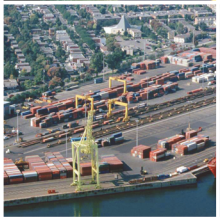
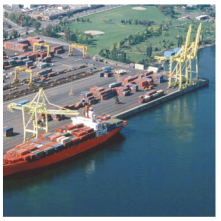
Saint-Laurent Vision 2000

Sustainable Navigation Strategy

FOR THE ST. LAWRENCE





Canada

Québec

Sustainable Navigation Strategy for the St. Lawrence

BY

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NAVIGATION CONSENSUS BUILDING COMMITTEE

Canada

Québec

CREDITS

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Message from the SLV 2000 Co-Chairs

We are pleased and proud to present the Sustainable Navigation Strategy for the St. Lawrence, the result of fruitful cooperation between the commercial and recreational boating industry, the Governments of Canada and Quebec, the environmental players and the riverside communities.

This reference work represents an impressive achievement of Phase 3 of the St. Lawrence Vision 2000 (SLV 2000) Action Plan which, we should recall, focused on consensus building, partnership and the achievement of concrete results.

The twenty-four members of the Navigation Consensus Building Committee had to take on a major challenge – to elaborate a strategic vision accompanied by an action plan for the next five years. Among other things, this strategy was intended to serve as a response to the concerns and expectations expressed by citizens, users and experts, particularly concerning integrated management of dredging and sediments, contaminated site management, shoreline erosion, ballast water discharges and finally the environmental risks in case of spills.

In a climate of mutual understanding, sharing and confidence, they therefore produced the Sustainable Navigation Strategy for the St. Lawrence, with the objective of harmonization between the protection of the St. Lawrence ecosystems and water resources with user needs and the development of the shipping industry.

While considering the different interests of the groups concerned, the Committee members, through their realistic analysis of the situation and the choice of appropriate measures, were able to reconcile the socioeconomic development of the St. Lawrence with the health of its ecosystems.

We are convinced that the Sustainable Navigation Strategy for the St. Lawrence will meet the expectations of the groups concerned, because it depends on their participation in the implementation of measures that will meet their needs, without compromising those of future generations with respect to other uses. As the Co-Chairs of the Navigation Consensus Building Committee have mentioned, the Strategy is primarily based on the mobilization of the main stakeholders and their commitment to bring their respective actions into line.

We wish to thank all the partners for their commitment to the management of all navigation activities and encourage them to continue the work already well under way to ensure the sustainability of the St. Lawrence's resources.

Mimi Breton
Chair for Canada
St. Lawrence Vision 2000

Pierre Baril
Chair for Québec
St. Lawrence Vision 2000

Foreword

An initiative associated with the St. Lawrence Action Plan Phase III, the Sustainable Navigation Strategy is intended as a contribution to the development of navigation, in its multiple aspects, in compliance with the environmental conditions of the St. Lawrence. Based on the sustainable development principles, the strategy has been drawn up by the Navigation Consensus Building Committee (NCBC) of the St. Lawrence Action Plan. It represents a first systematic attempt to orient the management of all navigation activities, taking into account their economic, environmental and social impacts.

The strategy is intended to complete the existing policies (transportation, environment, water, etc.) and the private initiatives that are often formulated for more specific purposes. In this perspective, the Committee solicited the participation, in public consultations, of various navigation stakeholders representing four sectors of activity: the shipping industry, recreational boating, the federal and provincial governments, the riverside communities and environmental groups.

This document is the product of these consultations and the consensus building efforts of all members who served on the Committee since its founding. All the members participated in formulating the strategy through their individual criticisms and review. This experience in consensus building is the result of a long process. However, through dialogue and harmonization of the different interests, consensus building contributes to the achievement of sustainable development by exerting a constructive influence on the decision-makers and the community.

We are very pleased to table the Sustainable Navigation Strategy and believe that it will contribute to improving the condition of the St. Lawrence and to the quality of life of its riverside communities.

We wish to thank all the members of the Navigation Consensus Building Committee and the other colleagues who contributed directly or indirectly to formulating the Strategy and count on their participation for its implementation.

Marc Demonceaux
Co-Chair for Canada
Navigation Consensus Building Committee
Fisheries and Oceans Canada - Coast Guard

Claire Poulin
Co-Chair for Québec
Navigation Consensus Building Committee
Ministère des Transports du Québec

Introduction

Growing environmental and social concerns oblige the stakeholders in the navigation field to consider the setting in which they operate. The fragility of the St. Lawrence ecosystems and their specific biological characteristics (presence of all the links in the food chain) are recognized, and it is admitted that commercial and recreational navigation activities must take place while taking their protection into consideration. This environmental protection of the St. Lawrence is the backdrop and cornerstone of the strategy, and thus it is consistently in line with the efforts made to improve the condition of the St. Lawrence.

The Sustainable Navigation Strategy is intended as a reference document concerning the environmental, social and economic aspects related to navigation. Its aim is to manage the impacts of navigation activities (commercial and pleasure) and to meet the needs of the current users and future generations. It seeks to harmonize protection of the ecosystems with the development of navigation activities and the needs of the St. Lawrence's other users. It will also increase the riverside communities' awareness of the constraints inherent in this activity and the efforts that everyone will have to make to ensure the river's harmonious development.

The strategy is a specific contribution to a group of initiatives currently in progress or on the verge of completion concerning the St. Lawrence, with the common objective of reducing manmade impacts on the environment within a perspective of integrated management of activities. It will therefore keep pace with emerging concerns and in this sense is an example of adaptive management.

This integral version is divided into two parts. Part I summarizes navigation activities on the St. Lawrence and contributes to an understanding of the importance of this sector of activity both historically (colonization of New France) and in terms of the environment, social concerns and the legal framework. This part ends with a presentation of the economic aspects of commercial and recreational navigation, more specifically their contribution to the current Quebec economy. This background fosters an understanding of the navigation field and opens the reader's perspectives for Part II, the core of the Sustainable Navigation Strategy.

Part II is composed, on the one hand, of a vision statement that spells out the concept of sustainable navigation and, on the other hand, a strategic action plan with implementation spread over the next five years. The vision statement consists of a definition of sustainable navigation based on the notion of sustainable development, as well as guiding principles and principles of application that provide a framework for the various actions (impacts) of commercial and recreational navigation. These principles have been formulated, bearing in mind the application of a balanced approach, i.e. targeting activities that have environmental impacts and finding the means to remedy or mitigate them, and promoting the use of marine transportation when this represents an activity with less impact than other modes of transportation.This approach offers the benefit of presenting environmental protection to the shipping companies not as a one-way restrictive requirement, but as a collective choice, where the benefits can be maintained when the practices adopted remain respectful of the environment and the stakeholders.

The action plan presents the issues recognized as priorities and seeks to reduce the impacts on the St. Lawrence ecosystems. This initial action plan will be improved as new issues emerge. It is thus a dynamic action plan that tends to consider evolving social and economic concerns.

The strategy is based on the involvement of numerous stakeholders in the navigation field and can serve as a link between the different existing policies and programs. Consensus building and commitment, coordination and harmonization of actions are the key themes of the strategy's implementation.

Part I

Brief Survey of Navigation Activities on the St. Lawrence

Brief Survey of Navigation Activities on the St. Lawrence

Some Characteristics of Navigation on the St. Lawrence

HISTORICAL SUMMARY OF NAVIGATION AND DEVELOPMENT OF THE ST. LAWRENCE WATERWAYS

In the early days of the colony, ships crossing the ocean ended their voyage at Quebec City. The shallows at some places upstream increased the risks of stranding. A river flotilla (wood canoes, barques, barges, rowboats) then took over the journey to Montreal (Lasserre, 1980). Transportation to the Great Lakes was initially accomplished by wood canoes. At the beginning of the 19th century, the St. Lawrence was the object of several successive navigation works, allowing ships of increasingly greater dimensions to travel its entire distance, carrying goods of increasing variety, for customers ever more dispersed around the world (Lasserre, 1980). These river development works facilitated navigation to the Great Lakes and highlighted the short distance between Lake Ontario and the Gulf of St. Lawrence (1600 km).

The needs of constantly growing commerce, competition with other transportation routes (construction of the Erie Canal by the Americans) and the necessity of linking the river corridor economically with the Great Lakes then served as fundamental arguments to alter the river's size (Figure 1). Before 1850, North America's waterways had a monopoly of long-distance transportation. However, beginning in the mid-19th century, the competition offered by new means of transportation, especially the railway, added to geographic competition, especially from the Hudson River, for bringing goods out of the interior (Lasserre, 1980).

Before proceeding with development of the river, efforts were directed to construction of an inland fleet adapted to the sectorial physical features of the St. Lawrence. However, this inland fleet required proliferation of the number of transshipments between the different sectors, consequently increasing transportation costs. The advent of increasingly powerful steamboats, capable of ascending the rapids against the current, ensured continuous navigation over a large portion of the river upstream from Montreal. Only three short sections (Montreal-Lachine, Pointe-des-Cascades–Coteau Landing, Cornwall-Dickinson's Landing) interrupted this continuity. This interruption made canal building imperative, because a very great proportion of the profits derived from the products was absorbed by their transportation cost to a port of export.

The development of spacious canals allowed construction of an inland fleet that could navigate the entire length of the St. Lawrence, rendering flotillas of small vessels and Durham barges obsolete. However, this development deprived Montreal of most of its transshipment activities to the benefit of the Port of Quebec. The only way for Montreal to survive was to take away Quebec's City function as the ocean navigation terminus (Lasserre, 1980). By different administrative strategies, Montreal managed to break Quebec's City monopoly and exclusive competency. Montreal port interests were thereby promoted better and it was possible to work on improving security on the St. Lawrence, particularly by the proliferation of buoys and lighthouses (Lasserre, 1980).

This is the context in which Montreal embarked on major campaigns to deepen the navigation channel, particularly in the Lake St. Pierre region (maximum depth 3 m at low water). However, the specialists did not agree on the type of work to be performed: dredge the meandering natural channel or develop a straight canal offering easier navigation

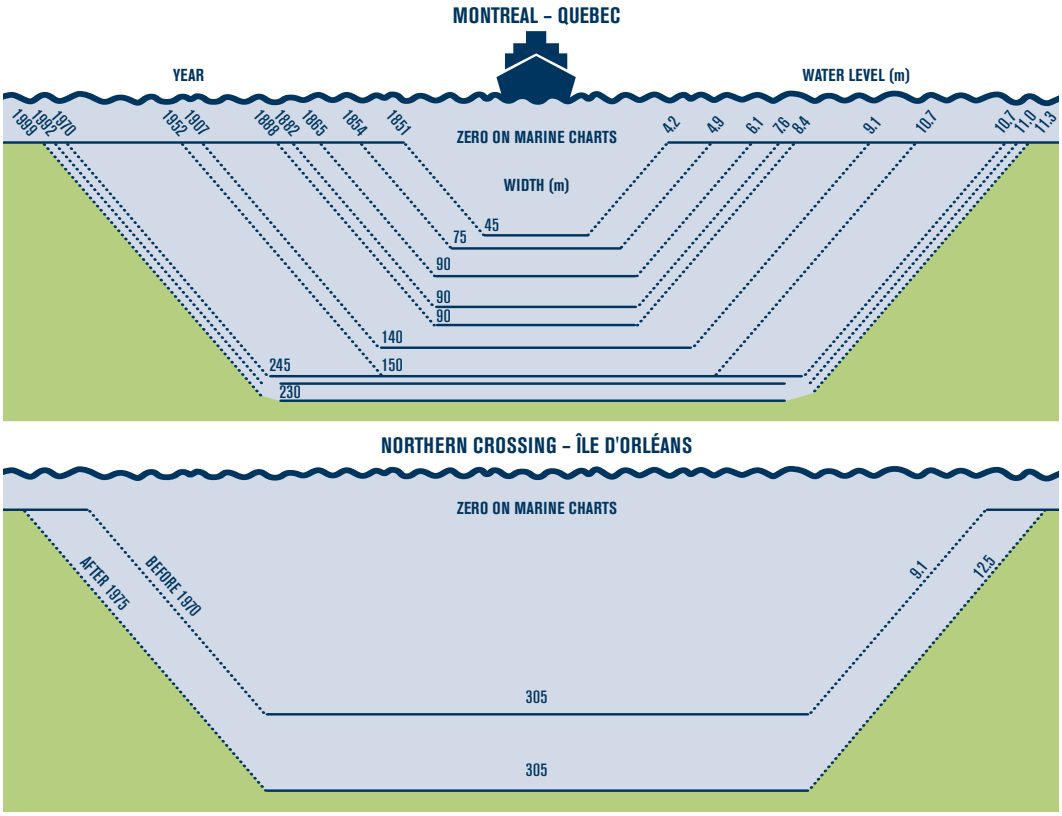
(Lasserre, 1980). A controversial atmosphere prevailed as the Government retained the second option and, in 1844, undertook the digging of a trench 45 m wide and 4.20 m deep. The cost and length of the work led to its suspension in 1847. It resumed under an 1850 law and the Commissioners of the Port of Montreal obtained responsibility for it. They had to cover the cost by imposing a tonnage fee not exceeding twenty cents per ton, levied on all ships with a draft greater than 3 m (Lasserre, 1980).The chosen option was to deepen and widen the natural channel, and spectacular results were quickly achieved. On November 3, 1851, a ship with 4.20 m of draft, the City of Manchester, arrived in Montreal. Navigation between Quebec City and Montreal remained no less difficult due to the meandering channel, the reefs and shallows, and the insufficiency of buoys and lighthouses. However, around the middle of the 19th century, Montreal merchants could count on a waterway that was completely transformed upstream and with works well under way downstream (Lasserre, 1980).

Despite a shorter transit time and lower costs of use than the Erie Canal, the St. Lawrence, after all the development work, did not surpass its rival and achieve the expected economic outlook. This reversal was attributable, in part, to the cost of transatlantic transportation, which was costlier from Quebec City than from New York. To this was added the constraint of ice for one third of the year, which made navigation impracticable during that period.

To withstand American competition better, a Royal Commission of Inquiry on canals was mandated to study the possibility of undertaking new works. It tabled a report in 1871, in which major works were proposed: enlarge the Upper St. Lawrence canals and build a new canal on the Canadian side at Sault Ste. Marie, applying the following rated standards everywhere: 3.60 m deep, and locks 81 m long and 13.5 m wide. Also, it recommended that downstream from Montreal, the navigation channel be dredged to a depth of 6.60 m. These works were spread over more than 30 years. The Commissioners of the Port of Montreal quickly found, in 1884, that the growth of ocean traffic, combined with ever bigger ships, required additional deepening. They therefore began a campaign to dredge the channel to 7.20 m (Lasserre, 1980).

The channel development work continued, reaching a depth of 8.25 m and a width of 135 m in 1888. After spending $4 million in 37 years on these dredging projects, the Port of Montreal Commission was relieved of this responsibility by the federal government, and the tolls collected based on tonnage were abolished. But the work continued and, by 1907, the channel was 9 feet deep. During the same period, channel marking works, lighthouses, buoys and signals proliferated to make the navigation channel safer. Parallel to these efforts, and before the end of the 19th century, many small towns and villages along the St. Lawrence obtained jetties, piers or landings built by the Department of Public Works (Lasserre, 1980). It was in this period that Quebec City, and especially Montreal, acquired the essential elements of their port configuration.

Figure 1 | *Changes in the Size of the Navigation Channel in Certain Sectors Between Montreal and Île d'Orléans, 1851-1999*



Source: DFO - GC, 2000

Traffic never ceased to intensify on the St. Lawrence during the period from 1850 to 1950, and the Port of Montreal gradually took over the leading position from the Port of Quebec.

This increase in traffic was identical upstream from Montreal. The intense economic development of central North America and the arrival of bigger ships with deeper draft on the Great Lakes again put the St. Lawrence under pressure for development projects. After several economic and political controversies, the Governments of the United States and Canada agreed to begin development of the Seaway. The work consisted of erecting hydroelectric facilities and altering the size of the channel to ensure a minimum depth of 8.20 m. Construction began in August 1954 and ended five years later, in spring 1959.

In the waterway downstream from Montreal, enlargement work has been carried on since the beginning of the 20th century. Thus, in 1952, a minimum depth of 10.6 m was ensured and the width reached 168 m. In 1970, this width was increased to 244 m. In 1971, the draft of the Northern ferry channel (eastern edge of Île d'Orléans) was increased from 9.1 m to 12.5 m and its width reached 305 m. This project, completed in 1974, allows ships with a 15 m draft to travel as far as Quebec City by taking advantage of the tides.

The latest capital projects were completed in the late 1990s in the sector between Montreal and Cap à la Roche. The shallows were selectively dredged at some locations to increase the depth from 11 to 11.3 m.

These developments necessarily altered the St. Lawrence environment, and it must be admitted today that, like the world's other great rivers, it is now one of the developed rivers (Berthemont, 1999).

WINTER NAVIGATION

Winter navigation began in the least urbanized section of the river, the North Shore. Before the first coasters were commissioned, this region was almost completely isolated due to the lack of an overland communication route. Only an icebreaker arriving once or twice a season interrupted this isolation by bringing the mail, but no cargo. In 1928, The Clarke Steamship Co. Limited commissioned a small ship of a few hundred tons assigned to the winter coasting trade between Pointe-au-Pic (near La Malbaie) and the small ports of the North Shore between Forestville and Sept-Îles. The economic development of these localities led to an increase in traffic and the commissioning of a second vessel in 1956-1957 (Lasserre, 1980). In the winter of 1957-1958, the D'Vora made nine shuttles between Quebec City and the North Shore ports as far as Sept-Îles. The following winter, three companies commissioned five ships on this coastal shipping line (Lasserre, 1980).

In 1958, it was established that winter navigation was possible as far as Quebec City, but it would have to be carried on under certain conditions in the Île aux Coudres – Quebec City section. The following prerequisites were necessary:

- the ships had to have hulls strengthened to withstand ice;
- the network of lighthouses and leading lights marking the waterway had to operate all year round;
- the Department of Transport icebreakers had to be available to lend assistance as needed;
- finally, ice movements had to be monitored by systematic aerial surveillance so that the ships could be told what routes to follow, particularly in the Gulf.

An unforeseeable climatic occurrence led to the discovery that winter navigation was also possible upstream from Quebec City. Exceptionally cold weather at the beginning of December 1958 caused quick and early freezing of the Lachine and Soulanges Canals, and many ships were trapped in the ice. Wintering these ships where they lay would have resulted in heavy losses for the shipowners, so the Government of Canada authorized a powerful icebreaker operation to allow these ships to reach the Atlantic. It was in this context that:

For the first time in Canadian history, thirteen ocean freighters descended the river from Montreal to Quebec City in the middle of January (Lasserre, 1980).

Two conclusions emerged from this occurrence:

1- winter navigation was also possible on the middle St. Lawrence;

2- the icebreaker operation lowered the water level in the Port of Montreal, facilitated the flow of water and consequently reduced the risks of winter flooding.

However, the inauguration of winter navigation in the Port of Montreal would only become official on January 4, 1964 when the Helga Dan docked after spending a week fighting the river ice (Montreal Port Authority, 1999). This arrival led to the establishment of better organized services for winter navigation.

The reduction of floods in Montreal gave the Government of Canada an incentive to also use icebreakers to keep a channel open to Montreal and prevent the formation of ice jams downstream. To complement this, a series of fixed structures, including artificial islands, were built at some locations to limit obstruction of the navigation channel by ice. The result of these interventions was the opening of the channel all winter long beginning in 1970. This year-round opening of the channel as far as Montreal altered the river's flow and certain biological features associated with it.

A range of services (aids to navigation, icebreakers, traffic and communications management, pilotage, etc.) were set up to ensure safe winter navigation on the St. Lawrence as far as Montreal. Upstream winter navigation is not yet possible, primarily due to the presence of numerous locks.

An initial context of colonization of the land, followed by development of trade with Europe and finally international competition set the conditions for the development of the St. Lawrence into a privileged channel of communication.

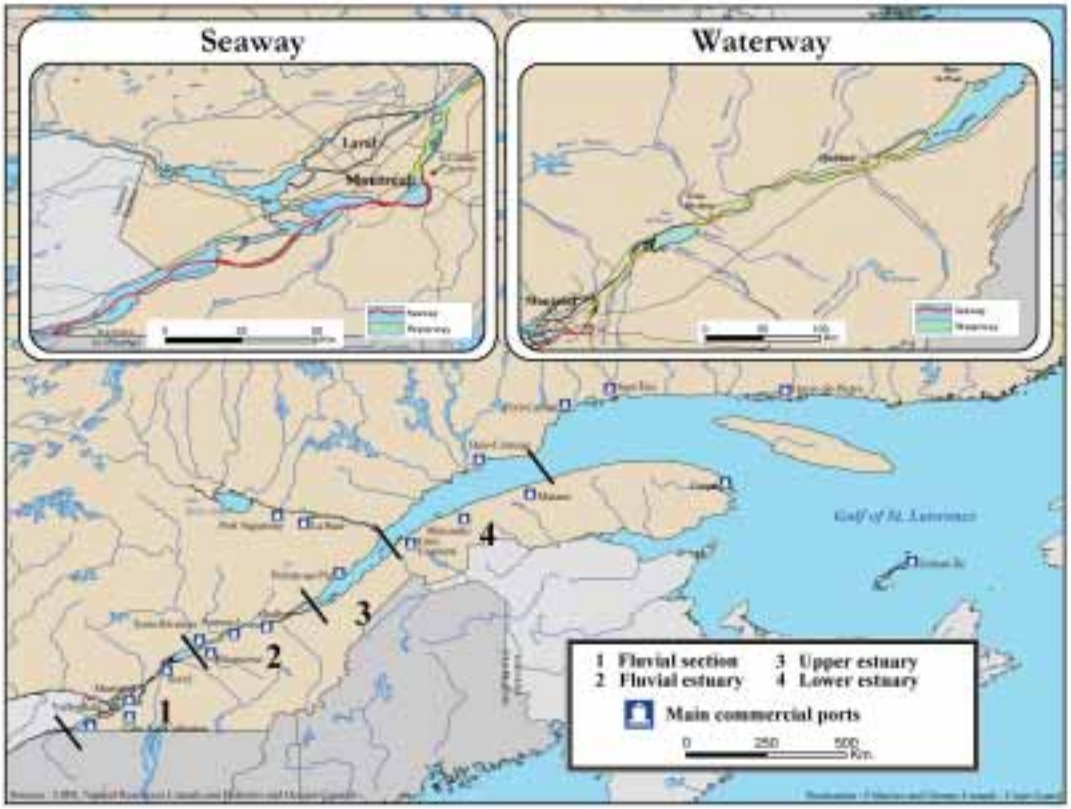
RELATIONSHIP WITH THE ENVIRONMENT

The movement of ships in an inland waterway like the St. Lawrence takes them through different ecosystems (river, lake and estuary) that vary in terms of fragility. These ecosystems are characterized by a set of biophysical characteristics, particularly the runoff profile, the flow rates, the depth and width of the river bed, the biological resources present and the salinity of the water. They also compose a mosaic of landscapes of varied visual appearance.

The Quebec portion of the St. Lawrence is subdivided into four main sectors (St. Lawrence Centre, 1996):

- the fluvial section from Cornwall to Lake St. Pierre – freshwater sector where the tides have no effect;
- the fluvial estuary from Lake St. Pierre to the eastern edge of Île d'Orléans – freshwater sector subject to tides;
- upper estuary from Île d'Orléans to Tadoussac – brackish and saltwater sector;
- the lower estuary from Tadoussac to Pointe-des-Monts – saltwater sector (Gulf of St. Lawrence).

Figure 2 | *Location Map of the Four River Sectors, the Port Network and the Waterways of the St. Lawrence River* Source: DFO - GC, 2003



Source: DFO - CG, 2003

The St. Lawrence's insular environment is also particularly rich. Over 600 islands shape the landscape, the best known of them being les Îles-de-la-Madeleine (the Magdalen Islands), l'Île d'Orléans, the Island of Anticosti and Île Sainte-Hélène (St. Helen's Island). Each island has its own unique and often little-known characteristics.

Since the implementation of the St. Lawrence Action Plan in 1988, several studies and reports have described and analyzed the St. Lawrence by using the PSR approach (Pressure – Status – Response). An exhaustive synthesis of the status of the St. Lawrence (St. Lawrence Centre, 1996) made it possible to produce a general picture of the environmental pressures to which the natural setting is subjected, the effectiveness of the solutions proposed and the determination of emerging pressures. This synthesis was completed by regional assessments produced on the scale of the priority intervention zones between 1994 and 1998. More recently, an overview of the status of the St. Lawrence (Painchaud and Villeneuve, 2003) targeted 21 environmental indicators, from which they derived a series of findings. These findings differ depending on the local environments and the variables analyzed. Regarding chemical contamination of water, the status of the St. Lawrence was qualified as fairly satisfactory, while the bacteriological quality is variable according to the sector analyzed. The waterway receives a poor rating in this regard, attributable to the concentration of urban effluents from the major urban centres of Montreal and Longueuil. Regarding the quality of

sediments, the samples taken in Lake St. François indicate that contamination has diminished in this natural setting. From a biological perspective, the status of the aquatic environments was qualified as intermediate considering the habitat losses over the past 200 years. In Lake St. François, the fish habitat is considered to be deteriorated. This situation is attributable to regulation and hydroelectric works, among other factors. The same situation applies for the Îles de la Paix and Lake St. Louis sectors located near the waterway.

Certain biological characteristics are worth mentioning to highlight a few striking features of the St. Lawrence. It is one of the most important ecosystems in Canada and, in some cases, unique:

- 1300 vascular plant species;
- 185 fish species;
- 115 bird species;
- 16 species of amphibians;
- 14 reptile species;
- 20 species of mammals.

Some animal species (32), including the beluga, and plant species (246) are having subsistence difficulties attributable to contamination or alteration of their habitat. Nearly 20% of plants are in a precarious situation. Several locations along the St. Lawrence have received protected area status in the past few years to preserve biodiversity. About 345,000 hectares received this status in 1992, and another 100,000 hectares were added subsequently (St. Lawrence Centre, 1996).

The St. Lawrence's rich biodiversity must be maintained by prevention, protection, conservation, restoration and development actions for present and future generations. In this regard, SLAP III has determined three sectors where improvements should be the object of special attention: industrial and urban effluents, diffuse agricultural pollution and the impacts of navigation. The main consequences relating to navigation are specified and detailed later on (Part II).

SOCIAL DIMENSION

Several aspects of the social role of navigation can be discussed. We will only retain two for our current purposes: the contribution to shoreline industrialization and the social pressure to maintain environmental quality and the sustainability of other uses.

The shores of the St. Lawrence did not, like several shoreline areas of the Great Lakes or Europe, experience intense industrialization attributable to navigation activities. It even appears to be recognized that this waterway has been increasingly used for the transport of cargo serving the industrial development of the Great Lakes region (Lasserre, 1980). Apart from a few port cities where local economic activity is heavily dependent on service of processing industries (aluminium smelter, paper mills, steel mill, etc.), the role of several ports is often limited to the flow of raw materials (wheat, iron, etc.) downstream and upstream to processing centres. Heavy industries generally tend to be located close to water transportation services. In this regard, the St. Lawrence has not fully benefited from its strategic position, and some observers have contended that its shores are industrially underutilized in comparison to other waterways (Lasserre, 1980).

However, this industrial underutilization of the shores may be considered an advantage by citizens who want to have access to the St. Lawrence for other uses. The social role of navigation, namely the relationship maintained between the representatives of commercial navigation and the riverside communities, remains relatively fragile, even though it has progressed over the past few years. The environmental vigilance of citizens has accentuated, and so have their demands. As much as possible, they want to preserve the last natural sites of the river and the public accesses and uses other than navigation. They therefore insist on participating actively in the decision-making process. Public health concerns, including the water supply (45 % of Quebecers obtain their water from the St. Lawrence), consumption of fish and wildfowl, water quality for swimming, and other nautical activities are uses on which the riverside communities want to be consulted before decisions are made. Protection of the visual quality of the landscape is also an increasingly mobilizing issue to the extent that it contributes to the real estate, recreational and tourist attraction of the shoreline cities and municipalities.

This reappropriation of the St. Lawrence implies that navigation activities that have environmental impacts are the object of sustained attention.

The recent deepening work (1998-1999) in the river section aroused strong opposition from some environmental stakeholders and created a climate of suspicion against the proponents. The complexity of environmental assessment due to overlapping federal and provincial processes was at the origin of the problems. The communities legitimately insisted on participating more actively in the discussions for future projects. The beginning of a transparent dialogue between navigation stakeholders and the riverside communities then appeared necessary to improve the comprehension of mutual interests. This approach is also consistent with the objectives of sustainable development.

LEGAL FRAMEWORK

Like other modes of transportation, marine transportation is subject to a complex regulatory framework in matters of safety and environmental protection (see Schedule 2). The many international trips made by ships in countries that sometimes apply contradictory legislation led to the awareness that some harmonization of the international legislation had become necessary. In some circumstances, this harmonization could make navigation less perilous.

In response to this need, the International Maritime Organization (IMO) was created in 1959. The IMO's primary mandate is maritime safety and control of pollution by ships. Under its auspices, several international conventions were adopted in the 60s and 70s, covering over 90 % (93.5-98.3 %) of worldwide tonnage. Among these we should note SOLAS (Safety of Life at Sea) and MARPOL 73/78 (Prevention of Pollution by Ships - Marine Pollution), which strengthened the application of safer and cleaner practices on the oceans.

The process of adopting an international convention takes a long time, however, normally extending over several years. The main reasons for this slowness are the fact that each convention must receive the support of a number of countries whose combined merchant fleets account for a significant portion of worldwide tonnage, usually more than half. Moreover, the signatory countries must first adopt national regulations, with requirements at least similar to those of the convention, which will ensure its application within the country.

Ad hoc problems, such as the introduction of exotic species, which have costly ecological and economic consequences for countries suffering from this plague, can be resolved more quickly by national legislation.

Navigation on the St. Lawrence is subject to a few dozen laws and regulations applied by different federal and provincial government departments. This legislation covers all activities to varying degrees, ranging from the structure of ships to training of navigators and including environmental considerations and everything pertaining to navigation on a waterway (communications, marking, etc.). Moreover, when an emerging problem is recognized and involves potential consequences for safety or the environment, interim measures (guidelines) can be put in place to circumscribe and mitigate this problem. If these guidelines are insufficient to restore the situation, due to a lack of compliance or for other reasons, draft regulations may be tabled.

All these numerous laws and treaties may appear complex and excessive, but time has shown them to be necessary to protect the environment, commerce and the safety of lives and property.

For recreational boating, all of the federal regulations fall under the Canada Shipping Act, while various provincial regulations apply to this sector of activity.

Economic Aspects of Commercial and Recreational Navigation

The economic stakes related to marine commerce, recreational boating or tourist cruises are many. We will emphasize the importance of these sectors and the striking trends of the past few years.

In Quebec, a 1998 evaluation of the various industries associated with the navigation field (including fisheries, nautical tourism, ports and ferries, government activities) reveals a gross production value of around $1.56 billion, to which corresponds the creation or maintenance of over 14,200 jobs. The direct and indirect economic impact (in added value) of these activities amounts to $1.2 billion and generates 4,130 additional jobs (Michaud *et al.*, 2002). These few figures illustrate the overall economic importance of this field.

The major economic poles related to navigation are commercial shipping, recreational boating, the tourist cruise industry and fishing. Maritime trade is a sector sensitive to market fluctuations, while recreational boating and the tourist industry have grown significantly in the past few years. The fishing sector has been subject to major fluctuations in its activity, mainly attributable to the availability of fishery resources.

A MULTISECTORIAL AND INTERMODAL TRANSPORTATION ACTIVITY

Like other modes, marine transportation essentially assures the movement of goods and passengers from one point to another. However, because these trips are dependent on water, the marine sector cannot accomplish every stage of transportation of goods, from the manufacturing plan to commercial delivery. It is thereby closely related to the railway and road sectors. Several activities are included within this mode of transportation:

- commercial (cargo);
- ferry services;
- tugboat, pilotage and other related services;
- commercial and sports fishing;
- river and international cruises (short or long);
- pleasure (motorized, non-motorized);
- ecotourism services (observation, etc.);
- marine rescue, surveillance and emergency services;
- military.

A group of infrastructures and links support the various activities of the marine and port industry (Table sectorielle de l'industrie maritime du Québec, 2002):

- port infrastructures;
- terrestrial transportation networks (railway, road);
- related services (pilotage, Seaway canal maintenance);
- shipping industries with different characteristics, depending on the market.

With these activities are associated four types of services specific to the marine and port industry:

- port services (docking, loading, unloading, etc.);
- port corporations and port authorities (port facilities, docks, Seaway);
- marine transportation services (water transport of passengers and cargo, ferries, tugboats, ship chartering);
- services related to marine and port transportation (marine salvage, pilotage, environmental emergencies, icebreaking, infrastructure maintenance, shipbuilding and ship repair, warehousing, support for commerce, supply, etc.).

Because of its nature and the volume and type of cargo it can transport, many industries depend on marine transportation, both for supply and to export their goods (DFO, 2002). This explains why more than three quarters of the tonnage handled in Quebec is related to international marine transportation.

TRENDS IN MARITIME TRADE AND COMMERCE

The tonnage of cargo handled in Quebec ports corresponds to nearly one third of the Canadian total. In 2000, this was equivalent to 104 million metric tons (Mt) (DFO, 2002). Annual fluctuations in marine traffic are recorded depending on the trend of costs relative to other modes of transportation, interport competitiveness and sectorial and global economic cycles (recession, growth), as was observed in the 1990s (MTQ, 2001).

Of this tonnage handled in Quebec, about 75 % depends on international trade (primarily with Europe and the United States) and the rest depends on domestic trade (Canada). The ports of Sept-Îles, Montreal, Port-Cartier and Quebec are the main transshipment sites (75 % of tonnage handled) (DFO, 2002). The tonnage transshipped in the other ports is quantitatively smaller but nonetheless remains very significant for the regional economies and local communities (MTQ, 2003). The growth of coasting trade since 1983 is evidence of this (Pelletier, 2002). The integration of the ports into the regional economy and production activities is essential on this scale. The Forestville and Port-Alfred ports, for example, support major resource sectors such as lumber and aluminium (Lagimonière *et al.*, 1993).

The Quebec port network can be divided into three groups based on their technical characteristics and economic importance: national ports, complementary ports and ports of local interest (MTQ, 2003). A certain specialization in the types of cargo transshipped has occurred in the case of the high-tonnage ports. The Port of Montreal, for example, has primarily concentrated its activities on containers, while the Port of Quebec specializes in oil, grain and other bulk cargo. Sept-Îles and Port-Cartier dominate in iron ore (DFO, 2002).

The financial position of the ports varies in terms of revenue. For the first half of 2002, the ports of Gros-Cacouna, Matane, Baie-Comeau, Port-Cartier, Sept-Îles, Saguenay, Bécancour, Trois-Rivières, Quebec and Montreal showed a positive ratio of operating revenue to expenditures. The balance sheet was similar for the complementary ports of Sorel and Valleyfield. Finally, the ports of local interest offered a more contrasting profile: a positive balance for the ports of Forestville and Havre-Saint-Pierre, and negative for the ports of Chandler, Pointe-au-Pic and Portneuf (Forum de concertation sur le transport maritime, 2003).

Regarding the Seaway, the general picture shows a downward trend in tonnage since the historic peak of 53.3 Mt in 1973 (St. Lawrence Project, 1985). This tonnage represented 42 Mt in 2001 (DFO, 2002). The proportion attributable to the Lake Ontario-Montreal sector alone corresponds to about 75 % of this volume (Transport Canada, 2001).

The marine sector benefits from government services, and the importance of this support changes over time depending on the established priorities. Some services then see their funding increase, while others are subjected to reductions. Rescue, Safety and Environmental Emergency Services, for example, rose from $104 million in 1999-2000 to $116.8 million in 2001-2002 (Fisheries and Oceans Canada, 2002, Performance Report, p. 89). On the other hand, the shipping industry is being solicited to assume all or part of certain costs related to marine services (dredging, icebreaking, etc.).

The case of cargo containerization deserves special attention, given this sector's growth over the past few years. Its main advantage is the considerable reduction of the time allotted to transshipment operations (from nearly one month to a few hours for the same volume) (TSIMQ, 2002). In the Port of Montreal, the increase registered between 1992 and 1998 was 76.6 % (CFORT, 2000). In 2000, the number of containers handled passed the one million mark (Table 1). Container ships can currently load up to 2800 TEU (twenty foot equivalent unit) containers and it is anticipated that ships will load up over 4000 TEU, with similar draft, in a close future.

Table 1 | *Trends of Containerized Traffic, 1995-2001*

Year	TEU *(thousands)*	Tonnage *(millions of metric tons)*
1995	726.4	7.14
1996	852.5	7.95
1997	870.4	8.22
1998	932.7	8.70
1999	993.5	9.15
2000	1 014.2	9.21
2001	989.4	8.71

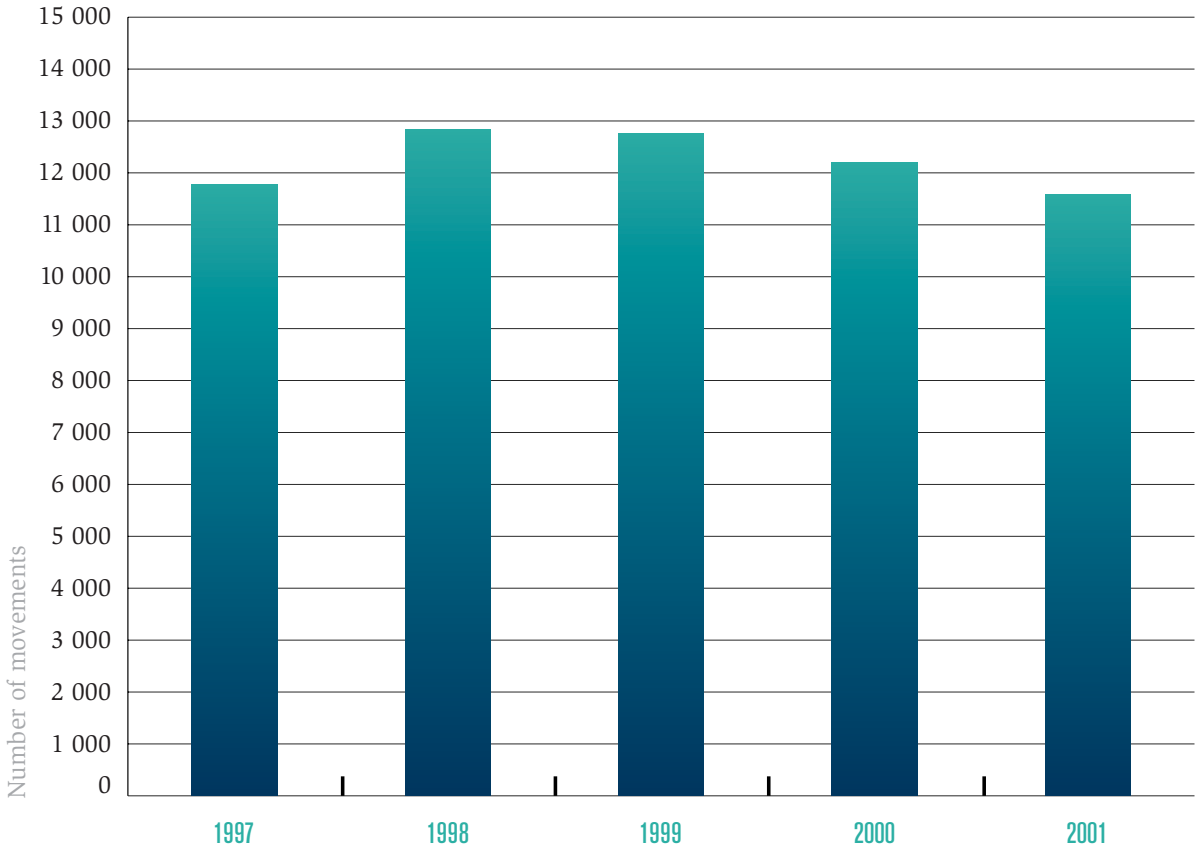
Source : DFO, 2002

By this specialization and the development of intermodality, the Port of Montreal is moving closer to the hub port concept advanced by Alix and Paquin (2002) to the extent that it remains interconnected with several other Quebec ports, modes and industries.

IMPORTANCE OF MARINE TRAFFIC

The number of ships only gives a very partial overview of the traffic intensity, because the same ship can make different stops along the St. Lawrence and only be accounted for once. On the other hand, the number of ship movements makes it possible to present a more accurate image of traffic density but means that each trip by the same ship will be counted. Figure 3 presents ship movements (freight transportation) for the period 1997-2001.

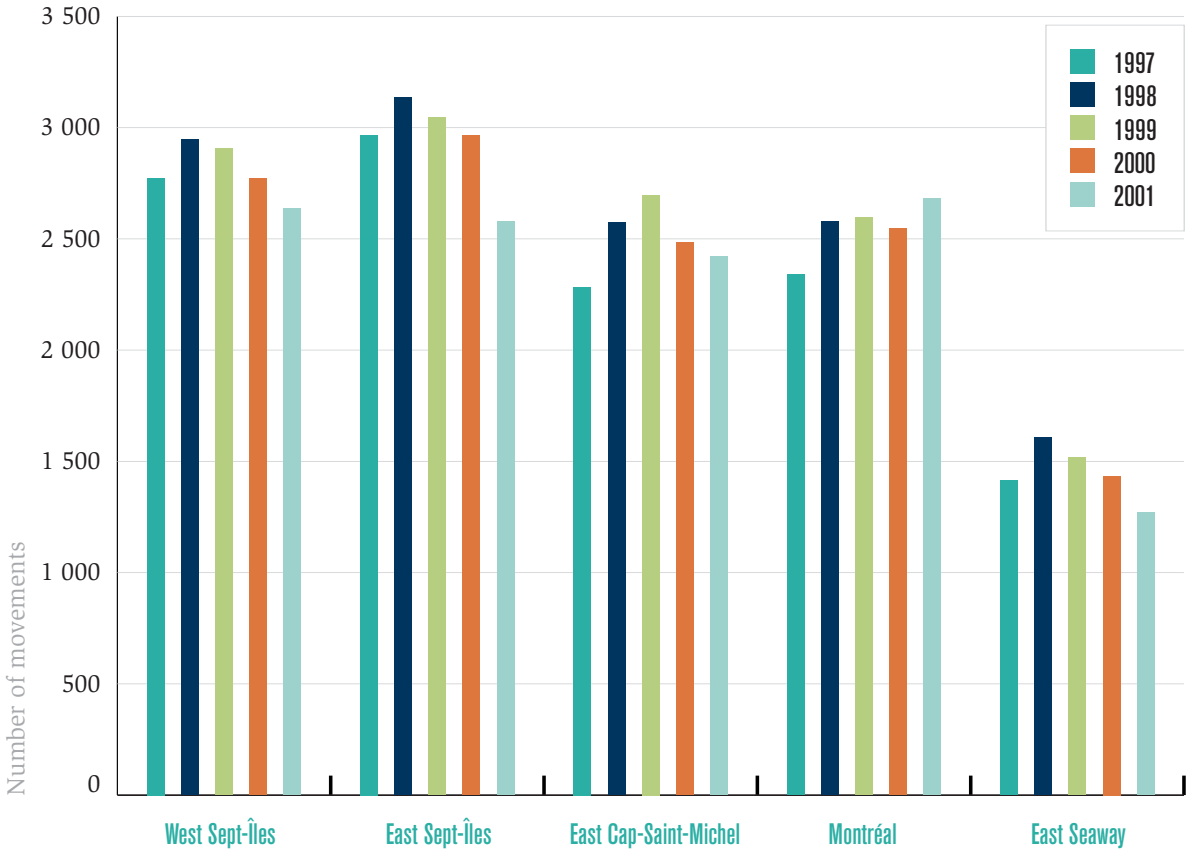
Figure 3 | *Total Number of Commercial Ship Movements on the St. Lawrence, Cargo Only, All Classes Combined, 1997-2001*



Source: DFO - CG, 2002

Even though the time frame is relatively short, we can nonetheless observe that commercial ship movements on the St. Lawrence do not show an upward trend. Several factors, such as ship dimensions and economic cycles, can help to explain this trend. Figure 4 presents the same data, but this time by geographic sector, with movements accounted for upon entering and leaving each sector.

Figure 4 | *Total Number of Commercial Ship Movements on the St. Lawrence, Cargo Only, by Geographic Sector, 1997-2001*

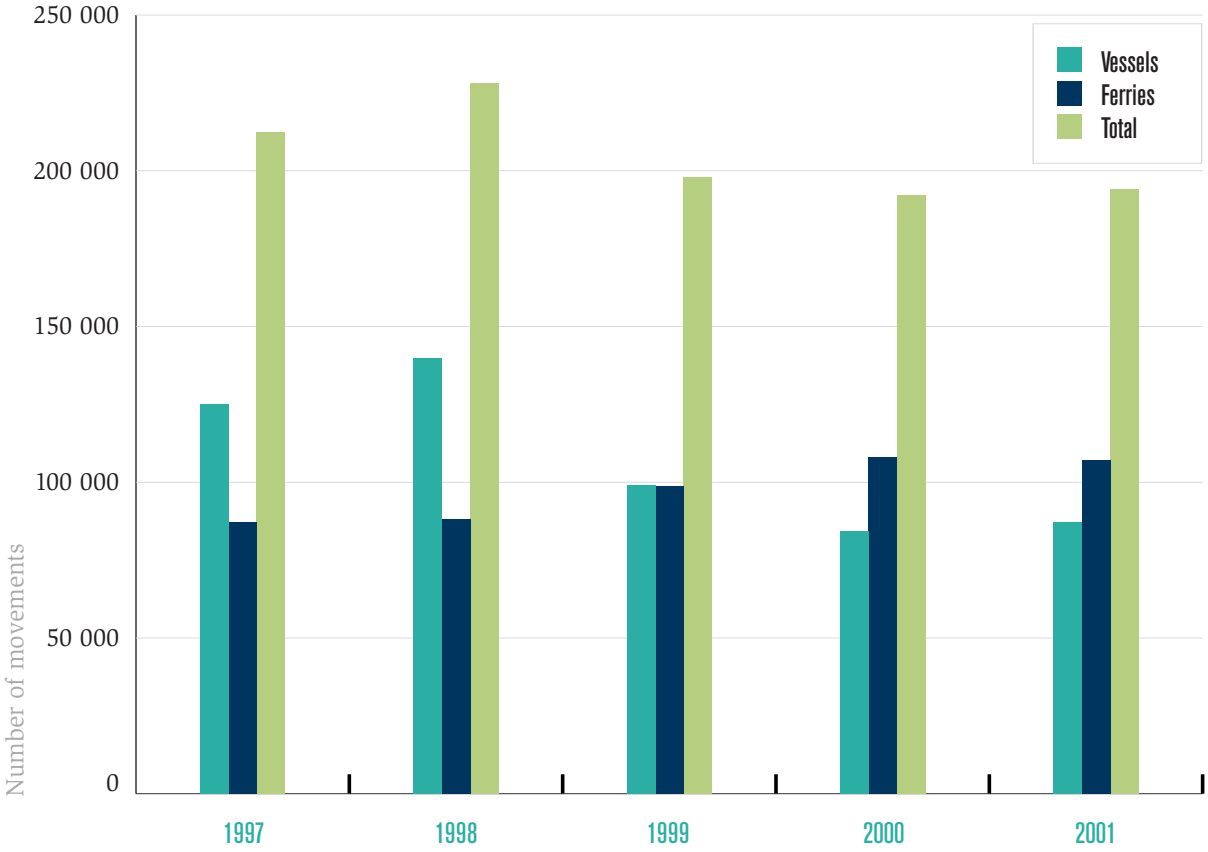


Source: DFO - CG, 2003

This figure gives a more precise overview of the situation. Indeed, it illustrates that there was an increase in the number of movements in the Montreal sector, while the other sectors experienced a downward trend.

The total number of movements on the river, i.e., all classes of ships combined (commercial, fishing, passenger, ferry, etc.), gives an idea of traffic density and consequently the environmental pressure and risk level associated with it (Figure 5).

Figure 5 | *Total Number of Ship Movements on the St. Lawrence, All Classes Combined, 1997-2001*



Source: DFO - CG, 2003

This figure clearly illustrates the substantial drop in ship movements, while ferries, for the same period, saw their trips increase constantly. In fact, ferries account for more than half of all ship movements of vessels on the river. This increased use of ferries may contribute, in some sectors, to reducing the pressure on the road network.

Even though the total number of movements appears high, it must be remembered that marine traffic is far from its saturation point on the St. Lawrence. On the contrary, there is room and even interest to increase the use of this mode of transportation, especially since significant growth is forecast for the other modes, contrary to the stagnation anticipated for marine transportation (Table 17).

RECREATIONAL USES AND NAUTICAL TOURIST SERVICES

Recreational boating is increasingly recognized as an activity that makes a substantial contribution to the economy. A recent survey conducted for Tourisme Québec indicated a revenue value of around $1.37 billion (manufactured goods, distribution, retailing, marinas), with which nearly 8,000 jobs are associated (DBSF, 2002). The cruise sector has diversified greatly in recent years, with the emergence of short cruises, adventure services and nautical ecotourism. These activities have also spread geographically to all sectors of the St. Lawrence.

Recreational Boating

Recreational boating activities on the St. Lawrence date back as far as Canadian Confederation in 1867. For example, this was the period when the Longueuil Boating Club was founded (De Lagrave, 1992). This activity, initially reserved for the economic elite, gradually became more accessible and is now practiced by nearly 17 % of shoreline residents (De Wailly *et al.*, 1999). The growth of leisure time (Pronovost, 1998) and the increase in *per capita* income have greatly contributed to the democratization of recreational boating activities.

The recreational boating sector currently uses 300 facilities on the St. Lawrence: public access ramps, recreational boating ports, yacht or canoe clubs and related services (CFORT, 2000). The number of places available at these locations is sometimes insufficient (Zins Beauchesne et associés, 2002), indicating that the potential development has not yet reached its maximum.

Several projects aiming at the revitalization of recreational boating have emerged in the past few years, including the reopening of the Lachine Canal (May 2002) and the ongoing study of the reopening of the Soulanges Canal. The five small canals near the St. Lawrence (including the Sainte-Anne-de-Bellevue Canal) allowed the passage of nearly 20,000 craft in 2000 (DBSF, 2002), while the number of Seaway lock passages by recreational boaters accounted for 11,735 in 2001 (St. Lawrence Seaway Management Corporation and St. Lawrence Seaway Development Corporation, 2002). These figures are evidence of a definite interest in using the St. Lawrence and its tributaries more intensively.

The number of American and Ontarian excursion goers (less than one day on the site) and tourists (more than one day) coming directly to Quebec was estimated at over 35,000 in 2000. A large portion of these visitors stay more than 3 days and may individually spend between $295 (Ontarian tourists) and $380 (American tourists) per day (DBSF, 2002).

Finally, the dynamism of the recreational boating sector can also be illustrated by the considerable increase in the types of craft and their power over the past few decades.

Ocean and River Cruises

The increase in the number of ocean cruise ships on the St. Lawrence is relatively recent (Table 2) and is particularly manifested in the Port of Quebec, where a host terminal was constructed for this purpose.

Table 2 | *International Cruise Passenger Traffic (thousands of passengers)*

Year	Montréal	Québec City	Total *(Montréal-Québec City)*
1995	27.4	39.0	66.4
1996	19.1	21.3	40.4
1997	29.3	35.5	64.8
1998	32.6	43.9	76.5
1999	18.3	34.6	52.9
2000	25.2	35.9	61.1
2001	23.8	48.8	72.6
2002*	32.8	70.0	102.8

Source: DFO, 2002

* This is an estimate based on partial data.

The development of river cruises is less significant, given the few existing cruise lines. However, this type of activity frequently leads visitors to spend several thousand dollars at a time (Audet, 2002). In this regard, the St. Lawrence Seaway is the privileged link between Montreal and Ontario. In 2001, 8,665 passengers were accounted for in this section (St. Lawrence Seaway Management Corporation and St. Lawrence Seaway Development Corporation, 2002). The Seaway is part of the infrastructure network that facilitates the organization of cruises in this sector. The arrival of new ships has fostered a rapid growth in the number of cruise passengers, from about 1,500 in 1997 to 14,000 in the early 2000s (www.grandslacs-voiemaritime.com). Wright (2002) indicates that large ships like the C Columbus (423 passengers - 6 cruises/year) have particularly contributed to this increase. Finally, the recent establishment of a link between Montreal and Îles-de-la-Madeleine (the Magdalen Islands) with stopovers is another indication of this sector's expansion.

Excursion Cruises and Nautical Ecotourism

A great diversity of services exists in the short cruise (less than one day) and ecotourism sector. This ranges from inflatable excursion dinghy (a few seats) to cruise ships of over 1,000 passengers (CFORT, 2000).

In 2001, 76 enterprises offered excursion services assured by a fleet of 148 ships (UQAM Chair of Tourism, 2003). The accommodation capacity was estimated at nearly 11,000 places and the number of excursion goers reached 1.2 million. This sector's total economic spin-offs were estimated at $160 million.

Regarding nautical services for smaller craft (kayak, inflatable raft, etc.), the daily spending related to these activities were estimated at $130 to $150/day/person respectively for average stays of 5 days (UQAM Chair of Tourism, 1999). These activities rely, among other factors, on the quality of environmental conditions, namely the Laurentian landscape as a whole or some of its special features (Lachine Rapids, St. Lawrence islands, whale watching, Lake St. Pierre, etc.), and on the dynamism of associations (Couture, a2002, b2002).

Finally, shuttle services linking opposite shores or giving access to certain islands are also increasingly popular (see Corporation du Croissant de l'Est, 2002). It is important to note that the protection and conservation of resources and landscapes continue to be an issue of the greatest concern with regard to these recreational tourism activities.

THE FUTURE OF NAVIGATION ACTIVITIES ON THE ST. LAWRENCE

The future of commercial navigation on the St. Lawrence is closely linked to economic conditions and to the national and international markets. At the international level, analysts forecast strong growth of navigation activities over the next fifty years. The Canadian forecasts (Table 20) are much less optimistic, however, and there is agreement that this sector will vary very little over this period, unless initiatives are taken to reinvigorate this mode of transportation. As a national and international waterway, the St. Lawrence will have to position itself and highlight its advantages to participate in and profit from this growth. However, this potential will have to be done in accordance with the requirements of sustainable navigation.

The development of nautical and recreational tourism activities will also have to be consistent with the rise of environmental awareness, which is at the origin of the ecotourism approach.

The future of navigation activities rests on several pillars, including cohesion among the stakeholders in the navigation field, their capacity for innovation, respect for the environment and harmonization with the needs of other users of the St. Lawrence.

Part II

Sustainable Navigation Strategy

Vision

FROM SUSTAINABLE DEVELOPMENT TO SUSTAINABLE NAVIGATION

In the 1960s, population growth, ever more intensive land use, accelerated harvesting of raw materials and the impacts generated by these activities on the environment (air-soil-water) led various international stakeholders to take into consideration the social, economic and environmental sustainability of this development. This reflection, and particularly the concerns that accompany it, then intensified and culminated in 1987 in the report of the World Commission on Environment and Development (Brundtland Report, Our Common Future). A simple but inclusive expression, of the sustainable development was finally proposed and accepted by the international community. Sustainable development is thus understood as:

> *Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*

This definition served as a frame of reference for different sectors that adapted it to their respective needs. Thus, in the transportation sector, the OECD has proposed a definition of sustainable transportation that makes no distinction between the different modes:

> *Transportation that does not endanger public health or ecosystems and meets mobility needs consistent with:*
>
> *a) use of renewable resources at rates below their own regeneration; and*
>
> *b) use of non-renewable resources at rates below the development of renewable substitutes.*
>
> *(Environment Canada and Transport Canada, 1997)*

These multiple efforts have made it possible to establish the orientation of sustainable development. It must consider the following three main poles – the economy, the environment and society – and tend to an equilibrium among them.

By applying these concepts to the various navigation activities, it becomes possible to define what could be a sustainable navigation for the St. Lawrence:

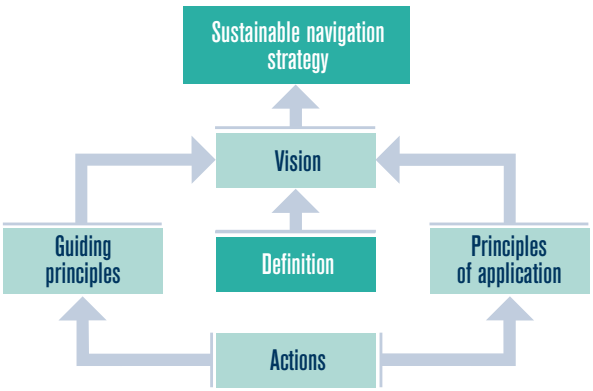
> *Management of commercial and recreational navigation and quayside ship operations, integrating the objectives of economic, environmental and social sustainability and assuring, in the short term and for future generations, adequate protection of ecosystems, quality of life, and human health and safety, while permitting the development of navigation.*
>
> (Comité de concertation navigation, 2003)

This definition focuses on the importance of subscribing to the imperatives of sustainability in the management of navigation activities. By basing the achievement of sustainable navigation on management practices, the precepts of durability will be integrated into the everyday activities of the stakeholders and managers concerned. Moreover, sustainable navigation adheres to the equilibrium sought by sustainable development, namely prevention, mitigation or elimination of the negative impacts of commercial and recreational navigation on St. Lawrence ecosystems and uses. Parallel to this and still seeking this balance, it emphasizes the advantageous environmental, social and economic aspects of navigation.

In support of this definition, guiding principles and principles of application have been formulated to serve as a frame of reference for stakeholders and decision-makers who have to act directly or indirectly on issues concerning commercial and recreational navigation activities. In accordance with the definition, the principles constitute a sort of ideal, a vision of the St. Lawrence to preserve by proposing a reference framework for navigation activities. The appropriation of this vision by the decision-makers and stakeholders will foster its fulfillment.

GUIDING PRINCIPLES AND PRINCIPLES OF APPLICATION

The organization chart below schematically shows how the strategy functions. The guiding principles and principles of application will provide a framework for the different actions related to navigation so that they can meet the requirements of sustainable navigation.



Guiding Principles

Protection of ecosystems and water resources

Assure the sustainability of the St. Lawrence ecosystems, their productivity and the essential roles they play and not disrupt the quality and quantity of water available.

Safety of persons and ships

Follow the recognized safety principles and measures for crews, users, cargo and ships.

Development of commercial navigation activities

Observe the requirements of economic development of navigation activities and assure their harmonization with environmental and social imperatives; maintain the port accesses supporting these activities and optimize reliance on navigation in situations where this mode of transportation offers comparatively more environmental gains.

Development of recreational and recreational boating activities

Promote the development and practice of these activities and ensure their harmonization with environmental and social imperatives.

Harmonization of uses and involvement of riverside communities

Meet the needs of the different users of the St. Lawrence, particularly in matters of accessibility, and ensure the participation of the riverside communities in the decision-making processes.

Principles of Application

Broadened consensus building among navigation stakeholders

Develop and maintain consensus building among public stakeholders, users and riverside communities, and promote participation in the decision-making process based on various conditions that may range from exchange of information to consultation and, as the case may be, takeover of specific projects.

Consolidation of best practices and innovation in environmental management measures

Support and consolidate existing best practices and initiatives and develop new ones in relation to the development of knowledge, technology and environmental conditions.

Acquisition and sharing of knowledge, and training

Promote, through research and development, the acquisition and sharing of environmental, technical and economic knowledge related to navigation, by assuring the transfer, through training, to the commercial and recreational users.

Dissemination of information, awareness and involvement

Disseminate information concerning the impacts and advantages of navigation to change the perceptions and behaviour of stakeholders in the navigation field, riverside communities and users, and to promote the development of targeted strategic actions.

Environmental assessment of actions

Assure systematic and regular monitoring of the environmental effectiveness of the measures implemented, and institute remedial measures as needed.

These principles are primarily based on environmental and social values such as maintenance and development of activities with less impact on the environment, cooperation and consensus building among the various stakeholders, but also a marine economy based on increased efficiency of navigation activities. The following section presents a set of issues in which efforts must be invested on a priority basis over the next few years to mitigate the impacts associated with certain practices.

INTRODUCTION

The environmental issues requiring remedial measures were determined based on discussions within the Navigation Consensus Building Committee, and sectorial consultations held with stakeholders closely related to the navigation field (shipping industry, recreational boating, riverside communities and environmental organizations, and government representatives at the federal, provincial and municipal levels). These issues are the basis of a first intervention plan, implementation of which will be spread over five years. Other issues will be added later to this nucleus, depending on changing environmental and socioeconomic concerns. The expression of current regional, national and international preoccupations has served to prioritize the issues. This priority is consistent with a will to optimize and rationalize the interventions so as to achieve the results within the designated period.

Implementation will involve the federal and provincial departments present on the Navigation Consensus Building Committee which, particularly in the course of their regular activities, will take charge of the issues that concern them and see to the implementation of their related objectives. The representatives of the shipping industry, recreational boating and the riverside communities will also participate on an ad hoc basis in the development of certain projects, and will remain very present and active concerning orientations and planning. Annex 3 presents a summary of the work plan scheduled for the next few years.

This section sets out the eight issues initially retained, i.e. consensus building, dredging, adaptation to water level fluctuations, shoreline erosion, sewage and ballast water management, and the risks of hazardous product spills. It ends with a presentation of the eighth issue, the development of marine transportation in relation to its environmental and social advantages. The consensus building issue is completed by awareness and involvement issues. This triad is recognized by the Committee as the main priority supporting the implementation of the whole strategy.

Each issue has been the object of technical and scientific documentation that is as recent as possible. The background of the issue is presented first, followed by a statement of the problem relative to the St. Lawrence. The targeted results and the actions to be taken conclude these sections. This formula immediately gives the environmental track record of navigation activities and puts the related impacts in perspective.

The strategic approach adopted involved selecting the environmental issues to be discussed. The other issues relating to technical aspects (growth of fleets), economic aspects (economic incentives for “green ships”), social aspects (training of marine personnel) or legal aspects (future regulation) are the focus of work by the authorities concerned in many cases. The strategy will assure monitoring of their development and will incorporate the results of this work as it becomes available.

CONSENSUS BUILDING – A PREREQUISITE

Consensus building is a principle of application defended since the beginning of the discussions on the development of a Sustainable Navigation Strategy. It constitutes a social principle that brings together the other poles of sustainable development and turns out to be a prerequisite to the justification of decisions that have a collective and public impact. The strategy can benefit in this regard from the experience accumulated over the past five years.

Consensus building is one of the challenges currently adopted by public administrations (DFO, 2001; MENV, 2002; MTQ, 2001; EC, 2001). It assumes better coordination both of policies and of private initiatives, as well as participation by riverside municipalities and other community stakeholders. This approach seeks to introduce a cost-effectiveness ratio of actions that is superior to the traditional command and control approach and that henceforth puts cooperation in the forefront of environmental management (Lepage *et al.*, a2002).

Consensus building, contrary to arbitrary processes, is based on debate and discussion among stakeholders from various backgrounds and can be applied to very specific cases of environmental management (Lepage *et al.*, 2002b). It also assumes the absence of strictly bilateral negotiations by considering an aggregation of position regarding a given situation. Consensus building is at the basis of a dynamic process that is meant to be as near as possible to an advantageous situation for all participants. A specific position, for example, can be improved by the contribution of the other stakeholders with the aim of a common position. The search for consensus prior to decision-making facilitates implementation of actions.

The sustainable development context proposes that the stakeholders consider other facets of a situation. The Navigation Consensus Building Committee has been recognized to date as an interesting formula for discussion and consensus building (Federal-Provincial SOE Team, sectorial consultations, March 2002). Other formulas exist and should have in common the commitment to fulfill the following conditions:

- a balance among the different sectors showing the diversity of the interests concerned by navigation activities;
- a common vision in terms of principles;
- transparency in debates and sharing of ideas;
- an ongoing exchange of information and a common and shared analysis of the problems and solutions;
- openness regarding the issues common to the Great Lakes-St. Lawrence system.

The context of flexible consensus building excludes, de facto, to rally behind a single solution. All participants have the right to speak or keep their opinions to themselves, and the moral obligation to get involved and clarify and justify their position for the benefit of the group.

Balanced consensus building depends on the diversity of the sectors considered. Four sectors have been determined in relation to navigation: higher levels of government (federal and provincial, commercial navigation (marine carriers, port authorities, pilots, etc.), recreational navigation (associations related to the various recreational boating activities) and riverside communities (municipalities, environmental groups, local consensus building tables and other community stakeholders). The number of representatives for each sector

should be as proportional as possible so as to institute a results-driven dynamic process representative of the community and focused on the achievement of results. However, the size of the group is a key factor in this dynamic process and the quality of its functioning.

Complementary to consensus building, it appears necessary to assure a flexible link between a main group and various groups with peripheral expertise so as to have the technical and scientific knowledge to answer specific questions, suggest new orientations and evaluate certain choices.

Stakeholder Awareness and Involvement

One general finding emerges regarding navigation: this is a field with advantages, constraints and disadvantages that are fairly unknown to the public. This lack of knowledge translates into demands for changes in practices that are often difficult to fulfill without compromising the principles of navigation safety. From the marine point of view, new knowledge and technology capable of limiting environmental impacts are being integrated at a relatively slow pace, often as a result of grass roots pressure.

From this perspective, increasing awareness appears to be a prerequisite to consensus building. A better knowledge of the realities, concerns and limits of one's counterparts can only contribute to the strengthening and maintenance of consensus building. The form this awareness may take varies, but the objective pursued is the same: make the other party aware of our concerns and ensure that accurate, up-to-date information is conveyed.

A continuous exercise of increasing awareness among the organizations concerned by navigation issues should be initiated and supported by effective communication mechanisms. For this purpose, a communication plan will be developed, based on the targeted audiences and specific geographic sectors. This plan will aim at better dissemination of information by updating knowledge and setting out the difficulties of implementing certain interventions. It will allow public validation of the issues and conditions of environmental management.

The stakeholders' involvement is an essential factor in the fulfillment of the sustainable development strategy and is the most concrete form of appropriating it. The stakeholders solicited are those closely related to the commercial and recreational navigation field, but a broadening to other social groups, including the riverside municipalities, private for-profit and non-profit organizations, and others, is expected. Their participation means that they bring about a direct, continuous and targeted support in time, money, equipment and knowledge to solve a specific problem or to ensure value-added for the interventions foreseen in the Sustainable Navigation Strategy. In this context, the involvement may be in terms of planning and implementation of customized intervention measures.

The objective pursued by this involvement is two-way, i.e. to facilitate and promote implementation of the strategy and receive feedback from the stakeholders regarding deficiencies or the determination of new issues. It is in this perspective that Sonntag-O'Brien (1998) pointed out that the early initiating role of the stakeholders (communities) contributed to the transposition of the overall problems to an adapted local human scale. In this regard, the contribution of the younger generation and their increased awareness of these issues prove to be important in ensuring the sustainability of this enterprise.

The conditions of participation vary and must adapt to the stakeholders' constraints regarding resources and the time available, as well as the interest they show in fulfillment of the issues. The involvement may concern planning or the issues of integrated management of dredging and sediments, and the strategies for adapting commercial and recreational navigation to water level fluctuations. These examples clearly illustrate that the stakeholders' participation in the discussions would facilitate consideration of their interests in the decisions. The same principle applies for draft regulations, such as those pertaining to sewage and ballast management. The involvement may also concern interventions and seek local monitoring of the measures adopted, such as, for example, those concerning the mitigation of shoreline erosion or the one regarding decontamination of sediments in Sector 103 of the Port of Montreal.

In these cases, participation makes it possible to discuss interventions more widely, improve the actions chosen at the local level and ensure broad support for the solutions adopted. This is a set of advantages recognized in other environmental contexts (Bernard and Armstrong, 1998; Chuenpagdee *et al.*, 2001; Torres, 2001; Wilson and Howarth, 2002).

Consensus building, awareness and involvement are three complementary levels of intervention that it is appropriate to consider as a whole in implementation of the strategy.

Targeted results

- Coordination of the implementation of the Sustainable Navigation Strategy and management of future initiatives is assured.
- Consensus building is preserved, with regular review of the mode of operation, and integration of stakeholders depending on the issues.
- Community stakeholders are involved, depending on the targeted issues.

Actions

- Assure monitoring of the various implementation projects (administrative and financial monitoring of the projects).
- Create and coordinate the working groups and ensure the performance of studies and other technical or scientific work.
- Propose new projects and funding sources in relation to the issues.
- Ensure the dissemination and exchange of information among the navigation stakeholders.
- Design a communication and awareness mechanism to reach efficiently all of the stakeholders concerned about navigation activities.

ENSURE IMPLEMENTATION OF INTEGRATED MANAGEMENT OF DREDGING AND SEDIMENTS

Context

The dredging performed within the context of navigation is an activity intended to remove sediments naturally deposited at the bottom of watercourses, so as to ensure continuous safe navigation. Dredging notably is carried out in navigation channels, in port approaches and near piers, in marinas and in harbours. Two types of dredging are generally practiced on the St. Lawrence: capital and maintenance. Capital dredging seeks to alter the watercourse to increase the water level useful for navigation. This activity has existed on the St. Lawrence since the 19th century (Villeneuve and Quilliam, 2000). The scope of capital dredging varies depending on changes in fleet dimensions and water level fluctuations. Maintenance dredging involves maintaining a rated depth ranging from 10.7 to 12.5 m in certain sections that are more particularly subject to sedimentation processes. Sedimentation in the river is a natural, dynamic phenomenon that varies depending on the sector. It is determined, among other factors, by the load of suspended matter and the speed of the currents.

The dredged sediments are managed according to environmental standards and economic constraints. Integrated management of dredging and sediments seeks to consider the entire dredging cycle, from removal of the sediments to their disposal, and to examine the potential consequences. Maintenance dredging is by far the type of dredging that is the most frequently carried out on the St. Lawrence. Table 3 shows the breakdown of dredged volumes by geographic sector for the period 1983-1996. The average for this period was greater than the average recorded for the years 1997-2000, 438,500 m^3/year (Lalancette, 2001).

Table 3 | *Volume of Dredged Sediments in the St. Lawrence (1983-1996) by Sector (m^3)*

Volumes dredged	Lake St. François to the eastern tip of Île d'Orléans	Eastern edge of Île d'Orléans to Tadoussac (south shore of Île Verte)	Tadoussac to the Gulf including the Îles-de-la-Madeleine (Magdalen Islands) and la baie des Chaleurs	Total
Total by sector	2,692,501	1,219,532	3,357,471	7,269,504
Annual average	192,322	87,109	258,267	519,250
Proportion of the grand total (%)	37 %	17 %	46 %	100 %

Source: Villeneuve and Quilliam, 2000

Other dredging work of lesser scope was also carried out all along the St. Lawrence to ensure the development, and then the maintenance, of recreational navigation. Some entrepreneurs have also revealed that they have used dredging to maintain their activities in the recent context of low water levels (Zins Beauchesne et associés, 2002).

The comparison between the mass of suspended matter resulting from erosion and transport with the volumes dredged makes it possible to estimate the relative importance of each one. Rondeau *et al.* (2000) calculated, for the period 1989-1993, the contribution of different sources of sediment in the river (tributaries, industries, cities) for the Cornwall-Quebec City sector, in order to estimate the portion attributable to erosion. This portion averages 67 % of the river's annual sedimentary mass balance (Table 4). By using the density of sand (quartz, 2.65) as a reference matter for the waterway, it is possible to convert the Table 3 volumes into tons and measure them in relation to suspended matter. This is presented in Table 4. The quantity removed for maintenance of the waterway represents a little over 5 % of the suspended matter transported by the river.

Table 4 | *Comparison of the Mass of Suspended Matter, Eroded and Dredged in the St. Lawrence (x 10^3 t/year)*

	Other sources	Dredging	
	Quebec City station	*Lake St. François – Île d'Orléans* (av./year 1983-1996)	*Maintenance and capital dredging Waterway only* (av./year 1990-2002)
Suspended matter	6,900	–	–
Erosion	4,630	–	–
Dredging		509	397
% in relation to suspended matter			
Suspended matter	100	–	–
Erosion	67,1	–	–
Dredging	–	7,4	5,7

Source: Rondeau *et al.* (2000) for the estimates of suspended and eroded matter.

Note: The other sources of suspended matter, including cities and industries, are not included in this table.

The nature of the sediments deposited in the navigation channel is generally sandy, less subject to contamination than finer particles (clay, limestone), which tend to be deposited in sectors protected from the currents (e.g. port areas). The physical impact of dredging on the environment is not negligible, however, the timing of operations may be critical for habitats.

The dredged sediments are disposed of at designated sites to minimize environmental disturbances. The period when the dredging and disposal activities occur is important. In such circumstances, compensatory measures and environmental monitoring may be requested (Bolduc and Lavergne, 2003).

Dredging is one of the activities that contribute to altering the profile of watercourses. Building up shorelines for urban development purposes and channelling of watercourses for agricultural purposes are other disruptive factors (BAPE, 2000).

Problem

Dredging is an essential activity to support navigation on the St. Lawrence, and the volumes to remove vary according to year. Selective dredging of the channel between Montreal and Deschaillons was the last capital dredging carried out in the waterway (1998-1999). The aim was to increase the depth at some locations from 11 to 11.3 m. About 244,500 m^3 of sediments were dredged and disposed of at sites intended for this use, one of which is located at Lake St. Pierre (Port of Montreal, 1999). By way of comparison, the quantity of sediments removed for the expansion of the MIL Davie pier in the 1980s was estimated at 200,000 m^3, while capital dredging for the Port of Sept-Îles totaled over 472,000 m^3 between 1998 and 2000 (Lalancette *et al.*, 2001).

Port maintenance work is also necessary, both for access and for maintenance of the depth at the pier approaches. The Port of Montreal, for example, annually removes a volume of sediments ranging from 2000 to 4000 m^3 (Ricard *et al.*, 2001). In Îles-de-la-Madeleine (Magdalen Islands), 200,000 m^3 of sediments were dredged in 1997 to facilitate access to the Mines Seleine entrance channel (Lalancette *et al.*, 2001).

The concerns raised with regard to dredging work focus on:

- the alteration of the configuration of the watercourse and the currents (hydrodynamics);
- the potential loss of habitats for aquatic fauna and flora (directly or indirectly);
- the alteration of the quantity of water and its impact on the health of organisms or on hydrants.

The impacts depend on the nature, quantity and quality of the materials in question and the choice of dredging operation and sediment disposal conditions (Villeneuve and Quilliam, 2000). In this regard, the resuspension of sediments and the scattering of particles, sometimes highly contaminated, by the currents remains a serious issue. The presence of sensitive components of the habitat (e.g. fish spawning or feeding area) or the human settlement near the dredging or disposal sites must be considered in the selection of dredging and disposal equipment and techniques, and when implementing mitigation measures. Finally, the impact of disposal in open water should be evaluated over a longer period, because the forces of erosion continue to act on the site by slowly dispersing the deposited sediments.

The dredging projects shall be the object of an environmental assessment before they are carried out. The main objectives of this assessment are to:

- determine the project's justification, including the options other than dredging;
- choose the most appropriate technique in environmental, technical and economic terms;
- select a disposal site for the sediments;
- propose mitigation and compensation measures for the anticipated impacts;
- develop a program for environmental surveillance and monitoring of the project.

Several laws and regulations under federal or provincial jurisdiction may apply to a dredging project. Table 5 summarizes the main legislation in force. Each text contains specific sections that may be invoked in the context of a project assessment.

Table 5 | *Legislative Framework for Dredging Projects, by Level of Government*

Level of government	Main legislation concerned
Federal	Canadian Environmental Assessment Act (CEAA), Navigable Waters Protection Act, Fisheries Act, Canadian Environmental Protection Act (CEPA), Migratory Birds Convention Act.
Provincial	Environment Quality Act (EQA) and its Regulation respecting environmental impact assessment and review, Act respecting the conservation and development of wildlife and its Regulation respecting wildlife habitats, Watercourses Act.

Two environmental assessment procedures apply for dredging projects in Quebec, one federal and the other provincial. Fisheries and Oceans Canada and Environment Canada enforce requirements regarding certain issues (disposal at sea, migratory birds, threatened species, fish habitat), and the Environmental Assessment Agency sees to general compliance with the procedure regarding properties or projects under federal jurisdiction. The Ministère de l'Environnement du Quebec manages the environmental impact assessment and review procedure for dredging projects of 5,000 m^3 or more, private projects, provincial government projects and certain federal government projects regarding restoration of ocean bottoms. It also issues authorization certificates for projects of lesser scope. Finally, other government departments or agencies intervene more specifically regarding land and aquatic wildlife habitats (Ricard *et al.*, 2001). Given the large number of stakeholders, coordination is a key issue.

Currently, the main issue relating to dredging sediments is the determination of quality thresholds regarding the toxic effects of contaminants on the health of organisms. Benthic microfauna constitute a population more vulnerable to these effects, given their direct contact with the sediments. A review of sediment quality criteria is currently in progress (see box) and should make it possible to establish standards adapted to the characteristics of the St. Lawrence.

Sediment Quality Evaluation Criteria

In 1992, Environment Canada and Environnement Québec formulated quality criteria for sediments. These criteria, based on exotoxicological knowledge, were primarily developed for management of dredging activities related to navigation. Depending on the chemical contamination level observed, recommendations are made concerning the disposal of dredging sediments in open water. The criteria can also serve to evaluate the relevance of rehabilitating a contaminated site. In the latter case, additional evaluation tools are suggested to define what actions to take.

These criteria must be updated regularly in the light of new knowledge and analysis methods. A technical workshop was organized in fall 2000 to discuss aspects to consider to improve the interpretation and application of the sediment quality criteria. Update or revision proposals are currently under study. The improvement of knowledge regarding the natural (preindustrial) concentration of metals in St. Lawrence sediments would be one of the main elements to integrate into these criteria. The St. Lawrence Centre has produced various studies of the natural concentrations of several problem metals and PAH. The revision of the discrimination levels retained with the detection level approach for the definition of thresholds (minor effects and harmful effects) also represents one of the avenues studied for revision of the criteria.

Within a slightly more global perspective, various initiatives have existed for the past few years with the aim of assessment of dredging activities and enhancement of sediments to improve the quality of the environment. This approach is particularly used in the United States and in the Great Lakes region by various federal stakeholders and riverside States. The need to carry out capital and maintenance dredging during more appropriate periods to minimize the environmental impacts is increasingly recognized. Also, different sediment disposal and enhancement techniques are being explored in relation to local environmental conditions (Great Lakes Dredging Team, 1999).

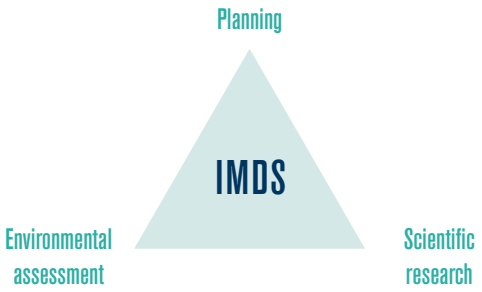
Plan for the Integrated Management of Dredging and Sediments

A working group composed of specialists in dredging and sediment issues has been set up by the Navigation Consensus Building Committee to develop an integrated management plan (Working Group on the Integrated Management of Dredging and Sediments, 2003). This plan proposes a general orientation framework that will facilitate the application of an integrated approach. The main objectives are:

1- consideration of environmental, economic, social and institutional requirements in dredging activities;

2- creation of tools to facilitate decision-making and the improvement of communications with promoters and the public.

This management plan is inspired in part by the American document The Dredging Process in the United States: An Action Plan for Improvement, produced by the Interagency Working Group on the Dredging Process (1994), but applied to St. Lawrence situations. Three orientation poles are thus proposed:



Their purpose is to:

- improve the short-term and medium-term planning mechanisms (five-year plan);
- improve interdepartmental and intergovernmental consensus building;
- make the project planning, evaluation and authorization processes efficient and predictable for the appropriate promoters;
- reduce the scientific uncertainties regarding dredging sediments;
- increase public information and participation;
- mitigate the environmental impacts.

A series of recommendations (see below) complete this plan and constitute the actions to be implemented within the context of the Sustainable Navigation Strategy.

Moreover, a master plan of the locations of the recreational boating ports on the river will be produced. Its purpose is better planning for the implementation of new recreational boating ports. It will also give priority to those with recurring problems caused by their current location. The environmental criteria, including the reduction of dredging operations on the river, will be among the factors to consider in formulating this approach. A pilot project has been identified for this purpose and should be carried out at Lake St. Pierre. Various criteria led to the selection of this site, notably the silting of the estuaries of the lake's tributaries, the low water levels observed in the past few years, which make navigation difficult, and the exceptional character of the Lake St. Pierre wetlands. This site recently was awarded the title of World Biosphere Reserve by UNESCO. The project will seek to propose an alternative to the recurring annual dredging of the navigation channels, action perceived by some as simple but not sustainable due to the special sedimentary dynamics of the estuaries in this sector. The results of this pilot project could subsequently serve as a reference for the drafting of a master plan for the entire river.

Targeted results

- Improvement of the planning mechanisms for maintenance and capital dredging activities, and sediment disposal activities, in cooperation with stakeholders in the field.
- Improvement of the consensus building within the context of the dredging project planning and authorization process.
- Reduction of the scientific uncertainties regarding dredging and sediment disposal.

Actions

Planning

- Create a planning committee responsible for providing the relevant information and directives to facilitate the preparation of regional (five-year) plans of dredging activities on the St. Lawrence.
- Produce and promote a guide to facilitate long-term planning of dredging activities and the preparation of regional dredging management plans.
- Develop a public information and awareness mechanism to facilitate the participation of the interested parties in the planning of dredging activities.
- Ensure that the planning committee works with the federal and provincial government departments and agencies responsible for pollution control (localized and diffuse).

Environmental Assessment

- Establish an advisory committee on environmental assessment for dredging on the St. Lawrence.
- Make available to the promoters, through documents, the requirements for production of impact studies for dredging projects on the St. Lawrence.
- Standardize the methods to avoid problems during application of the various dredging project environmental assessment plans.
- Promote the public's involvement within the context of environmental assessment.
- Promote communication and consensus building among the government departments and agencies responsible for the application of the various environmental assessment plans.

Research and Development

- Establish a committee for consensus building and monitoring of applied research in dredging and disposal.
- Define a set of common decision help rules for evaluation of dredging and sediment management activities.

- Define or improve the various sediment quality assessment tools, including those derived from ecotoxicology.
- Improve and develop the technologies contributing to management of contaminated sediments.
- Assess the impact of dredging and disposal activities on the fish habitat.
- Continue the St. Lawrence River modelling efforts to obtain a better understanding of the mechanisms for transport of particles and sedimentation, and improve impact assessment of dredging projects.
- Assess the potential for enhancement of dredging sediments.
- Improve the cumulative environmental impact assessment tools.
- Optimize access along the river for recreational navigation and commercial fishermen using small craft (Lake St. Pierre pilot project).

Contaminated Sediments

Context

According to the 11th Biennial Report on Great Lakes Water Quality in 2002, "Contaminated sediments are the biggest source of residual toxic substances in the Great Lakes waters and, at the same time, the most important channel for their introduction in humans" (p. 27 - translation). This concern reflects the contents of Annex 12 of the Canada-United States Agreement, which deals with the issue of virtual preventive elimination of inputs of these substances, an intervention completed by the restoration of the contaminated aquatic sites. In this regard, the port areas are recognized as problematic due to the transshipment activities that have been carried on there for several decades, and due to industrial effluent from plants located nearby.

Problem

In the early 1990s, the aquatic sectors adjacent to the main port sites designated for commerce (Sept-Îles, Baie-Comeau, Quebec City, Montreal, Trois-Rivières, La Baie, Sandy Beach) were the object of a special assessment of their degree of toxicity. Various problems were specified: heavy metals in Baie des Sept-Îles and in the approaches to the Port of Sandy Beach (Gaspé), PAH and PCBs in Baie des Ha! Ha! (Saguenay) and Baie des Anglais (Baie-Comeau), heavy metals in several aquatic sectors at the pier approaches of the Port of Montreal, Ultramar (Lévis) and the Sillery marina (Quebec City) (Gagnon *et al.*, 1997; Fortin *et al.*, 1996; Fortin and Pelletier, 1995a and b; Fortin, 1995).

This detailed review exposed the fact that certain port sectors could be recognized as critical. This is the case for Sector 103 of the Port of Montreal and Sandy Beach in Gaspé. Since there may be multiple causes of contamination, the review favoured a good corporate citizenship by various companies likely to have contributed to the contamination of the natural setting.

The active role of Environment Canada and the Comité ZIP Jacques-Cartier in East End Montreal also greatly facilitated the dialogue. This approach was productive to the extent that, in the case of Sector 103, nearly $6.4 million has been set aside for restoration work, which should materialize during Phase IV of the St. Lawrence Action Plan (Bibeault *et al.*, 2002). This initiative has had positive repercussions elsewhere and a procedure has been put in place to start the work on the Port of Sandy Beach in Gaspé.

Another problem related to contaminated sediments concerns the Lachine Canal sector, previously the industrial and commercial centre of Montreal and Quebec City. This sector was the focus of special studies in the 1990s, and partial restoration work led to its reopening for recreational boating purposes in 2002. Several thousand recreational boaters have already used the Canal during the summer season (Parks Canada, 2002). An environmental monitoring program and a detailed plan of the standards to be observed in the return of contaminated sediments to the suspended state were developed jointly by Environment Canada and Parks Canada.

Result

- Support to activities for restoration of priority port sites or recreational boating.

Actions

- Estimate the natural concentrations (background noise) of contaminants in aquatic, estuarine and marine settings.
- Characterize and formulate intervention scenarios for the contaminated aquatic sites, giving priority to those located in port zones.
- Foster implementation of solutions to problems of contaminated sites.

EVALUATE OPTIONS FOR ADAPTING NAVIGATION WITH REGARD TO THE FLUCTUATING WATER LEVELS

Context

The needs of commercial navigation are part of the water level management criteria applied by the International Joint Commission. The IJC has the mandate to resolve conflicts regarding certain uses of the boundary waters between Canada and the United States since the signing of the International Boundary Waters Treaty in 1909. To support navigation, the Canadian and U.S. Governments agreed in the 1950s on the usefulness of setting up an international waterway. After the opening of the Seaway in 1959, exploitation criteria were defined (regulation plan 1958-D) and applied starting in 1963, with the notable purpose of ensuring adequate water levels at the Port of Montreal (International St. Lawrence River Board of Control, 1997; Levels of Reference Study Board, 1993).

Fisheries and Oceans Canada. M. Plamondon

The stabilization of the water level of Lake St. François (Morin and Leclerc, 1998) and the limitation of seasonal fluctuations at the Port of Montreal (Robichaud and Drolet, 1998) were outcomes of this decision for the St. Lawrence River. Table 6 shows the water level variations for the period 1968-1995, after the winter extension of commercial navigation in the Port of Montreal. The average water level remains slightly lower than the level preceding the construction of the Seaway and the application of the Lake Ontario and St. Lawrence River regulation plan. Since regulation, the amplitude of water level variations has been generally lower than in the past (standard deviation), except for the Sorel region, where the fluctuation is in the same order of magnitude.

Table 6 | *Water Level Data (According to Reference IGLD85) for a Period Before and After Regulation of St. Lawrence River Flows*

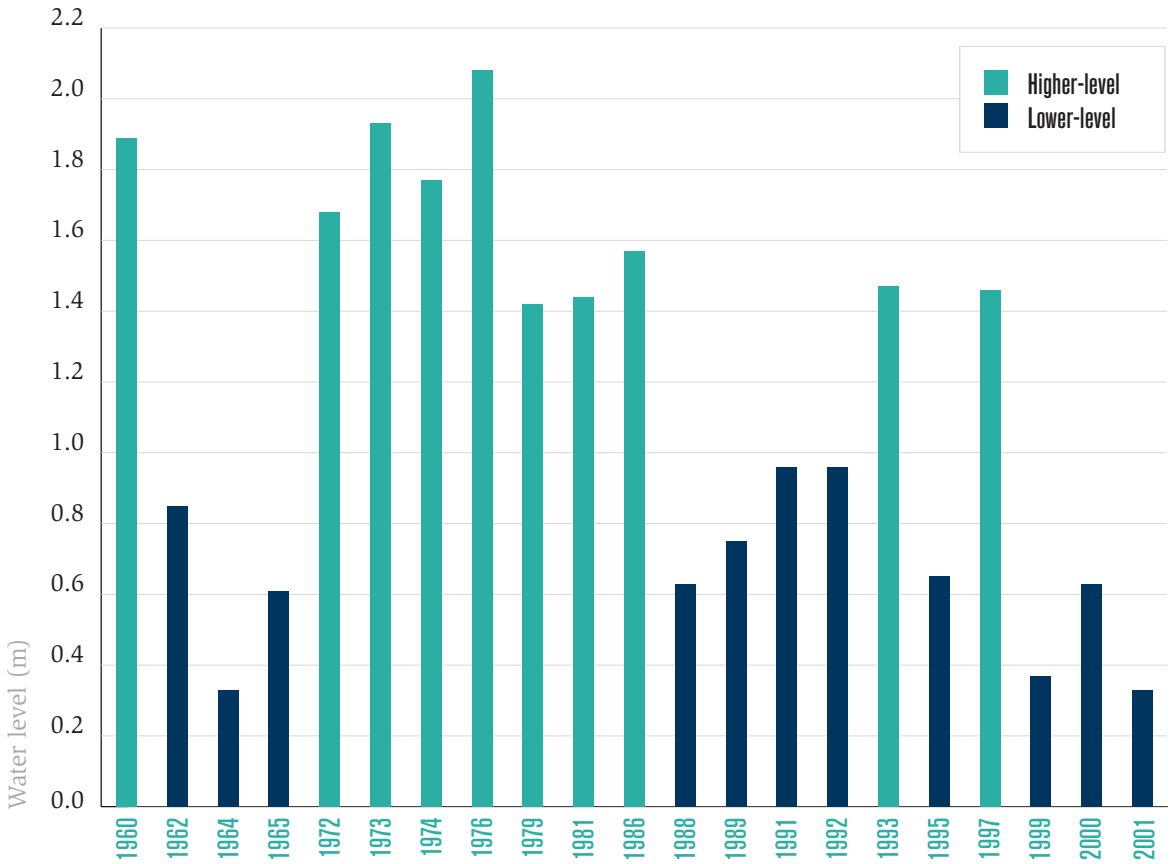
Station	1919-1946		1968-1995	
	Level according to reference		*Level according to reference*	
	Average water level *(m)*	Standard deviation of water level	Average water level *(m)*	Standard deviation of water level
Pointe-Claire	20.96	0.25	21.48	0.20
Port of Montreal	7.37	0.43	6.83	0.32
Sorel	4.99	0.25	5.07	0.25

Source: Robichaud and Drolet, 1998

Note: The levels are established on the basis of the International Great Lakes reference system datum 1985, which compares the levels at various points along the Great Lakes and the St. Lawrence.

However, flow regulation does not exert any control over climatic variations or cycles, and years with very low precipitation may influence water levels. Historically, periods of very low water levels were recorded in the 1930s and the early 1960s, and very high levels in the 1970s (Mortsch *et al.*, 2000). The sequence of higher-level and lower-level years since 1960 in the Montreal region (Figure 6) gives reason to assume the existence of a succession of ten-year cycles. However, longer-term data will be necessary to validate this hypothesis.

Figure 6 | *Sequence of Higher-Level and Lower-Level Years in Relation to the Chart Datum, Period 1960-2001, Montreal Region*



Source: DFO, 2002

An additional difficulty in the past few years is attributable to the trend to an increase in the size of ships and pleasure craft. The constant growth in size makes ships and craft potentially vulnerable during low water periods. The advent of winter navigation as far as Montreal in 1968 represents a major commercial gain and necessitates maintenance of a suitable level all year round.

Since the early 1990s, the low levels reached have been very worrying (Figure 6). These years have been particularly problematic for commercial and recreational navigation (Bergeron *et al.*, 1997; Zins Beauchesne et associés, 2001) and for certain municipal hydrants. The recent climate change prediction models forecast that flows in the Great Lakes-St. Lawrence system (fluvial waters) will diminish, which will not improve the situation.

The Mortsch model, in Table 7, estimates a 40 % decrease in flows for the St. Lawrence River. The average loss in water level would be 80 cm to 1 m of water in the Montreal region. This scenario is still recognized as plausible (International Water Uses Review Task Force, 2002), but the forecasting quality and the amplitude of the variations projected up to 2030 will necessitate constant review and validation.

Table 7 | *Flows at Montreal: Current Status and in Relation to Climate Change ($2xCO_2$), in Accordance with the Kyoto Protocol*

	1900-1990	Moderate climate change scenario *(GHG 1990)*	Difference *(%)*
Average flow (m^3/s)	8,200	5,100	- 38 %
Maximum (m^3/s)	12,800	7,600	- 40 %
Minimum (m^3/s)	5,900	3,300	- 44 %

Source: Mortsch *et al.*, 2000

Note: This concerns the Agreement for limitation of greenhouse gas emissions.

Problem

The section between Lake St. Louis and the outlet of Lake St. Pierre might be the sector where the consequences of low water levels risk being the greatest (St. Lawrence River-Lake Ontario Study Board, 1999). Upstream from Lake St. Louis, a regulation work controls the flows (Lake St. François), while downstream from Lake St. Pierre, the tides and the anticipated increase in sea levels could offset the declining levels of the freshwater section.

Commercial Navigation and Long Cruises

The low levels have the effect of limiting ship loads and reducing the profitability of trips on the St. Lawrence. The data available show a load loss of around 2000 tons, for certain cargo, per 30 cm of water. The impact of low levels is ordinarily felt around the end of the summer period, but it can exceptionally occur at other times of the year (e.g. March 1990) (Bergeron *et al.*, 1997).

The port infrastructures located upstream from Lake St. Pierre, and particularly those visited by high-draft ships, are the most likely to suffer the costs and after-effects of low levels. The competitiveness of some Quebec ports could suffer, and it is far from certain that the ports located outside the impact zones can benefit from this or take over from the ports affected. International traffic is a highly mobile sector, and competition with the Ports of Halifax, the U.S. East Coast, or even the Mississippi inland route in the United States is very intense. Hence the importance of having a good knowledge of the potential for adaptation on the St. Lawrence River. The Lake Ontario-St. Lawrence Regulation Board, under section 8 of the International Boundary Waters Treaty, tries to minimize the negative impact felt in the Port of Montreal. The review of Regulation Plan 1958D is seeking better ways to meet this objective, while considering the other uses of the environment (International Lake Ontario-St. Lawrence River Study Board, 2002).

Whether in traffic, transshipment or marine traffic costs, the issue that emerges is one of adaptation, the ability to maintain a competitive activity despite the low levels, while limiting the environmental impacts. Adaptability then involves mitigating the damage and benefiting from new opportunities that arise (Olmos, 2001). Various options are possible, and the Intergovernmental Group on Climate Change has already recognized some of them (IGCC, 2001). It should be noted the adaptability may also mean that the shipping industry will have to find new ways of using the St. Lawrence to adapt to the river's changing conditions.

Long cruises will be affected similarly by low water levels. The orientations favoured to maintain marine transport in the river section will inevitably have impacts on the natural setting and the river's various uses.

Fisheries and Oceans Canada. P. Dionne

It is important to note that no exhaustive study was conducted on the St. Lawrence and the Great Lakes regarding the potential impacts of water level fluctuations on navigation activities. Hofmann *et al.*, (1999) produced a very general picture of the potential impacts of climate change in Canada. They report that navigation would be one of the sectors affected if the water levels drop, but they do not document the anticipated effects or the potential for adaptation.

Recreational Navigation and Short Cruises

Recreational navigation and short cruises have been fast-growing sectors in Quebec for several years. Marinas, yacht clubs and other specialized services have already experienced problems related to water level fluctuations on the river. Some of these problems concern current operations, while others have the effect of reducing traffic or increasing the risks of stranding (Zins Beauchesne et associés, 2002; Boudier and Bibeault, 2001). The years 1999 and 2001 were critical in this regard.

The cruise services located in the Old Port of Montreal sector have also experienced problems related to berths, impassable routes and the decline in the number of visitors (Audet, 2001). The impacts of these two years have been felt as far as Lake St. Pierre, where other nautical services have been affected.

Fisheries and Oceans Canada. P. Dionne

Accessibility of the marinas for recreational boaters is a very serious adaptation issue, and the very viability of some marinas may be at stake. Dredging is often the preferred option for maintaining access and compensating for water level fluctuations. The poor physical location of certain marinas in high-sedimentation sectors does not help the situation and is sometimes even at the root of the problem

Adapting to Low Levels

The Navigation Consensus Building Committee has recognized the interest of questioning the impacts and adaptation of these two modes of navigation based on well documented factual elements, and of an analysis focusing on the contrasted adaptation options. In the light of this information, the Committee will be able to proceed with a more detailed analysis of the commitments to be made for the future in a sustainable development perspective.

Targeted results

- Reduction of the effects of water level fluctuations on the St. Lawrence for commercial and recreational navigation activities, and short and long cruises.
- Documentation on adaptation options that are economically and environmentally reasonable fot the St. Lawrence.

Actions

Document the technical, economic and environmental advantages and disadvantages of the adaptation options.

Commercial Navigation and Long Cruises

- Produce adaptation scenarios that exclude a physical modification of the river and others that include it, to ensure cargo and passenger transportation.
- Improve the models for predicting the water level usable for commercial shipping.
- Study the possibility of reorganizing marine transportation, intermodality and port collaboration, in a context of low water levels and competitiveness.
- Evaluate the possibilities of capital dredging at certain strategic points in the navigation channel.
- Ensure consensus validation of the results by the Committee members.

Recreational Navigation and Short Cruises

- Ensure follow-up of the studies of the International Joint Commission regarding this sector (Recreational Boating and Tourism Technical Work Group).
- Support the development of a common position on water needs for the St. Lawrence.
- Ensure integration of the problem of water levels into integrated management of dredging.

PREVENT THE IMPACT OF THE WAKE PRODUCED BY SHIPS AND OTHER CRAFT IN THE SENSITIVE SECTORS OF THE ST. LAWRENCE

Context

The erosion of the St. Lawrence shoreline is a phenomenon that varies in intensity depending on different factors, such as the nature of the materials (clay, sand, rock, etc.), the slope of the banks, the degree of exposure to erosive agents and the extent of the plant cover. Erosion has various causes: natural forces (wind waves, drifting ice, water level variations, runoff, etc.) and human forces (wake produced by ships and other craft, disturbed shorelines).

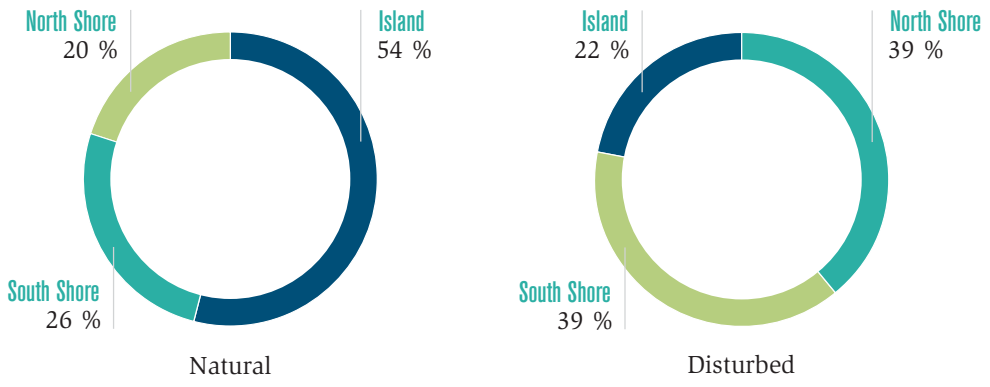
Erosion annually removes a substantial quantity of shore materials. An average volume of over 700,000 m^3 was eroded annually in 1964-1983, for the Montreal-Sorel sector alone (Dauphin, 2000). This quantity is equivalent to an average shoreline recession of 1.6 m/year for this sector. The riverside communities directly suffer the consequences of this erosion. To offset the effects in terms of loss of land, works (low walls, riprap, etc.) have been built to protect and stabilize the shoreline. Villeneuve (2001) presents a picture of the state of the disturbed and natural shoreline for the section between Cornwall and the eastern edge of Île d'Orléans, which contains 1,532 km of shoreline, including the islands. Table 8 and Figure 7 below summarize these findings.

Table 8 | *Overview of Shoreline Conditions in the Section from Cornwall to the Eastern edge of Île d'Orléans*

Shores	Length *(km)*	Disturbed *(km)*	Natural *(km)*
North	433	264	169
South	489	269	220
Island	610	151	459
Total	**1,532**	**684**	**848**

Source: Villeneuve, 2001

Figure 7 | *Percentage of Natural and Disturbed Shorelines in the Section from Cornwall to the Eastern Edge of Île d'Orléans*



Source: Villeneuve, 2001

This overview only partially illustrates the reality of certain sectors where urbanization has left very little room for natural shorelines (Table 9).

Table 9 | *Shoreline Conditions in the Cornwall–Repentigny River Sector*

Shores	Length (km)	Disturbed (%)	Natural (%)
North	130	87	13
South	188	85	15
Islands	156	67	33
Total	**474**	-	–
Average	-	80	20

Source: Villeneuve, 2001

However, downstream from Repentigny and as far as Bécancour, the percentage of natural shoreline is almost the opposite of what is found upstream from Repentigny. This is also the sector that contains the greatest number of islands (Table 10).

Table 10 | *Shoreline Conditions in the Repentigny–Bécancour River Sector*

Shores	Length (km)	Disturbed (%)	Natural (%)
North	93	38	62
South	121	47	53
Islands	359	7	93
Total	**573**	–	–
Average	–	30	70

Source: Villeneuve, 2001

The proximity of the waterway's shores exposes them to the wake caused by ships, which may prove to be the dominant erosive agent under some conditions.

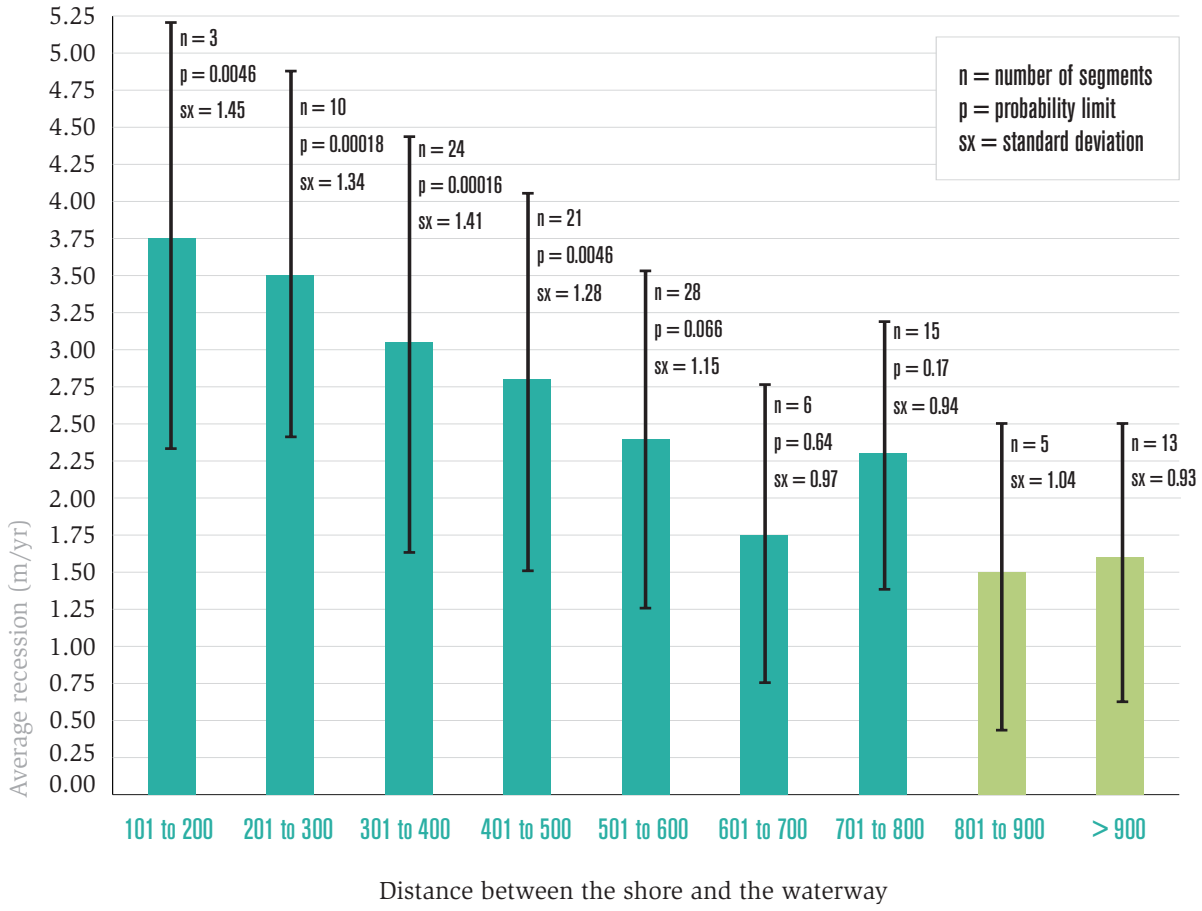
Problem

The wake is the beating of the waves against a watercourse's shores, produced by the deadwater of ships and other craft and causing shoreline erosion. The amplitude of the wake varies according to the speed of the ship, the shape of the hull and the tonnage transported. The erosive effect on the shore closely depends on the distance between the ship and the shore. The report of the advisory committee on nautical safety and the quality of life on Quebec lakes and watercourses (Boucher Report - Comité de consultation sur la sécurité nautique et la qualité de vie sur les lacs et cours d'eau du Québec) has emphasized the concern of riverside communities regarding shoreline erosion caused by the passage of commercial shipping on the St. Lawrence.

By comparing different distances from the waterway to the shore, it has been shown that wake erosion could be preponderant up to a distance of 800 m (Dauphin, 2000). Beyond this distance, the wake effect becomes negligible (≈ 10 %), and other factors, including wind waves, have the main impact in shoreline erosion (Figure 8). Even though shoreline erosion is, in fact, caused by the combined action of different factors, which are difficult to quantify

individually, isolating one of these factors (the distance between the waterway and the shore) allowed a direct estimate of the significance of the wake. Commercial navigation impact, for the period 1964-1983, would have been responsible for no more than 60 % of the erosion noted on one specific shore (Dauphin, 2000). In the archipelagoes between Montreal and Sorel, the contribution of ships to erosion for the period 1983-1997 ranged between 36 % and 58 %, depending on the segment. Table 11 allows an evaluation of the number of kilometres of shorelines located in the sensitive zone of the waterway, i.e. at a distance less than 800 m from the waterway. This table clearly illustrates that the Montreal-Sorel sector, regardless of the importance of the other sectors, is the most likely to suffer the greatest wake wave-related loss.

Figure 8 | *Effect of the Distance Between the Shoreline and the Waterway on the Average Annual Shoreline Recession in the Montreal-Sorel Sector for the Period 1964-1983*



Source : Dauphin, 2000; adaptation, Navigation Consensus Building Committee, 2000

Table 11 | *Shoreline Erosion Length Attributable to Commercial Ships for the Different Sectors of the Cornwall-Montmagny Section*

Sector	Total length of shoreline	Erosion length	Erosion length in communication with the waterway ≤ 600 m	Erosion length in communication with the waterway 800 m	% of shoreline in erosion in relation to the total in erosion in the Cornwall–Montmagny section	% of shoreline in erosion in relation to the total length of the sector's shorelines	% of shoreline in erosion ≤ 800 m in relation to the total shorelines in erosion ≤ 800 m in the Cornwall–Montmagny section	% of shoreline in erosion ≤ 800 m in relation to the erosion length in the sector
	(km)	*(km)*	*(km)*	*(km)*				
Lake St. François		122.36.6	0	0.03	1	5	0.04	0.5
Lake St. Louis	306.7	35.7	2.4	1.0	8	12	5.1	9.5
Montreal-Sorel	605.1	293.4	46.4	11.3	67	48	85.7	19.7
Lake St. Pierre	91.9	6.6	0.1	0	1	7	0.1	1.5
Lake St. Pierre – Quebec City	322.4	51.7	2.1	0.8	12	16	4.3	5.6
Quebec City – Montmagny	148.5	46.6	0.04	3.1	11	31	4.7	6.7
Total	**1,596.9**	**440.6**	**51.1**	**16.2**	**100**	**28**	**100**	**15.3**

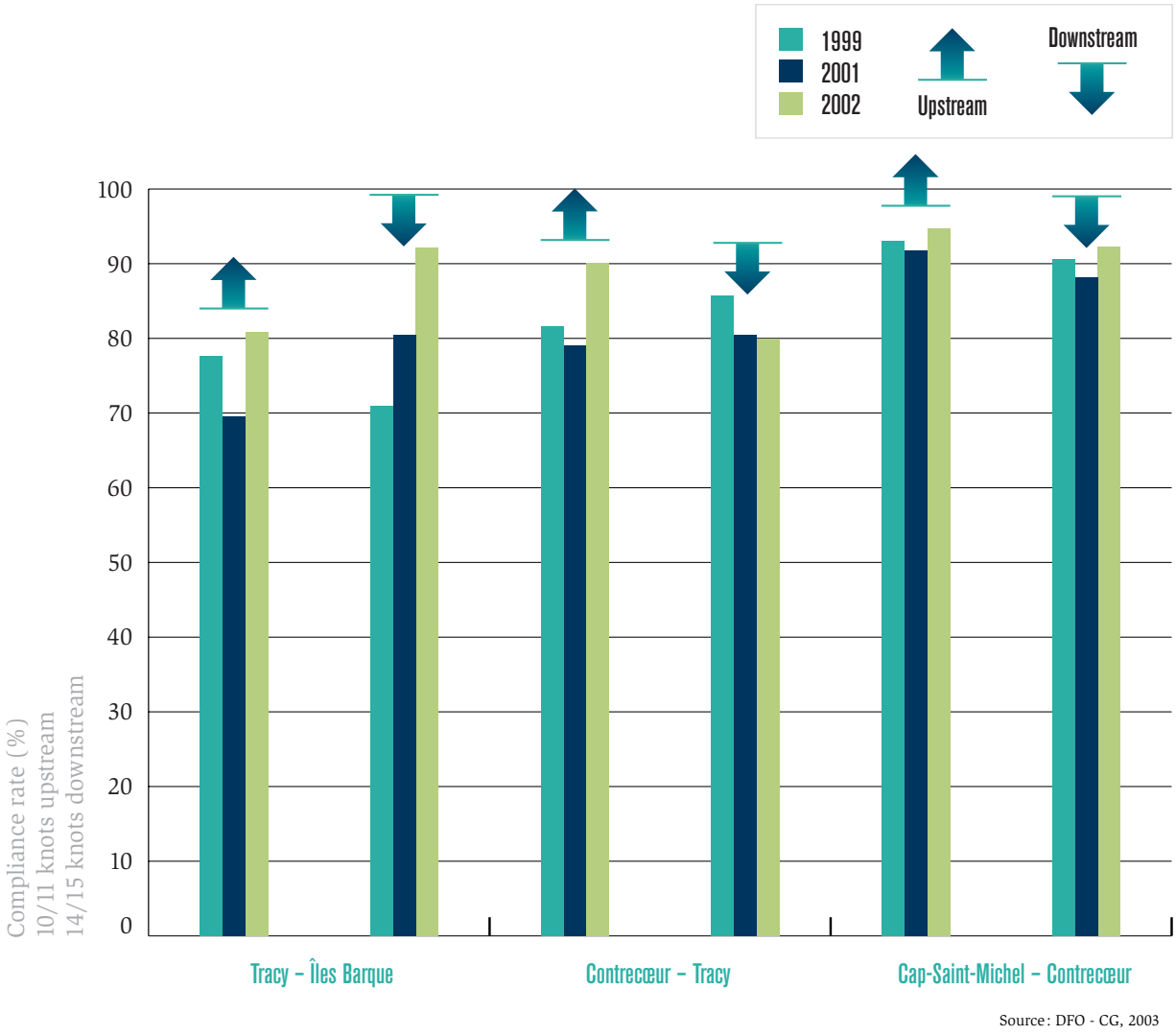
Sources: Dauphin, 2000; adaptation, Navigation Consensus Building Committee, 2003

Total length of shorelines and length of shorelines in erosion: ARGUS (1996)

Erosion length ≤ 600 and ≤ 800 m in communication with the waterway: calculated from the ARGUS charts (1996)

In fall 2000, this sector's fragility led the shipping industry to adopt a voluntary speed reduction measure over a distance of nearly 25 km between the Sorel Archipelago and Varennes. This measure encourages ships not to exceed a speed of 10 knots (18.5 km/h) upstream and 14 knots (26 km/h) downstream. The speed was established in consideration of certain safety aspects, including ship maneuverability. Since it came into force, the rate of compliance with this directive is relatively satisfactory, ranging from 70 % to 94 % depending on the sector and the year. Figure 9, among others, illustrates that the measure seems easier to apply when ships are heading downriver than when they are traveling upriver. Even though the compliance rate remains high after two years of application, a slight decrease is observed in almost all sectors in 2002. Monitoring in 2003 will make it possible to verify whether this is a new trend and take the appropriate remedial measures, if applicable. Figure 9 also indicates that the speeds initially adopted affected less than 30 % of the ships passing through this sector of the St. Lawrence.

Figure 9 | *Compliance Rate of Commercial Ships with the Speed Reduction Measure in the Sorel Archipelago –Varennes Sector*



Source: DFO - CG, 2003

Preliminary data (Lehoux, 2002) regarding the impacts of this speed reduction measure on shoreline erosion show a positive balance after two years of monitoring (Table 12).

Table 12 | *Preliminary Data on the Variation of Shoreline Erosion in the Sorel Archipelago Section Following the Implementation of the Voluntary Speed Reduction Measure for Commercial Ships*

Year	Reference*		Experimental**		Impact
	Number	*Recession (m/year)*	*Number*	*Recession (m/year)*	*(%)*
1999-2000 (before)	5	0.83	29	0.85	–
2000-01 (after)	5	1.54	29	0.53	-66
2001-02 (after)	5	0.96	27	0.70	-27

Source: Canadian Wildlife Service, 2002

*Notes: Reference, shoreline settings affected by ships but not subject to the speed reduction program.

**Experimental: shoreline settings affected by ships and subject to the speed reduction program.

Longer-term monitoring, with an increase in the number of monitoring stations, will be necessary for a more precise quantification of the impact of the wake attributable to ships. However, these preliminary data allow us to observe that the wake plays a significant role in shoreline sections subject to similar hydrological (water level) conditions.

Recreational navigation is also suspected of contributing to shoreline erosion in its own way, and measures will have to be developed so that recreational boaters play an active part in reduction of the impacts they are likely to cause. Even though no quantitative data exist to measure the scope of the impact of recreational navigation in the problem of erosion, quantitative observations give reason to believe that the Lake St. Pierre channels would be particularly sensitive to the high-seed passage of craft (Dauphin, 2000). However, the problem is more subtle regarding pleasure craft, because speed reduction is not the only way – or in some cases the best way – to reduce the wake. In fact, some craft produce less waves at high speeds, due to hydroplaning, than at low speeds. The shape of the craft is predominant in this case, and an effective measure applicable to all recreational boaters will have to be explored.

Targeted results

- The environmental effectiveness of the voluntary speed reduction measure for commercial shipping is reviewed.
- Knowledge of the impact of erosion attributable to pleasure craft is improved.

Actions

To mitigate shoreline erosion by the wake produced by ships and other craft, the Strategy recommends implementation of the following actions:

- continue environmental monitoring to reduce the speed of commercial shipping and improve the methodology;
- maintain the current speed reduction measure in the Sorel Archipelago–Varennes sector;
- document the impact of pleasure craft on shoreline erosion;
- document the impact of the wake produced by ships on human safety;
- provide recreational boaters with awareness tools. For example, integrate mapping of erosion-sensitive zones into the raster charts of the Canadian Hydrographic Service.

IMPROVE MANAGEMENT OF SEWAGE DISCHARGES AND CARGO RESIDUES FOR ALL TYPES OF SHIPS AND CRAFT

Context

Sewage refers to all liquid discharges produced on ships and pleasure craft. It is divided into two categories:

- *black water:* discharges from toilets, urinals and medical sinks;
- *grey water:* discharges from washing machines, dishwashers, showers, bathtubs, etc.

Regulations exist concerning the discharge of black water by commercial vessels on the Great Lakes, but its application does not extend to the waters downstream from the St-Lambert Locks. Concerning pleasure craft, the Ontario provincial regulations prohibit the discharge of sewage into this province's waters. There are also two regulations under the CSA (Canada Shipping Act), which make it possible to determine where sewage discharge is deemed to be inappropriate. It is up to the different provinces to hold consultations with communities and then submit recommendations to Transport Canada and Fisheries and Oceans Canada to have the regulations amended (Pleasure Craft Sewage Pollution Prevention Regulations and Non-Pleasure Craft Sewage Pollution Prevention Regulations). The Western provinces have used this legislation to prohibit discharges on certain bodies of water in their respective territory. These regulatory differences lead some commercial and recreational navigators to adopt behaviour on the St. Lawrence that is not in harmony with environmental hygiene. Mobile sewage collection units exist in the ports (Villeneuve and Quilliam, 2000), and user fees are charged. The same principle applies for equipped marinas. In a context of non-regulation, these charges may appear dissuasive and the land facilities can easily be avoided.

In places where direct discharge into the water is prohibited, as in Ontario, Manitoba, British Columbia and certain U.S. states, control measures are prescribed in the regulations, obliging recreational boaters to have a tank with a seal on the discharge valve. The seal is broken only when the tank is emptied. Breaking the seal under any other circumstances automatically results in a fine.

For ships engaged in international trips, the IMO has instituted Annex IV of the MARPOL Convention. Ships registered in the signatory countries of Annex IV undertake not to discharge untreated sewage within 12 miles of the coast. Within this 12-mile limit, discharges of disinfected or treated sewage are permitted under certain conditions. It should be noted that some ocean liners are equipped with secondary and tertiary sewage treatment facilities.

Contrary to liquid discharges, the Canada Shipping Act prohibits the discharge of solid waste (kitchen waste, paper, glass, plastic, metal, etc.) into Canadian waters, within the 200 nautical mile limit.

Problem

No study has been conducted on the St. Lawrence concerning the volume of liquid waste produced by the commercial and recreational fleet, and the quantity directly discharged into the water (Villeneuve and Quilliam, 2000). However, a study produced by the Swedes in 1994 gives us an order of magnitude of the related environmental impact. They estimated that a fleet of 195,000 pleasure craft produced a volume of untreated sewage, during the two-month summer season, equivalent to the annual discharges of a population of 32,500 inhabitants (SEPA, 1994). The bacterial pollution associated with this type of discharge is very high and may include pathogens with harmful effects on human health and aquatic fauna. The U.S. Environmental Protection Agency has estimated that bacterial pollution from the fecal coliforms produced by the discharge of one pleasure boat's untreated sewage during one weekend was equivalent to the treated discharge of a population of 10,000 people during the same period (EPA, 2001). Estimating the population of recreational boaters on the St. Lawrence at a little over 500,000 people (Dewailly *et al.*, 1999), we can readily imagine the environmental impact of unsound practices and a shortage of collection units. The best intentioned recreational boaters report that it is particularly difficult to respect the environment downstream from Quebec City, where there are few collection units and the distance separating them is greater (sectorial consultations, Navigation component, March 2002). We must point out in this regard that, during these sectorial consultations, recreational boating representatives themselves mentioned that a regulation for the river, in line with those of the Great Lakes and the United States, would be the most appropriate way to address this problem. The same reasoning could also extend to the commercial sector.

Cargo Residues

Ore, grain and other materials are loaded into the holds of cargo vessels. When a ship changes this type of cargo, the holds are cleaned, meaning that they are swept and washed with water to avoid possible cross-cargo contamination. In some circumstances, it is permissible to discharge the hold sweepings and wash water into the sea. No data exist concerning the quantitative significance of this practice on the St. Lawrence, but the toxicity level of certain materials and the disruption of wildlife habitats by the accumulation of deposits have impelled the authorities to regulate this practice to mitigate its impacts.

An Enforcement Policy for Cargo Residues on the Great Lakes has existed since the early 1990s (Melville, 1993). This policy is reviewed and modified regularly in consultation with the scientific community, industry, environmental groups, Fisheries and Oceans Canada, and the USCG. The Lake Carriers Association and the Canadian Shipowners Association have established their own cargo sweepings cleanup guidelines for their members.

Port of Quebec

Port of Quebec

In the mid-1990s, Transport Canada formed a working group to study the situation on the
St. Lawrence. Referring to common practices on the Great Lakes, the working group drew up interim guidelines. These guidelines concern unregulated substances that do not have dangerous chemical properties and for which the principal effect on the aquatic environment is to form deposits on sea beds (Transport Canada, 2001). The proposed policy governs the disposition of the subject substances as follows.

1- Prohibition of any discharge in ports.

2- Discharge of bulk cargo residues and wash water is authorized east of Les Escoumins when the ship is under way and is more than three nautical miles from the nearest shore. However, it is recommended to use the land collection units.

3- Only wash water may be discharged into the environment west of Les Escoumins when the ship is under way. This provision is subject to conditions of application such as sweeping and storage of residues to avoid their direct discharge into the water.

4- The person responsible for cleanup operations must ensure, by visual observation, that no marine mammal is located within one kilometre of the ship during operations to discharge cargo residues into the environment.

It should be noted that, in each of these cases, the recommended option is to dispose of the residues in land collection units.

Targeted results

- More environmentally-friendly management of bulk cargo residues of ships.
- Better control of sewage discharges of all types of ships and craft.

Actions

This issue must be resolved by raising awareness, but also by regulation. The Strategy proposes to work on these two fronts simultaneously:

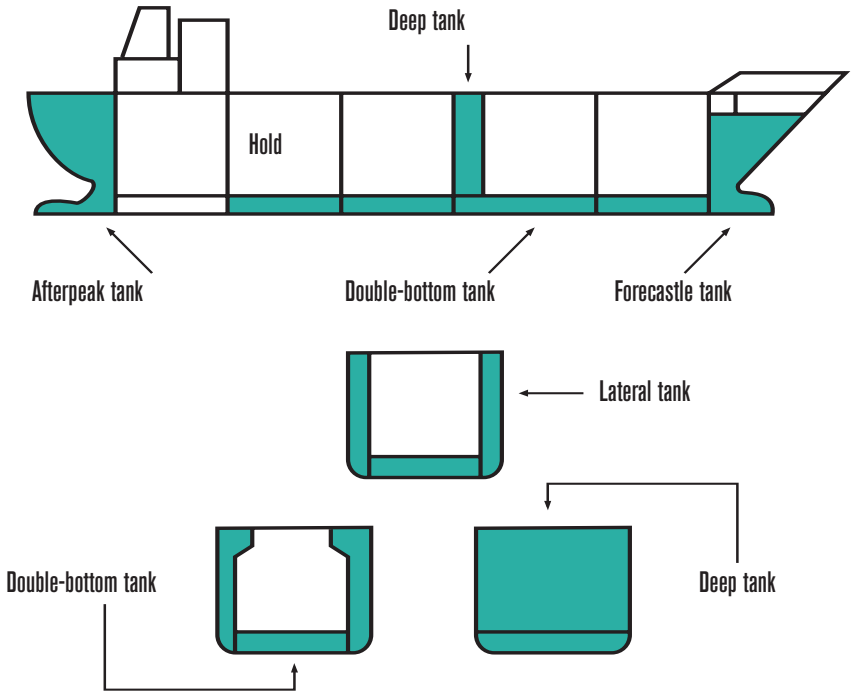
- inventory polluting materials and collection and treatment systems;
- draft and implement control procedures;
- harmonize management of discharges of sewage and cargo residues with Great Lakes practices.

REDUCE THE RISKS OF INTRODUCTION OF EXOTIC ORGANISMS BY BALLAST WATER FOR ALL TYPES OF SHIPS

Context

Ships began to use water as ballast around the 19th century with the advent of steel hulls. By offering advantages that other types of ballast, such as iron and rock, found it difficult to equal, water became the only ballast used by ships. The water is loaded into tanks (Figure 10) and serves to improve their stability and draft, and to balance the weight of partial loads.

Figure 10 | *Location of Ballast Water Tanks on Ships*

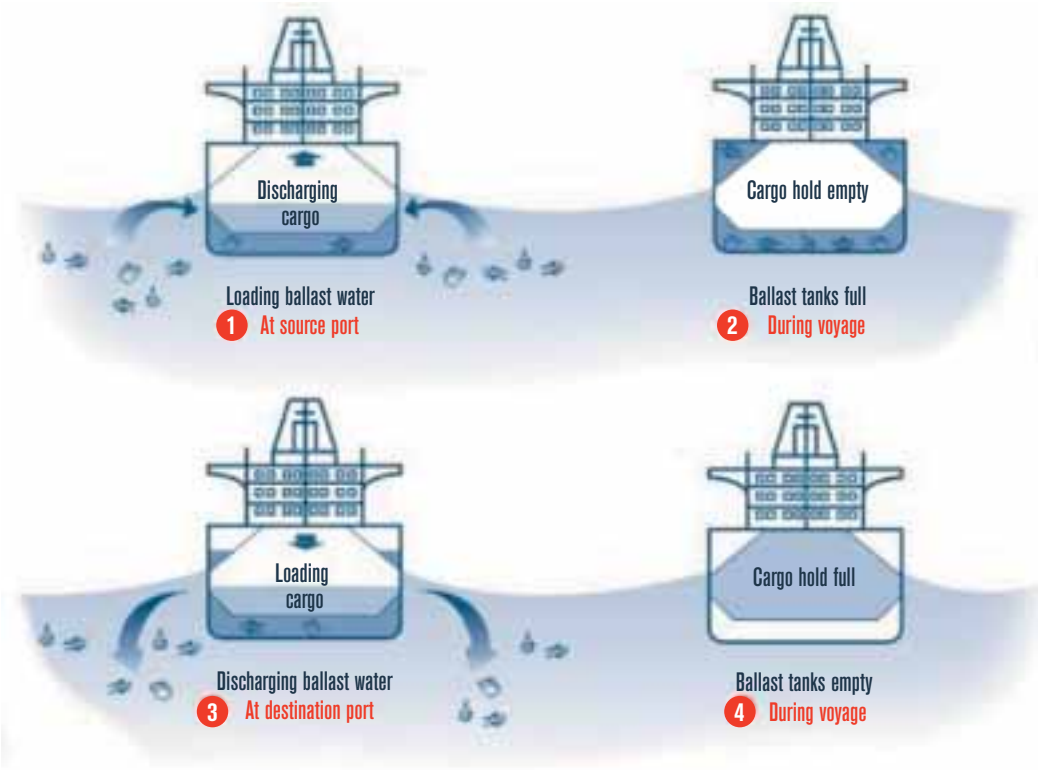


Water is taken on during unloading and discharged while loading cargo in port. For reasons of stability, ballast can also be taken on while under way. These adjustments during the voyage are necessary to compensate for the effects of fuel and drinking water consumption, or to allow the ship to navigate in more confined or ice-encumbered waters. By proceeding in this manner, ships not only take on water, but also organisms (Figure 11) present in that water, as well as sediments when the water is not deep enough, and transport them to the port of destination. The natural boundaries between organisms, such as water temperature, which prevented migration from place to place, have thus been breached. In 1993 and 1997, the International Maritime Organization (IMO) adopted guidelines that changed this practice for the member countries.

The use of water as ballast, combined with the attachment of organisms to ship hulls, has contributed to make marine transportation one of the main factors for dissemination of aquatic organisms on the planet and has been qualified by the IMO as one of the four greatest threats to which the world's oceans were exposed.

It took negative ecological and economic consequences, such as the introduction of the zebra mussel into the Great Lakes and the St. Lawrence in the 1980s, for the international community to pay attention to such invasions.

Figure 11 | *Illustration of Ballast Water Loading and Discharging*



(Note: The tanks are never completely drained and residual sediments and water remain.)
Source: IMO, 2003

roblem
Problem

The IMO estimates that 3 to 5 billion tons of ballast water are transported annually between countries and that a similar quantity is transported by local and regional traffic. This means that at least 7,000 different species, including human pathogens (Ruiz *et al.*, 2000) are potentially displaced in this manner.

In the St. Lawrence and Great Lakes ports, Bourgeois *et al.*, (2001) estimated that slightly more than 28 Mt of ballast water was transported in 1996 by foreign ships. The number of introductions of foreign species by this vector is difficult to quantify precisely, although an introduction rate of one species per year is assumed for the Great Lakes over the past 80 years (de Lafontaine, 2002). An in-depth review of the species introduced into the St. Lawrence-

Great Lakes basin inventoried some 163 species introduced over the past two centuries, including 85 for the St. Lawrence (de Lafontaine, 2002). However, it must be emphasized that the introduction vector is not specified here and that it is very difficult to prove the role played by ballast water beyond any doubt (Gauthier and Steel, 1996). Most of these species, i.e. 90 %, were reported for the first time in the Great Lakes, while 10 % were reported in the St. Lawrence (de Lafontaine, 2002), thus proving the possibilities of transfer between the two hydrological systems.

S. van Mechelen

The zebra mussel

The survival rate of the organisms present in ballast water and sediments decreases with the ship transit time (Harvey *et al.*, 1999), and most will not adapt successfully to their new environment. However, the most resistant can accomplish this and colonize the new territory to the detriment of indigenous species. The ecological and economic costs of this dissemination are considerable. For example, the economic impact of the introduction of the zebra mussel in the Great Lakes, where it has an occupation density of up to 200,000 individuals/m^2 (Mackie, 1991) – even though it does not seem to have significantly exceeded 20,000 individuals /m^2 in the St. Lawrence (Villeneuve and Quilliam, 2000), is estimated on the Canadian side at between $70 million and $120 million for the period 1989-1995 (Wiley, 1997). On the American side, control measures have required expenditures of over US$1 billion since 1989, and it is forecast that the damage caused to infrastructures and the associated control costs will require annual investments of around US$100 million in the years ahead (Casale *et al.*, 2001).

The consequences of these introductions vary along the St. Lawrence, and the marine part of the river still seems to be free of invasion. There are currently no notable impacts documented for the marine St. Lawrence directly attributable to the transport of ballast (Bourgeois *et al.*, 2001).

In 1989, recognizing ships as introduction vectors, countries faced with chronic invasions, including Canada, Australia and the United States, put pressure on the IMO for the application of remedial measures. The IMO adopted guidelines in 1993 and improved them in 1997. Essentially, these guidelines proposed a set of measures that would reduce the risks of introduction, including exchanging ballast water at sea. This practice assumes that the organisms originating from coastal and freshwater habitats will not survive under the environmental conditions present offshore. Moreover, the new water taken on at sea will contain a lower biomass, reducing the chances of survival when discharged in port. Applied on a voluntary basis, these guidelines account for safety imperatives for exchanges at sea, which can only be practiced under favourable weather conditions.

Canada and other countries did not wait for the IMO's response to establish control measures. Voluntary Guidelines for the Control of Ballast Water Discharges from Ships Proceeding to the St. Lawrence River and Great Lakes were adopted in 1989, in cooperation with the shipping industry. Essentially, the purpose of these guidelines was for ships coming from a foreign port and for destinations west of the 63rd meridian of west longitude to change their ballast

offshore at a depth exceeding 2,000 m, outside any continental influence. An alternative exchange zone, the part of the Laurentian Channel located east of the 63rd meridian of west longitude, is also proposed when conditions do not allow a safe exchange at sea and when the depth at this location is greater than 300 m. The compliance of foreign ships with this measure was difficult to evaluate, because only a verbal check certified the information provided when the ships entered Canadian waters.

These guidelines were replaced in 2000 with Guidelines for the Control of Ballast Water Discharges from Ships in Canadian Waters. The enforcement of these guidelines remains voluntary, but their application now extends to all Canadian waters. The requirements for ships to produce a written report indicating the location of ballast exchange, among other information, is maintained. Regulations are currently being drafted for the purpose of harmonization with the American authorities, who already force ships bound for the Great Lakes to submit to mandatory measures.

Exchanging ballast water does not completely solve the problem of introduction of exotic species, but contributes to its mitigation nonetheless. In fact, since the guidelines came into force in 1989, no new species with ballast water as its introduction vector has been found in the St. Lawrence. However, ballast exchange at sea is a short-term solution that is currently under review by the IMO.

Parallel research is in progress to develop treatment systems that could be installed aboard ships. Four approaches are being considered:

- mechanical treatment by filtration and separation;
- physical sterilization treatment by ozone, ultraviolet light, electric current, heat;
- chemical treatment by addition of biocides to ballast water to kill the organisms;
- varied combinations of these three treatments.

These systems must achieve a higher neutralization or elimination level than exchange at sea. Their implementation aboard ships is difficult, however, and conditional on ship design and the following normative criteria (IMO):

- safe;
- environmentally acceptable;
- cost effective;
- operative.

Targeted result

The risks of introduction of exotic organisms are significantly reduced for all types of ships.

Actions

Considering that a regulation is currently being drafted, the Strategy seeks to consolidate and improve the current practices and increase recreational boaters' awareness of the problem of dissemination:

- enforce the current guidelines;
- increase awareness of recreational boaters and the shipping industry to the problem of dissemination;
- monitor the effectiveness of ballast water exchange in port areas;
- establish a decision help model for exchanges in the alternative exchange zone, i.e. the Laurentian Channel;
- monitor the effectiveness of other control methods.

COLLABORATION OF RIVERSIDE COMMUNITIES IN THE EVENT OF HAZARDOUS PRODUCT SPILLS AND OPTIMIZATION OF RESPONSE METHODS IN THE EVENT OF OIL SPILLS

Context

Since the Exxon Valdez accident in 1989, several countries, including Canada, have reviewed the supervision of marine activities to avoid this type of disaster or mitigate the consequences. A public review panel (Brander-Smith Report) on tanker safety systems and marine spills response capability was set up in Canada in 1989 to review the control and response methods for bulk transport of oil and chemicals. This committee presented 107 recommendations, which led to the adoption in 1995 of new regulations and a new national preparedness and response regime in case of marine oil spill. This regime is financed and managed by the private sector. Its purpose is to ensure that the industry has appropriate means to clean up its own spills, under the authority of the Canadian Coast Guard. The designated ships and oil handling facilities must enter into agreements with one of the four private response organizations approved by the CCG to ensure a response capability of 10,000 t (DFO, 2002). The CCG also maintains a significant response capability that can serve as a safety net.

Parallel to the establishment of the new system, the emergency response community in Quebec instituted two series of community exercises, within the context of the National Exercise Program. One of them, called Prevention, has been held every year since 1990. The private sector, generally an oil company present in Quebec, acts as the leader for the exercise. A preparation committee coordinated by the CCG works several months a year on preparing this exercise. It may last three days, with the participation of several hundred stakeholders. Among other things, it improves response practices and increases the awareness of the staff of companies involved in handling oil. This initiative allows complete cooperation with local and national organizations, as recommended by the Royal Commission of Inquiry set up after the sinking of the Arrow in 1970. It should be noted that this accident was the starting point of environmental protection in Canada.

In addition, a Community Action Program (CAP) was set up by the CCG in cooperation with the provincial government and the riverside municipalities. The main objective is to integrate a marine component into the emergency plan of the riverside municipalities concerned, focusing on the risks of oil spills. This program particularly emphasizes the means of preparedness to be implemented, which will facilitate and speed up the work of the response teams. The CCG is also part of a Regional Advisory Committee on Oil Spill Response, which has the purpose of sharing information concerning these important issues. This Committee may formulate recommendations to the CCG Commissioner regarding matters related to the improvement of the strategic response framework in the event of a spill, so as to protect the public interest and mitigate the economic and environmental repercussions of these incidents. It is composed of representatives of the marine transportation industry, operators of oil handling facilities and emergency response or general public interest organizations.

Besides the improvement of response methods, tightening of port authority control of ships has contributed to better targeting the ships considered to be at risk (Table 13).

Table 13 | *Comparison of Ships Inspected, Exhibiting Deficiencies and Detained in Canada in the Period 1995-2000*

Year	1995	1996	1997	1998	1999	2000
Inspections	1,348	1,184	1,011	1,191	1,076	1,070
Exhibiting deficiencies	692	568	470	587	563	583
Detentions	149	118	118	142	125	103
Deficiencies/ Inspection (%)	51.3	47.9	46.4	49.3	52.3	54.5
Detentions/Inspection (%)	11.1	9.9	11.7	11.9	11.6	9.6

Source: Transport Canada, Marine Safety, 2000; modification: Navigation Consensus Building Committee, 2003

The first three lines of this table indicate the variations in the number of inspections, deficiencies (minor problems) and detentions (major problems),while the last two lines make it possible to verify whether the reduction in the number of deficiencies or detentions is attributable solely to a decrease in the number of inspections. Even though the number of inspections dropped by nearly 20 % in Canada between 1995 and 2000, the proportion of deficiencies and detentions in relation to inspections remained practically unchanged. The improvement of the quality of inspections over the past few years, more specifically targeting the ships at risk, can be put forward as an explanation for this situation. The picture for the Quebec Region is more difficult to establish, because the only statistic available is the number of inspections per port.

Despite the increase in the effectiveness of inspections, it remains worrying to note that certain shipowners are not more aware of the importance of maintaining their ships.

Thanks to the various measures put in place, the St. Lawrence has been relatively spared by major spills in terms of the number of tons spilled over the past ten years. The latest major spill occurred at Havre Saint-Pierre in 1999 and came from a ship traveling in inland waters. A strong gust of wind struck the ship, which banged into the pier, cracking the hull and releasing about 49 tons of heavy oil (Ship-source Oil Pollution Fund, 2002). Recovery of the oil took several months under difficult conditions, since the shores were still covered with ice.

The other major spills occurred in the 1980s (Table 14).

Table 14 | *Major Spills on the St. Lawrence in the 1980s*

Ship	Year	Location	Tons spilled
Rio Orinocco	1990	Island of Anticosti	260
Czantoria	1988	Saint-Romuald	100 to 400
Barge *Pointe Lévy*	1985	Matane	200

Source: DFO - CG, 2002




Fisheries and Oceans Canada.

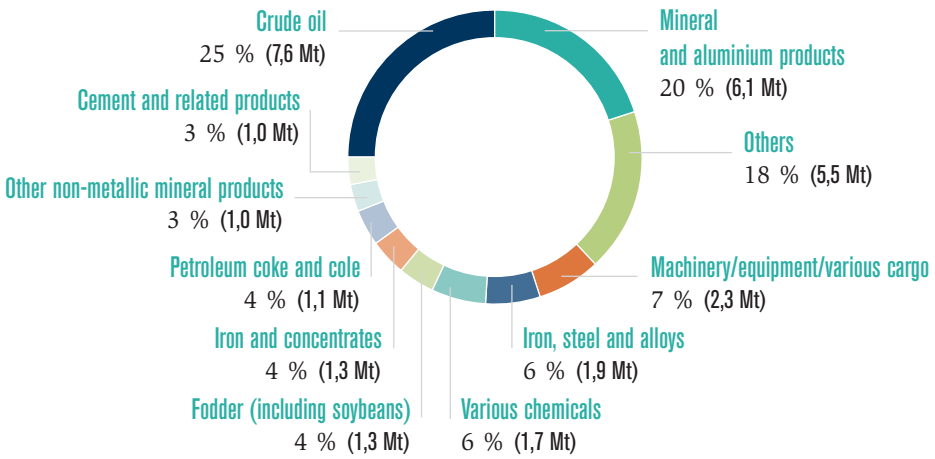
By way of comparison, the amount of oil from anthropogenic sources discharged into North American coastal waters and attributable to marine transportation would account for only 9 %, according to a National Academies study (2003). The quantity of product spilled is one of several factors serving to qualify the importance of a spill. The nature of the product, the location of the spill (urban area, ecologically sensitive area, aquaculture site), the season and weather conditions are all factors that may convert a spill of limited quantitative importance into a major spill. The time needed for an impacted site to recover its pre-disturbed status is also variable. A recent study showed that organisms took from 2 to 10 years to regain their initial status after the Exxon Valdez incident (Dean and Jewett, 2001). In Quebec, the CCG carries out 25 to 35 environmental responses per year, concerning commercial vessels, pleasure craft, terrestrial discharges and spills of still unknown origin.

It is important to point out that, during a major spill, there may be a considerable need for labour to recover the spilled products. There is currently no official training program for volunteers that would enable them to provide auxiliary support to the technical teams. This deficiency could prove critical in an emergency, which is why it is necessary to find means to remedy it.

Problem

Based on the density of marine traffic and a recurring statistical probability, it is estimated that a catastrophic spill (> 10,000 t) could occur every 15 years in Canada (Brander-Smith, 1990). Even though international conventions and national regulations increasingly regulate marine activities, the risk of such an incident still remains present on the St. Lawrence. The types of cargo transported and the volume of ship propulsion fuel explain this risk. In fact, crude oil heads the list of international cargoes unloaded in Quebec (Figure 12) and its handling is mainly concentrated in the Port of Quebec (7.6 Mt). The specific location of the pier, across from Quebec City, induced Ultramar to require that the oil tankers serving it be double-hulled. A high-quality environmental response plan was designed by the company and was recently added to the array of safety measures.

Figure 12 | *International Freight Unloaded in Quebec, Top Ten Commodities, 2000*



Source: Statistics Canada, compilation by DFO

In addition to oil, many chemicals pass through the St. Lawrence. These products are transshipped in about ten ports or at docks located along the St. Lawrence, the Saguenay and the Seaway (Table 15).

Table 15 | *Quantity of Chemicals Transshipped at Quebec Ports/Docks*

Port/Dock	Annual Quantity *(metric tons)*
Seaway (Montreal – Lake Ontario)	696,974
Quebec City	583,000
Montreal	270,963
Gaspé	207,529
Baie des Ha! Ha!	162,611
Trois-Rivières	151,000
Saguenay	30,000
Baie Déception (Raglan)	14,600
Port-Cartier	5,552
Valleyfield	3,700
Cap-aux-Meules	493,3

Source: DFO - CG, 2001

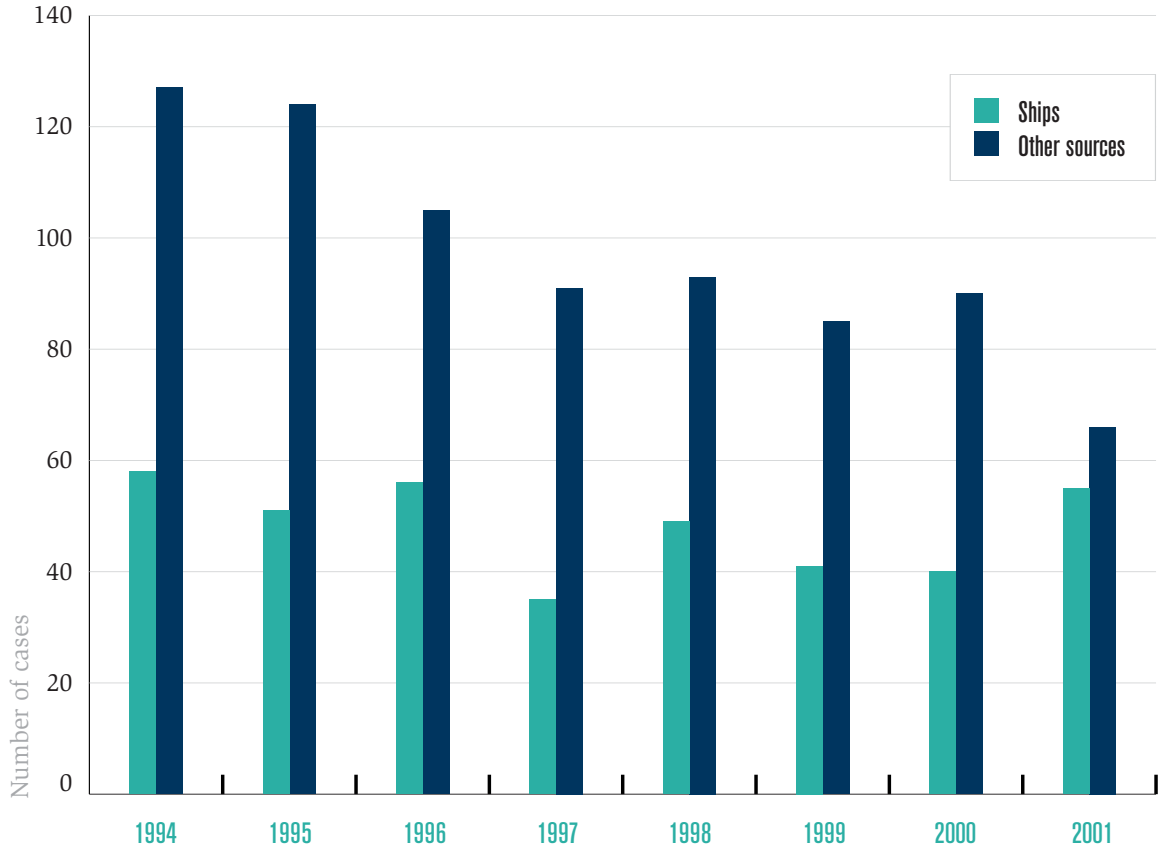
The degree of toxicity of these products and their physical properties, whether in deposit, flotation or dissolution, are variable and add a component of complexity to risk management. The U.S. Coast Guard has estimated that cleanup of chemical spills costs an average of 10 times more than cleanup of oil spills and may take up to 5 times longer (Brander-Smith, 1990).

In addition to the cargo they carry, ships have a significant quantity of fuel on board for their own propulsion. In many cases, this quantity is equivalent to or greater than the volume carried by small tankers and constitutes a potential risk proportional to the number of ships in transit on the river.

The proximity of inhabited environments to the waterway accentuates this territory's sensitivity.

In Quebec, an annual average of fifty cases of pollution involving ships were reported for the period from 1994 to 2001 (Figure 13). However, the number of cases in which the origin of the pollution is terrestrial or unidentified is greater than the number that can be linked to ships, although constantly declining since 1994. However, as pointed out previously, not all cases of pollution necessitate an environmental response. The "unidentified" category may also include ships for cases where it was impossible to link the incident to a specified source.

Figure 13 | *Number of Cases of Pollution from Ships and Other Sources (Terrestrial and Unknown) for the Period 1994-2001*



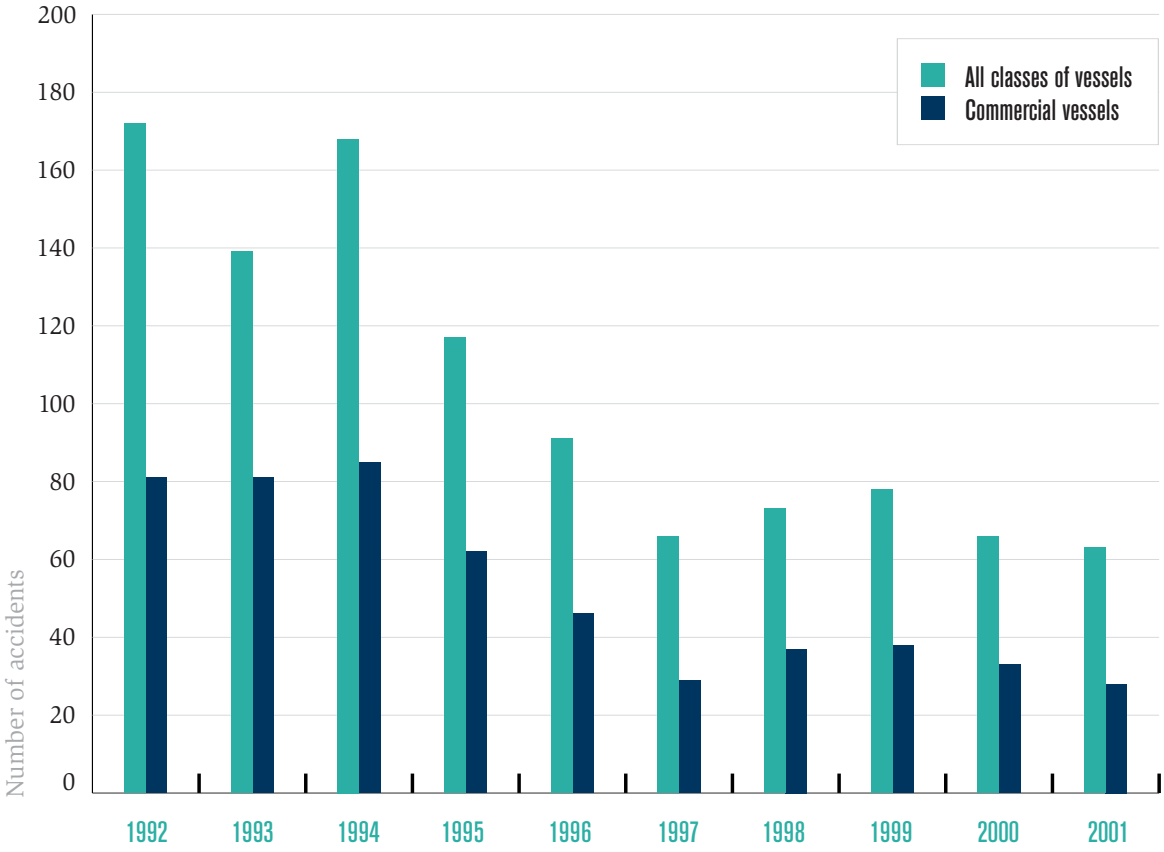
Source: DFO - CG, 2002

The period during which the Seaway is open, namely from the end of March to the end of December, is the segment of the year when pollution cases are most frequent. They may be two to six times more numerous.

In Quebec, most of the spills reported currently occur at the pier during loading or unloading operations (≈ 80 % of the cases between 1975 and 1994 for five major ports (Environment Canada, 1996). The volumes spread are generally small (< 1000 l) and in some cases contained within the pier or the ship (Transport Canada, 2002).

The rigorous supervision of navigation on the St. Lawrence seems to be yielding results, and the improvement is observed in several ways, including the substantial reduction in the number of accidents involving ships registered by the Transportation Safety Board for the Quebec Region (Figure 14). In 2001, there were nearly three times fewer accidents than in 1992.

Figure 14 | *Number of Cases of Accidents Involving Vessels for the Period 1992-2001, All Categories Combined (Freighter, Tanker, Ferry, Fishing Vessel, Tugboat, etc.) and Commercial Vessels (Freighter, Bulk Carrier, Iron, Ore Carrier, Oil Tanker, Tanker) Only.*



Source: BST, 2001

Surveillance of Canadian waters is difficult, given the extent of the territory, and some ships do not hesitate to dump hydrocarbon residues from the engine rooms, often at night. These discharges are illegal when the undiluted effluent has a hydrocarbon content exceeding the permitted limit of 15 ppm (parts per million). This limit drops to 5 ppm in inland waters, including the Great Lakes, while no discharge is authorized in the Arctic region. The impacts relating to these discharges are difficult to quantify, but estimates in the Newfoundland region assume that several tens of thousands of birds are affected annually by this practice (Prevention of Oiled Wildlife Project, 2001). In 2001-2002, the CCG aerial patrol in Quebec located four ships that proceeded with this type of discharge. In three other cases, it was impossible to link the oil slick to the ship (CCMC - CCG, 2002).

Given the environmental and economic consequences linked to spills, including the bad reputation these incidents give to the shipping industry, and with the aim of ensuring sustainable navigation that respects the environment in which it operates, the Ship-Source Oil Pollution Fund is trying to convince its members to adopt a "safety culture". This approach

tends to convince company owners that taking environmental protection, among other factors, into account in current operations can be considered profitable, in that the benefits obtained far exceed the associated costs (International Oil Spill Conference, 2001). Indeed, the direct costs related to a spill are compounded by indirect and hidden costs, such as decline in employee morale and productivity, erosion of consumer confidence, increased insurance premiums, etc. These indirect costs are more difficult to quantify but are 2.7 times greater than the direct costs.

The generally positive track record of the past few years on the St. Lawrence is an inducement to maintain vigilance in risk management associated with navigation activities. Everyone is aware that a single major spill can disrupt ecosystems and the public's quality of life for years. Awareness and preparedness efforts must be constantly maintained, as well as experimentation with new recovery methods. A well-supervised participation of riverside communities in cleanup operations should be further investigated. Manual cleanup still seems to be the most appropriate method for recovery of oil spread on beaches without causing too much damage to the underlying soil (Whitfield, 2003). However, this method assumes a large workforce, making it necessary to rely on rapidly available volunteers. The riverside communities can provide invaluable support by constituting reserve workforces trained by specialists in emergency response procedures and precautions. Preparedness, training and coordination of the local stakeholders thus become key elements in this cooperation.

Targeted results

- Cooperation from riverside communities increases, under the supervision of emergency response specialists, to mitigate damage caused by spills.
- Support is obtained from the authorities concerned to develop training programs for volunteers.
- Environmental knowledge of spilled products is improved to reduce health risks.

Actions

The proposed actions primarily concern risk management, with an emphasis on the preparedness of the various stakeholders and the cooperation of the riverside communities:

- ensure adequate training, in accordance with occupational health and safety standards, to the riverside communities;
- offer the communities a forum where emergency response priorities could be established;
- increase the riverside municipalities' awareness of the risk factor represented by a marine spill and the importance of adopting an emergency plan;
- improve winter emergency response methods;
- support the preventive measures in force and promote them to all stakeholders in the navigation field;
- verify the applicability of burning as an emergency response method on the St. Lawrence;
- document the residual risks relating to consumption of resources after a spill.

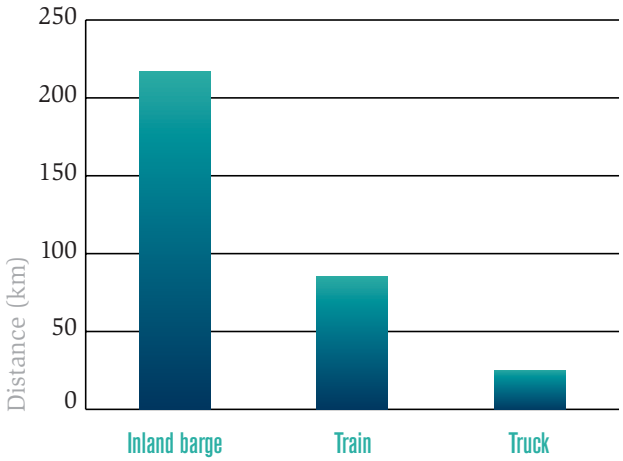
DEVELOPMENT OF MARINE TRANSPORTATION IN RELATION TO ITS ENVIRONMENTAL AND SOCIAL BENEFITS

The issues discussed above have allowed us to define certain actual or potential environmental pressures, occasioned by navigation activities on the St. Lawrence ecosystems. However, marine transportation does not only involve negative environmental aspects. A brief comparison with other modes of transportation highlights its advantages.

Although standard units of comparison are unavailable, it appears that, in general, marine transportation is the most energy efficient mode of transportation (Figure 15).

Fisheries and Oceans Canada. D. Chamard

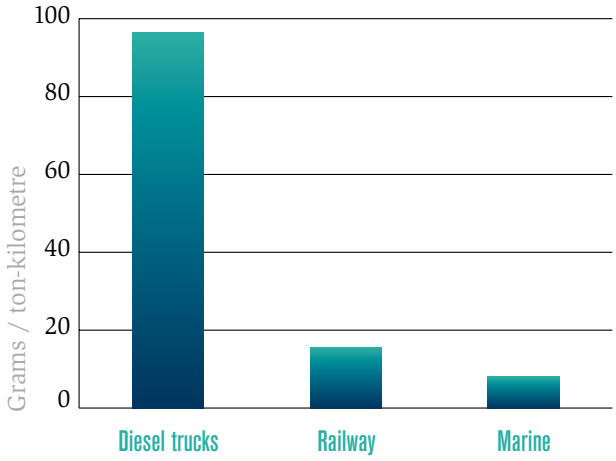
Figure 15 | *Distance Travelled by One Ton of Cargo on One Litre of Fuel*



Source: US DOT, 2002

This energy advantage is primarily based on the load capacity of ships. An inland barge can carry 15 times more freight than a railway car and 60 times more than a truck (U.S. DOT, 2002). Consequently, the quantities of atmospheric pollutants emitted by marine transportation, including greenhouse gases, are less than those produced by other modes when expressed in kilometre tons (Figure 16).

Figure 16 | *Greenhouse Gas (GHG) Emissions Related to Freight Transportation per Kilometre-Ton, by Mode, 1997*



Source: Transportation Climate Table, 1999

Marine transportation incidentally is becoming a leading alternative solution, when it is possible to use it, to achieve the objectives of the Kyoto Protocol, especially for the gases targeted in this agreement (Table 16).

Table 16 | *Atmospheric Emission Coefficients of Three Modes of Transportation, in Grams per Kilometre-Ton*

Pollutant	Truck	Train	Ship
CO	0.25 – 2.4	0.02 – 0.15	0.018 – 0.20
CO_2	127 - 451	41 – 102	30 – 40
HC	0.3 – 1.57	0.01 – 0.07	0.04 – 0.08
NO_x	1.85 – 5.65	0.2 – 1.01	0.26 – 0.58
SO_2	0.10 – 0.43	0.07 – 0.18	0.02 – 0.05
Particles	0.04 – 0.90	0.01 – 0.08	0.02 – 0.04
VOC*	1.1	0.08	0.04 – 0.1

Source: OECD, 1997

* VOC = volatile organic compounds

Over the past few years, freight transportation has gradually shifted, in North America, to terrestrial modes in response to economic imperatives, including just-in-time production and delivery. This shift has primarily occurred to the benefit of road transportation, which offers greater flexibility. The exclusion of environmental and social factors in selecting a carrier results in a paradox, because considerable efforts will have to be invested in road transportation to reduce GHG emissions (Transportation Climate Change Table, 1999). The growth forecasts for this sector up to 2020 (Table 17) indicate that major investments in the road network will be necessary to maintain its quality and ensure traffic flow.

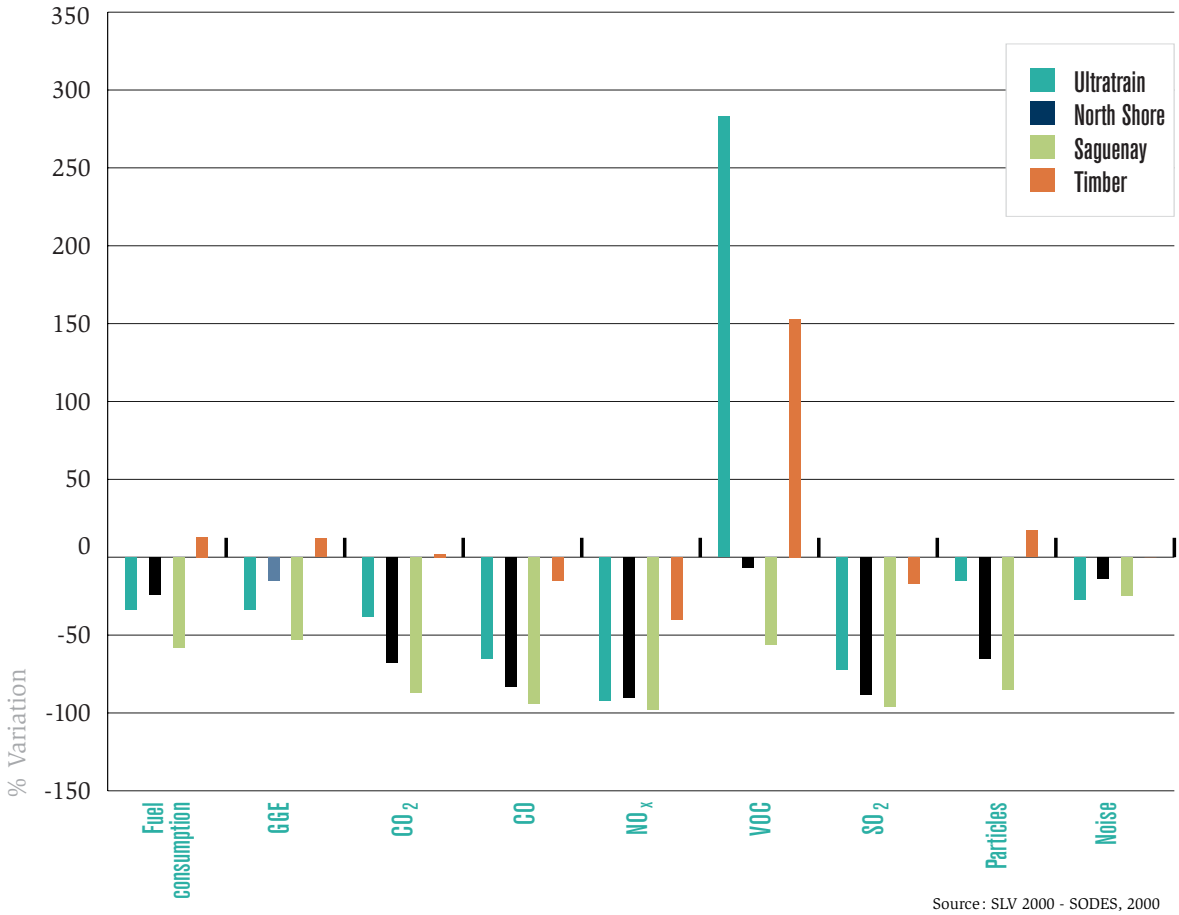
Table 17 | *Forecast Variation of Freight Transportation Activities by Mode in Canada (millions of km-tons)*

	1990	1995	2010	2020	Variation 1990-2020 *(%)*
Trucking	149,000	180,000	240,000	289,000	94 %
Air	544.5	584.8	859.5	1,111	104 %
Railway	250,100	282,400	342,800	390,000	56 %
Marine	50,900	42,500	42,500	42,500	-16.5 %
Total	**450,544.5**	**505,484.8**	**626,159.5**	**722,611**	**60 %**

Source: Transportation Climate Change Table, 1999

With the exception of the marine mode, all other modes are likely to see a substantial growth of their activities. This outlook is an inducement to review the current organization of freight transportation to include non-economic considerations in choosing what modes to use. Energy efficiency and environmental studies of transportation modes have been conducted for the St. Lawrence (SLV 2000 - SODES, 2000) and the Great Lakes (Great Lakes Commission, 1993), in which alternative freight transportation scenarios were analyzed in terms of the environmental gains that would result from them. These scenarios are considered to be theoretical, because they are not economically viable in the current state of affairs. However, they show that substantial gains would result from a transfer of freight from terrestrial modes to the marine mode. (Figure 17). Conversely, the transfer to terrestrial modes of freight currently carried by ship would significantly increase atmospheric pollution, including GHG (Figure 18). The increase in VOC reported in Figure 17 comes from scenarios that include the railway mode. This scenario appears to be more efficient in this regard (Table 16).

Figure 17 | *Decrease in Atmospheric Emissions of Different Gases by Transferring Cargo Currently Carried by Terrestrial Modes to Marine Mode*



Source : SLV 2000 - SODES, 2000

A more detailed analysis of one of the alternative scenarios, the Ultratrain for example, allows us to measure the extent of the gains in terms of the number of tons of gases not emitted (Table 18).

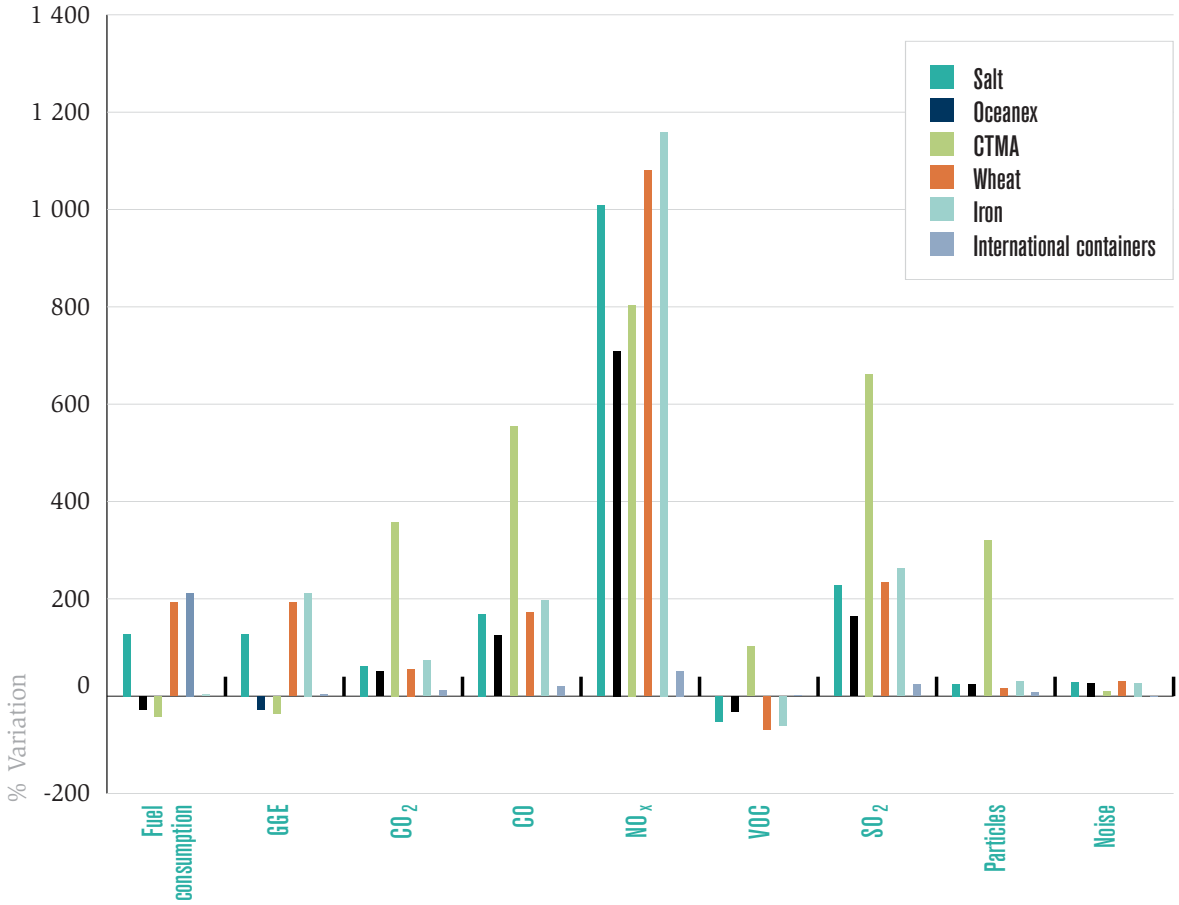
Table 18 | *Comparison of Data for the Ultratrain Scenario*

Variables	Current scenario Railway	Alternative scenario Marine
Energy consumption		
Consumption (M l)	4.37	2.89
Type of fuel	Diesel fuel	Oil
Kilometrage, return trip	500	500
Number of return trips	250	165
Annual kilometrage	125,000	82,500
Atmospheric emissions (tons)		
CO_x	12,616.5	7,849
CO	101.2	35.4
NO_x	255.9	20.2
VOC	11.9	45.6
SO_2	17.9	5.1
Particles	11.9	10.1
Total GHG	**13,414,5**	**8,875.4**

Source: SLV 2000 – SODES, 2000

Considering only carbon dioxide (CO_2), the alternative scenario represents a decrease of nearly 4,800 tons of gas. This is one of the most conservative scenarios for this analysis, because the distance used is relatively minimal compared to the distances in which the marine mode is particularly efficient (≥ 1500 km).

Figure 18 | *Increase in Atmospheric Emissions of Different Gases by Transferring Cargo Currently Carried by Marine Mode to Terrestrial Modes*



Source: SLV 2000 - SODES, 2000

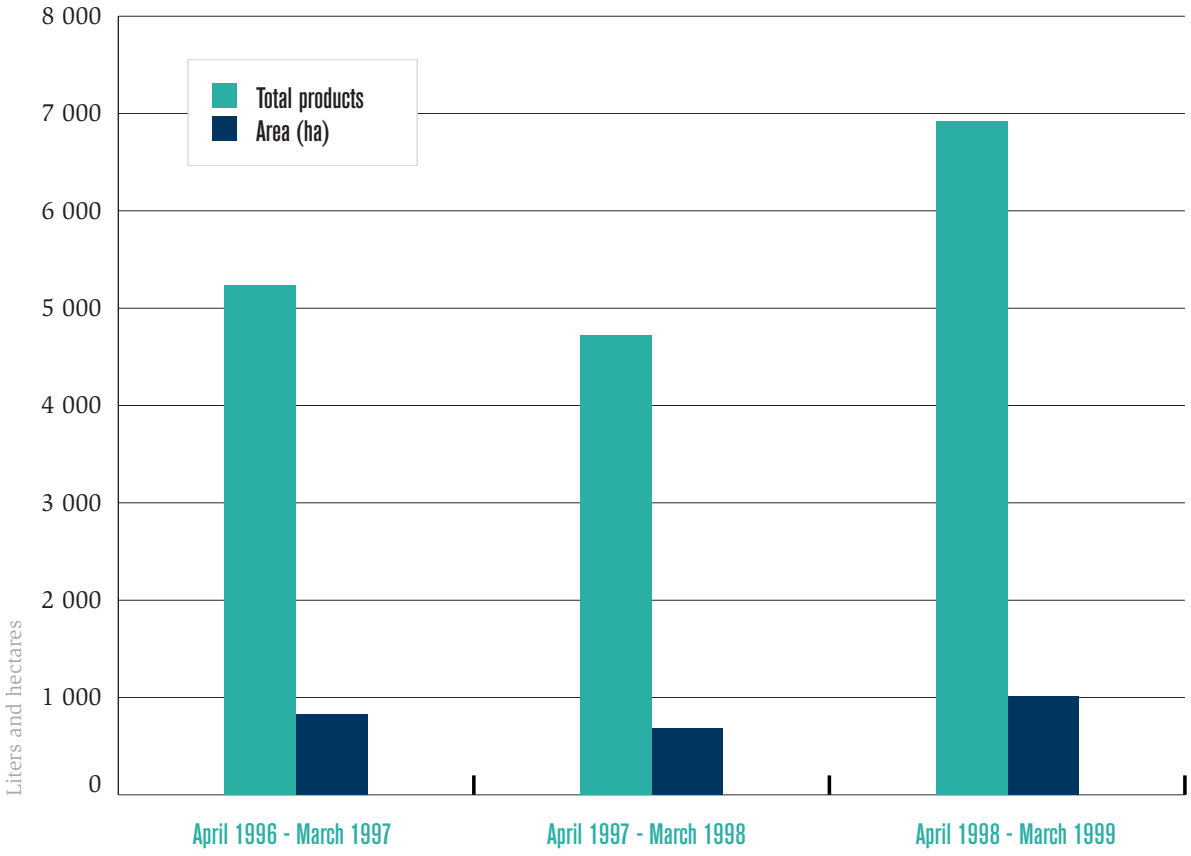
It should be noted that the quantity of emissions also depends on parameters such as types of fuels used, cruising speed, engine combustion performance, etc. In this regard, technological progress can be favourable to the three modes of transportation. However, the prospect of future environmental efficiency should be no substitute for choices that can immediately produce a return. In this context, it appears essential to conduct an in-depth review of the organization of freight transportation so that companies are induced to include criteria, in the selection of their carriers, which would also be favourable to them. Without incentives, there is a high risk that the paradoxical forecasts of Table 17, in which the mode of transportation emitting the least pollutants is doomed to decline, will be fulfilled.

In addition to atmospheric emissions, which can easily be forecast due to the doubling of road transportation activities by 2020 (Table 17), social and environmental impacts affecting public health are apprehended. They are manifested, in particular, by road congestion in the cities, road rage, the high costs of road network maintenance, accidents, urban smog, daytime and nighttime noise, disruption of land ecosystems, and use of defoliants and melting agents. The reduction of atmospheric pollution is therefore one of the few environmental benefits related to marine transportation.

The low land use inherent in this mode of transportation is another significant benefit. In Quebec alone, road and railway networks extend over 185,000 km and 6,554 km respectively (MTQ Web site), whereas the port network occupies about 50 km of territory (Villeneuve and Quilliam, 2000) and the waterway (Cap Gribane to Saint-Lambert) takes up 350 km, only half of which requires maintenance dredging. Although use of the road network is not exclusively reserved for trucks, it nonetheless remains that construction and maintenance of this network have irreversibly altered the land ecosystems. Boundaries have been erected between previously continuous habitats, amplifying the risks of mortality for the species that cross them. Maintenance of the road and railway networks requires the use of chemical substances, such as ice melting agents for roads, and defoliants and treated wood for railway tracks, with environmental impacts that have not yet been properly assessed. Winter maintenance of a simple road, without shoulders, results in the spreading in Quebec of an average of 28 t/km of ice melting agents in the form of NaCl (97.5 %) and $CaCl_2$ (2.5 %) (SLV 2000 - SODES, 2000). This quantity increases to 92.1 t/km for Highway 20. In addition to the environmental consequences of using these melting agents, such as contamination of the water table, soil, surface water and the biota, there are social consequences such as corrosion of vehicles and metallic structures.

Defoliants and herbicides are also used to control the invasion of railway tracks by vegetation. Environmental standards regulate the application of these substances but cannot eliminate the impacts they are likely to cause on human health, crops, livestock, neighbouring animal and plant species, and bodies of water (SLV 2000 - SODES, 2000). Figure 19 illustrates the quantities of defoliants and herbicides used in the railway corridors during the period 1996-1999, and the areas affected.

Figure 19 | *Quantity of Defoliants Used in the Railway Corridors and Impacted Areas*



Source: SLV 2000 - SODES, 2000, Navigation Consensus Building Committee Compilation, 2003

The noise pollution generated by the different modes of transportation is another factor that sheds light on the environmental benefits of marine transportation. Even though studies are in progress to determine the impact of the sounds emitted by ships on the behaviour of marine mammals, it seems that noise pollution is not considered to be a problem intrinsic to the navigation field by international organizations such as the IMO and the OECD. Conversely, the frequency of road and railway trips, the characteristics of the zones crossed (open or closed), the proximity of housing and the period when freight transportation occurs (daytime, nighttime or continuous) are all imponderables for the human environment, health (stress) and public safety.

If the railway noise nuisance appears to be less annoying than the noise from heavy trucks, this is attributable to the intermittent character (trip frequency) of the noise emitted by trains compared to trucks (OECD, 1997). In fact, the noise volume produced by a train running on diesel fuel is 100 decibels (dB), compared to 90 to 95 for a truck (OECD, 1997). This problem is not minor, given that pain is felt in the ear at 120 dB and that hearing damage may occur at 150 dB (Cité des sciences, 2003). Moreover, the public regularly complains about the intensity of noise from marshalling yards, especially at night.

One last point of comparison pertains to the risks of spills and accidents inherent in each mode (Table 19). The data are expressed in 100 millions of kilometre-tons transported per year.

Table 19 | *Accident and Spill Rate by Mode of Transportation*

	Road	Railway	Marine
Accidents (/100 million km-t)	1.943	0.357	0.026
Spills (/100M km-t)	0.30	0.08	0.008

Source: SLV 2000 - SODES, 2000

The accident rate in the marine sector is very low, 75 and 14 times lower than the road and railway modes respectively. The same is true of the spill rate, regarding which the marine sector still has an appreciable advantage, 37 and 10 times lower respectively. However, the spectacular nature of some marine spills darkens this sector's performance by implying that this mode of transportation is riskier than the other two. The rates presented in Table 19 can help correct an image too often distorted by exceptional occurrences.

Despite the environmental and social benefits related to marine transportation, it must be admitted that it alone cannot ensure every link in the delivery chain. Its starting and stopping point is the port, from which the other modes must take over. Intermodality thus appears to be an essential component of marine transportation. Judicious use of intermodality, with more reliance on marine transportation, thus optimizing the benefits specific to each mode of transportation, could only be beneficial and profitable in social, environmental and economic terms.

Conclusion

The discovery of the territory, the occupation of the shorelines and the economic development of Quebec and Canada are closely related to marine transportation on the St. Lawrence. The gradual expansion of this mode of transportation to the Great Lakes, combined with the construction of a fleet of ships with ever more imposing dimensions, led to river and port works to ensure and structure its development. These developments were the first river modifications, to which other environmental impacts specific to this mode of transportation were added over the course of time. However, marine transportation is not only a matter of imponderables. On the contrary, the intensive development of road and rail transportation over the past few years has highlighted the environmental aspects of navigation, which gains an advantage from lower atmospheric emissions, better energy efficiency, a lower noise level and a reduced accident rate.

The Sustainable Navigation Strategy gives preference to a balanced approach between reduction of environmental impacts and development of the positive aspects of this mode of transportation. It serves as a first structured intervention framework for navigation on the St. Lawrence, oriented both to compliance with the imperatives of sustainable development and a more harmonious sharing of resources and potentialities among the users. This Strategy is a special contribution to a more comprehensive integrated management framework for the St. Lawrence and the Great Lakes.

For the purpose of consolidating its bases and fostering its appropriation by the various stakeholders, the strategy is based on a series of guiding principles and principles of application that are meant to serve as a reference for administrators, managers and project managers when they have to intervene on matters relating to the navigation field. To complement this, a strategic action plan oriented to the remediation or mitigation of commercial or recreational navigation practices has been drafted and constitutes the first phase for implementation of this strategy. Even though a substantial part of implementation depends on the involvement of the various levels of government, its continuous updating, the guarantee of its sustainability, is based on the close cooperation and involvement of the stakeholders in the field.

The initial group in charge of the implementation of this strategy will be the current members of the Navigation Consensus Building Committee. However, an expansion to a diversified pool of stakeholders is among the objectives to be achieved. Within a perspective of continuous improvement and in accordance with the principles of application adopted, the members will keep each other informed on everything concerning navigation activities on the St. Lawrence. This watchfulness regarding environmental concerns, and the emerging scientific, technological and regulatory innovations will make it possible to integrate the new discoveries and decisions into the strategy and will ensure its updating.

The fulfillment of the strategy depends on consensus building, but also on a form of moral commitment by the stakeholders, and its continuation beyond the initial action plan (2004-2009) will depend on the interest and commitment applied to it. The ultimate purpose is to instill responsible behaviour in the commercial and recreational navigation community, which will ensure that the environmental impacts associated with their activities are reduced or decline to a socially acceptable level. The Strategy's sustainability will then be assured by a commitment, on the part of those in charge and stakeholders concerned, to improve their adaptation and compliance with respect to the various environmental, social and economic imperatives.

The consensus building approach followed by the members of the Navigation Consensus Building Committee was a first initiative in this matter for the Quebec marine community and represented a particular challenge in this regard. The many discussions served to ensure the recognition and consideration of each party's interests and concerns, and the search for common ground so that respect for the St. Lawrence ecosystems can harmonize with the development of navigation activities and other users' needs. Even though this initiative was crowned with success, many challenges still must be overcome to implement it. The Committee's stakeholders and all the others in the navigation field will be under strong pressure in this regard.

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Annexes

Annex I

Members of the Navigation Consensus Building Committee

Fisheries and Oceans Canada – Coast Guard	Marc Demonceaux (Co-Chair - Canada)
Transports Québec	Claire Poulin (Co-Chair - Quebec)
Canadian Auxiliary Coast Guard	Robert Petitpas
Corporation des pilotes du Saint-Laurent central	Gilles Giroux
Environment Canada	Caroll Bélanger
Environment Canada	Jean-François Bibeault
Environnement Québec	Gilles Brunet
Fédération de Voile du Québec	André Huoto
Fisheries and Oceans Canada	Robert Dorais
Fisheries and Oceans Canada	Pascale Fortin
Fisheries and Oceans Canada – Coast Guard	Pierre D'Arcy
Fisheries and Oceans Canada – Coast Guard	Pierre Rouleau
Les Amis de la vallée du Saint-Laurent	André Stainier
Montréal Port Authority	Lyne Martino
Ressources naturelles, faune et parcs Québec	François Caron
Société d'initiative et de conservation du Bas-Richelieu	Normand Gariépy
Transport Canada	Michel Boulianne
Transport Canada	Danielle Duranceau
Shipping Federation of Canada	Ann Legarso
St. Lawrence Economic Development Council	Claude Mailloux
St. Lawrence Shipowners Association	Nicole Trépanier
Stratégies Saint-Laurent	Pierre Latraverse
Transports Québec	Josée Bernard
Transports Québec	Rachid Raffa

Annex II

Legislation Governing Navigation in Canada

Note: The quotations are not the official versions of the laws and regulations of Canada and Quebec.

FEDERAL LAWS

Legal framework	*Main objects related to the environment*
Canada Shipping Act	• Protect the marine environment from damage due to navigation and shipping activities; • ensure that Canada can meet its international obligations under bilateral and multilateral agreements with respect to navigation and shipping; • encourage the harmonization of marine practices; • establish an effective inspection and enforcement program; • ensure the custody and disposition of wrecks in Canadian waters; • establish a Canadian register and provide for the conditions of registration and the rights and obligations relating to registration.
Maritime Liability Act	• Offer an appropriate liability and compensation plan in the event of incidents involving ships; • prohibit bulk water removal out of the boundary waters between Canada and the USA; • consolidate various civil liability plans of ship owners and operators, particularly with regard to property damage or pollution.
Canada Marine Act	• Base the marine infrastructure and services on international practices and approaches that are consistent with those of Canada's major trading partners in order to foster harmonization of standards among jurisdictions; • ensure that marine transportation services are organized to satisfy the needs of users and are available at a reasonable cost to the users; • provide for a high level of safety and environmental protection; • manage the marine infrastructure and services in a commercial manner that encourages and takes into account input from users and the community in which a port or harbour is located.

FEDERAL LAWS

Legal framework	*Main objects related to the environment*
Coasting Trade Act	• A foreign ship wishing to engage in the coasting trade in Canada must submit a licence application to the Canadian authorities. Before issuing the licence, the ship must be inspected by Transport Canada Marine Safety (TCMS), which will ensure that it meets the Canadian regulatory requirements for marine safety and pollution prevention.
Pilotage Act	• The administration of pilotage must be managed to ensure the safety of navigation and effective piloting.
Marine Transportation Security Act - Marine Transportation Security Regulations	• Ensure the security of cruise ships and marine facilities for cruise ships.
Oceans Act	• Promote the understanding of oceans, ocean processes, marine resources and marine ecosystems to foster the sustainable development of the oceans and their resources; • ensure conservation, based on an ecosystem approach, to maintain biological diversity and productivity in the marine environment; • apply the precautionary approach to the conservation, management and exploitation of marine resources in order to protect resources and preserve the marine environment; • promote integrated management of oceans and marine resources; • encourage the development and implementation of national strategy for the management of the estuarine, coastal and marine ecosystems.
Fisheries Act	• Supervise all activities related to commercial fishing; • protect the fish habitat; • prevent pollution.
Navigable Waters Protection Act	• Approve the construction of works in navigable waters and ensure the removal of any obstruction to navigation; • regulate the implementation and maintenance of the precautionary measures necessary to ensure the safety of navigation during construction of works in navigable waters.

FEDERAL LAWS

Legal framework	*Main objects related to the environment*
Canadian Environmental Protection Act	• Take preventive and remedial measures to protect, enhance and restore the environment; • implement an ecosystem approach that considers the unique and fundamental characteristics of ecosystems; • encourage the participation of the people of Canada in the making of decisions that affect the environment; • facilitate the protection of the environment by the people of Canada; • establish nationally consistent standards of environmental quality; • provide information to the people of Canada on the state of the Canadian environment; • apply knowledge, including traditional aboriginal knowledge, science and technology, to identify and resolve environmental problems; • protect the environment, including its biological diversity, and human health, from the risk of any adverse effects of the use and release of toxic substances, pollutants and waste; • act expeditiously and diligently to assess whether existing substances or those new to Canada are toxic or capable of becoming toxic and assess the risk that such substances pose to the environment and human life and health.
International Boundary Waters Treaty Act	• Comply with the criteria of uses or needs regarding water levels for the Great Lakes and the St. Lawrence; • comply with water quality objectives for the Great Lakes and the St. Lawrence; • adopt rules and regulations governing the use of canals within its own territory and consider the possibility of imposing tolls for the use of such canals.
Safe Containers Convention Act	• Maintain a high level of safety of human life in the handling, stacking and transportation of containers; • formalize structural requirements to ensure safety in the handling, stacking and transportation of containers in the course of normal operations.

FEDERAL LAWS

Legal framework	*Main objects related to the environment*
Transportation of Dangerous Goods Act	• Have an emergency response assistance plan before offering to transport or import certain dangerous goods (the most noxious or dangerous as indicated in Schedule II of the Act); • comply with the safety marks, rules and standards, including accompaniment of the goods with the prescribed documents and use of containers.
Canadian Transportation Accident Investigation and Safety Board Act	• Conduct independent investigations into transportation accidents in order to make findings as to their causes and contributing factors; • make recommendations designed to eliminate or reduce safety deficiencies.
Migratory Birds Convention Act	• Prohibit pollution of areas frequented by migratory birds.
Saguenay–St. Lawrence Marine Park Act	• Increase the level of protection of the ecosystems of a representative portion of the Saguenay fjord for conservation purposes, while encouraging its use for educational, recreational and scientific purposes; • prohibit certain activities in certain park zones for protective purposes.
Canadian Environmental Assessment Act	• Encourage the federal authorities to achieve sustainable development conducive to a healthy environment and a healthy economy; • ensure that responsible authorities carry out their responsibilities in a coordinated manner with a view to eliminating unnecessary duplication in the environmental assessment process; • ensure that projects that are to be carried out in Canada or on federal land do not cause significant adverse environmental effects outside the jurisdictions in which the projects are carried out; • facilitate public participation in the environmental assessment process.

PROVINCIAL LAWS

Legal framework	*Main objects related to the environment*
Act respecting the Société des traversiers du Québec	• Link the shores of rivers and lakes located in Quebec.
Act respecting the Compagnie de gestion de Matane inc.	• Offer a ferry service.
Act respecting the Société du port ferroviaire de Baie-Comeau	• Develop and administer a port and railway complex at Baie-Comeau.
Environment Quality Act, Regulation respecting the application of the Environment Quality Act	• Assess, in particular, the impacts on the environmental all dredging, digging, filling and other operations pertaining to marinas, ports, piers, watercourse diversions or any water access infrastructure.
Watercourses Act, Regulation respecting the water property in the domain of the State and Public Water Regulation	• Manage public water.
Transport Act and Regulation respecting the transport of passengers by water	• Regulate transport, particularly the transport of passengers by water.
Act respecting petroleum products and equipment and Petroleum Products Regulation	• Ensure the safety of persons and the protection of property and the environment from the risks arising from the use of petroleum products and equipment.
Act respecting threatened or vulnerable species, Regulation respecting threatened or vulnerable species and their habitats and Regulation respecting threatened or vulnerable plant species and their habitats	• Protect the threatened or vulnerable species that live in Quebec.

PROVINCIAL LAWS

Legal framework	*Main objects related to the environment*
Act respecting the conservation and development of wildlife and Regulation respecting wildlife habitats	• Conserve and develop wildlife and its habitat within a sustainable development perspective, recognize any person's right to hunt, fish and trap.
Natural Heritage Conservation Act	• Safeguard the character, diversity and integrity of Quebec's natural heritage through measures to protect its biological diversity and the life-sustaining elements of natural settings.
Parks Act and Regulation respecting the establishment of Parcs du Saguenay, du Bic, de l'île Bonaventure et du rocher Percé	• Establish parks and regulate the activities within their limits.
Act respecting the Saguenay–St. Lawrence Marine Park	• Design, protect and regulate the activities within this park.
Water Resources Preservation Act	• Prohibit the transfer outside of Quebec of water taken in Quebec.

INTERNATIONAL MARITIME ORGANIZATION (IMO)

Theme	*Conventions*
Maritime safety	• International Convention for the Safety of Life at Sea (SOLAS), 1974 • International Convention on Load Lines, 1966; Special Trade Passenger Ships Agreement, 1971; Protocol on Space Requirements for Special Trade Passenger Ships, 1973 • Convention on the International Regulations for Preventing Collisions at Sea (ColReg), 1972 • International Convention for Safe Containers (CSC), 1972 • Convention on the International Maritime Satellite Organization (INMARSAT), 1976 • Torremolinos International Convention for the Safety of Fishing Vessels (SFV), 1977 • International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978; International Convention on Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel (STCW-F), 1995 • International Convention on Maritime Search and Rescue (SAR), 1979
Marine pollution	• International Convention on the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78) • International Convention Relating to Intervention on the High Seas in Case of Oil Pollution Casualties (INTERVENTION), 1969 • Convention on the Prevention of Marine Pollution by Dumping of Waters and Other Matter (LDC), 1972 • International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), 1990 • Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000 (HNS Protocol) • International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001

INTERNATIONAL MARITIME ORGANIZATION (IMO)

Theme	*Conventions*
Liability and compensation	• International Convention on Civil Liability for Oil Pollution Damage (CLC), 1969 • International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (FUND), 1971 • Convention Relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material (NUCLEAR), 1971 • Athens Convention Relating to the Carriage of Passengers and their Luggage by Sea (PAL), 1974 • Convention on Limitation of Liability for Maritime Claims (LLMC), 1976 • International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea
Other subjects	• Convention on Facilitation of International Maritime Traffic (FAL), 1965 • International Convention on Tonnage Measurement of Ships (TONNAGE), 1969 • Convention for the Suppression of Unlawful Acts Against the Safety of Maritime Navigation (SUA), 1988 • International Convention on Salvage (SALVAGE), 1989

Note: even without being a signatory, Canada can apply the conventions or their amendments (e.g. certain MARPOL schedules).

Annex III

Synthesis of the 2004-2009 Action Plan

CONSENSUS BUILDING

Targeted results

- Coordination of the implementation of the Sustainable Navigation Strategy and management of future initiatives is assured.
- Consensus building is preserved, with regular review of the mode of operation and integration of stakeholders depending on the issues.
- Community stakeholders are involved, depending to the targeted issues.

Actions

- Assure administrative and financial monitoring of the various projects.
- Create and coordinate the working groups and ensure the performance of studies and other work.
- Propose new projects and funding sources (*ad hoc*).
- Ensure the dissemination and exchange of information among the navigation stakeholders.
- Design communication and awareness mechanisms to reach effectively all of the stakeholders concerned about navigation activities.

INTEGRATED MANAGEMENT OF DREDGING

Targeted results

- Improvement of the planning mechanisms for maintenance and capital dredging activities, and sediment disposal activities, in cooperation with stakeholders in the field.
- Improvement of the consensus building within the context of the dredging project planning and authorization process.
- Reduction of the scientific uncertainties regarding dredging and sediment disposal.

Actions

- Set up the management structure (planning, environmental assessment, research and development).
- Prioritize and implement the recommendations of the Working Group on the Integrated Management of Dredging and Sediments (see the orientation document on integrated management of dredging on the St. Lawrence, 2003).

ADAPTATION OPTIONS

Targeted results

- Reduction of the effects of water level fluctuations on the St. Lawrence for commercial and recreational navigation activities, and short and long cruises.
- Documentation on adaptation options that are economically and environmentally reasonable fot the st. Lawrence.

Actions

Commercial Navigation and Long Cruises

- Produce adaptation scenarios that exclude a physical modification of the river and others that include it, to ensure cargo transportation.
- Improve the models for predicting the water level usable for commercial shipping.
- Study the possibility of reorganizing marine transportation, intermodality and port collaboration, in a context of low water levels and competitiveness.
- Evaluate the possibilities of capital dredging at certain strategic points in the navigation channel.
- Ensure consensus validation of the results by the Committee members.

Recreational Navigation and Short Cruises

- Ensure follow-up of the studies of the International Joint Commission regarding this sector.
- Support the development of a common position on water needs for the St. Lawrence.
- Ensure integration of the problem of water levels into integrated management of dredging.

IMPACT OF THE WAKE PRODUCED BY SHIPS AND OTHER CRAFT

Targeted results

- The environmental effectiveness of the voluntary speed reduction measure for commercial shipping is reviewed.
- Knowledge of the impact of erosion attributable to pleasure craft is improved.

Actions

- Continue environmental monitoring of the voluntary speed reduction measure for commercial shipping.
- Maintain the current speed reduction measure in the Sorel Archipelago–Varennes sector.
- Document the impact of pleasure craft on shoreline erosion.
- Document the impact of the wake produced by ships on human safety.
- Provide recreational boaters with awareness tools.

SEWAGE AND CARGO RESIDUE MANAGEMENT

Targeted results

- More environmentally-friendly management of bulk cargo residues of ships.
- Better control of sewage discharges of all types of ships and craft.

Actions

- Inventory polluting materials and collection and treatment systems.
- Draft and implement control procedures.
- Harmonize management of discharges of sewage and cargo residues with Great Lakes practices.

INTRODUCTION OF EXOTIC SPECIES

Targeted result

- The risks of introduction of exotic organisms are significantly reduced for all types of ships.

Actions

- Enforce the current guidelines.
- Increase awareness of recreational boaters and the shipping industry to the problem of dissemination.
- Monitor the effectiveness of ballast water exchange in port areas.
- Establish a decision help model for exchanges in the alternative exchange zone (Laurentian Channel).
- Monitor the effectiveness of other control methods.

HAZARDOUS PRODUCT SPILLS

Targeted results

- Cooperation from riverside communities increases, under the supervision of emergency response specialists, to mitigate damage caused by spills.
- Support is obtained from the authorities concerned to develop training programs for volunteers.
- Environmental knowledge of spilled products is improved to reduce health risks.

Actions

- Ensure adequate training, in accordance with occupational health and safety standards, for riverside communities.
- Offer the communities a forum to establish emergency response priorities.
- Increase the riverside municipalities' awareness of the risk factor represented by a marine spill and the importance of adopting an emergency plan.
- Improve winter emergency response methods.
- Support and promote the preventive measures in force to all stakeholders in the navigation field.
- Verify the applicability of burning as an emergency response method on the St. Lawrence.
- Document the residual risks relating to consumption of resources after a spill.

DEVELOPMENT OF MARINE TRANSPORTATION

Targeted result

- Reliance on marine transportation is optimized in situations in which it offers more environmental gains.

Action

- Make decision-makers and stakeholders aware of the environmental benefits of marine transportation.

Sustainable Navigation Strategy

FOR THE ST. LAWRENCE

The Sustainable Navigation Strategy is intended as a contribution to the development of navigation, in its multiple aspects, in compliance with the environmental conditions of the St. Lawrence. Based on the sustainable development principles, the strategy has been drawn up by the Navigation Consensus Building Committee of the St. Lawrence Action Plan. It represents a first systematic attempt to orient the management of all navigation activities, taking into account their economic, environmental and social impacts.

Montréal Port Authority
St. Lawrence Shipowners Association
Corporation des pilotes du Saint-Laurent central
Environnement Canada
Environnement Québec
Fédération de Voile du Québec
Shipping Federation of Canada
Canadian Auxiliary Coast Guard
Les Amis de la vallée du Saint-Laurent
Fisheries and Oceans Canada
Ressources naturelles, faune et parcs Québec
St. Lawrence Economic Development Council
Société d'initiative et de conservation du Bas-Richelieu
Stratégies Saint-Laurent
Transport Canada
Transports Québec