
St. Lawrence River
Baie d'Ungava
Baie d'Hudson
Labrador (T.-N.)
QUÉBEC
Baie James
ONTARIO
TERRE-NEUVE
Golfe du Saint-Laurent
N.-B.
Fredericton
N.-E.
Halifax
Québec
Montréal
Ottawa
Toronto
Lac Ontario
OCÉAN ATLANTIQUE
ÉTAT-UNIS D'AMÉRIQUE
Serge Villeneuve
St. Lawrence Centre
Environment Canada

Information sources

- Hydrology section – Environment Canada
- Christiane Hudon – Environment Canada
- Martin Jean – Environment Canada
- François Morneau – Public Safety Ministry of Quebec
- State of the St. Lawrence Monitoring Program's Partners

The information presented here is drawn from numerous researchers and professionals from :

- Environment Canada's Meteorological Service and St. Lawrence Centre
- Quebec Ministry of Public Safety
- SSLMP Partners, namely :
  - Quebec Ministry of the Environment,
  - Quebec Ministry of Natural Resources Wildlife and Parks
  - Fisheries and Oceans Canada
  - Environment Canada

The SL is the gateway to the heart of the NA continent. Since the arrival of European settlers in the 17th century, the SLR has known major structural changes to its course, its hydrodynamics and its resources.

Modifications were brought about for numerous reasons :

- Extension of fertile grounds for agriculture in the lowlands
- Protection from floods and ice jams
- Urban development
- Shipping route
- Hydroelectric power generation.

Overview

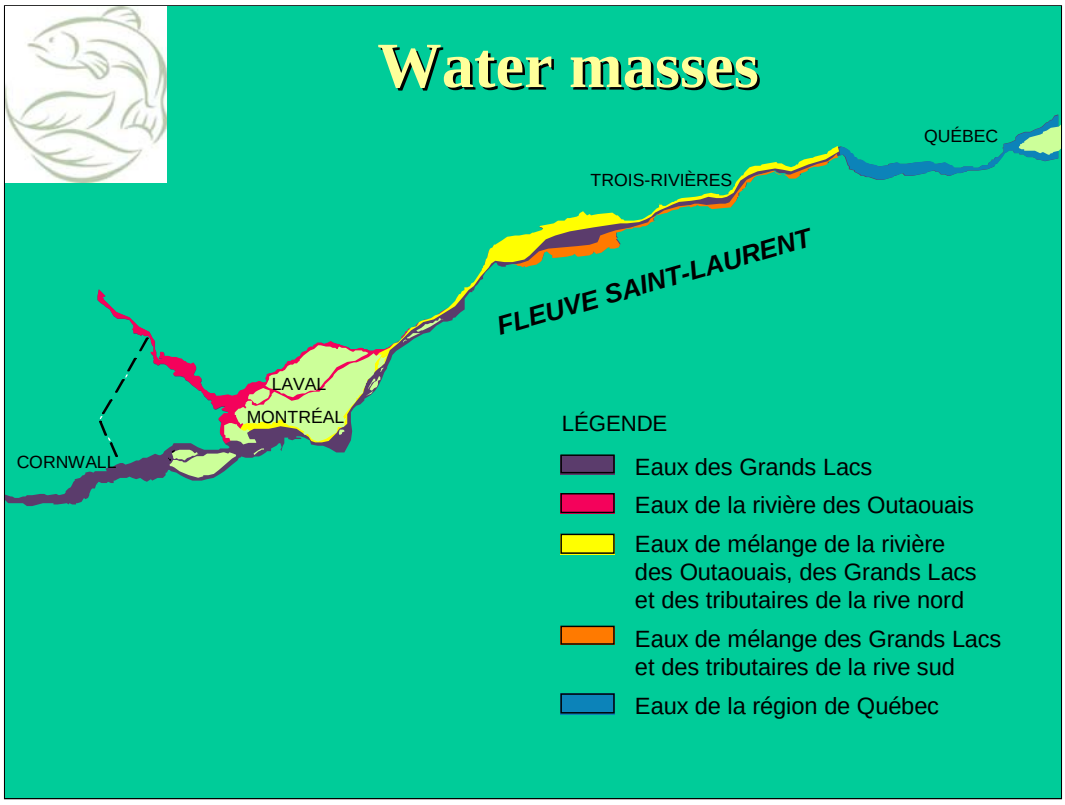
- Structural changes
- Hydrodynamic alterations
- Shoreline alterations
- Habitat/biological resource alterations
- Indicator suite

Following a description of the **major structural changes**, I will show some examples of the alterations to:

- the hydrodynamics,
- the shoreline,
- the habitats and the biological resources

and conclude with a synoptic view of the State of the St. Lawrence indicator suite.

The picture shows the flooded Bonaventure depot in 1886 close to Environment Canada's office in downtown Montreal. The regulation of St. Lawrence and Ottawa River flows has greatly decreased the recurrence of these events.



First, I have to mention a unique characteristic of the St. Lawrence, which is the presence of three distinct water masses that flow side by side down to Donacona, some seventy kilometres upstream of Quebec City. The Great Lakes water (green water) flows in the center with the Ottawa River – North Shore Tributaries mass (brown water) on the left bank and the South Shore tributaries water mass on the right bank. Downstream of Donacona, strong tidal forces enable the complete mixing of the water column. Such flow characteristics have tremendous effects on the structure of biological assemblages.

It’s not known to which extent, the numerous structural changes, particularly the dredging of the shipping channel, have altered the flow of those water masses and impacted the biological communities

Structural changes

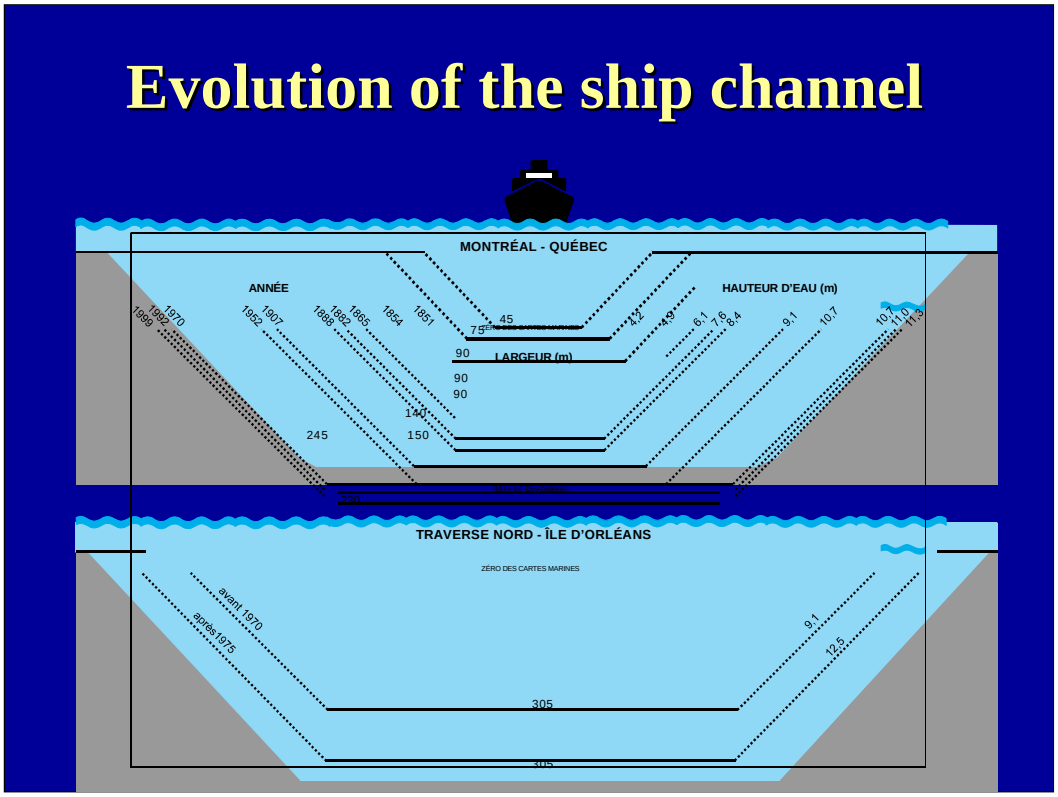
- Navigation channel (1847-present)
- Hydrolectric power and seaway (1954-1959)
- Shoreline encroachment (17th century)
- Natural processes
- Major weather events

The construction of **dams for hydroelectric power**, the **Seaway** between Prescott-Ogdensburg and Montreal and the **Shipping Channel** from Montreal to Orleans Island downstream of Quebec City are by far the most important structural changes to the St. Lawrence.

Urban, industrial and agricultural development have also altered the shores significantly.

Major weather events and climatic changes are another important source of change.

The ice bridge like the one shown here between Quebec City and Lévis (around 1900) is of course no longer possible, nor desired.



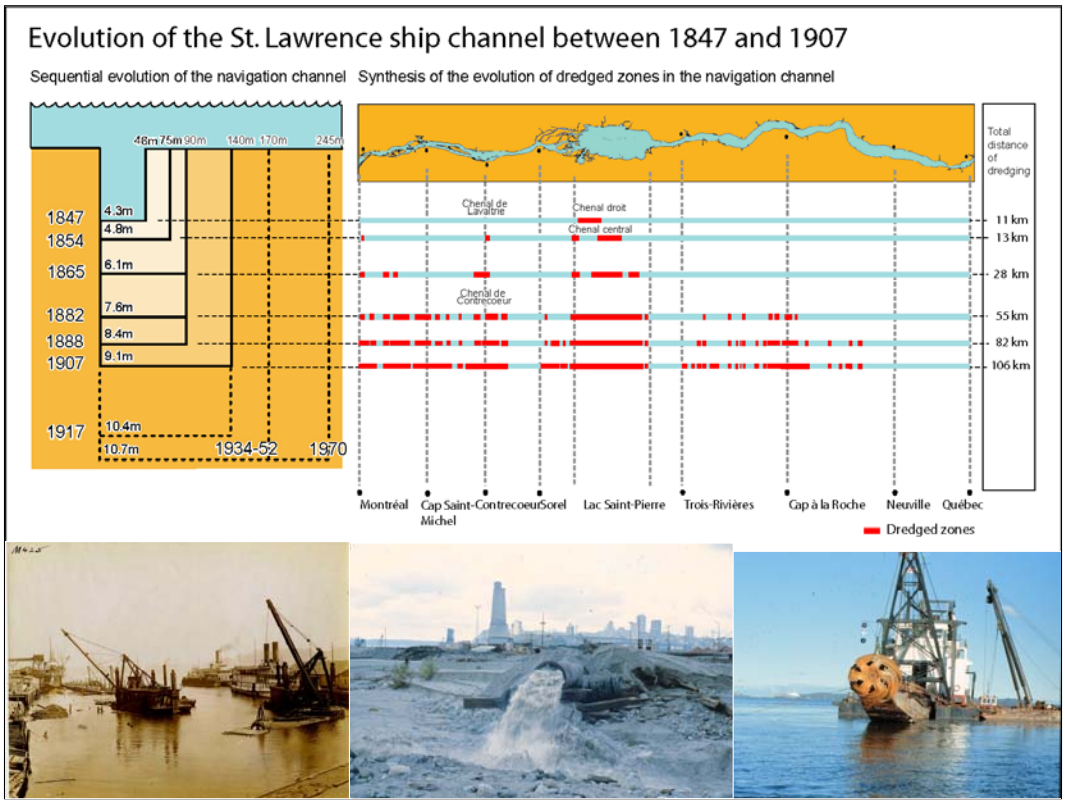
Over 150 years, from 1847 to 1998, the Shipping Channe l was deepened and widened between Quebec City and Montreal.

Upper diagram

Gauges between Quebec City and Montreal

Lower diagram

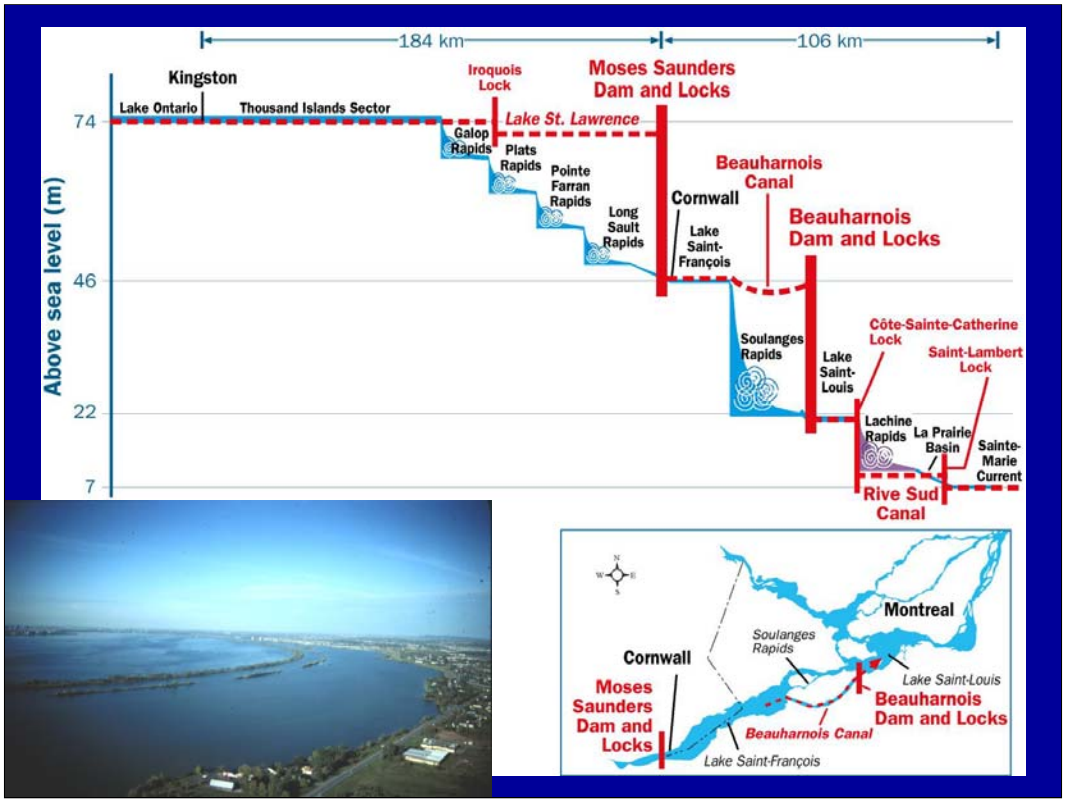
Gauges between Quebec City and the Estuary at the freshwater – saltwater interface.



Central part of Lake St. Pierre was the initial bottleneck.

While deep pools were encountered in many sections, widening of the channel required extensive dredging of always larger segments of the River.

This work represented millions of cubic meters of dredged sediment that were deposited for the most part close to the Channel or on the shores of the River.



Shore modifications for the section upstream of Montreal also started in the 19th century. But the most compelling works were initiated in the 1930s and 1950s, with the construction of dams for hydroelectric power generation and the Seaway.

Lake Ontario is 74 m above sea level; the SLR used to flow through three series of rapids :

- The international sector: Prescott-Ogdensburg to Cornwall (25 m)
- Soulanges – Les Cèdres (25 m)
- Lachine (12m)

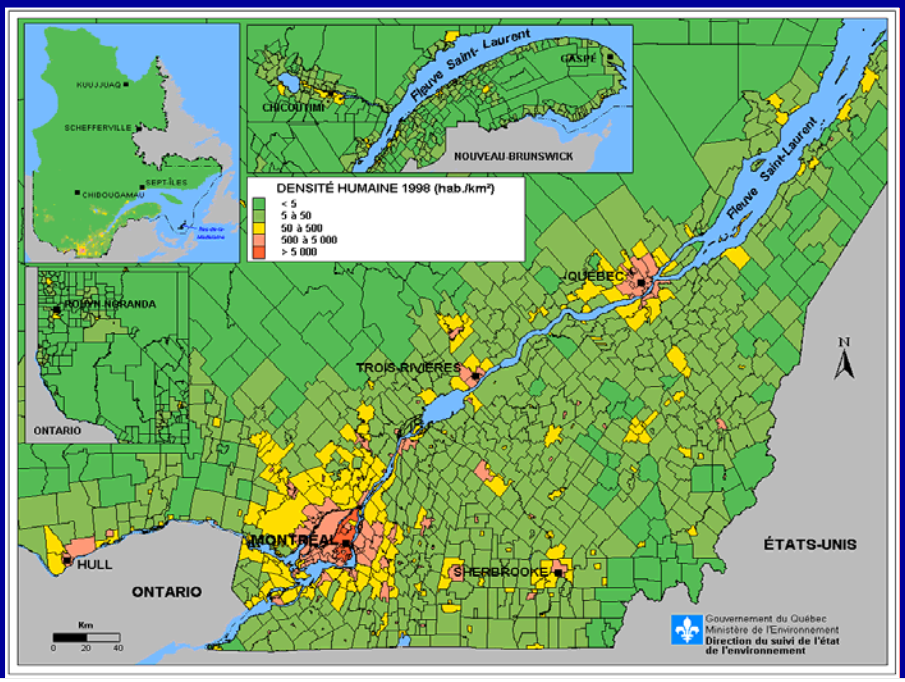
The Galot, Plats, Pointe Faran and Long Sault Rapids were flooded: over 260 km which is now Lake St. Lawrence; 6500 inhabitants in 7 villages were displaced.

86 % of the flow is now diverted in the Beauharnois Canal: 21 km long, 1 km wide and 9 m deep. LSF is raised 1 m and its level stabilized.

The Lachine Rapids are now the only remaining ones in the River.

Hundreds of millions of cubic meters were excavated or dredged; in 1957, there were 22000 workers on site: Those works were bigger than the Panama Canal.

Population density



Half of the Quebec population lives in the Montreal Metropolitan area

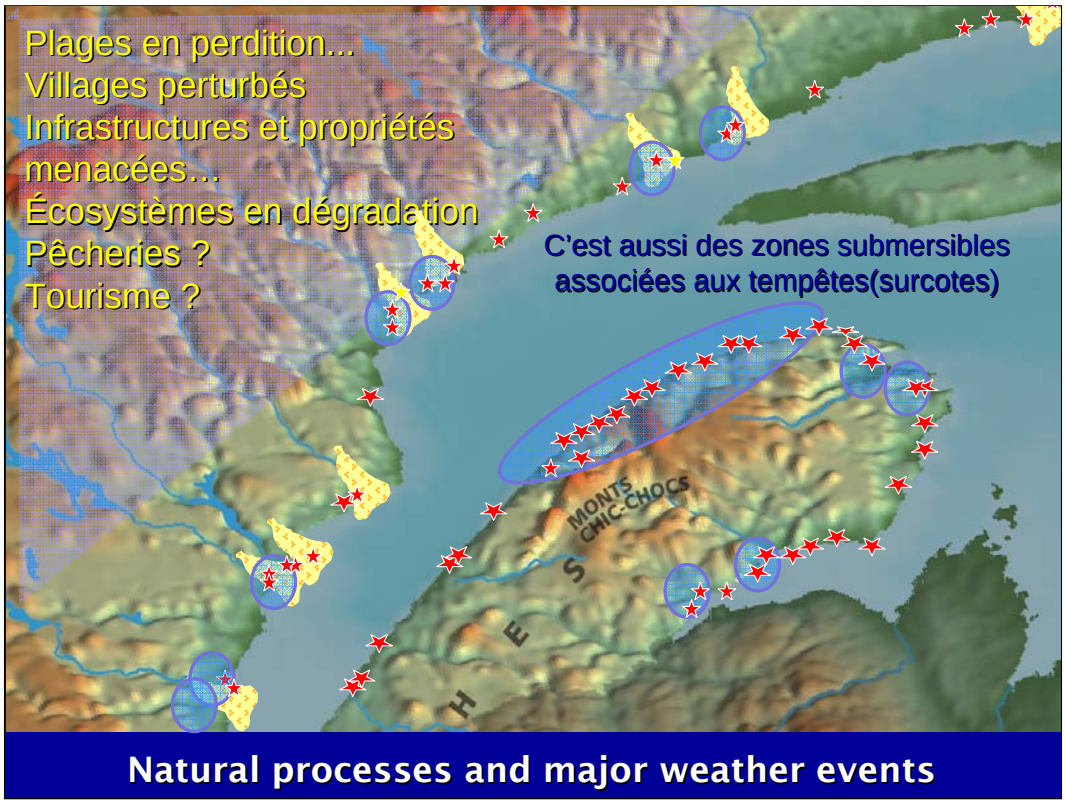
Next in importance are Quebec City and Trois-Rivières

Intensive agriculture in the Lowlands has extensively altered the shores of SLR

Around Montreal and its suburbs, shores are hardened on 80 % of their length.

Shoreline encroachments:
Ports and highways *vs* wetlands

Downstream of Quebec City, dredged spoils from the harbour were used in the 1970's to build a highway through an embayment, with concurrent losses of numerous hectares of productive marshes.



Shore erosion is a natural process but climatic change and urbanization have exacerbated the phenomenon.

On the Gulf's North Shore: 50 % are rocky shore and 50 % coastal plain delta where villages and towns are located.

In the Gaspésie Peninsula, on the South Shore, the main regional road is built at the base of erodable siltstone cliffs.

Stars show were there is an erosion problem

Circles point to sectors where storms surges can create floods and exacerbate the erosion processes.

Natural processes and major weather events

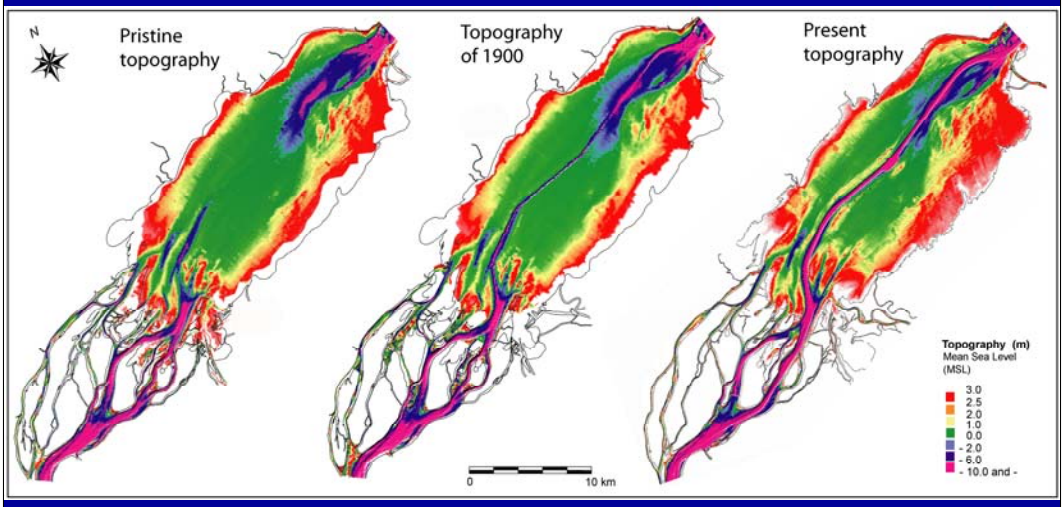
In the last years, coastal fast ice was not formed on the North Shore which agravated the erosion due to winter storms.

The hardening of shores offers only a local protection and amplify the phenomenon downstream of the erosive forces.

Here in Pointe Lebel, wave breakers were added in front of hardened shores in 2001 and are already destabilized. They may not reach their 10-20 years useful life service.

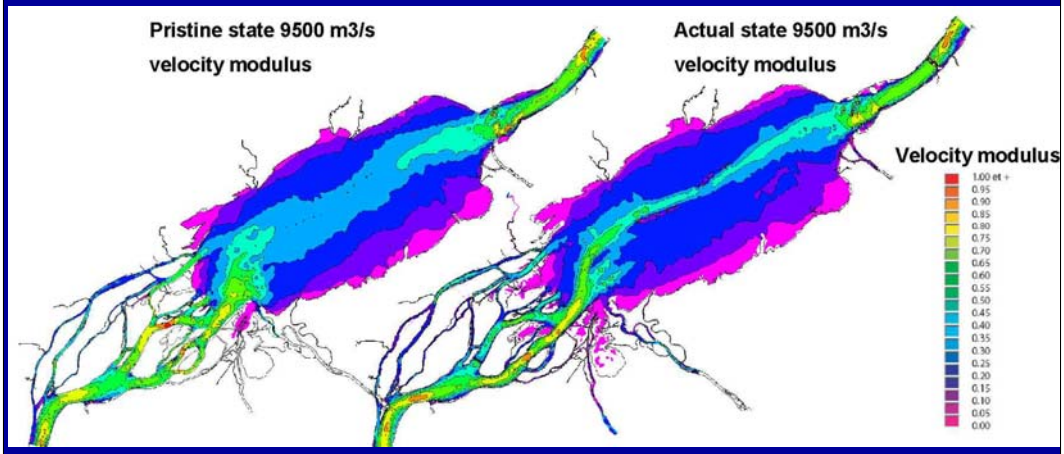
Severe coastal erosion in the St. Lawrence Estuary and Gulf will require difficult social and economical decisions in the near future, since very costly shore protection structures do not resist winter storms and inhabitants are threatened in their homes and on highways.

Hydrodynamic alterations



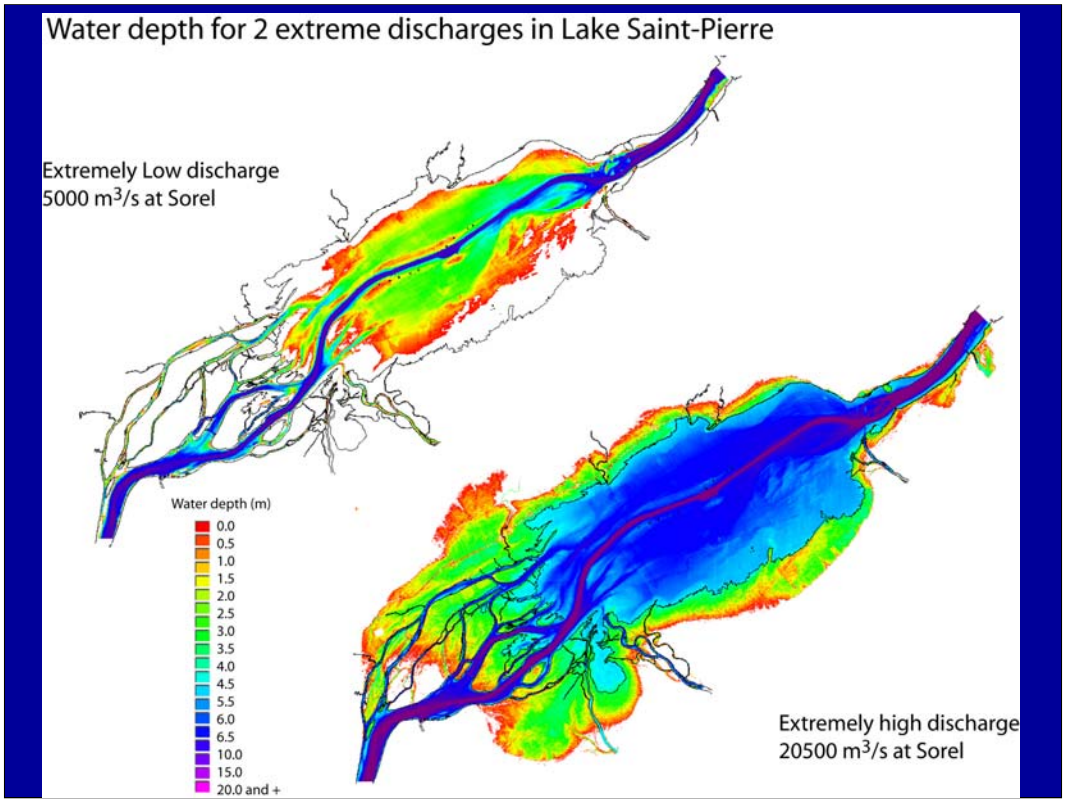
This figure shows the evolution of the Lake St. Pierre topography following the dredging of a 11,3 m deep and 230 m wide channel has drastically changed the hydrodynamic of the Lake.

Hydrodynamic alterations



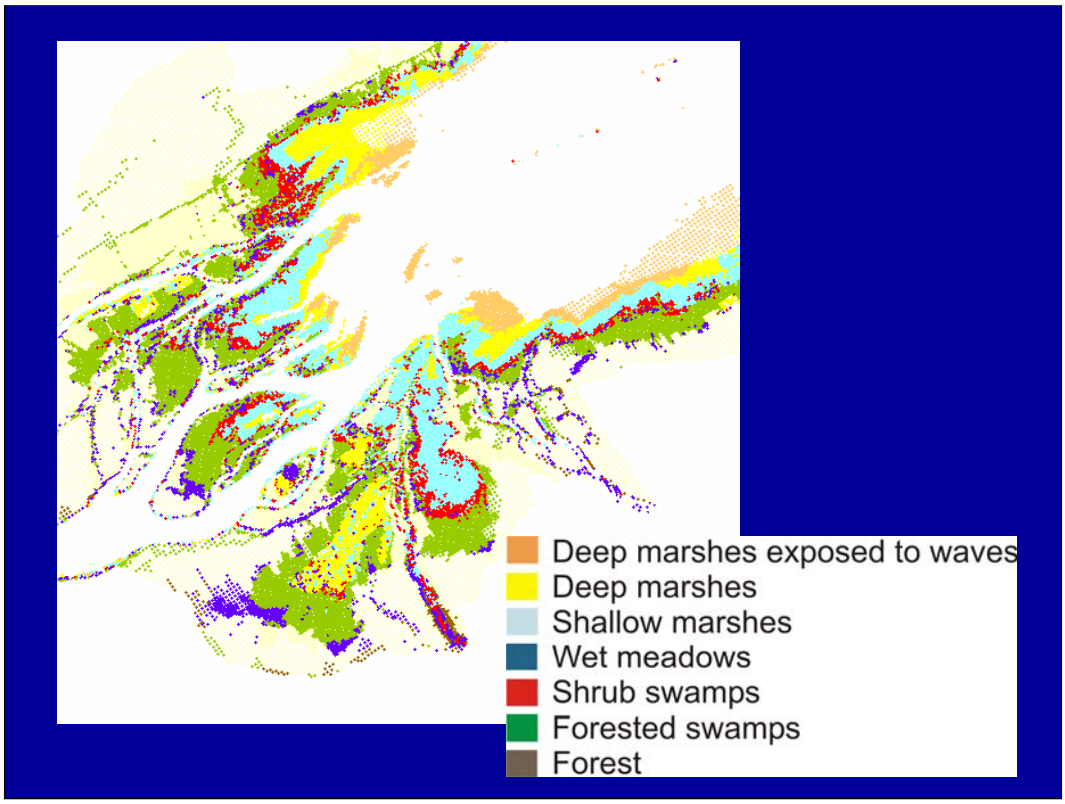
Prior to dredging, strong currents were limited to the channels at the head and the mouth of the lake, while a wide area at the center showed fast moving waters; weakest currents were limited to the nearshore.

Now, the water flow is mainly restricted to the shipping channel with much reduced currents on each side of it, and even wider zones of much slower waters by the shores. .



Such a situation is exacerbated in years of low discharge.

Extreme flow conditions illustrate the size of the flood plain and overall shallowness of the lake and the low lying islands of its delta which are frequently flooded.

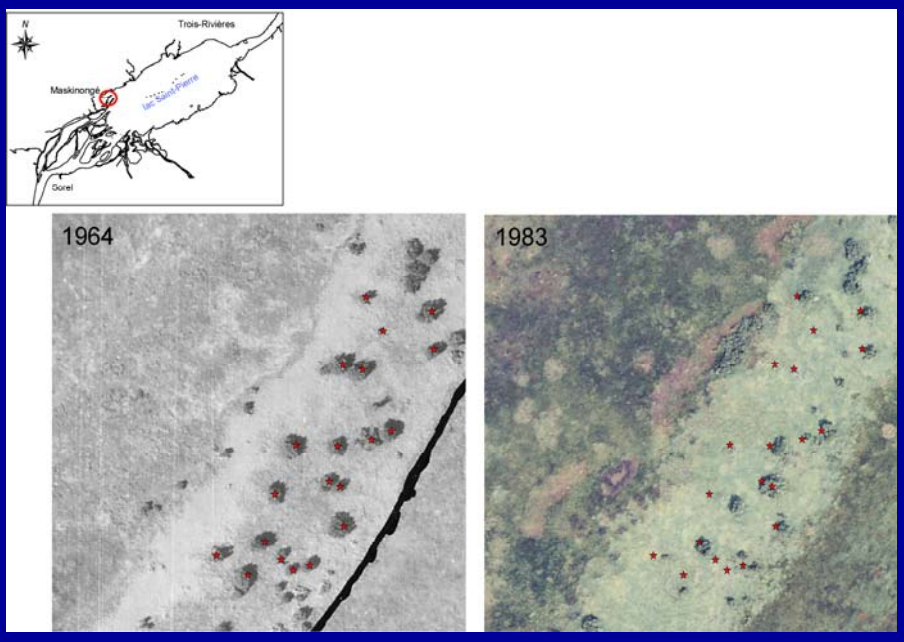


This animation shows the modeled evolution of wetland plant communities over a 40 year cycle of low and high discharges based on wetland characterization in the 90s.

One observes wide variations in the surface area of the wetlands in relation to water levels, from low marshes to tree swamps,.

Here one needs to focus on the shrub swamps shown in red. They occupy very large area following a low water level period in the mid 60s. However, a few years of high waters in the 70s brought a major die back in the 80s.

Shrub swamps alterations

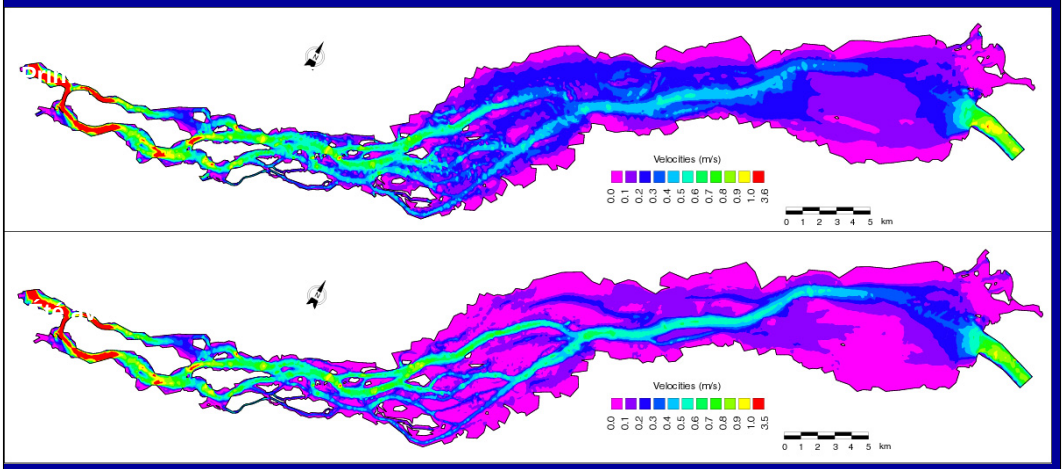


Shrubs can’t withstand long flooding periods.

No one had ever reported this die back.

Aerial photograph analysis witnessed the accuracy of the model.

Effect of plants on hydrodynamics



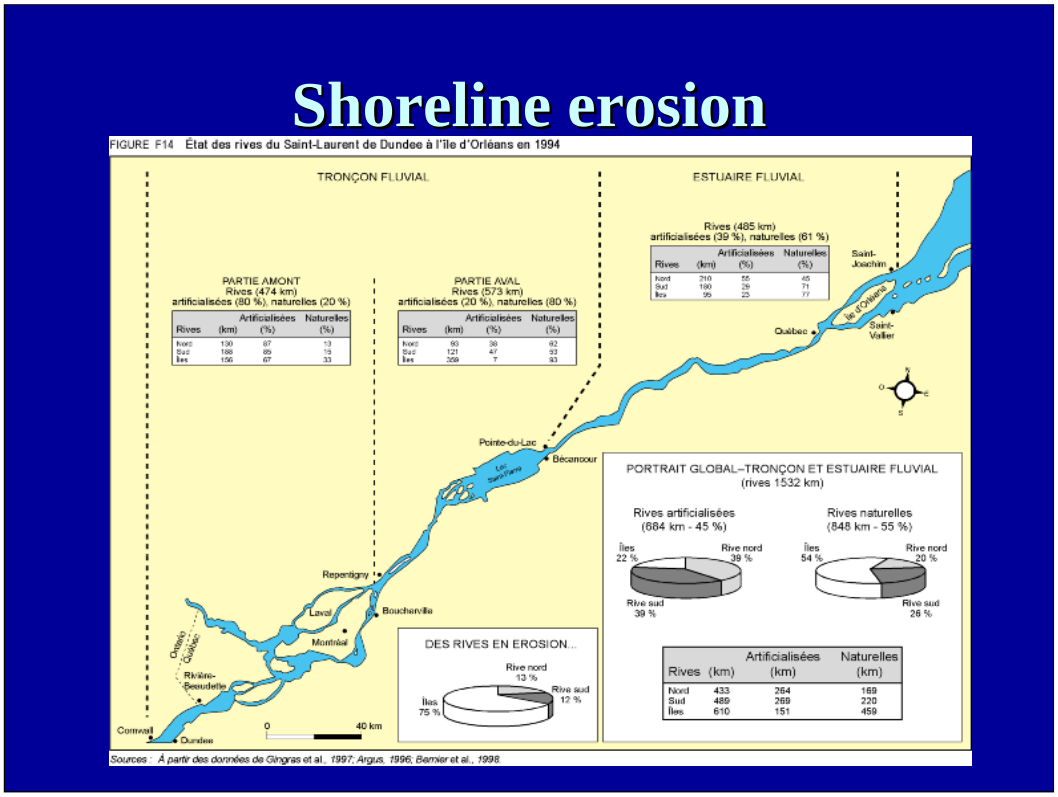
Aquatic plants are a major component of the system, They influence the physics, current, waves and sedimentation.

In the absence of plants in Spring, water moves faster on the entire central portion of Lake St. François and slow waters are limited to the shores.

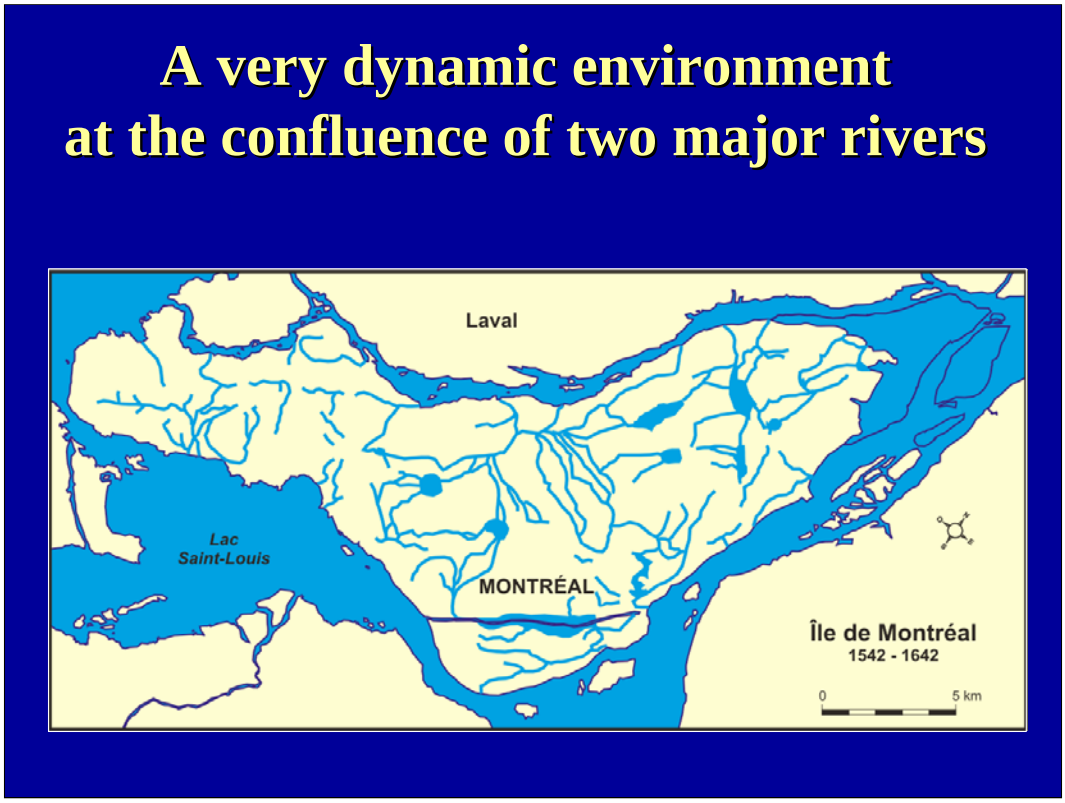
In Summer, water currents are reduced on much of the surface of the lake but for the channels and adjacent areas.

The deepening of the shipping channel has contributed to amplify the phenomenon.

Shoreline erosion



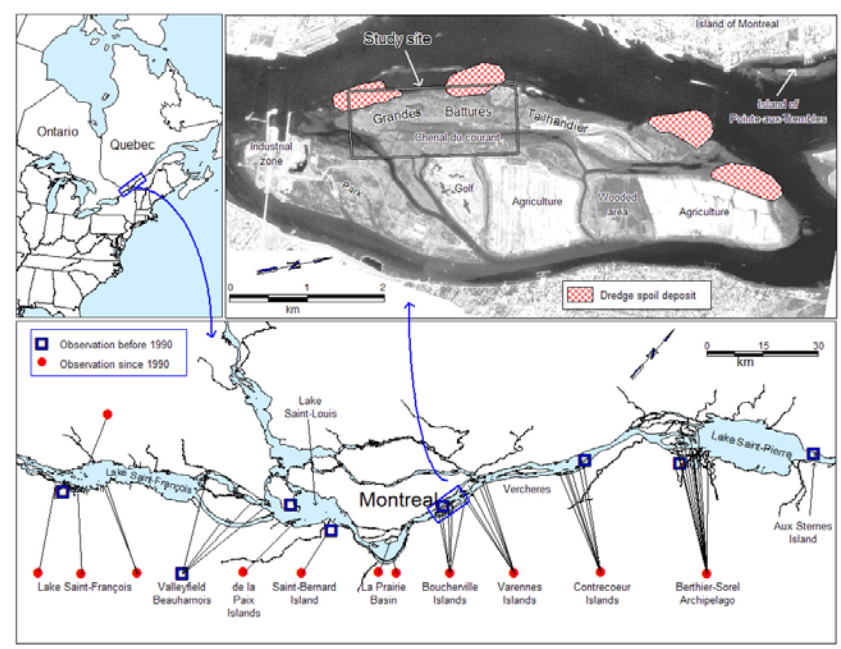
From Cornwall to the downstream end of Montreal Island, som e 80 % of the shores are hardened and 20 % are natural, whil e the reverse situation occurs in the fluvial sector, down to the outlet of Lake St. Pierre where 80 % of the shores are natural. Downstream to Quebec City, the ratio hardened/natural shore s is 40:60. The most severe erosion is observed on the islands of the fluvial sector between Montreal and Lake St. Pierre; it is due mostly to navigation and overall disruption of the sediment dynamic of the system.



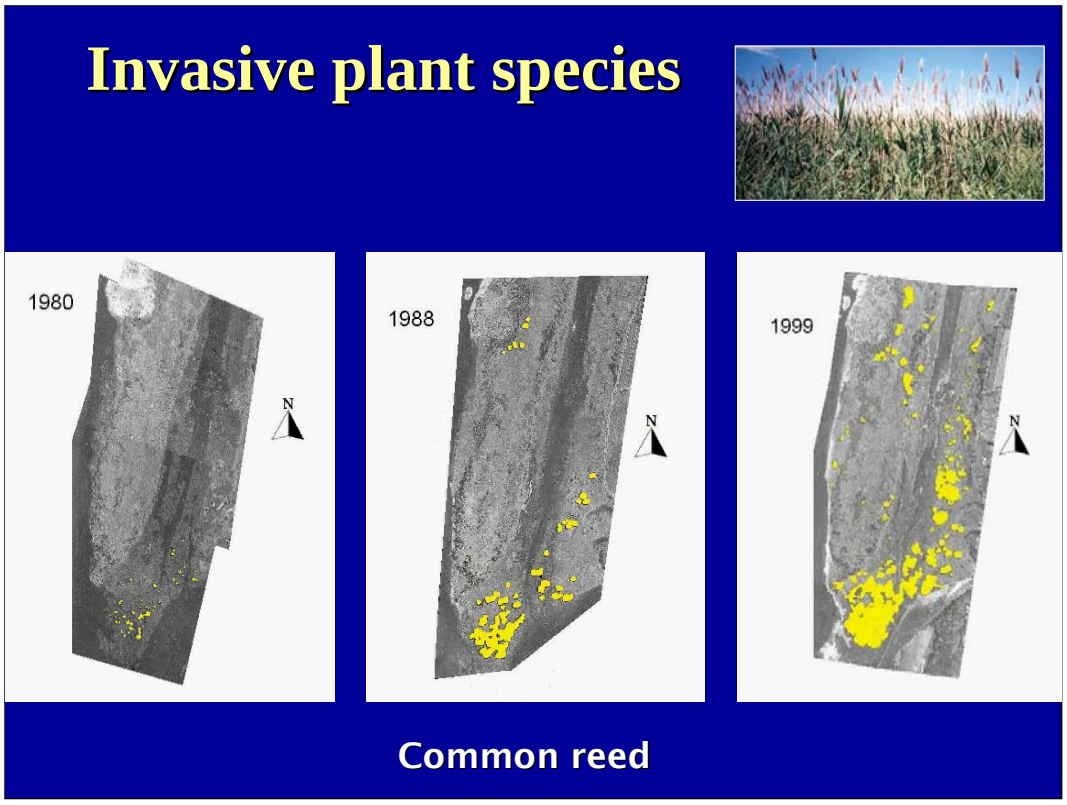
The historic view of Montreal Island with present day contour in black line

Around Montreal Island, hardened shores due in large parts to urbanization and civil protection have resulted in major losses of wetlands and accompanying fish, invertebrates and bird populations.

Common reed distribution



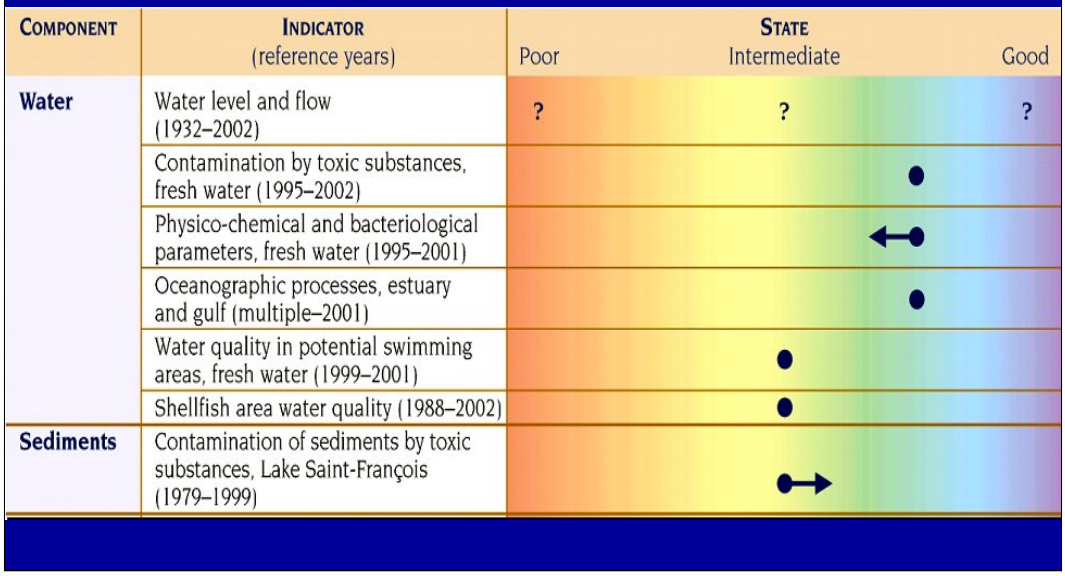
It has been demonstrated that the invasion of a very aggressive race of Common Reed may be facilitated by **man made or natural perturbations**.



Common Reed has known exponential progression in some parts of the SLR as shown here on the Boucherville Islands south of Montreal.

Very dense beds of that plant have major impacts on fish and birds habitats and may threaten local populations.

State of the St. Lawrence monitoring program



In order to assess the state and the evolution of the SLR, Provincial and federal departments have united their expertise for the implementation of a long term environmental monitoring program. There are 21 monitoring activities pertaining to water quantity and quality, sediment quality, as well as diversity and condition of biological resources at the habitat, community and species level.

Trends are shown when time series are available.

Results show that since the 1970s, toxics have decreased in water, sediments as well as biota. However uses restriction due to bacterial contamination is still a cause of concern.

State of the St. Lawrence monitoring program

Component	Indicator (reference years)	State: Poor — Intermediate — Good
Biological Resources	Wetlands and exotic plants (1976–2002)	
	Freshwater fish communities (1995–1997)	
	Contamination of freshwater fish by toxic substances (1976–1995)	
	Contamination of marine resources by toxic substances (1990–2001)	
	Great Blue Heron (1977–2001)	
	Seabirds (1925–1999)	
	Northern Gannet (1887–2001)	
	Beluga Whale population of the estuary (1988–2000)	
	Reintroduction of Striped Bass (2002 on)	To follow

Some endangered animal populations have been re established (Northern Gannett) or will soon be (Beluga Whale), marine organisms and fresh water fish are safe to eat and losses of wetlands have essentially disappeared. However, there are still important concern, such as emerging toxic substances, long term and cumulative impacts of toxics and invasive species.

Despite the major structural changes to its ecosystems, the SLR has shown a strong resilience and still shelters very productive habitats and diversified fauna and flora.

Despite the major structural changes to its ecosystems, the SLR has shown a strong resilience and still shelters very productive habitats and a diversified fauna and flora. Those positive signs need to be publicized as more and more people are interested in the conservation of our heritage.

Acknowledgments

- François Boudreault
- Édith Lacroix
- Jean Painchaud
- Magella Pelletier
- Denise Séguin

The help of colleagues at the St. Lawrence Centre and at the Quebec Ministry of the Environment is greatly appreciated and acknowledged.