique semblent en voie de réduction à la suite de l'application de mesures d'assainissement, mais aussi de la fermeture de plusieurs industries. L'interception des eaux usées des réseaux d'égouts municipaux et leur traitement dans des installations d'épuration sont aussi presque complétés.

La vie économique du secteur a été sévèrement touchée par les ralentissements d'activités et les fermetures d'usines. Les autorités locales comptent faire du récréo-tourisme une assise supplémentaire à l'activité économique régionale. Plusieurs réalisations récentes témoignent de cette nouvelle orientation et d'autres projets à l'étude vont dans le même sens.

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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-seated feeling of belonging to the land traversed by its waters on its 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 and spring flooding. In return, the river 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 peoples and many sport fishers were exposed. As the list of toxic substances detected 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 Priority Intervention Zone 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 concrete, joint action. This paved the way for the 1972 *Canada–U.S. 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). One of the objectives of this action plan is to conduct local environmental assessments to encourage community stakeholders to work together to restore and protect the St. Lawrence and harmonize uses of the river (Figure 1). As part of the groundwork for public consultations, SLV 2000 partners review and synthesize current knowledge about the state of the environment in each study area.

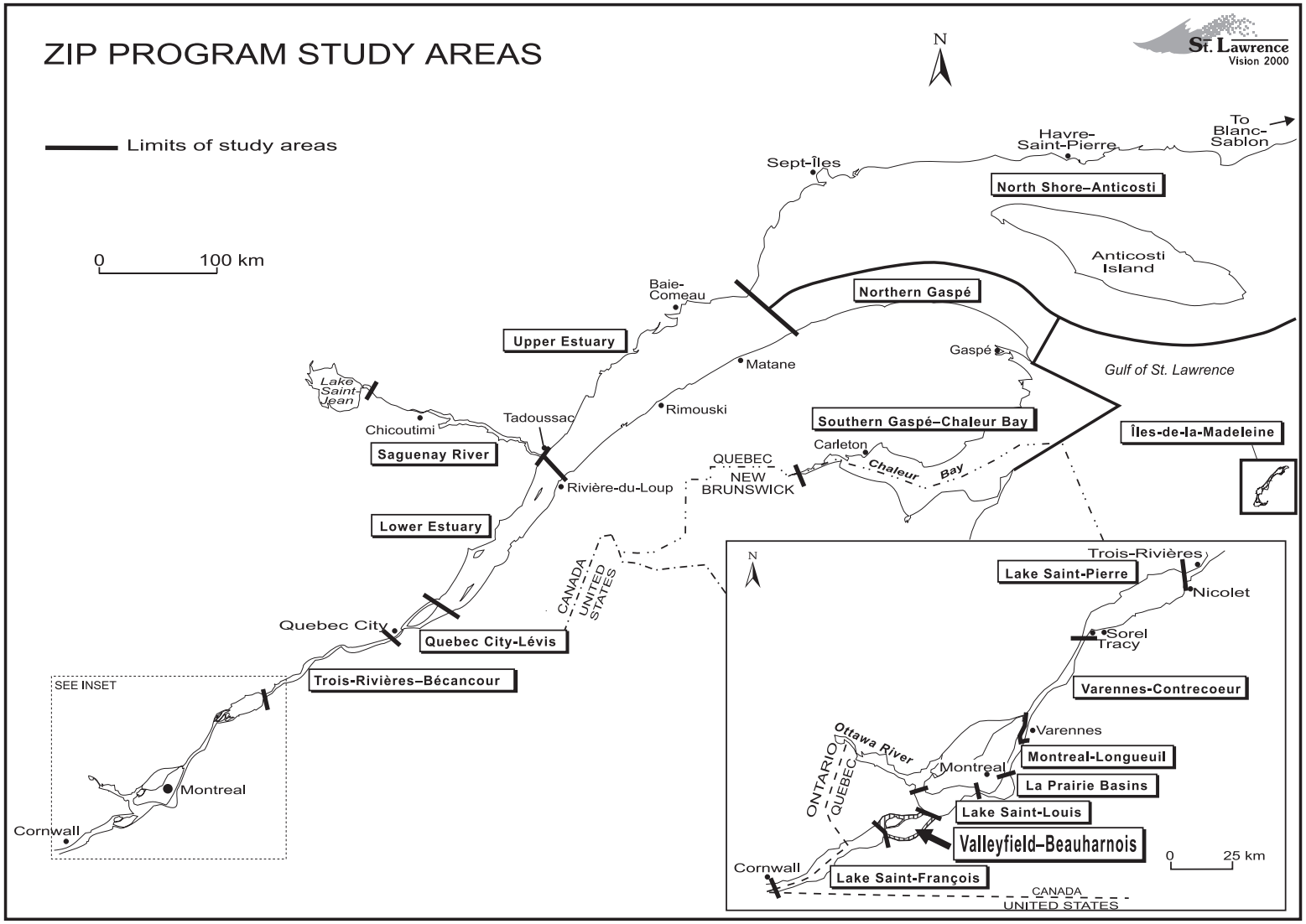

Figure 1 ZIP Program study areas

Prior to the consultations, a state-of-the-environment review is conducted by the partners and the findings are compiled in four technical reports[1]. This report summarizes the detailed data on ZIPs 3 and 4, jointly referred to in the following pages as the *Valleyfield–Beauharnois 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.

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.

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

CHAPTER 3 Original Characteristics of the Study Area

At the end of the last ice age, several thousand years ago, the southern part of Quebec and Ontario was covered by a major inland arm of the ocean. As the ice receded, the Earth's surface gradually rebounded, exposing some land areas and leaving salt water in the huge basins that now form the Great Lakes. The surplus precipitation from the catchment area flows to the sea by way of the St. Lawrence River.

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

The stretch of river studied here goes from Salaberry-de-Valleyfield to Beauharnois. It includes all the connecting channels linking Lake Saint-François and Lake Saint-Louis and the adjacent land. This section of the river was originally characterized by major differences in elevation and by rapids which prevented the passage of ships; however, the lay of the land was modified radically during the 20th century. Today, most of the river water flows through the Beauharnois Canal, while the rest still follows the original course of the river, descending a series of artificial basins in a stepwise fashion to Lake Saint-Louis (Figure 2).

The most striking characteristic of this part of the St. Lawrence is undeniably the sharp drop in elevation of the river bed (some 25 m), which necessitated human-built structures to permit the passage of ships and later prompted the construction of hydro-electric generating plants. As a result of this energy source, industrial plants were established in the region, eventually turning Salaberry-de-Valleyfield into a large industrial centre.

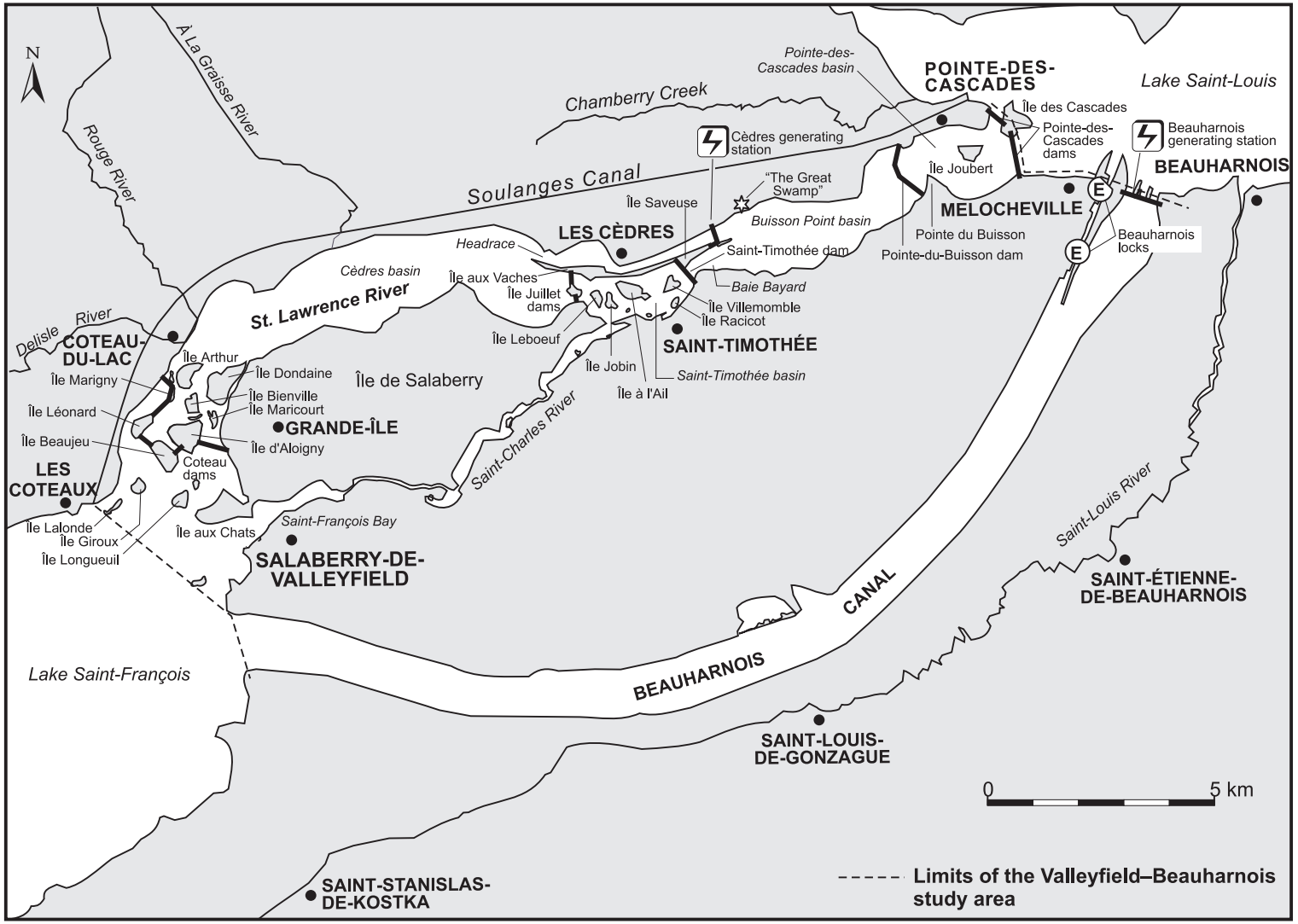

Figure 2 Valleyfield–Beauharnois study area (ZIPs 3 and 4)

3.1 River Flow and Water Masses

The Great Lakes are supplied with precipitation from a drainage basin of 1.2 million km^2, and the surplus flows to the sea through the St. Lawrence River, at an average rate of 6850 m^3/s as it leaves Lake Ontario.

From the outlet of Lake Ontario, the St. Lawrence, whose flow is regulated by a series of structures, travels a distance of about 170 km between Ontario and the state of New York before reaching Quebec. The water then flows through Lake Saint-François, a widening of the river channel, before reaching the Valleyfield–Beauharnois sector.

The tributaries in the international section of the St. Lawrence and those that empty into Lake Saint-François contribute little to the river discharge, which comes primarily from Lake Ontario. The same is true for the few tributaries[2] that join the St. Lawrence in the study area; their contribution to upstream river flow is minor (0.1%) compared to that of Lake Saint-François (99.9%). Thus, the inflow to the Valleyfield–Beauharnois sector consists of a single water mass, which originates from the Great Lakes[3]. Hard and alkaline, this water has a chemical composition very similar to that of Lake Ontario.

The outlet of Lake Saint-François between Coteau-du-Lac and Pointe-des-Cascades is a section of the river that used to be characterized by a steep drop in elevation and by rapids at Coteau, Les Cèdres and Soulanges. In addition, the flow velocities were so great that all but the coarsest material — pebbles, cobble and bedrock — was carried away.

These tumultuous waters have virtually disappeared and the flow is now regulated by numerous structures that control the discharge rates and water levels.

The waters of Lake Saint-François transport little suspended matter (less than 5 mg/L). The distribution of sites conducive to sedimentation depends largely on the flow configuration, which in this sector is controlled entirely by human-made structures. The available data on this topic are presented in Section 4.2.1.

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[2] The Graisse, Delisle, Rouge rivers plus a few streams.

[3] In the sections of the St. Lawrence farther upstream, this mass of green waters can be distinguished from the browner water mass of the Ottawa River and other Laurentian rivers.

3.2 Original Plant and Animal Life

Only a sketchy picture can be provided of the natural environment that existed along this stretch of river before it was substantially altered. The major construction work that affected the sector took place more than a century ago, and we have no systematic inventory of the elements of the natural environment which existed prior to then.

In this region of Quebec, the terrestrial vegetation, had it not been altered by human activities, would typically consist of Sugar-maple–Hickory stands[4]. For the most part, natural forest areas have long since disappeared, giving way to agricultural, industrial and municipal uses. Reworking of the river channel has also resulted in major changes in the aquatic environment and the riverbanks, affecting the plant communities.

All that remains of the original vegetation is a few linear stands of Red maple along the banks and a few small areas where natural plant communities have survived despite the disturbances because they are located on islands.

Little is known about the wildlife that occupied this region, particularly the aquatic communities that were typical of this section of the St. Lawrence before control structures were built. The vestiges of Indian camps at Buisson Point attest to the site's former importance for fishing and hence the abundance of fish in the adjacent waters. Information obtained from archaeological digs at such sites indicates that the fish communities that existed back then comprised a number of species characteristic of zones of rapids.

The areas of rapids likely contained spawning grounds, which may have been used by fish populations such as Lake sturgeon, living in the watercourses farther upstream or downstream. Migratory species, like American eel and shad, would have had to swim through the turbulent waters in the study area in both directions to complete their life cycle.

Since the physical alterations appear to have had a decisive impact on the structure and composition of the aquatic and riparian habitats, this report presents a brief look at present-

[4] A zone representative of this type of plant community can still be found today at Buisson Point.

day habitats and the wildlife that have adapted to them, following a description of the physical environment (see Section 4.2).

3.3 Early Human Settlement

The archaeological vestiges at Buisson Point indicate that the area was used by Indians in the Early Woodland period (3000 to 2500 years before the present era) and that seasonal camps were established there for hunting and fishing.

When the region was colonized by the French, the first seigneuries granted were those of Soulanges and Beauharnois. In the late 18th century, the first canals were built[5] to allow boats to bypass the rapids, first for military purposes and later for trade activities.

To harness the energy of the rapids, watermills and then later hydro-electric generating stations were built along the river — two of which, Cèdres and Beauharnois, are still in operation. This power source was a determining factor in the establishment of manufacturing industries, which stimulated the region's economic development and made Salaberry-de-Valleyfield relatively independent of Montreal from an economic standpoint.

A brief portrait of present human occupation of the region is presented in Section 4.3 of the next chapter.

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[5] Coteau Canal (1780), the first Beauharnois Canal (1842-45), Soulanges Canal (1892-99) and the present Beauharnois Canal (1929-1932).

CHAPTER 4 Main Human Activities and Present State of the Environment

Human activity has affected the St. Lawrence River along its entire length. In the Valleyfield–Beauharnois sector, however, interactions between the river and human populations that settled its banks are particularly complex.

Human activities and the state of the St. Lawrence are presented here in an order which reflects the relative importance of the main driving forces of change in the study area, while highlighting the principal links, to create a portrait of the current situation.

4.1 Flow Regulation and Physical Alterations of the Environment

In the Great Lakes–St. Lawrence Basin, the stretch of river between Lake Saint-François and Lake Saint-Louis is the sector with the highest density of flow regulation structures.

The earliest structures, built in the late 18th century, were designed to enable boats to bypass the rapids. A number of watermills and hydro-electric power plants were constructed later on. Then, finally, impoundment structures had to be built, at first to maintain the water levels needed to operate the hydro-electric plants, and later to compensate for environmental degradation and create artificial basins in the original channel of the St. Lawrence for aesthetic or recreational purposes.

As these different works were built, most of the rapids located between Lake Saint-François and Lake Saint-Louis gradually disappeared, resulting in the present flow configuration.

Today, the water in Lake Saint-François flows to Lake Saint-Louis through various connecting channels, the major ones being the Beauharnois Canal (receiving 84% of the river's discharge), the original river channel, which receives no more than 15% of the discharge, and the Saint-Charles River (0.4%)[6].

A historical account of the numerous control structures built in the Valleyfield–Beauharnois area can be obtained from various documents. The brief portrait drawn in the

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[6] The other channels are Moulin Langevin, Camp Bosco, the Soulanges Canal and the Saint-Louis Canal.

following pages focuses on the main works that are still in operation (Figure 3) and present flow conditions. Readers must have at least a general idea of the region's present physical configuration in order to understand the description of the natural components that have adapted to the altered environment, along with that of human settlements in the sector[7]. Table 1 summarizes some of the present-day physical characteristics of the region.

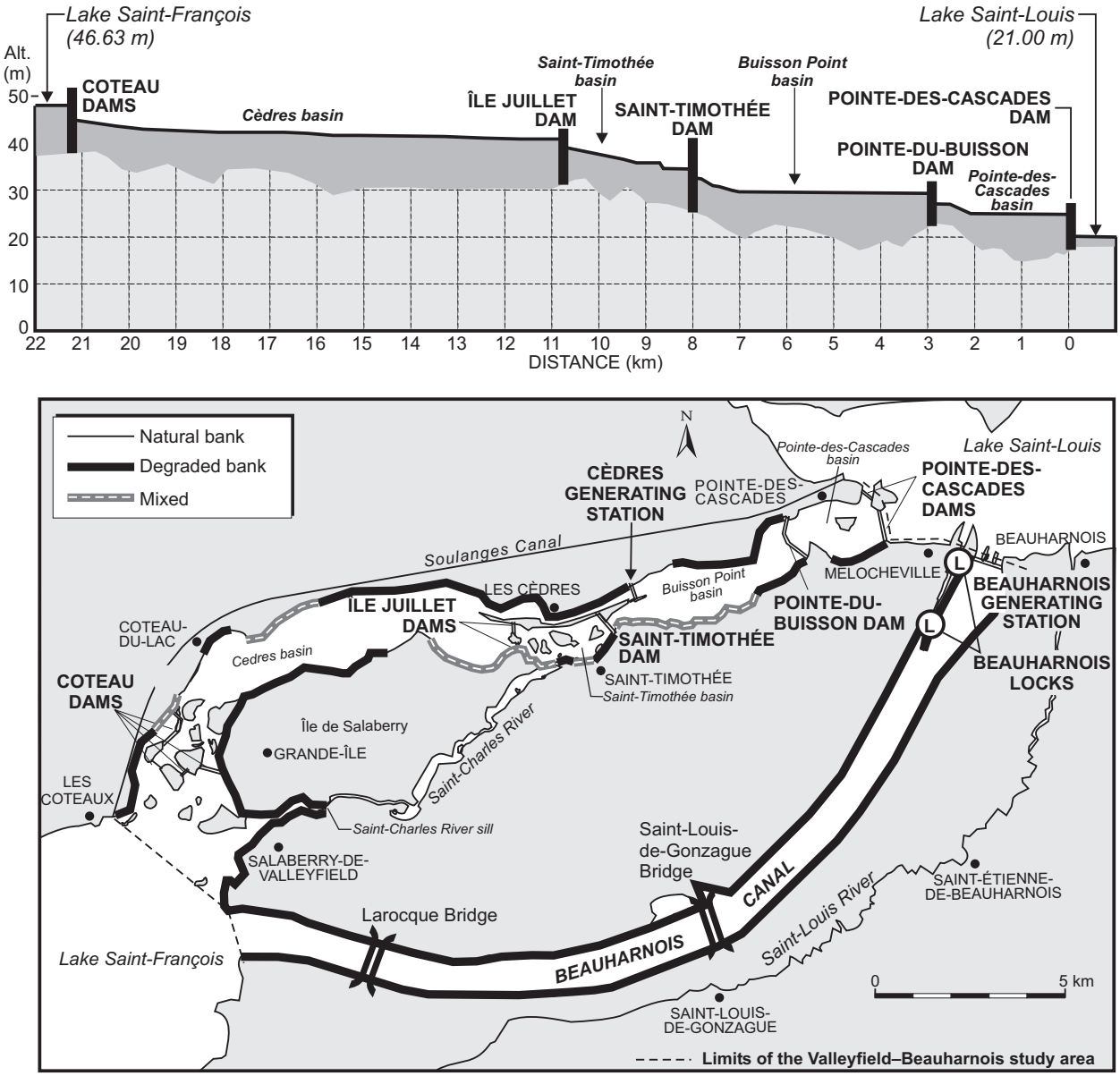
Table 1
General characteristics of the aquatic environment in the Valleyfield–Beauharnois sector

Area of water (km^2)	Beauharnois Canal	24
	Reduced-discharge section of the river	35
Length (km)	Beauharnois Canal	25
	Reduced-discharge section of the river	21
Average width (km)	Beauharnois Canal	1
	Reduced-discharge section of the river	1.7
Mean annual discharge (m^3/s)	From the St. Lawrence to the entrance to the sector	8217
	From the tributaries	42
	Total, exiting the sector	8259
Distribution of river water (%)	Beauharnois Canal	84%
	Reduced-discharge section of the river	15%
	Other connecting channels	1%

Source: Fortin et al., 1998; Environnement Illimité Inc., 1987; Hydro-Québec, 1992; Les Consultants en Environnement Argus Inc., 1996.

Note: The Saint-Charles River and islands were not surveyed.

[7] Unlike previous documents, this report describes aspects of the natural environment and of human settlements that were affected by the alteration of river flow *before* the control structures themselves for three reasons. First, very little is known about the original situation because conditions have changed so radically and only fragmentary information is available on the period prior to construction. Second, many components of the natural and human environment have adapted to the changed conditions to some extent. The third reason is basically pragmatic: Were the description of the natural environment given first, this would necessitate a large number of cross-references to subsequent sections.



Source : Environnement Illimité Inc., 1987; Hydro-Québec, 1992; Les Consultants en Environnements Argus Inc., 1996.

Note : The Saint-Charles River and islands were not inventoried.

Figure 3 Flow regulation and shoreline degradation

4.1.1 The Beauharnois Canal and hydro-electric generating station

The first Beauharnois hydro-electric plant and the canal were built under dry conditions, on land. Work began in the fall of 1929 and the first four generators were brought on stream three years later. As the demand for electricity grew, the original plant was initially equipped with additional turbines (Beauharnois I, completed in 1948) and then expanded by adding a second section (Beauharnois II, completed in 1953), followed by a third section (Beauharnois III, finished in 1961). The last part, located in the north, was built at the same time as the St. Lawrence Seaway locks. These locks enable ships to traverse the 25-m difference in water level between Lake Saint-Louis and Lake Saint-François, which they can then reach via the Beauharnois Canal. The canal was built in stages and completed in 1964, culminating in its present configuration with an 8.2-m-deep channel.

As the Beauharnois plant's generating capacity was increased, the portion of river discharge that was diverted through the Beauharnois Canal also rose, going from 15% in 1932 to the present-day level of 84% (mean annual discharge).

By the 1920s, the creation of this 25-km-long artificial waterway had resulted in the loss of terrestrial habitats comprising 9573 hectares (ha) of agricultural and forest land. The material removed during the initial excavation work and subsequent dredging was dumped on either side of the canal, creating embankments 5 m high and 100 m wide. Settling basins were built in this material to allow dredged material to dry. Not since the 1960s has there been major reworking of the unconsolidated material deposited along the banks of the canal.

The Beauharnois Canal is an artificial aquatic environment. Since the waterway's configuration and characteristics were designed primarily to meet the needs of the generating station and ship traffic, the aquatic environment is not very conducive to the establishment of living communities. The strong current and the compact bottom substrate tend to hinder sedimentation and the growth of aquatic plant communities; the steep banks limit the zones of exchange between the aquatic environment and the river banks. In short, the aquatic habitats in the area are not of very good quality.

Furthermore, the construction of the canal transformed the area of land on which the cities of Salaberry-de-Valleyfield, Saint-Timothée and Melocheville were originally founded into an island, and this has had an undeniable impact on their development.

4.1.2 Reduced-discharge section of the St. Lawrence

Many watermills and small hydro-electric power stations harnessed the river's power in this stretch of river, before the Beauharnois facility came into being. The Cèdres power plant, built between 1912 and 1924, is the oldest structure still in operation. Ever since the river's flow was diverted toward Beauharnois, the Cèdres facility has been cut off in the part of the St. Lawrence where the discharge was gradually decreased. Originally designed to exploit a portion of the flow passing between Ile aux Vaches and the north shore, the Cèdres plant now plays a subordinate role to permit optimal use of the Beauharnois facility. The outflow from the Cèdres plant has an immediate effect on the water level in the basins upstream (Cèdres basin) and downstream (Buisson Point and Pointe-des-Cascades basins). In the early 1990s, Hydro-Québec began looking at options for redeveloping the Cèdres facility, but deferred the project to 2005.

The other flow regulation structures in this sector are called *compensating works*. Impoundment works such as dams, dikes, spillways and weirs were constructed to maintain water levels or create artificial basins in the original river channel.

The dams at Coteau and Ile Juillet were built in the 1930s and 1940s to maintain a crest level that would permit the optimal functioning of the Beauharnois and Cèdres power plants, respectively. At present, a minimum flow of 290 m^3/sec (440 m^3/sec during the fish spawning period) is maintained constantly in the Cèdres basin by adjusting the hydraulic gates in the Coteau works.

The other three basins[8] serve mainly aesthetic or recreational purposes. Some of these impoundment structures were not designed to withstand ice, and so the basins have to be drained in fall and refilled in spring. The Saint-Timothée basin must be emptied completely, while the

[8] The Buisson Point basin was built in 1960-62; the Saint-Timothée basin in 1965-1971, and the Pointe-des-Cascades basin in 1963-64.

Buisson Point and Pointe-des-Cascades basins, which receive the outflow from the Cèdres plant, are only partly drained.

The flow from the Saint-Charles River, a tributary of the St. Lawrence, goes from Saint-François Bay to the Saint-Timothée basin. The flow through this channel is roughly 31 m^3/s.

4.1.3 The Soulanges Canal

The Soulanges Canal, 24 km long, was built on the north shore of the river between 1892 and 1899 to enable boats navigating between Lake Saint-Louis and Lake Saint-François to bypass the Soulanges rapids. This waterway was decommissioned in 1959, when the St. Lawrence Seaway locks were opened, providing ship access to the Beauharnois Canal. The present discharge in the Soulanges Canal is about 5 m^3/s.

4.2 Present State of the Altered Aquatic and Riparian Habitats and Wildlife Use

Since little information is available on the condition of natural resources before the physical environment and the flow regime were modified, it is difficult to identify clearly the concomitant effects.

In a few cases, however, certain characteristics of the biological communities in the local water bodies can be attributed to the management of water flows and levels.

4.2.1 Sedimentation and erosion

Because of its substantial discharge, the St. Lawrence carries a large suspended load. The strong currents in the Beauharnois Canal, however, prevent the fine particles in the water mass from settling as it flows from Lake Saint-François to Lake Saint-Louis. The compact bottom substrate in this sector also limits erosion.

The basins in the reduced-discharge section of the St. Lawrence do not retain much fine sediment, because of the water's short residence time. There are, however, some

sedimentation zones in a few bays that are sheltered from currents and waves. Judging from the thickness of the sediment deposits and the aquatic vegetation that has colonized them, the particles that accumulate in these sheltered spots remain there for long periods of time. By contrast, the areas in the artificial basins where the water level changes rapidly have a bottom substrate composed of coarse material. Although fine particles may settle out in some locations, most of this fine material is washed away when the water level changes or when the basins are drained in the fall.

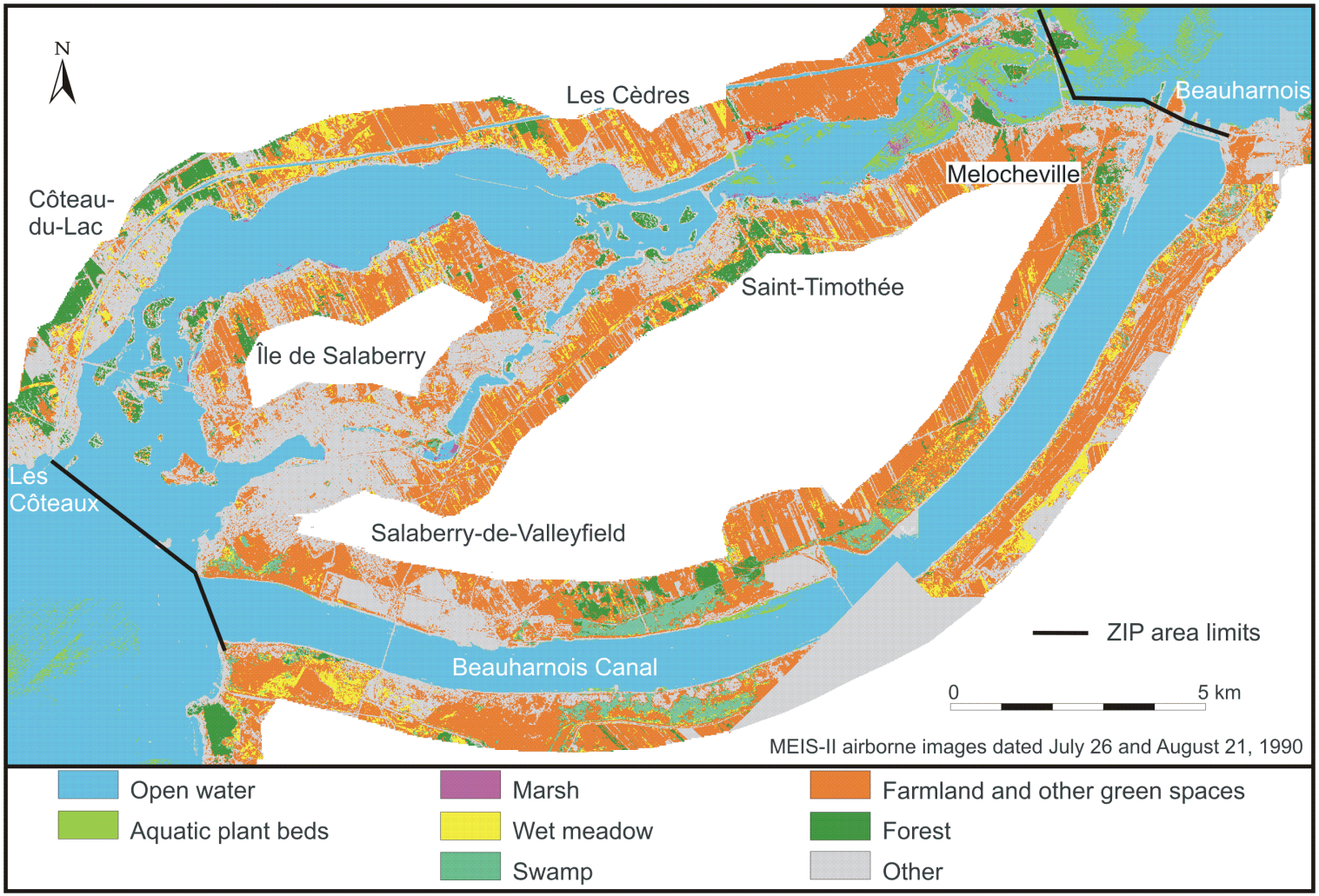
Little erosion occurs in the basins. Only one sector, located downstream from Buisson Point, may be exposed to erosion from strong easterly winds.

4.2.2 Vegetation and habitats

The terrestrial and riparian habitats were heavily impacted by the major construction that changed the flow of the St. Lawrence. Only 15% of the 98 km of shoreline in the sector is still in its natural state: these areas being scattered along the reduced-discharge stretch of the river (Figure 3). The banks of the Beauharnois Canal are completely artificial. The only remnants of plant groupings typical of the region are a few linear Red maple stands along the original part of the river channel, together with patches of vegetation on some islands that have remained almost intact.

Wetlands, important habitats for wildlife, cover a small area in the Valleyfield–Beauharnois sector. Marsh occupies only 56 ha, all in the reduced-discharge part of the St. Lawrence. Aquatic plant communities are not extensive either, accounting for a total of 22 ha, likewise in the original river channel[9] (Figure 4).

[9] Since rapids were a predominant feature of this river section before it was developed, the original aquatic plant communities were probably quite limited.



Source: Létourneau and Jean, 1996.

Figure 4 Distribution of Wetlands in the Valleyfield-Beauharnois sector in summer 1990.

This vegetation supports the richest living communities in the aquatic environment. Very dense stands of aquatic plants, like those in Lake Saint-Louis and Lake Saint-François, provide shelter and feeding areas for a rich and abundant community of small invertebrates. This concentration of prey in turn attracts waterfowl and fish. The plant beds also serve as spawning grounds for several species of fish, including Yellow perch, Northern pike and Brown bullhead. The plants help to keep the roe above the muddy bottom. After hatching, fry can find food and shelter in the same area. Muskrats, amphibians and reptiles use these habitats as well.

4.2.2.1 *The Beauharnois Canal*

The natural terrestrial vegetation has all but disappeared from the edges of the canal. Over the last few decades, the settling basins have been colonized by Common reedgrass, a highly invasive species, which for several years occupied half of the available space (see Section 4.5.1). A large part of this area has since been returned to cultivation, attenuating the disadvantages associated with the presence of Common reedgrass.

Although there are no wetlands in the Beauharnois Canal, some of the settling basins were turned into impoundment structures so they would retain water and provide suitable habitats for waterfowl (see Section 5.3). Strictly aquatic organisms cannot access these habitats from the canal.

4.2.2.2 *Reduced-discharge section*

Overall, the most diverse and extensive plant communities in the reduced-discharge part of the river are found in the upstream retention basins.

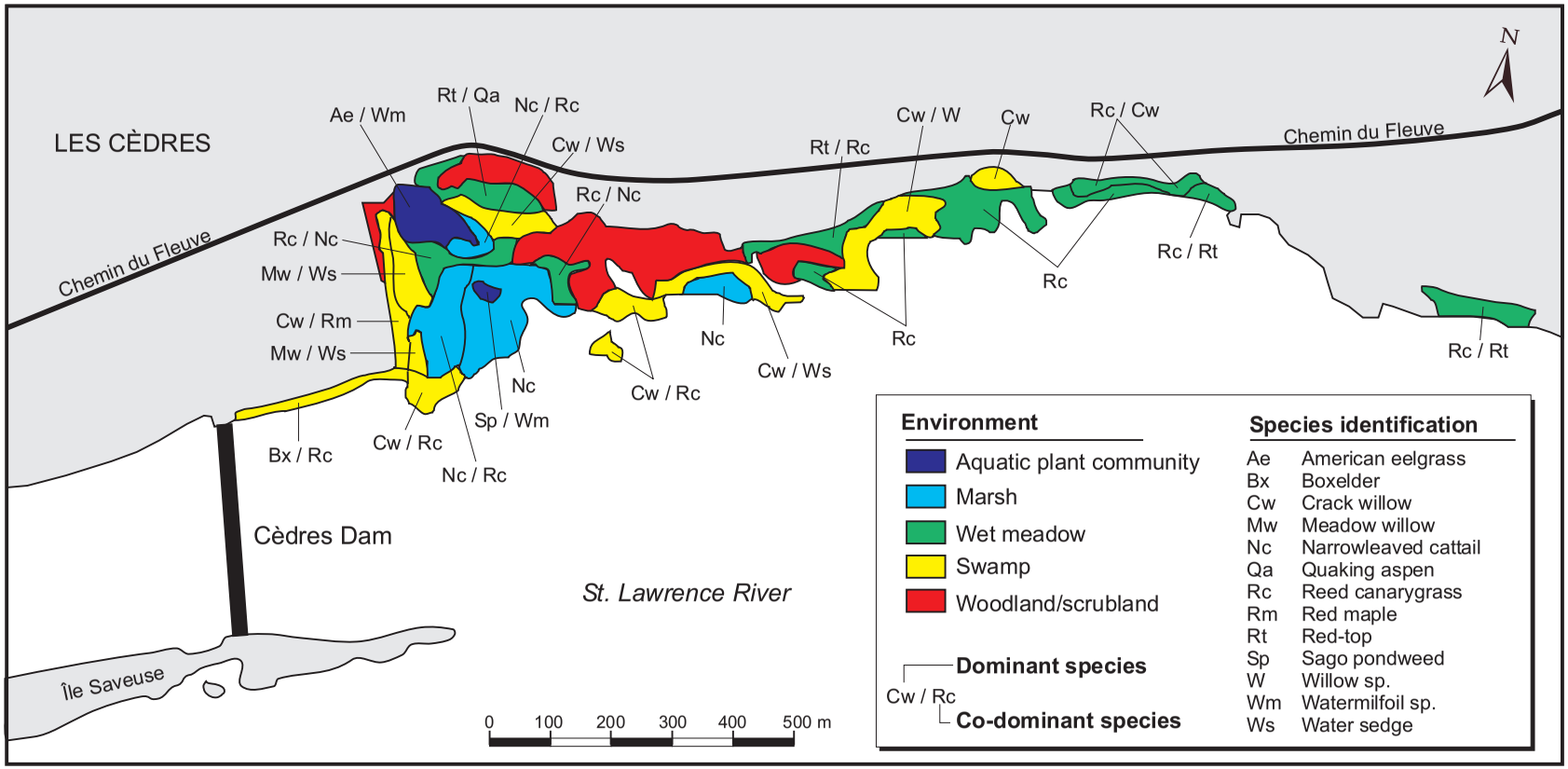
With regard to terrestrial vegetation, the islands in Cèdres basin are of greatest interest. Their unique soil and microclimate conditions have favoured the development of pockets of exceptionally diverse terrestrial vegetation. There are mature stands of Hackberry, a rare species in Quebec, associated with Dotted hawthorn, Staghorn sumac, Butternut, Basswood, Red ash, Slippery elm and Silver maple. In the Saint-Timothée basin, the vegetation on Ile à l'Ail and Lemoine Island comprises Quaking aspen, Sandbar willow, Staghorn sumac and Slippery

elm. The terrestrial vegetation growing around the other basins is of lesser interest, except at Buisson Point, where a rich variety of plants can be found.

The riparian vegetation is generally poor in all the basins. The most interesting plant communities are found on the Coteau islands, and include Sandbar willow, Stalked willow, Red-osier dogwood, Sensitive fern, Red-top**,** Virginia creeper**,** Staghorn sumac and American bladdernut. On the perimeter of the basins, the banks were reworked in many locations, giving rise to walls, steep embankments or rip-rap. In general, there are fewer artificial aspects on the south shore of the basins than there are on the north shore. Most of the islands still feature natural shoreline. Some 300 m downstream from the Cèdres power plant is an area known locally as the *grand marecage* or «Great Swamp.» Here, marsh and wet meadows are dominated in spots by Reed canarygrass or Narrowleaved cattails, alongside Great bulrush (Figure 5).

There are a few zones of wet meadow in Pointe-des-Cascades basin (e.g. at the far end of Buisson Point), together with a fringe of marsh and wet meadows on the north shore. Given that the water level fluctuates and the basins are emptied in winter, the species present here are likely to be those with the greatest tolerance for the severe conditions. Cèdres basin contains a few submergent plant communities[10], in sheltered island bays, near the Réserve Écologique du Micocoulier (Hackberry ecological reserve) and along the north shore of Ile Dondaine. In Saint-Timothée basin, upstream from the Cèdres power station, there is a large expanse of submergent vegetation. There are also a few stands of American eelgrass and pondweed in the bay located downstream of the Ile Juillet dam. Similarly, Buisson Point basin has an extensive aquatic plant community. Submergent aquatic plants are common in the Pointe-des-Cascades basin.

[10] The main species are *Canada waterweed, Coon's tail, Grassleaf mud plantain, eelgrass and Shortspike watermilfoil*.



Source: Adapted from Environment Illimité, 1994.

Figure 5 Distribution of aquatic and riparian vegetation in the "Great Swamp" at Buisson Point Basin

4.2.2.3 The Soulanges Canal

The discharge in Soulanges Canal is always low (5 m^3/s), providing a suitable environment for numerous aquatic plants, dominated by Shortspike watermilfoil. This area has high densities of small aquatic organisms, along with spawning grounds and nursery areas for juveniles of many fish species.

4.2.3 Benthos

Benthos comprises all organisms that live on, within or attached to the water bottom. The distribution of benthic animals depends to a great extent on local conditions (presence of aquatic plant communities, type of bottom, depth) and individual species' needs in this regard; one species may live almost exclusively in aquatic plant beds, while another will seek out unvegetated areas.

The information available on the benthos of the Valleyfield–Beauharnois sector is sketchy and of limited use because there are no descriptions of environmental variables at the sampling stations. The benthic fauna in the basins appears to be quite poor. It is not known to what extent this situation can be blamed on water level fluctuations and the winter draining operation.

In the Beauharnois Canal, two species characteristic of the green waters of the Great Lakes, a mollusc called the Faucet snail (*Bithinia tentaculata)* and the crustacean *Gammarus fasciatus*, are the most common specimens in benthos samples.

4.2.4 Fish

All of the information available on fish communities suggests that the construction of flow regulation structures and the associated water-level management methods have profoundly modified fish populations.

The elimination of zones of rapids probably had a major impact on the populations of species that frequent these habitats. Another consequence appears to be the loss of spawning

grounds for certain fish species, such as Lake sturgeon, that spend most of their life cycle in the lacustrine expanses of water farther up or down river.

This segment of the St. Lawrence is part of the migratory route used by species, such as American eel and American shad, that have to travel between the sea and fresh water to complete their life cycle. These fish, which used to swim through the rapids, found their way either blocked or seriously impeded by the impoundment structures. At present, there are no fish passage facilities in the Valleyfield–Beauharnois sector.

It has been reported that some fish can still move upstream, by travelling through the Seaway locks, for instance. However, no effort has yet been made to estimate the percentage of migrating fish that are able to do so. Some species, Lake sturgeon for instance, appear to avoid the locks.

The routes followed by fish during their downstream migration are not known either. Those that swim with the main outflow of the St. Lawrence, such as American eels, should in theory go through the Beauharnois Canal and reach the power plant's water intakes. However, any animals that get caught in the turbines will die. There have been several reports of injured or dead eels found downstream from the Beauharnois facility.

Since 1993, Hydro-Québec has been studying the ability of eels to bypass river works during their upstream movement and the deaths of adult eels that get caught in the turbines while migrating downstream. This experimental research has not, however, resulted in any permanent measures.

In the reduced-discharge section of the St. Lawrence, the artificial basins do not constitute quality habitats for fish. Because of the variations in water level and winter draining, the aquatic plant communities are not well developed and the benthic fauna is not very diverse. Two elements are essential to quality habitat for many fish species. In the case of species that are able to tolerate the existing conditions in the basins, the seasonal draining of water may limit survival. When the water level is lowered in the fall, some fish remain trapped in deep holes and

many of them die[11]. Starting in the early 1990s, however, the trapped fish have been removed manually and placed in flowing water areas, from which they can swim to Lake Saint-Louis.

In recent years, at the request of the Quebec Environment Ministry (MEF), Hydro-Québec has adjusted its management of hydro-electric facilities in order to reduce the impacts on the natural environment. Since 1993, a minimum flow of 440 m^3/s has been maintained in Cèdres basin during the spawning periods of certain fish species, and wildlife and habitat conservation is increasingly being taken into account in the management of hydro-electric works (e.g. closing hydraulic gates later in the spring to make it easier for fish to reach spawning grounds).

No detailed studies have been carried out on the fish communities of the artificial basins, although experimental fisheries have been conducted as part of impact studies. The data obtained show that these water bodies are used by species that are common in Lake Saint-François and Lake Saint-Louis. The species typical of the fish communities in both lakes, considered to have average productivity, are the Smallmouth bass, Northern pike, Yellow perch, White sucker and Walleye. Other species, particularly minnows, are found there as well.

4.2.5 Birds

Overall, the Valleyfield–Beauharnois sector is of less importance for waterfowl than are Lake Saint-François and Lake Saint-Louis. This difference can be explained by the limited area of wetlands and less favourable conditions for nesting and brood rearing.

Although the Pointe-des-Cascades and Buisson Point basins contain marshes, the vegetation is very dense. In addition, the wet meadows are submerged during the nesting season. Lastly, the degradation of shoreline areas and disturbances from nearby highways and houses are a hindrance to breeding.

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[11] One-quarter of the fish killed are game species. The families with the largest number of specimens killed are Cyprinidae (minnows), Percidae and Catostomidae.

Waterfowl use the water bodies in this region primarily as staging areas. In winter, some ducks[12] can be spotted in open-water areas, especially in Cèdres basin, which is not drained. These fast-flowing zones are also frequented by Common mergansers and Black ducks, in spring and during the summer. A few dabbling duck pairs nest and rear their young near the islands.

In spring, Buisson Point basin is visited by many waterfowl species, including Canada geese, Mallards, American wigeons and Common mergansers. Nesting does not appear to take place in this basin; however, a few breeding pairs rear their young in Bayard Bay and in the «Great Swamp,» where waterfowl mainly congregate during their fall migration.

Pointe-des-Cascades basin is used above all in spring, before it is refilled with water. A few duck pairs have successfully nested here. Saint-Timothée basin is of little interest for avian fauna.

The Beauharnois Canal is not a suitable environment for waterfowl nesting, in contrast with some of the nearby basins which offer markedly more favourable habitats. Ducks Unlimited Canada has enhanced the area by turning some of the basins into impoundment structures that retain water, permitting the development of marsh vegetation. These habitats, used mainly by dabbling ducks[13] to rear their young, are also frequented by other groups of waterfowl.

In the study area, there is a growing heron colony, on Ile Bienville; another colony, located on Ile Villemomble, was abandoned in 1981 (Figure 6). Other colonial species include the Common tern (one colony in the Pointe-des-Cascades basin, and two on islets in the canal), Black tern (in managed basins along the canal) and the Ring-billed gull (one colony on Ile au Chat, abandoned in 1991).

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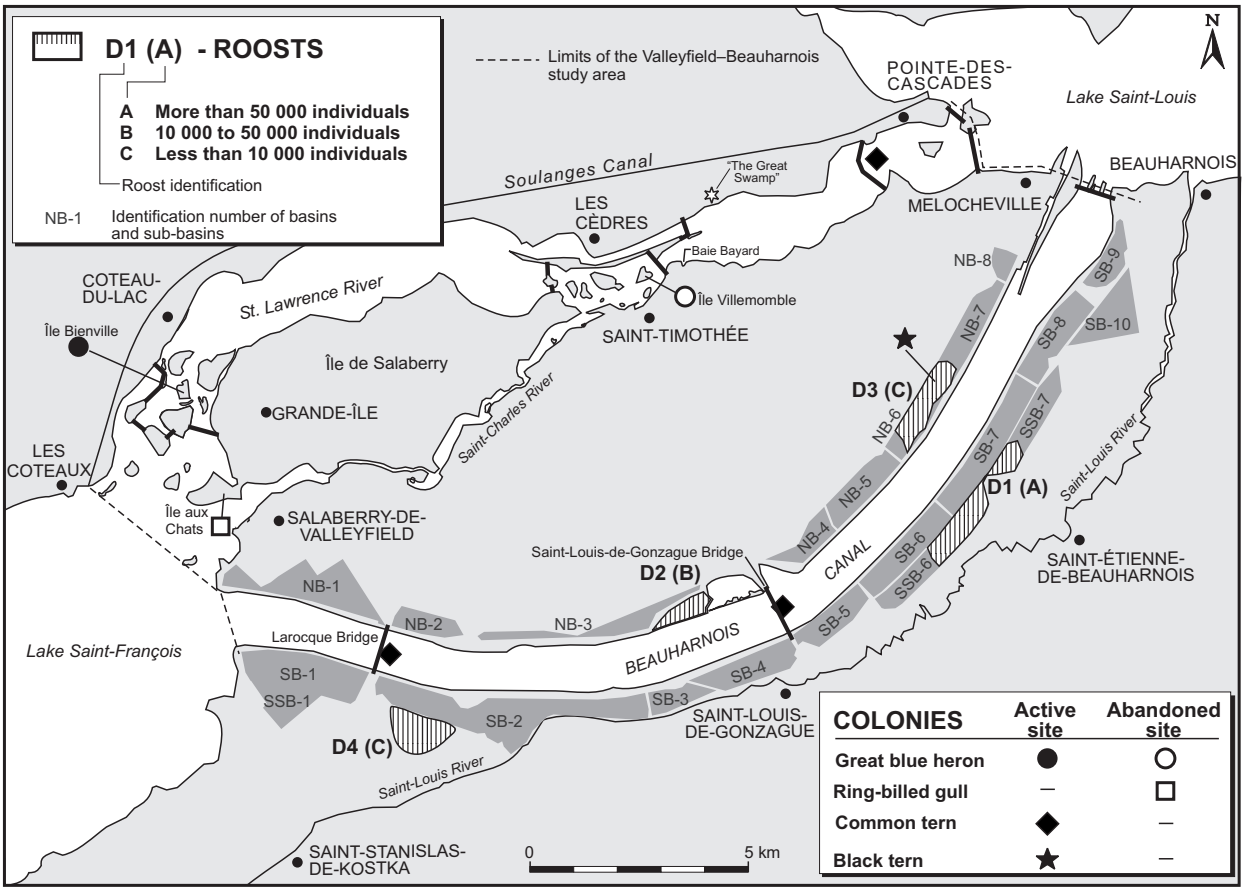
[12] Common merganser, Black duck, Common goldeneye and Mallard.

[13] Mallards, Black ducks, Blue-winged teal, Gadwalls and Northern shovelers, in particular.



Source: Rodrigue, 1996; Razurel, 1994; Gervais and Hogue, 1993; Brousseau, 1992; GREBE, 1990; Mousseau and Beaumont, 1982.

Figure 6 Bird colonies and roosts

The diversity of bird life is closely related to the available habitats. The largest number of bird species are observed in locations with the richest plant communities, such as the Réserve Écologique du Micocoulier and the archaeology park, Parc Archéologique de la Pointe-du-Buisson (Figure 13). Zones with a limited variety of plants, in particular the banks of the Beauharnois Canal, support a large number of birds from only a few species, primarily blackbirds[14], in spring and late summer.

[14] Red-winged blackbirds, European starlings, Brown-headed cowbirds and Common grackles.

The expansion of blackbird populations has been attributed partly to the crop residues left on the ground from corn monocultures. Some species have learned to capitalize on this food resource, which is available in the fall and spring. These birds may, however, damage crops prior to harvest time in certain areas. At the end of summer in 1990, a total of 190 000 Red-winged Blackbirds were counted, in flocks at four different roosting areas.

The measures implemented to control Common reedgrass along the Beauharnois Canal may have prompted these groups of birds to roost at other sites (woodlands, groves, marshland).

Readers should refer to Appendix 1 for the list of bird species potentially at risk in Quebec which have been sighted in the Valleyfield–Beauharnois sector.

4.2.6 Other animals

No systematic inventory has been conducted of the amphibians and reptiles in the study area. However, the region comprises the geographic range of three Urodela species (salamanders and newts), ten Anura species (frogs, tree frogs and toads), three turtle species and two snake species. Of this number, two species have been designated as priorities under SLV 2000: the Western chorus frog and the Wood turtle, considered vulnerable in southwestern Quebec.

No historical data on abundance are available, a situation which prevents us from describing changes in the size of these populations and linking their presumed decline to a specific factor. A consensus exists among herpetologists, however, regarding these animals' strong habitat dependence. It is postulated that the disappearance of wetlands and mature forests may have had a negative impact on their numbers.

The Muskrat is the most common mammal species in the wetlands of the study area. The habitats used most by this rodent appear to be the managed basins along the Beauharnois Canal. The reduced-flow section of the river appears to be much less suitable for Muskrats, although sightings have occasionally been reported in Pointe-des-Cascades basin.

4.3 Human Occupation

The Valleyfield–Beauharnois sector comprises 12 riverside municipalities in two regional county municipalities (RCMs)[15], with a total population of 65 660[16].

The highest population density is in Salaberry-de-Valleyfield (1240 inhabitants/km^2) and the lowest densities in Saint-Louis-de-Gonzague and Saint-Étienne-de-Beauharnois (just under 20 inhabitants/km^2). The mean density for the region as a whole is 138 inhabitants/km^2.

The urbanized part of the Valleyfield–Beauharnois sector makes up 19% of the total area. It includes two large urban centres where industrial activity is also concentrated (see Section 4.4.1.2). The main centre consists of the Greater Valleyfield area, which includes the downtown core of Salaberry-de-Valleyfield and the nearby municipalities of Saint-Timothée and Grande-Île; the municipality of Coteau-du-Lac, on the north shore, is considered part of this greater region. The second urban centre, situated at the downstream end of the study area, comprises the municipalities of Beauharnois and Melocheville, which are closer to Lake Saint-Louis.

Between 1976 and 1996, the population in the study area grew by 16%. However, this increase was concentrated in the municipalities of Les Cèdres, Coteau-du-Lac and Grande-Île, whereas the downtown cores (Salaberry-de-Valleyfield and Beauharnois) actually reported a stagnating or declining population trend. The phenomenon of urban sprawl has multiple consequences for human communities and the environment: impoverishment of central municipalities, vacant land is used to build residential developments in suburbia, increased congestion on roads, pressure on natural habitats and associated problems.

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[15] Regional County Municipality (RCM) of Vaudreuil–Soulanges, north of the St. Lawrence, and Beauharnois–Salaberry RCM on the south shore.

[16] According to 1996 census data, there were 13 354 residents in the four municipalities north of the St. Lawrence (Coteau-du-Lac, Les Coteaux, Les Cèdres and Pointe-des-Cascades), 39 563 in the area between the original river channel and Beauharnois Canal (Salaberry-de-Valleyfield, Grande-Île and Saint-Timothée) and 12 743 south of there (Saint-Louis-de-Gonzague, Saint-Étienne-de-Beauharnois, Beauharnois, Melocheville and Saint-Stanislas-de-Kostka).

Most of the Valleyfield–Beauharnois sector is rural (Figure 7), primarily farmland[17]. The region is part of the St. Lawrence Lowlands, considered a productive agricultural area owing to the clayey soil and the length of the growing season. In 1991, the study area contained a little over 30 000 ha of agricultural land, shared by 405 active farms. Grain crops, forage crops and market garden produce are the main crops grown.

The area's role in hydro-electric production has created a number of constraints for the residents, along with some benefits.

The construction of the Beauharnois Canal turned the area containing the municipalities of Salaberry-de-Valleyfield, Saint-Timothée and Melocheville into an island, posing obstacles to their development. For people living on the banks of the original river channel, the diversion of the river flow toward the Beauharnois Canal led to a drastic change in the landscape, which has been mitigated partly by the impoundment facilities. While the artificial basins improved the appearance of the surrounding area and permitted certain recreational activities, the water level fluctuations limit certain uses, such as recreational boating, and the basins are drained in the fall.

In terms of benefits, the hydro-electric power operations created jobs, attracting mostly manufacturing industries. The city of Salaberry-de-Valleyfield has long been recognized as a hub of economic activity in southwestern Quebec. Although considered a satellite community of Montreal, it has remained relatively autonomous.

Economic activity in the Valleyfield–Beauharnois area was hit hard by the recession of the early 1980s; however, the situation appears to be improving. Local authorities are constantly seeking to breathe new life into the manufacturing sector, but are also counting increasingly on recreation and tourism to boost economic activity (see Section 5.2). In this regard, the planned extension of Highway 30 from Châteauguay should have an impact on the region's economic development.

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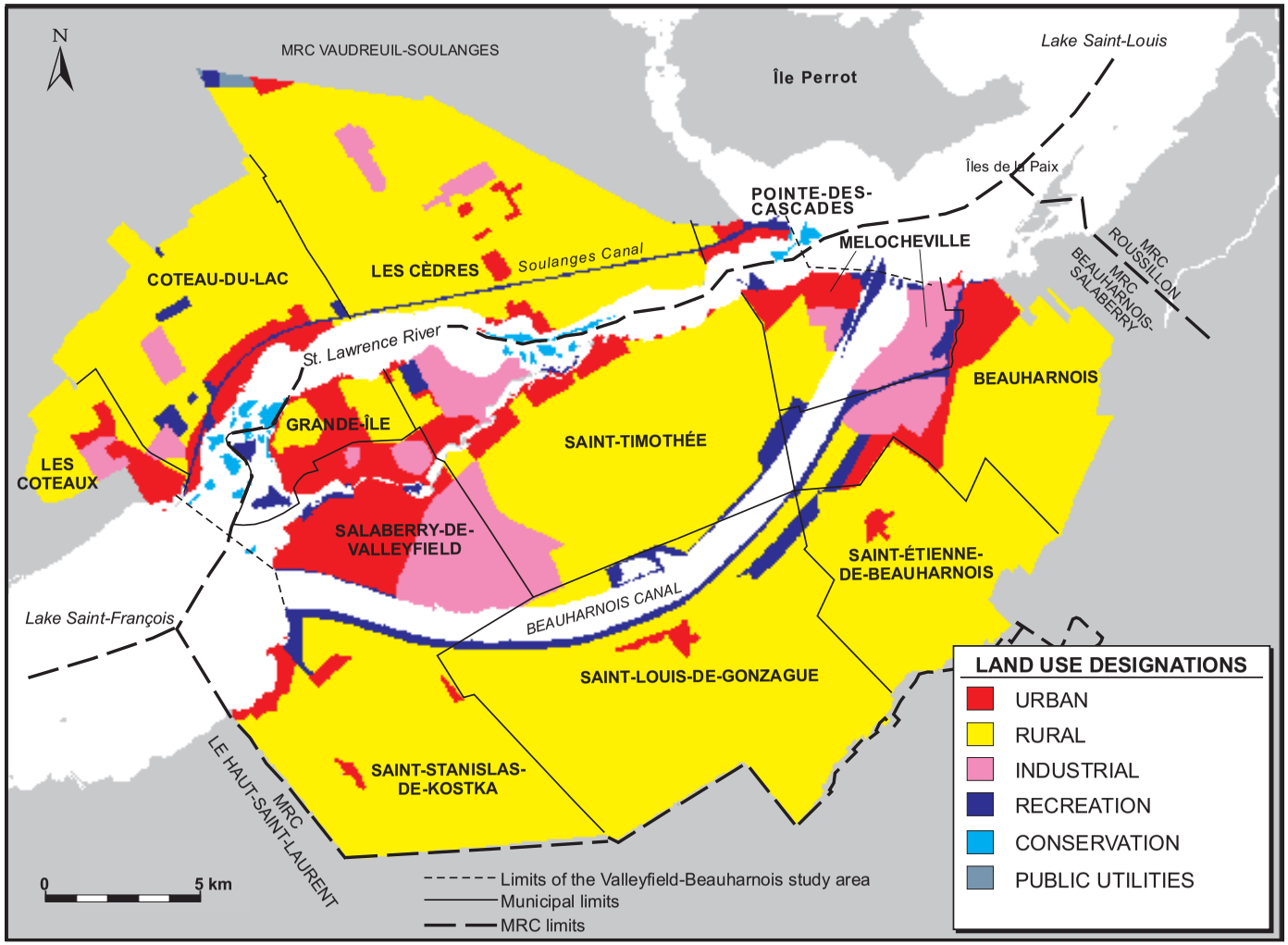
[17] This rural portion also includes low-density residental areas, cottages and a few woodlands.



Source: Adapted from MRC Beauharnois-Salaberry, 1987 and MRC Vaudreuil-Soulanges, 1989.

Figure 7 Land use patterns in riverside municipalities

The land use patterns associated with urban development and with the operation of the Beauharnois Canal for power production and marine shipping have resulted in the degradation of many shoreline areas and affected their accessibility.

Urbanization has given rise to urban sprawl across large areas and the associated need for service infrastructures. The municipalities near Salaberry-de-Valleyfield are growing at the expense of this city and forming suburbs. In the late 1980s, it was estimated that just over half of the property bordering the original channel of the St. Lawrence (56%) was devoted to urban uses, and nearly all of the shoreline was privately owned.

Most of the lands bordering the Beauharnois Canal belong to Hydro-Québec and Transport Canada. Owing to renewed interest in the land near the canal, recreational uses occupy nearly 60% of the area along the waterway.

4.4 Contamination

For a long time the St. Lawrence was considered a convenient and inexpensive dump site for wastewater. Industries, municipalities and agricultural operations all discharged their 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 the governments to monitor effluent and establish concentration standards for various substances. A number of substances had already built up to considerable levels in the environment, and continued to constitute a source of contamination for many years.

The volume and type of effluent determine their impacts on the environment. For example, industrial plants are usually the main sources of toxic chemicals, while municipal sewage contributes to bacterial contamination, which makes water unsafe. Municipal effluent discharges also boost biological productivity considerably, which among other things can lead to rapid algae growth and give the water a foul odour that turns people off swimming and other recreational activities. Agricultural activities can contaminate the aquatic environment through runoff of pesticides and fertilizer applied to crops.

Salaberry-de-Valleyfield was the first major urban centre established on the banks of the St. Lawrence in Quebec. It was also the site of the first large concentration of point sources of pollution likely to alter water quality[18].

4.4.1 Sources of contamination

The pollution sources with the greatest impact on the aquatic habitats in the Valleyfield–Beauharnois region are believed to be the St. Lawrence itself at the outlet of Lake Saint-François, local industrial discharges, tributaries[19] and municipal effluents.

Some substances also enter the aquatic environment from surface runoff, ground water table and atmospheric deposition. However, not enough data are available at present to assess the relative contributions of these different pathways of aquatic contamination.

4.4.1.1 *Municipal effluents*

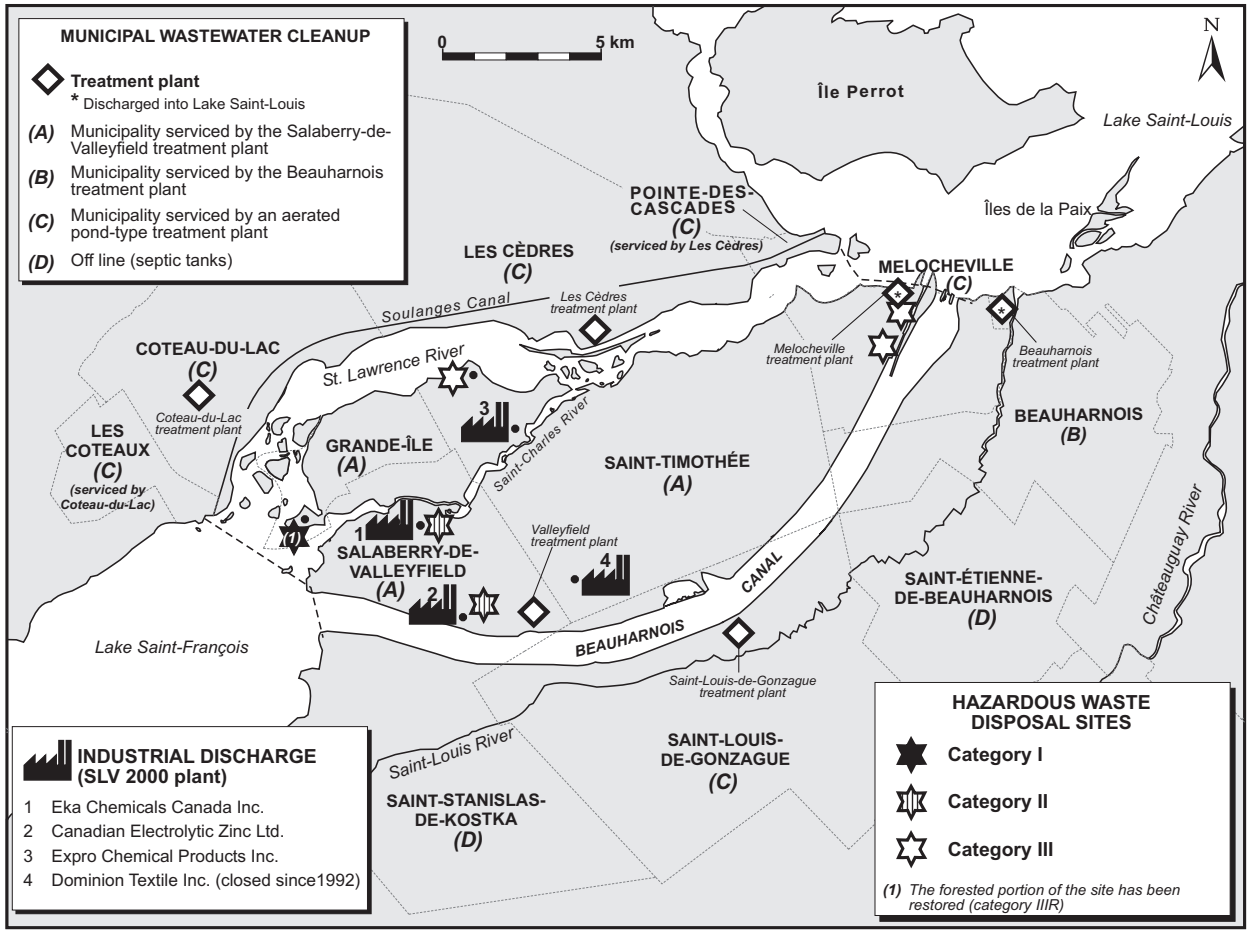
Until just a few years ago, local municipalities dumped raw wastewater into the water bodies in Valleyfield–Beauharnois. This situation is changing.

In 1998, about 84% of the region's population, comprising 12 municipalities, was served by a wastewater treatment plant (Figure 8). The Salaberry-de-Valleyfield plant, commissioned in 1987, serves almost the entire population of this city, along with that of Saint-Timothée and Grande-Île. Treated effluents from this sewage plant and the one in Saint-Louis-de-Gonzague are released into the Beauharnois Canal. The wastewater from the Coteau-du-Lac facility (which also serves Les Coteaux) and the Les Cèdres plant (which also serves Pointe-des-Cascades) is discharged into the original part of the river channel. The Melocheville and Beauharnois facilities discharge treated wastewater into Lake Saint-Louis. Some 10 500 people who live in the study area are not served by a treatment plant. This includes the entire population

[18] Farther upstream, the zones of industrial discharge with the most impact on water quality are in Cornwall, Ontario and Massena, New York.

[19] Tributaries, which actually collect both diffuse pollution and pollution from all sources within their drainage basin, are treated here as if they were point sources of effluents along the St. Lawrence.

of Saint-Stanislas-de-Kostka and Saint-Étienne-de-Beauharnois. Since these municipalities are not equipped with a sewer system, the homes use septic tanks.



Source: Jourdain, 1998; Fortin et al., 1998, MENVIQ, 1991.

Note : Effluents from plants in Melocheville and Beauharnois are treated in the Lake Saint-Louis study area (ZIPs 5 and 6).

Figure 8 Main local sources of contamination

Only one treatment plant, the one at Salaberry-de-Valleyfield, has undergone testing. Its performance is considered acceptable: treatment removes a large part of the suspended solids and biochemical oxygen demand (BOD_5). However, although wastewater treatment reduces the quantity of micro-organisms in the water, it does not eliminate them altogether. Furthermore, during heavy rains, the collector system becomes overloaded and untreated sewage is discharged at a series of overflow points.

4.4.1.2 *Industries*

The industrial plants in the study area, most of them located in urban areas, belong to the textile, rubber, metallurgical and chemical manufacturing sectors. They are concentrated in the two large urban centres, Salaberry-de-Valleyfield and Beauharnois–Melocheville. Salaberry-de-Valleyfield is most likely to have an impact on aquatic habitats because its effluents are discharged into the upstream sector; it also has more industrial plants than does the other urban centre. Releases in the Beauharnois–Melocheville region affect Lake Saint-Louis instead, which is outside the study area.

Industrial effluents. Industrial discharges in the Valleyfield–Beauharnois region were quite heavy in the past, although, they have declined because of plant shutdowns and because those still in operation are participating in a treatment program.

Four industrial plants in the study area (Figure 8) are among the 50 facilities originally targeted by the St. Lawrence Action Plan, renewed as SLV 2000, which comprises 106 priority industrial plants along the St. Lawrence and some of its tributaries. Dominion Textile Inc., which closed in 1992, used to discharge its effluents into the Beauharnois Canal, into which Canadian Electrolytic Zinc Limited and Eka Chemicals Canada Inc. also released their wastewater. Expro Chemical Products Inc. discharges its effluents into the Saint-Charles River.

In 1995, the three plants still in operation discharged nearly 219 000 m^3 of effluents daily into the aquatic environment, 80% of which was discharged by the Canadian Electrolytic Zinc plant.

The Dominion Textiles Inc. (Domtex) plant in Saint-Timothée, which closed in 1992, was engaged in fabric finishing. In 1990, it discharged a daily load of 7500 m^3 of treated wastewater into the Beauharnois Canal. The discharges were characterized by a large volume of suspended solids, a high biochemical and chemical oxygen demand, large quantities of oil and grease, and discoloration due to organic products. A few inorganic contaminants were also present at low concentrations, albeit not exceeding the guidelines agreed to under a cleanup program signed in 1987.

Expro Chemical Products Inc. manufactures civilian and military explosives. Following settling, its process waters are discharged, together with untreated rainwater and domestic effluents, into the Saint-Charles River at a point 3 km from its mouth, and into the municipal sewer system. Part of the neutralized acidic waters are channelled via the sewer system to the Salaberry-de-Valleyfield treatment plant. After some production operations were discontinued and three polluting processes were abandoned in 1991, discharges decreased substantially, from a loading of about 37 300 m^3 per day in 1988 to 19 300 m^3 in 1995. In addition to their heavy chemical and biochemical oxygen demand and elevated suspended solids loads, the discharges from Expro Chemical Products Inc. pose special problems owing to their load of oil and grease. In 1987, the company signed a memorandum of agreement on wastewater treatment with the MEF; however, it was not implemented after the company stopped producing cyclonite in 1991.

The Canadian Electrolytic Zinc Ltd. plant refines zinc and produces sulphuric acid, zinc ingots and cadmium. A first outfall discharges untreated cooling waters that are relatively uncontaminated into the Beauharnois Canal at a rate of about 172 650 m^3 per day. A second outfall is used to discharge domestic effluents that have previously undergone activated sludge treatment, along with runoff, wash water and process effluents. These different wastewater streams represent a loading of about 7000 m^3 per day; they are treated with lime, passed through a settling basin and then pumped to the Beauharnois Canal. The main contaminants released into the water are zinc, selenium, ammonia nitrogen and iron. In 1990, the company reduced its zinc pollution load by installing new equipment. In 1993, it signed a memorandum of agreement on waste treatment which expires in 1998. Improved treatment methods helped to reduce releases of zinc by 93% and cadmium by 88% between 1988 and 1995. Efforts are currently under way to remove selenium.

Eka Chemicals Canada Inc. produces sodium chlorate and hydrogen peroxide. Its process waters are recirculated in a closed loop system. The blowdown and domestic effluents are channelled to the Salaberry-de-Valleyfield sewer system. The main contaminants in the discharges are vanadium and nitrites and nitrates.

Hazardous waste sites. In addition to effluents, industries produce hazardous waste, which they dispose of at land-based sites. In the long run, these hazardous waste sites can add to contamination of the aquatic environment, since some substances may leach into the ground water and eventually end up in watercourses.

In the study area, there are eight hazardous waste sites (Table 2). Two of them, located at Beauharnois–Melocheville, could be a source of contamination for Lake Saint-Louis, which is downstream from the study area. The other six sites (Figure 8) have the potential to contaminate the aquatic environment in the sector. One of these, located on Ile aux Chats, was found to pose a high environmental and health risk in the early 1990s. While the terrestrial part of the site has been restored, the aquatic portion is currently the subject of an impact study.

In addition, Hydro-Québec has used a basin in the Beauharnois Canal (basin SB-9, see Figure 6 for location) as a disposal site for sediment dredged from the lower reaches of the Saint-Louis River. This sediment is contaminated with mercury.

4.4.1.3 *Tributaries*

Industrial and municipal effluents are collected by some tributaries from point sources in their watersheds and transported to the St. Lawrence. The Rouge and Delisle rivers drain areas of land characterized by many different use patterns, including urban zones and agricultural land. As well, tributaries are also the main pathway through which fertilizers and pesticides used on farms enter the St. Lawrence. In contrast with industrial and municipal effluents, which are released from point sources, agricultural pollution tends to be diffuse. The rain, snowmelt and irrigation water that runs across cropland carries nutrients and pesticides to rivers via a multitude of furrows, gullies and streams.

Table 2
Hazardous waste sites in the Valleyfield–Beauharnois sector

Location	*Description of site*	*Category**	*Contaminants identified*	*Potential impacts in 1991*	*Situation in 1996*
Salaberry-de-Valleyfield	Settling basins of Canadian Electrolytic Zinc Ltd.	II	Heavy metals (acidic pH)	Potential for contaminating the regional aquifer and the Beauharnois Canal. Low health risk.	A new basin was built, and another basin was raised
	Former sanitary landfill used by the city of Salaberry-de-Valleyfield	II	Fluorides, cyanides and heavy metals	Contamination of privately owned wells and contamination of sectors of the St. Lawrence	No change
Île-aux-Chats, Grande-Île (2 sites)	Settling basins used by General Chemical Canada Ltd.	III R I	Mercury, fluorides, arsenic, selenium, pyrite ash (acidic pH)	Contamination of groundwater and sections of Lake Saint-François	Restored land-based site (III R) Aquatic site (I) is currently the subject of an impact study
Saint-Timothée	Disposal site used by Expro Chemical Products Inc.	III	Metals	Contamination of sectors of the St. Lawrence	No change
Beauharnois	Solid waste disposal site (mercury sludge from the operations of Stanchem)	III	Mercury		Site restored
Melocheville	Soil and dust from the treatment system of the Chromasco Ltd. plant	III	Heavy metals		
Melocheville	Disposal site used by Elkem	III	Manganese, iron, aluminum, carbon, calcium, potassium, magnesium and heavy metals	Contamination of the air and groundwater, and some sectors of the St. Lawrence	Plant operations shut down in 1991
Melocheville	Former municipal dump of Melocheville	III	Fluorides and cyanides	Contamination of ground and surface water	No change

Source: MENVIQ, 1991.

* Classification by the provincial government based on the potential risk of environmental contamination.

The study area comprises just over 30 000 ha of farmland, on which the main crops grown are grains, forage crops and market garden produce. Grain crops have the greatest impact on the aquatic environment because they require large amounts of fertilizer and pesticide, a large part of which ends up in watercourses. Agricultural census data for the sector show an increase of about 50% in the total area treated with herbicides and insecticides and fungicides over a 10-year period (1981 to 1991).

Very few data are available on the pollution resulting from agricultural activities. Several tributaries empty into the St. Lawrence in the Valleyfield–Beauharnois sector. Information on metals and organic substances has been collected for two of them, the Delisle and Rouge rivers, as part of an overall assessment of loadings to the St. Lawrence in 1991–92. The limited temporal coverage of the samples raises questions about how representative they are of actual inputs to the river, however. At first glance, it appears that the metal, PCB and PAH loadings from these small watercourses is minimal compared to the fluvial input that flows through Lake Saint-François. However, the Delisle River contains substantial concentrations of atrazine, a herbicide used primarily in corn production.

Between 1988 and 1996, some 20 farmers sought to improve their manure management through a financial assistance program offered by the MEF. Reducing manure discharges is one of the measures included in agricultural clean-up initiatives.

4.4.1.4 *Fluvial inputs*

The St. Lawrence carries a large number of substances from upstream sources to the study area. Mass balance calculations of these inputs were done for nitrogen, phosphorus and suspended solids (SS) in 1990 and 1991 — that is, before most municipal and industrial effluents in the Montreal area began to be sent to treatment plants. For the three parameters, the results showed that the loads transported by the river were fairly low in the vicinity of Valleyfield, but increased rapidly in a downstream direction, particularly between Montreal and Trois-Rivières.

As regards fluvial inputs of metals and organic substances, the available estimates are

based on concentrations measured in the St. Lawrence proper, at the inlet of Lake Saint-François, to which the contribution of tributaries is added (Table 3). Fluvial inputs of PCBs, shown in Table 3, stem primarily from human activities, while part of the PAHs may be of natural origin. Metal loads, which are markedly higher, include a natural component arising from the geochemistry of the watershed, and inputs from human activities. The *anthropogenic enrichment factor*, calculated for metals, is a ratio of measured levels to background concentrations.

Table 3
Average annual inputs of contaminants to the Valleyfield–Beauharnois sector from the St. Lawrence and its tributaries

	Average annual inputs (kg/year)		
	River (at Cornwall)	*Cornwall–Valleyfield tributaries*	*Total at the outlet of Lake Saint-François*
Metals			
Cadmium	4 206	5	4 211
Cobalt	43 690	88	43 778
Chromium	363 606	9	363 615
Copper	168 015	30	198 045
Nickel	354 987	137	355 124
Lead	52 352	6	52 358
Zinc	597 995	41	598 036
Organic substances			
PCBs*	29.0	0.0	29.0
Total PAHs	2298.0	2.4	2300.4

Source: Proulx, 1993a; 1993b.

Note: The information shown in this table is based on data collected in 1990, 1991 and 1992.

* To estimate total PCBs, this value must be multiplied by a factor of 4. The annual loading of total PCBs from the river would thus be about 116 kg.

Variations in levels of contaminants, as determined from the sediment layers laid down over many years on the bottom of Lake Saint-François, provide clues to the history of contaminant releases in the waters that flow into the study area.

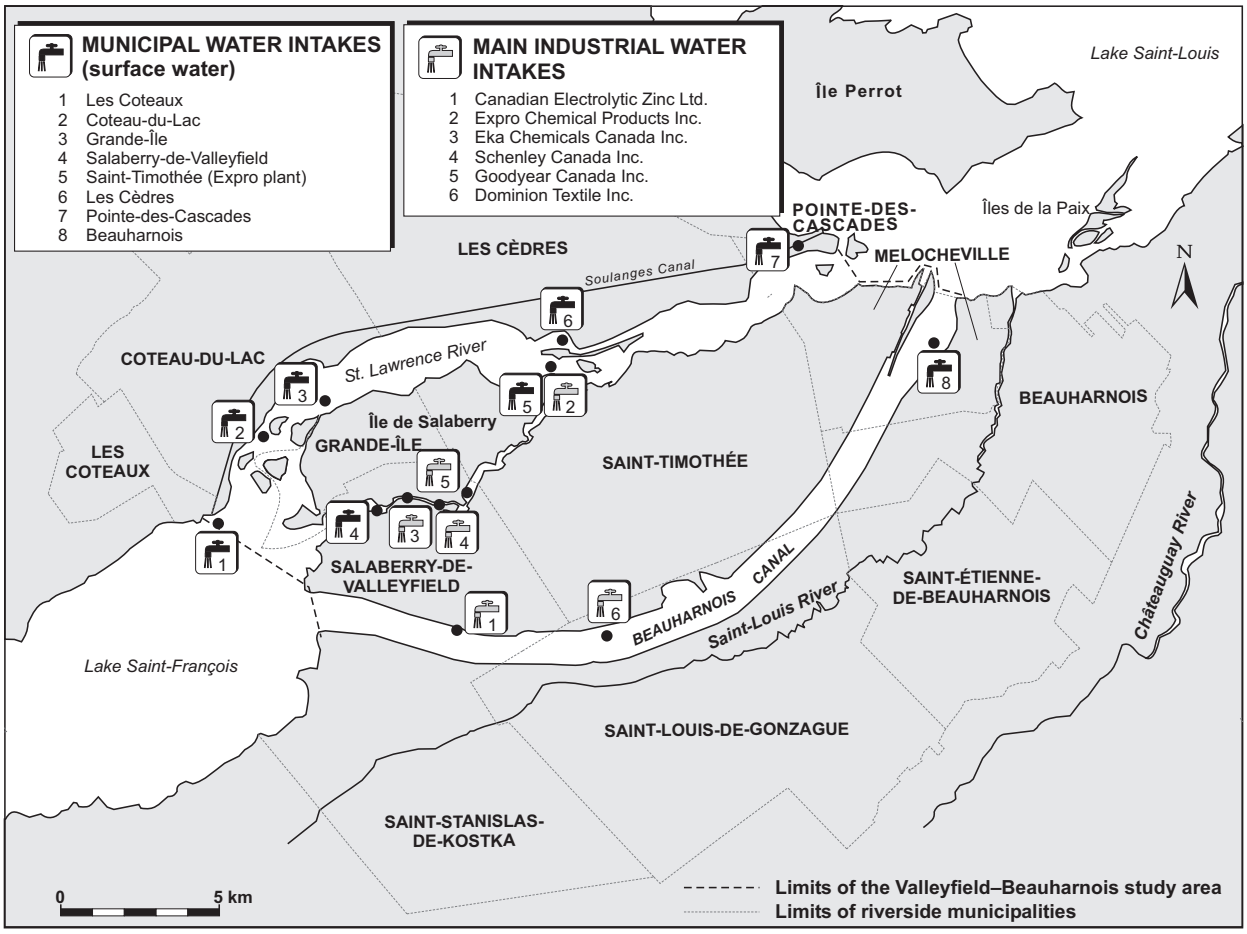
This information is used to trace the situation back to when industrial activity was just beginning. Contaminant levels in the St. Lawrence appear to have peaked during the 1960s and 1970s and then gradually declined. The nickel and chromium concentration in the surficial sediment layer corresponding to the early 1990s differed from the pre-industrial level by a factor of 1 or 2. By contrast, the copper and lead concentration was three to four times higher than the pre-industrial level, while zinc and cadmium were five to six times greater owing to human activities. PCB concentrations decreased by a factor of 10 between the mid-1960s and the early 1980s.

4.4.2 Effects of contamination on the aquatic environment

Whatever their origin, the pollutants found in the aquatic environment present varying degrees of risk to the normal functioning of living organisms. Some types of contamination have no lasting effects, and environmental quality improves quickly as soon as the waste discharges stop. This is the case, for example, with bacterial pollution, nutrient enrichment of waters, and highly soluble substances which are carried to sea by the current. However, some insoluble toxic substances adsorb to particles and can build up in sediment or in organisms that ingest sediment. These persistent substances, or their environmental degradation products, can therefore be found in high concentrations in living organisms.

The level of a toxic substance in an organism can increase through its life, a phenomenon known as *bioaccumulation*. It can also increase as materials pass up the food chain, through a process called *biomagnification* (Figure 9). Substances are thus gradually transferred to predators (fish, birds or mammals) at the top of the food web, attaining high concentrations in these animals.

For researchers seeking to confirm the presence of a substance in the environment, biomagnification can provide useful clues. Analyses of tissue samples from predator fish or birds can sometimes reveal the presence of contaminants that are in quantities too small to be detected in the water, even with the best analytical techniques.



Adapted from *Toxics in the St. Lawrence: An Iinvisible but Real Threat*. 1990. «St. Lawrence UPDATE» series. Environment Canada, Conservation and Protection, Quebec Region, St. Lawrence Centre.

Figure 9 The phenomenon of bioamplification

To assess the magnitude of contamination of the aquatic environment and the associated loss of uses, quality criteria for water, sediment and aquatic organisms are employed (Appendix 2).

4.4.2.1 *Water*

At present, the bacteriological quality of the water is quite good throughout the reduced-discharge section, although fecal coliform levels have sometimes exceeded the guideline for swimming(e.g. near the Saint-Timothée overflow pipe and at the mouth of the Saint-Charles River). In recent years, the ratings assigned to the beach in Saint-Timothée islands park under the MEF's beach water monitoring program have ranged from good to excellent, except on one occasion. It appears that the bacteriological quality of the water in this location may be affected by a number of factors, such as heavy rainfall, settling of coliform bacteria, the number of swimmers and daytime warming of the water. Furthermore, the water at this beach is replenished only when the Ile Juillet dams release surplus flow from the two hydro-electric power plants. Since 1994, Hydro-Québec has adjusted the way it manages the dams to ensure the beach water is renewed more often to maintain its quality.

Some so-called *conventional* parameters are analysed in evaluating water quality in the St. Lawrence in relation to certain uses (drinking water supply, recreational activities involving contact with the water, protection of aquatic life, and so on). The most stringent quality criteria for phosphorus, pH levels and turbidity have been exceeded on several occasions. For the most part, however, the conventional parameters do not show worrisome trends. Data on toxic chemical substances come from a single station situated in the Beauharnois Canal. Between 1985 and 1990, the aluminum concentrations recorded there exceeded the strictest criterion (the criterion for the protection of aquatic life) on several occasions. In addition, arsenic levels sometimes exceeded the criterion for raw water[20] along with that related to contamination of aquatic organisms. It should be noted, however, that the criteria for arsenic are currently under review. At first glance, the levels of organic substances in the Beauharnois Canal do not appear to be problematic. Out of 18 substances analysed in the water between 1985 and 1990, only two — the organochlorine pesticides α-BHC and γ-BHC (lindane) — were regularly detected, both at

[20] Untreated water taken directly from a water body and intended for human consumption; living organisms (fish, molluscs, etc.) found there must also be safe for human consumption.

concentrations below the most stringent criterion. However, interpretation of these data is limited, because they all come from the same station and the analyses cover a very short time period and a small range of substances. These results cannot be used to confirm that the water is or is not contaminated. The sketchy data obtained at the head of Lake Saint-François in the early 1990s are worrisome since the PCB and DDT concentrations exceeded some of the quality criteria.

Lastly, the time intervals between visits to the sampling stations were too great to be able to identify seasonal fluctuations. The levels of certain substances (metals or organic substances) in the water may be higher during spring runoff, and in fall after the aquatic plants die, or after the artificial basins have been drained.

4.4.2.2 *Sediments*

Many contaminants adsorb 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, creating a potential source of contamination for living organisms. Depositional zones often correspond to areas with aquatic plants, which are home to benthic organisms occupying the bottom of the food chain. The presence of contaminated sediment is a potential hazard for the fish, birds and mammals that feed at these sites, and ultimately for the hunters and fishers who eat them.

In the Valleyfield–Beauharnois sector, there are few areas where sediments are likely to accumulate over long periods of time. Based on fragmentary data collected in the late 1980s, however, contaminated sediments are believed to have reached the Buisson Point basin via the Saint-Charles River.

An analysis of sediments sampled in 1985 in the Beauharnois Canal revealed the presence of certain metals, including zinc, nickel and copper; however, the measured concentrations were not high enough to have a significant impact on aquatic organisms.

The sediments in Saint-François Bay and the Saint-Charles River contained substantially higher levels of contaminants than did the Beauharnois Canal and the impoundment

basins in the reduced-discharge section of the St. Lawrence. Samples taken in 1973 indicated that metals were present in potentially harmful concentrations for benthic fauna. Effluents from industrial plants operating in the Cornwall region were believed to be the source of some of the contaminants, particularly mercury. Local effluents may also have contributed to this degradation of the aquatic environment; in 1989, contamination of sediment by a number of metals appeared to be worse in sectors influenced by the Saint-Charles River, such as the Buisson Point basin.

The sketchy data available on organic contaminants such as PCBs do not make it possible to assess the risk posed by their presence in sediments.

While the data gathered in the 1970s and 1980s may no longer be representative of present conditions, more recent information is not available.

4.4.2.3 *Benthos*

Compared with other groups of aquatic animals, benthos move relatively little. The composition of benthic communities and their degree of contamination therefore gives a good idea of the distribution of toxic substances in the environment.

Data on the benthos, albeit fragmentary and about 20 years old, appear to indicate that the quantities of contaminants in aquatic habitats were high enough back then to adversely affect living communities. At sites with the greatest exposure to toxic substances, the number of species appeared to have declined; the samples showed that the species most tolerant to pollution[21] were predominant in Saint-François Bay and the Saint-Charles River. However, none of the benthos studies in Valleyfield–Beauharnois allow a clear distinction to be made between the impacts of toxic substances and those due to organic enrichment of the water.

In the 1970s, it was observed that the proportions of metals found as contaminants in Pelecypoda molluscs (mussels) could vary from site to site. In Saint-François Bay, samples of mussel flesh showed an elevated titanium concentration, while specimens taken from the

[21] For the most part, samples from degraded stations are dominated by tubificid worms; where insects from the family Chironomidae are dominant, this is an indication of organic contamination.

upstream portion of the Beauharnois Canal exhibited high levels of chromium, and to a lesser extent, copper and silver.

Metal analyses done in the 1980s on samples of benthic organisms, all species taken together, indicated that the metals were not evenly distributed on the river bottom. For example, a sharp increase in zinc contamination of benthos was found moving in a downstream direction in the Beauharnois Canal. Until the late 1980s, a large metallurgical plant released substantial loads of zinc in its effluent discharges. However, these results, obtained for a group of benthic organisms, permit only limited interpretation. The changes observed may actually stem partly from variations in the species composition of the samples.

4.4.2.4 *Fish*

In 1977, mercury, the most worrisome substance in the case of fish, was present in all species at levels exceeding the guideline set for commercial sale. The highest concentrations were detected in Northern pike, Walleye, Smallmouth bass and Yellow perch.

Fishers have known since at least the early 1970s that there is mercury in the fish in Lake Saint-François, which is upstream from the Valleyfield–Beauharnois region. According to surveys conducted in the lake at that time, mercury concentrations exceeding the guideline for the sale of fish and protection of aquatic life[22] were found in Walleye, Northern pike and Smallmouth bass; the problem seemed to be less severe in White sucker and Yellow perch.

Subsequent sampling showed a significant drop in mercury levels in the flesh of these fish species between 1976 and 1988, following a decrease in the amount of mercury discharged by industrial plants in Cornwall. The measurements showed that the level of mercury contamination in fish in Lake Saint-François had fallen about 30%, while PCBs had dropped 80%. Although no data are available to make a similar comparison for the fish in the study area, it can be assumed that a general downtrend has occurred. Nonetheless, the mercury levels measured

[22] See Appendix 2.

in large specimens of Northern pike in Saint-François Bay in the late 1980s, remained above the limit set for the sale of fish and protection of aquatic life.

In the 1970s, other toxic substances[23], including metals and organic substances, were detected in the flesh of fish taken from Lake Saint-François, albeit at lower concentrations than for mercury. In 1988, PCB levels in Lake Saint-François exceeded the criterion for the protection of aquatic life in Northern pike, Walleye and White sucker. In the early 1980s, analyses of young-of-the-year fish at the upstream limit of the study area pointed to the existence of local sources of PCB contamination.

4.4.2.5 *Birds*

Analyses of tissue samples from Mallard ducks revealed a low level of cadmium, lead and mercury contamination, but no organochlorine compounds.

In an early 1990s study of Common tern colonies along the St. Lawrence, to measure levels of organochlorine compounds in the aquatic environment, the bird specimens taken near Valleyfield showed the highest DDE and mirex concentrations. Analyses of Great blue heron eggs collected on Ile Villemomble in the early 1980s revealed high levels of DDE, dieldrin and total PCBs.

4.4.3 Risk to human health from contamination

Based on the information available, the present level of contamination poses little risk to human health, provided the recommendations and advisories issued concerning certain activities are respected.

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[23] Arsenic, cobalt, chromium, copper, selenium, manganese, nickel, lead, zinc, PCB, DDT, PAH and hexachloro-benzene.

4.4.3.1 *Consumption of fish and game*

Regular consumption of large amounts of fish caught in the study area may pose a health hazard, particularly from mercury. Based on the guide prepared by the MEF and the Quebec Health and Social Services Ministry (MSSS), anglers may indeed eat their catch, but moderation is advised, especially with regard to the largest predatory fish. Depending on the species, fish size and the catch site, the maximum number of meals that can be eaten without risk of contamination varies between 1 and 8 per month. In the study area, the most stringent restrictions apply to Northern pike, Walleye, Smallmouth bass and, above all, American eel. Young children and pregnant or nursing women should not eat eel. As long as people abide by the recommendations concerning consumption (number of meals) and preparation of fish[24] and also avoid eating fish with external lesions[25], the health risks are negligible.

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 6 meals of 230 g per month) had higher body burdens of mercury, PCB and DDE (a degradation product of DDT) than did individuals who ate little fish (one meal per month). The levels found in all the fishers, however, were below the Health Canada guidelines, with only one exception, which related to PCBs.

In short, the risk of contamination from eating fish is negligible, provided that people abide by consumption advisories. 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 polyunsaturated fatty acids and nutrients in fish meet essential requirements for the fetal nervous system.

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

[25] Parasites and external abnormalities may sometimes be prevalent in fish taken from the St. Lawrence. Most fish parasites are not dangerous for humans. As a precaution, however, the flesh should be thoroughly cooked and the skin and viscera should not be eaten. It is also recommended that people not eat fish that have external abnormalities (ulcerating dermatitis, dermal growths, oral papilloma, etc.).

With regard to waterfowl, contaminant levels have not been found which would warrant restricting consumption[26]. To avoid any risk of parasitic or microbiological contamination, the meat should be cooked thoroughly.

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

4.4.3.2 *Water consumption*

Some 57 000 people, or 87% of the population[27] in the study area, are served by a municipal water distribution system which draws its water supply primarily from local water bodies: Lake Saint-François, Beauharnois Canal, Soulanges Canal or the reduced-discharge section of the St. Lawrence. The water is chlorinated prior to being distributed; its quality is good and it meets government standards. No epidemics connected with drinking water consumption were reported between 1989 and 1995.

In some cases, water treatment includes chlorination. Public health researchers are interested in the by-products of chlorination, such as trihalomethanes (THMs), the main indicators of the chlorination process. THMs are believed to be carcinogenic for humans. Analyses have shown, however, that the THM levels are all below 50 µg/L and so fall within the present provincial and federal guidelines (350 µg/L and 100 µg/L, respectively).

4.4.3.3 *Recreational activities*

In the Valleyfield–Beauharnois area, Saint-Timothée beach is the only beach open to the public. It was monitored under the MEF's beach water quality program until 1995 and then again in 1997[28]. Although there are other places to swim (see Section 5.2.4), these sites may not necessarily have regular water quality monitoring or lifeguards to ensure swimmers' safety.

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[26] Although contaminant levels may be low, as an additional precaution people can use cooking methods that eliminate as much fat as possible.

[27] The rest of the population draws its water from private wells.

[28] Out of five samples collected from this location by the MEF between June 25 and July 29, 1997, three were rated A and two were rated B.

Analyses done in recent years at various sites show that the water quality is generally sufficient to permit activities involving direct water contact, such as swimming, windsurfing, water skiing and personal water craft use.

However, the bacteriological quality of the water depends on numerous factors and can change considerably over the space of a few days, or even a few hours. Recent analyses are the only way to have an accurate assessment of the risks. Caution is therefore advised in practising these water sports. Before deciding to engage in one of these activities, users should check whether the water quality is adequate by contacting local authorities (MEF, Public Health Branch, or municipalities). As well, users should not go swimming where prohibited to do so. Exposure to contaminated water can cause health problems, such as gastro-enteritis, and skin, eye and ear infections.

Furthermore, for their own safety, people should swim only at beaches where there are lifeguards on duty.

4.5 Other Pressures on the Sector, its Resources and Residents

Various other processes can affect the natural environment and local residents, but the extent of the impacts may not be easy to evaluate at the present time.

4.5.1 Introduced or expanding species

Today, we know that the introduction of new species into an ecosystem, a fairly widespread practice in the 19th century, can have drastic effects on the indigenous flora and fauna. Most people are familiar with the case of the House sparrow and the European starling, introduced species which are now completely integrated with the local fauna. With regard to fish species, the Brown trout, the Rainbow trout and the carp are exotic species that were not part of the original fish communities in the region.

For some more recent invaders, the process of colonization or expansion is still under way, and the associated repercussions have not yet been fully evaluated.

Purple loosestrife is a plant species that is currently expanding. This introduced species tends to colonize marshland and wet meadows, displacing native plants such as Reed canarygrass, Prairie cordgrass and Bluejoint.

Common reedgrass has spread in Quebec mainly since the 1970s. This plant, which propagates by means of rhizomes, has colonized the reworked riverside areas and drainage ditches, forming dense communities that prevent other species from becoming established. The land along the Beauharnois Canal, where excavation material and then dredged material from the canal was deposited, has been invaded by Common reedgrass over the years. Until the mid-1980s, thousands of blackbirds used to roost together in reedgrass stands, in spring and late summer. This species' dense growth, the associated risk of fire and the huge flocks of blackbirds led to complaints to Hydro-Québec from local farmers. A committee made up of representatives of the main stakeholders developed a solution to the reedgrass problem within the broader context of integrated management of the former basins. Since 1990, nearly 1100 ha of basin areas colonized by dense stands of reedgrass have been brought back under cultivation. This total area does not include the land managed by Ducks Unlimited Canada. At present, Common reedgrass is much less of a problem than it was some 15 years ago.

Two invertebrates, both of them molluscs, are currently invading the St. Lawrence River. The Zebra mussel has colonized the Great Lakes–St. Lawrence system from its starting point in Lake St. Clair, Ontario; it is believed to be displacing native bivalves, including members of the family Unionidae. A more recent invader, the Quagga mussel, is wreaking similar havoc, although it is much less abundant and less worrisome than the Zebra mussel. The profound impacts that these two invasive species have had on ecosystems have not yet been described fully. The most noticeable problem so far has been their tendency to clog water intakes.

In the part of the St. Lawrence extending from Lake Saint-François to Berthier-sur-Mer (Upper Estuary), the highest concentrations of veliger larvae (a juvenile stage that Zebra mussels go through before they attach themselves to a hard substrate) have been found in the vicinity of Ile au Chat, in the Valleyfield–Beauharnois area. The highest density of attached Zebra

mussels in the upper St. Lawrence was found in the Soulanges Canal (3712 individuals/m^2) in 1994.

4.5.2 Environmental accidents

In the study area, civil authorities have identified zones where there is a risk of natural disasters, such as flooding and landslides**.** The control over water levels exercised by Hydro-Québec's impoundment facilities has reduced the risk of flooding in this part of the St. Lawrence. No public health problems have been reported in recent years in connection with such events.

Accidents can also occur as a result of human activities. Evaluating the risks, both for public health and for the environment, is a difficult task, because the parameters involved vary with the type of incident. In the case of accidental spills, the risk factors vary according to the type of substance released.

The storage of hazardous products near the river and transportation of such materials by boat entail certain risks. Over the past 10 years, 15 accidents involving marine spills have been reported in the Quebec part of the St. Lawrence. Only one minor incident occurred in the Beauharnois Canal, however.

CHAPTER 5 Sector Resources and Assets

In spite of 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. The development of this sector in consideration of all the interests concerned should make it possible to capitalize on all its potential.

5.1 Practical Uses of Water

Proximity to a major waterway provides numerous benefits that can easily be forgotten in a country that is blessed with navigable rivers.

5.1.1 Electricity production

Production of hydro-electric power has been one of the driving forces of economic development in the Valleyfield–Beauharnois sector. The region has long been known for its electricity-generating capacity, as is evidenced by the vestiges of several small hydro-electric plants abandoned many years ago. The Beauharnois plant, which was built in 1929 and expanded in stages until 1961, is the backbone of the present-day facilities. The plant was recently upgraded. With a production capacity of 1673 MW, Beauharnois still ranks among the largest generating facilities in the world. The Cèdres plant, also located in the study area, dates back to 1910, and has a smaller capacity (158 MW); it plays a secondary role relative to the Beauharnois plant. This smaller plant was originally built to harness that portion of the river flow between Ile aux Vaches and the north shore.

Hydro-Québec, which is omnipresent in the region, plays a major economic role as a provider of direct and indirect jobs. As one of the largest landowners, it has many dealings with the municipalities in which its properties and equipment are located. In the past, Hydro-Québec has transferred the use of a large part of its land holdings to various agencies; for example, it permitted the establishment of an archaeological park at Buisson Point. Its land along the

Beauharnois Canal is sought after for projects of various types, including agriculture, conservation and recreation and tourism.

5.1.2 Shipping

Of all the transportation infrastructures in the study area, the St. Lawrence Seaway has had the strongest influence.

The Seaway, which opened in 1959, comprises locks near the Beauharnois power plant, and allows vessels to travel between the Great Lakes and Montreal via the Beauharnois Canal. Not only does this navigation channel generate considerable economic benefits for the entire Great Lakes–St. Lawrence Basin, but Salaberry-de-Valleyfield and Beauharnois have undergone considerable industrial expansion as a result of its creation.

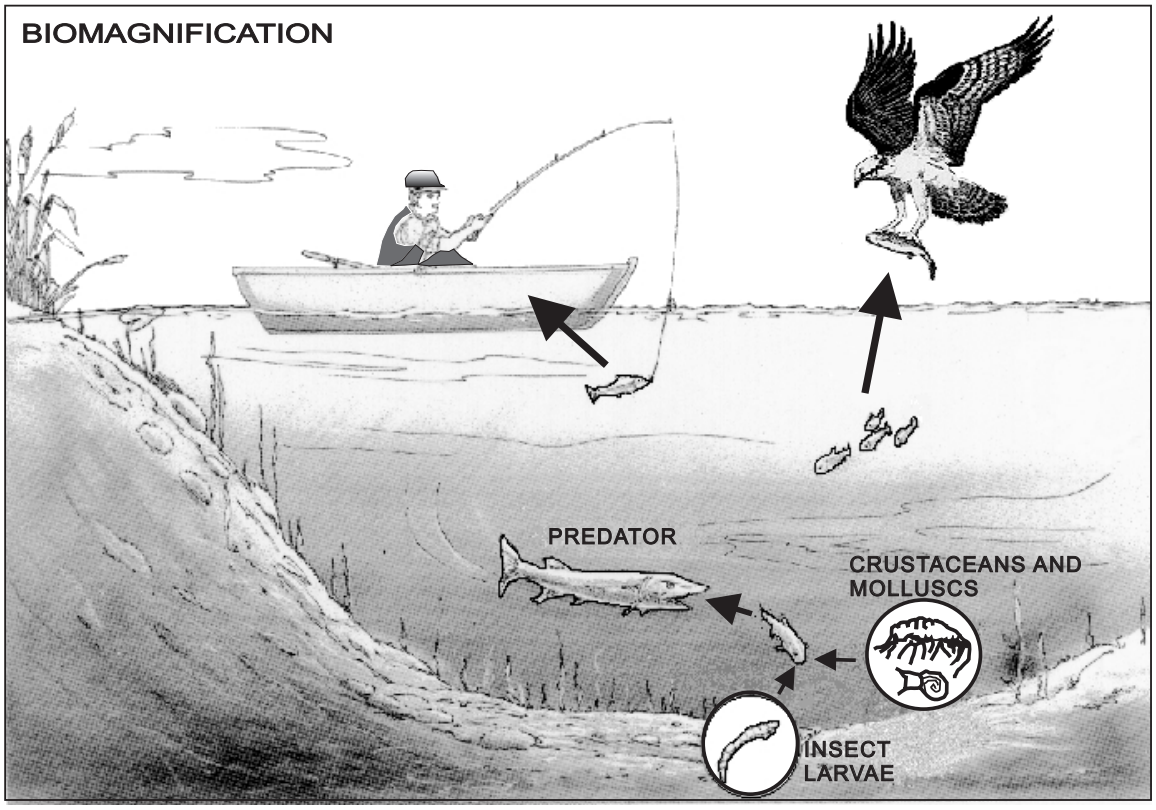
In 1995, the cargo transported by ships through the Seaway totalled an estimated 38 million tonnes (t), mainly bulk goods (50%) and grain (40%). Tolls and related revenues amounted to $45 million.

Although the port of Valleyfield is an asset for nearby industrial plants, its facilities remain largely unused. In 1995, only 23 ships called at this port and only 209 290 t of cargo was handled there.

5.1.3 Water supply

The availability of an abundant supply of good-quality water is another benefit for riverside communities and industrial plants in the region.

There are eight municipal water-distribution systems here, serving about 87% of the population; they draw their water from the water bodies in the sector (Figure 10). In 1996, municipal water intakes withdrew some 61 000 m^3 per day, on average, of which at least 27% was used by industry.



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 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 in the food chain to the next , toxic substances accumulate in increasingly larger concentrations.

Source: Jourdain, 1998.

Note: The towns of Melocheville, Saint-Stanislas-de-Kostka, Saint-Louis-de-Gonzague and Saint-Étienne-d e-Beauharnois draw their water from underground sources.

Figure 10 Water supply

In 1991, six industrial plants in the area each drew more than one million cubic metres of water per year for their operations; their annual withdrawals totalled about 97 cubic metres of water. The largest users of water for industrial purposes are Canadian Electrolytic Zinc Ltd. (59% of the total) and Expro Chemical Products Inc. (22%).

5.2 Recreation and Tourism

Located near Montreal, the United States and Ontario, the Valleyfield–Beauharnois region has a large potential pool of clients for its recreational and tourism activities.

5.2.1 Boating

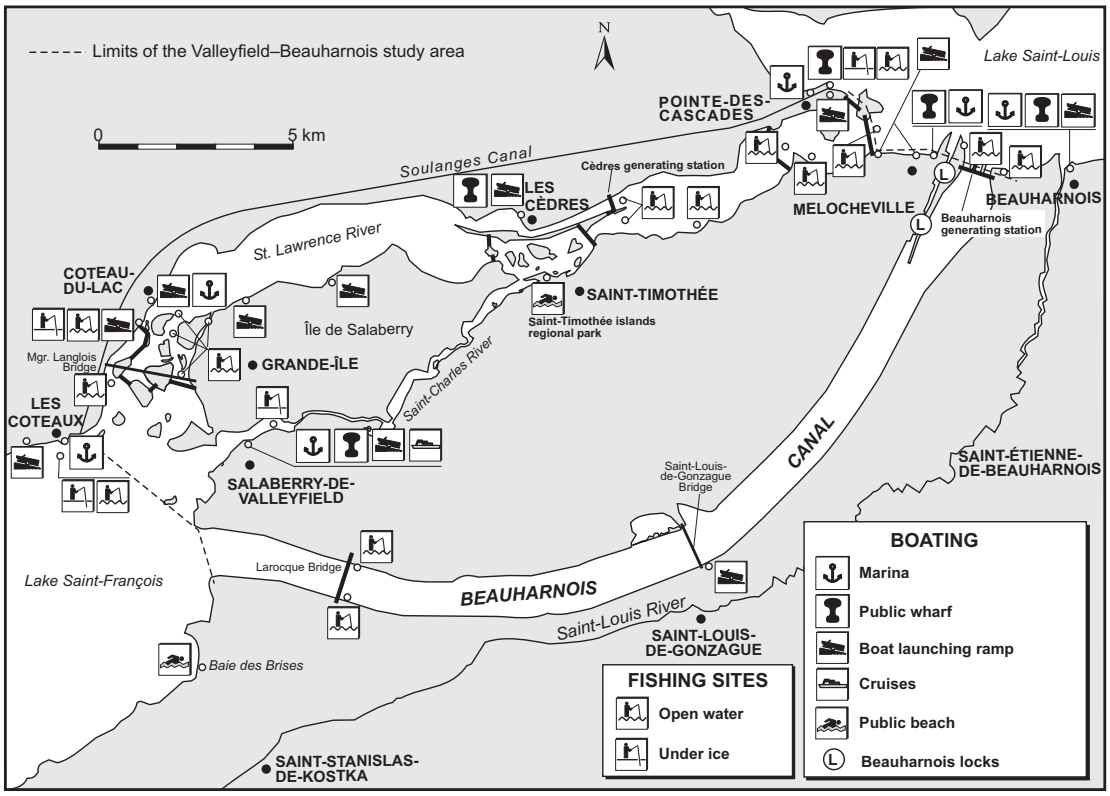
Recreation and tourism in the study area centre on Lake Saint-François, in the upstream portion, and Lake Saint-Louis, downstream. These two bodies of water contain more fish and offer a wider range of activities than the Beauharnois Canal and the basins in the reduced-discharge section of the river. There is a marina at Marcil Park, in Saint-François Bay, and another one on Lake Saint-Louis at Melocheville, near the outlet of the Beauharnois Canal.

Public access to the basins between Coteau-du-Lac and Pointe-des-Cascades is restricted. However, the boat launching ramps there (Figure 11) are heavily used. Riverside residents, who know these artificial water bodies well and are familiar with the constraints imposed by the variations in water level fluctuations and by winter draining, appear to be the main users. Roughly half of local residents have a boat. Cèdres basin, which covers a large area and has a stable water level, is used most. Various water sports are carried out there, including pleasure boating (small craft, dinghies), water skiing and windsurfing. Conditions in the Beauharnois Canal are not conducive to such activities.

In 1996, there were 160 incidents involving pleasure boats on Lake Saint-François and Lake Saint-Louis, including the study area. These incidents, 63% of them involving motorboats, required the assistance of the Canadian Coast Guard Marine Search and Rescue Centre. Mechanical failure and loss of control were the two main causes of these problems.

Serious accidents are usually caused by pleasure boaters' lack of training, alcohol consumption and failure to wear lifejackets. Prudence is essential when boating on the St. Lawrence in order to prevent accidents and to lessen the risk of drowning, injury, hypothermia or psychological distress.

Between 1988 and 1995, nine drownings occurred in the sector during recreational activities.



Source: ATRM and Tourisme Québec, 1995; Longtin, 1997; Fournier et al., 1987; Mongeau, 1979; MLCP, 1990.

Figure 11 Boating infrastructure and main access points for fishing

5.2.2 Hunting, fishing and trapping

The best sport fishing sites are situated at either end of the study area — that is, in the remaining white water zones (Figure 11). Many anglers fish in the rapids at Coteau and Cascades Island (Lake Saint-Louis). In winter, ice fishing takes place in Saint-François Bay, at Coteau-du-Lac, Grande-Île and Pointe-des-Cascades. An outfitter based at Coteau-du-Lac offers some services and rents equipment.

Sport fishing in the basins is carried out mainly by local residents, who are familiar with the area. The upstream part of Cèdres basin appears to be the most popular fishing spot, judging from the number of people who use it. These fishers look for zones of rapids, downstream from the flow regulation structures. Yellow perch and Smallmouth bass make up most catches, although Northern pike, Walleye, Largemouth bass, Muskellunge and introduced salmonid species are also caught.

Hunting takes place primarily around the Coteau islands, where flocks of waterfowl gather during the fall migration.

Wildlife are no longer harvested for commercial or subsistence purposes in the Valleyfield–Beauharnois region, although Muskrats are still trapped. This activity has slowed considerably in recent years as a result of the declining value of pelts. In 1996, some 20 trappers were still active in the study area.

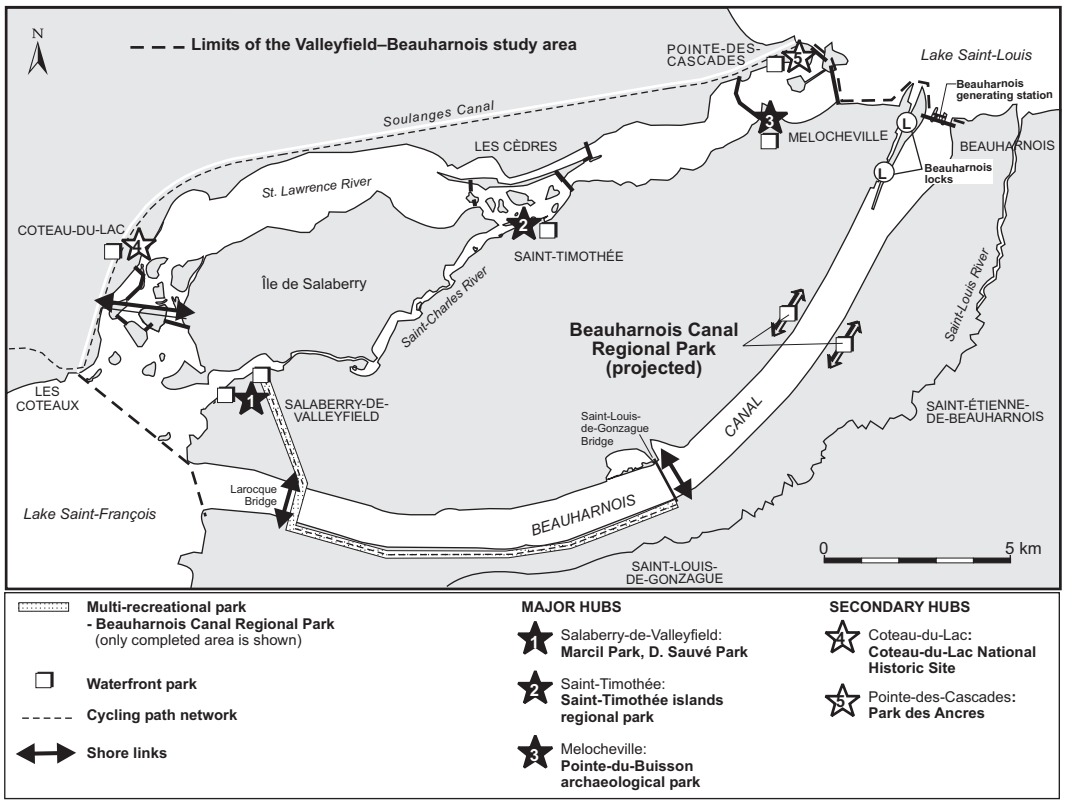
5.2.3 Bird watching

Naturalists, particularly bird watchers, can enjoy their favourite pastime at several shoreline sites. A large variety of birds can be observed in the Pointe-du-Buisson archaeological park or on the islands in Saint-Timothée basin. In addition, many trails along the riverbanks provide a suitable setting for this type of activity. Ducks Unlimited marshes on either side of the Beauharnois Canal are popular staging areas for migrating waterfowl and also provide excellent habitat for brood rearing.

5.2.4 Other tourist attractions

The region's recreational facilities (Figure 12) include a number of riverside parks, including the new Beauharnois Canal regional park, created through co-operation among local authorities, Hydro-Québec and the St. Lawrence Seaway Authority.

Only one beach is open to the public, in the Saint-Timothée islands regional park. This site is used by roughly 500 people on weekends. Other public beaches existed in the past. The one at Salaberry-de-Valleyfield gave way to a marina; another one, at Pointe-des-Cascades, was closed in 1977. People swim at various sites, including the Coteau-du-Lac Historic Site, in front of Ile Dondaine, at Grande-Île, upstream from the Ile Juillet dams, and on Ile Saveuse.



Source: Jourdain, 1998.

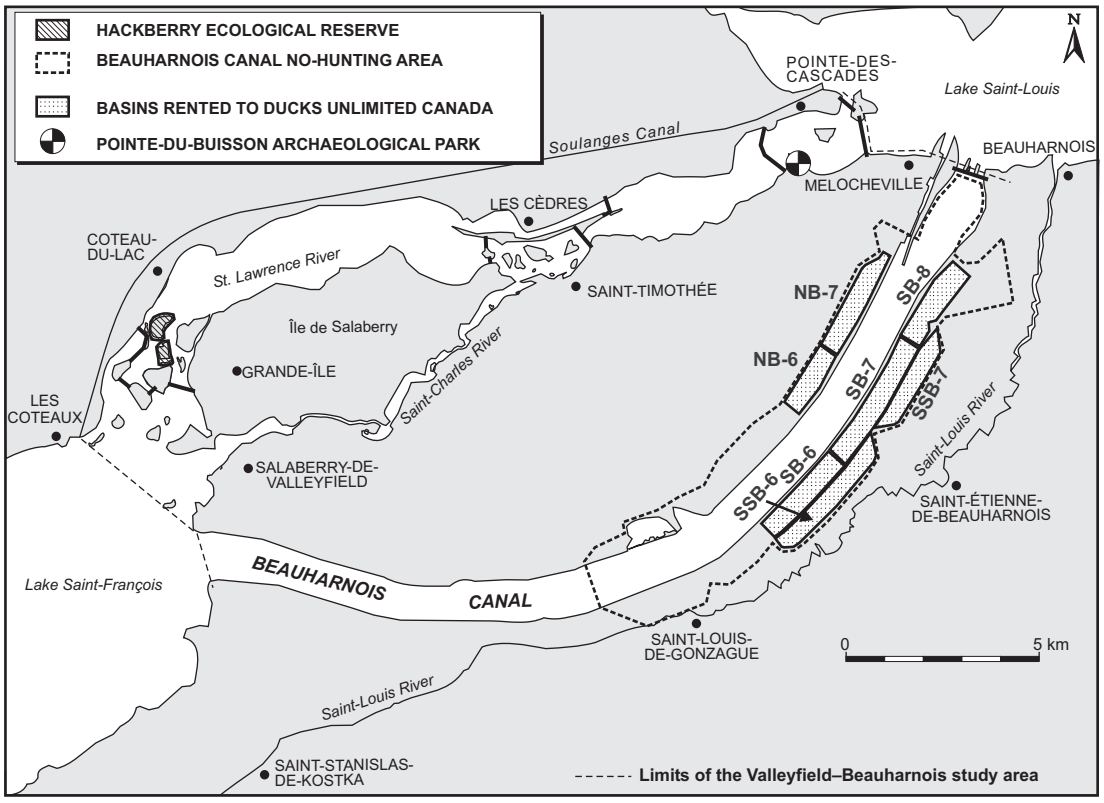
Figure 12 Recreational hubs and corridors

The peak period for tourism coincides with the Valleyfield regattas, in July. There are many other attractions in the region, including several historic sites, some of which are protected. This is the case for the Coteau-du-Lac National Historic Site, the Cèdres generating station, the historic plant on Soulanges Canal at Les Cèdres, and the archaeological park at Pointe-du-Buisson. Other sites, while of recognized heritage significance, have not been granted special status. Visitors can learn the basics of hydro-electricity and environmental conservation in the interpretation centre at the Beauharnois power plant.

Steps have been taken to establish other recreational facilities, such as a regional park along the Soulanges Canal. Local authorities are also considering other projects, such as expanding the Saint-Timothée park and creating a regional park on the Coteau islands.

5.3 Biodiversity, Conservation and Enhancement

Certain elements of the flora and fauna in the study area are of indisputable significance in terms of biodiversity, and thus deserve protection. At present, a few portions of the study area have a status that ensures the conservation of their natural components, to varying degrees (Figure 13).



Source: MEF, 1995; CWS, 1990.

Figure 13 Protected areas

The Réserve Écologique du Micocoulier (Hackberry ecological reserve), on Bienville and Arthur islands in the Coteau archipelago, was established in 1983 by the Quebec Environment Ministry. Covering an area of 29 ha, the site is designed to preserve a pure stand of

Hackberry, a species which may be at risk in Quebec and which is expected to be granted special status soon to facilitate its conservation. Access to the reserve is permitted only for well-defined and supervised research and educational activities.

The Parc Archéologique de la Pointe-du-Buisson is protected under the *Cultural Property Act*. Aside from its interpretation centre, which focuses on Native Indian settlement of the point, this site is of ecological interest. The vegetation, along with the bird life, is richly diverse.

To foster waterfowl breeding along Beauharnois Canal, Ducks Unlimited has leased several basins from Hydro-Québec and built dikes around them. The resulting ponds offer suitable conditions for brood rearing, particularly because of the type of vegetation that colonizes them. Four such basins have been modified on the south shore of the canal and two on the north shore, permitting the creation of 350 ha of wetlands and 72 ha of cropland that can be used by waterfowl. The agreement signed with Hydro-Québec was recently extended to the year 2035.

The Canadian Wildlife Service has designated the eastern part of the Beauharnois Canal, between Saint-Louis-de-Gonzague Bridge and the generating plant, along with the adjacent basins, as a no-hunting area. Although it covers a total area of 4200 ha, this recognition provides only limited protection for waterfowl, in the form of a staging area where they cannot be shot by hunters.

In recent years, the goal of preserving natural habitats appears to have garnered support from local residents. Certain environmental groups have been formed to plan action and raise awareness of environmental protection issues.

The plant and animal species given priority under the SLV 2000 action plan are listed in Appendix 1.

CHAPTER 6 Options for Sustainable Development

To ensure the sustainable development of the St. Lawrence, we must direct our efforts at promoting economic development while guaranteeing resource sustainability and environmental quality.

6.1 Main Challenges

Sustainable development of the Valleyfield–Beauharnois region involves protecting the existing natural components and promoting a variety of water-related uses, thus enhancing the quality of life of riverside residents.

6.1.1 Reconciling flow management with resource use and protection

Today, the sector has only a small portion of the wetlands and aquatic and riparian habitats that existed before the flow regime of the St. Lawrence was profoundly modified. The shoreline environment is now largely degraded (artificial). Most of the river's discharge is now diverted to the Beauharnois Canal for the production of hydro-electric power. Although, in absolute terms, the canal increased the total surface area of the aquatic environment, the prevailing conditions diminish the value of the habitat. The reduction of discharge in the original channel of the St. Lawrence eliminated zones of rapids which were probably important for several fish populations living in the vicinity. Furthermore, the impoundment facilities that were built appear to impede the migration of certain fish species or to hinder spawning.

At the time when these major engineering works were constructed, they were designed solely with a view to energy production and marine transportation. Natural resource conservation was not a concern back then.

The initial mitigation measures that were implemented involved the construction, in the 1960s, of basins to enhance the appearance of the landscape and permit certain water sports. While these artificial bodies of water have certainly enhanced the quality of life of riverside

residents, they offer a much smaller range of recreational activities than do lakes Saint-François and Saint-Louis. Furthermore, they provide only limited benefits for the plant and animal life.

Addressing the concerns and demands of riverside residents and considerations related to protecting fish populations during the management process for the artificial basins represents a step in the right direction. However, there is still room for improvement in the protection afforded natural resources. For example, the many obstacles to the passage of fish in the sector and the associated impacts on migration continue to be a cause for concern.

6.1.2 Reduction in contamination

With regard to contamination, the Valleyfield–Beauharnois region is the first point in the Quebec portion of the St. Lawrence River to receive major inputs of toxic substances from urban and industrial discharges. The quality of the water, which has already been altered in the Great Lakes and while passing through the area of Cornwall and Massena, appears to be further degraded in the study area. For decades, municipal and industrial effluents were discharged into the river untreated, primarily from Salaberry-de-Valleyfield and local industrial plants. The main substances of concern are metals, especially mercury, which have contaminated the sediments in Saint-François Bay and the Saint-Charles River. Some chemical substances (metals and PCBs) have been found in high concentrations in aquatic organisms. However, contaminant loadings to the aquatic environment, which were much worse in the past, have declined as a result of industrial and municipal waste treatment programs and industrial plant closures. Lastly, there is little bacterial contamination from domestic sewage, and the water is generally clean enough for swimming and recreational activities involving water contact.

The continuation of the industrial and municipal wastewater treatment programs already in place is the best way to achieve further progress consistent with the improvements made thus far.

6.1.3 Recreational and tourism development and habitat enhancement

Despite all the changes that have occurred in this section of the St. Lawrence, there are still several nearly intact terrestrial and riparian habitats, particularly in the Coteau archipelago and at Buisson Point. The region also offers numerous tourist, cultural and recreational attractions. In recent years, shoreline areas have been reclaimed and developed for recreational and tourism purposes.

Action taken by local authorities to develop and improve the recreational and tourism product — for example, the regional park established near the Beauharnois Canal — attests to their desire to make recreation and tourism a development thrust for the region. Enhancing components of the natural environment may help to diversify the themes exploited in existing parks and broaden their appeal to visitors.

6.2 Toward Sustainable Development of Local Water Bodies

To bring the planning of the uses of local water bodies into line with the goals of sustainable development, several aspects of the problems mentioned so far must be kept in mind. In addition to the limitations placed on natural resources by some uses — inevitably giving rise to conflicts among users — the permanency of certain changes must be considered. For example, the water flow and level control structures represent an irreversible constraint from a planning point of view. However, greater emphasis can be placed on protecting those natural habitats that subsist, on revegetating specific sites, on enhancing wildlife habitats, and on improving access to riverside areas for local residents.

There is some indication that environmental contamination from industrial and municipal discharges is decreasing. Abatement efforts must nonetheless be maintained, in view of the tenuous nature of the gains achieved so far and the need to consolidate them.

To ensure that habitats are not degraded further as a result of short-sighted decisions made in response to the concerns of small interest groups, an integrated land use plan for the region should be drawn up as soon as possible.

These issues need to be assessed and discussed, in full knowledge of the facts, by all groups who are concerned about the health of the St. Lawrence and with the local quality of life, so that the strategies which are eventually developed suit the entire community. Table 4 provides useful background information for discussing the potential development options for the water bodies in the sector. Community stakeholders can add to and improve it.

Following these discussions, it should be possible to plan uses in keeping with the goal of limiting damage to the natural environment and restoring some 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 the partners will willingly comply.

Table 4
Sustainable development issues in Valleyfield–Beauharnois

Issues to be addressed in the sector	*Main effects on the water body and its resources*	*Assessment of present state relative to sustainable development goals*	*Strategies for sustainable development*
Management of water flows and levels and creation of impoundment structures. The facilities have been designed with a view to hydro-electricity production and shipping.	Diversion of the fluvial discharge toward the Beauharnois plant and construction of a canal that does not favour biological communities. Reduction of discharge in the original river channel. Loss of zones of rapids and creation of artificial basins with few wildlife habitats. Impediments to the movement of fish. Reduced access to the river and landscape degradation.	**Biodiversity:** Many biological communities (terrestrial, riparian and aquatic) have been impacted by the successive alterations in river flow. The scope of these losses has never been evaluated. **Uses:** Certain wildlife uses have been altered, both in the study area and all along the St. Lawrence (e.g. commercial fishing for Lake sturgeon and American eels). The wildlife resources of the artificial basins are less abundant than elsewhere in the St. Lawrence, and hunting and fishing activities are more limited as well. Fishing for stocked salmonids, which is done upstream and downstream from the original river channel, is a popular sport. **Quality of life:** Riverside residents have adjusted their use patterns and lifestyle to the artificial basins. New methods of flow management in the basins have improved the landscape and a limited range of recreational activities can now be carried out. The mitigation measures implemented in response to residents' demands have resolved some conflicts, but not all.	**Biodiversity:** While a complete return to natural conditions is impossible, certain measures may help to enhance diversity: shoreline restoration, habitat creation, fishways, and changes in the way flow regulation structures are managed to facilitate the passage of fish. Integrated development supports the coexistence and harmonization of certain uses (e.g. agricultural activities and enhancements for waterfowl). Measures adopted in the basins along the Beauharnois Canal are helping to promote brood rearing. Nesting conditions should also be enhanced on nearby land. **Uses and quality of life:** Mechanisms introduced to reconcile the interests of the different users have been successful. It appears, however, that additional improvements can still be made with respect to wildlife habitat, recreational facilities and riverbank access.

Table 4 (cont'nd)

Issues to be addressed in the sector	*Main effects on the water body and its ressources*	*Assessment of present state relative to sustainable development goals*	*Strategies for sustainable development*
Contamination (industrial and municipal effluents; agricultural pollution). For decades, industrial and municipal effluents were discharged into the river untreated. Tributaries drain urban and agricultural land areas.	Contamination by untreated effluents has many adverse effects on the aquatic environment. Sediments in Saint-François Bay and the Saint-Charles River were heavily contaminated in the 1970s by inputs from the St. Lawrence and by local municipal and industrial discharges. Some chemicals reached high levels in aquatic organisms. Industrial wastewater treatment programs and plant closures have improved the situation, but vigilance is still necessary. The connection of muncipal sewer systems to wastewater treatment plants is nearing completion. However, during periods of heavy rainfall, untreated wastewater ends up being discharged into the river, primarily from overflow points in the Salaberry-de-Valleyfield collector system.	**Biodiversity:** Pollution has caused a reduction in the populations of several species and modified the structure of living communities. Species that can tolerate this environmental degradation become predominant. **Uses:** Environmental contamination leads to restrictions on uses (fish consumption, health risks associated with swimming and other water sports) and affects the aesthetic appearance of the water body. **Quality of life:** Pollution results in a loss of enjoyment of the water body for riverside residents. Pollution has repercussions on recreational and tourism potential, since it leads to restrictions on recreational activities involving water contact.	**Biodiversity:** The effects of pollution can be reversed over a variable time period depending on the substances discharged and the amount of time they spend in the environment and in aquatic organisms. No zones of long-term accumulation of contaminated sediment have so far been identified. **Uses:** The most effective way to reduce the losses of use resulting from pollution is to control discharges at source by all users (industrial, domestic and commercial). Effective treatment processes for municipal effluents are essential in order to clean up the environment and reclaim it for all recreational uses. Improving agricultural practices contributes to soil conservation and reduces contaminant loadings to watercourses. **Quality of life:** Pollution control can allow communities to once again benefit from living near a body of water.

Table 4 (cont'nd)

Issues to be addressed in the sector	*Main effects on the water body and its resources*	*Assessment of present state relative to sustainable development goals*	*Strategies for sustainable development*
Recreation and tourism and enhancement of the natural environment	Local authorities are looking to recreational and tourism activities to help bolster the region's economic development. The construction of infrastructures on a body of water can wipe out aquatic and riparian habitats. Some recreational activities, if not controlled, can damage sensitive components of the natural environment. Many species of fish and birds may be affected by disturbances during the breeding season.	**Biodiversity:** In general, the animal populations that have persisted in the sector are accustomed to the presence of humans. Several species can support a moderate level of harvesting by fishers or hunters. Intensive use of water bodies can have repercussions on living communities. **Uses:** The presence of a large number of boats and the associated noise may disturb other users and riverside dwellers. Pleasure boating is governed by safety rules, as are hunting and fishing activities. **Quality of life:** The possibility of practising these water-related activities contributes to the well-being of riverside residents and attracts tourists. Recreational and tourism activities can generate considerable economic spinoffs.	**Biodiversity:** By protecting wildlife habitats, we will help to maintain animal and plant populations and the recreational activities linked to them. In those situations where recreational and tourism activities may have an impact on the natural environment, guidelines should be set and users made aware of conservation issues. **Uses**: Pleasure boating, hunting and fishing must be controlled to prevent conflicts with other uses of the environment (disturbances to wildlife, public access to the water body, safety). Certain nature watching and interpretation activities that are gaining popularity need to be considered in the planning process. **Quality of life:** Boating, nature watching and other outdoor activities can help to promote tourist attractions. Care must be taken in selecting and locating the facilities needed for these activities to prevent degradation of the natural environment and loss of enjoyment thereof.

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Appendices

1 St. Lawrence Vision 2000 (SLV 2000) Priority Species Present in Valleyfield–Beauharnois

Common or scientific name	*Type of distribution or local status*
Plants (6 of the 110 priority species)	
Coast cockspur	Peripheral North
Cockspur hawthorn	Peripheral North
False mermaidweed	Sporadic
Lizard's tail	Peripheral North
Mayapple	Peripheral North
Yellow giant hyssop	Peripheral North
Fish (5 of the 14 priority species)	
American eel	Migrant
American shad	Migrant
Copper redhorse	Resident, earlier presence confirmed
Lake sturgeon	Resident, migrates during spawning period
River redhorse	Resident
Amphibians and reptiles (2 of the 6 priority species)	
Western chorus frog	Observed - population status unknown
Wood turtle	Observed - population status unknown
Birds (9 of the 19 priority species)	
Bald eagle	Migrant
Barrow's goldeneye	Migrant
Blue-winged teal	Confirmed nester
Caspian tern	Migrant
Common moorhen	Confirmed nester
Horned grebe	Migrant
Least bittern	Possible nester
Northern pintail	Confirmed nester
Peregrine falcon	Nests outside the sector

2 Environmental Quality Criteria
(for assessing loss of use)

Ecosystem component	*Reference criterion*	*Objective*
WATER	Raw water (untreated water taken directly from a body of water) (MENVIQ, 1990)	Protect the health of persons who may both drink water directly from a body of water and eat aquatic organisms caught there throughout their lives.
	Contamination of aquatic organisms (MENVIQ, 1990)	Protect human health from the risks associated with consumption of aquatic organisms.
	Aquatic life (chronic toxicity) (MENVIQ, 1990)	Protect aquatic organisms and their offspring and wildlife that feed on such organisms.
	Recreational activities (direct contact) (MENVIQ, 1990)	Protect human health in the context of recreational activities involving total body contact with the water, e.g. swimming and windsurfing.
SEDIMENT	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 marketing guidelines (Health and Welfare Canada, 1985)	Maximum acceptable contaminant levels in the flesh of fish, molluscs and crustaceans sold for consumption.
	Freshwater sport fish consumption guidelines (MSSS and MENVIQ, 1993)	Prevent harmful effects on human health from eating contaminated fish, molluscs and crustaceans.

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3 Glossary

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

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

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.

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 watersheds, as litres per second (L/s).

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 to continue doing so indefinitely by virtue of matter and energy inputs.

Ecosystem productivity: Quantity of biomass produced annually maintaining the equilibrium of animal and plant populations.

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.

Haulout: Stretch of shoreline where seals come out of the water to rest.

Hydrophobic: Refers to toxic substances that show little tendency to dissolve in water.

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.

Peripheral distribution: Situation of a species that lives on the periphery of its geographic range.

Primary production: Quantity of organic matter synthesized by autotrophic organisms in a given period.

Secondary production: Quantity of organic matter generated by heterotrophic organisms in a given period.

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

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.

Spawning ground: Place where fish gather to breed.

Sporadic distribution: Situation of a species with a scattered distribution.

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

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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