Info-flash series on the state of the St. Lawrence River, published by the ST. LAWRENCE CENTRE

St. Lawrence UPDATE

The River at a Glance

Environment Canada
Québec Region

Environnement Canada
Région du Québec

Canada

St. Lawrence UPDATE

The Info-flash series is part of a project aimed at reviewing the state of the St. Lawrence River. These fact sheets, prepared within the framework of the St. Lawrence Action Plan, provide information on the biological, physico-chemical and socio-economic aspects of the River. Their design and production requires the collection, analysis, synthesis and verification of the most recent information possible on the various subjects examined.

It should be noted that the Info-flash series is produced in continuity and subject to regular updates. Copies may be obtained by contacting:

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Published by authority of the Minister of the Environment

Cat. No.: En 40-213/5-1993Erev
ISSN 1180-1220
ISBN 0-662-21404-8

ST. LAWRENCE ACTION PLAN

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N.B. : Info-flash sheets 71 to 75 are in production.The information they contain is nonetheless available in a working document.

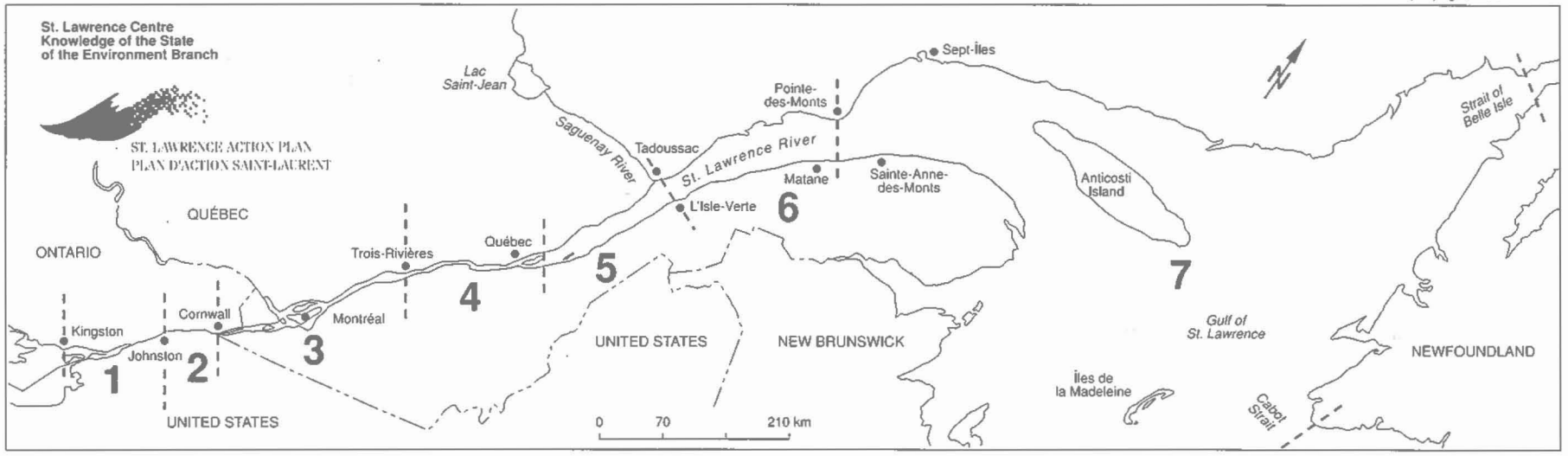
INFO-FLASH 1

Up and Down the St. Lawrence River

Section	from.....to.....	Length (km) by section	Length (km) Total	Width (km)	Altitude (m)	Depth (m)	Section	Main tributaries: North shore	Main tributaries: South shore
1. MILLE-ÎLES	Kingston	114	184	2					
2. INTERNATIONAL RAPIDS	Johnston Bridge	70			74		Freshwater: No tides		
QUÉBEC BORDER	Cornwall			5 [Lac Saint-François]	46				
3. RIVER	Montréal	≃ 600			7	10 to 12		Du Nord, Ottawa, L'Assomption	Richelieu, Yamaska, Saint-François
	Trois-Rivières			2				Saint-Maurice	
4. FLUVIAL ESTUARY	Québec			1 [and 870 m at Québec bridges]			Weak tides	Jacques-Cartier	Chaudière, Etchemin
	Cap Tourmente Île d'Orléans (eastern tip)			15			Brackish		
5. UPPER ESTUARY			1 200 (Lasserre) to 1 500 (MENVIQ)			100 to 300			Ouelle
	Tadoussac L'Isle-Verte	≃ 600						Saguenay	Du Loup
6. LOWER ESTUARY	Baie-Comeau			60			Saltwater: Strong tides (4 to 6 m)	Betsiamites, Aux Outardes, Manicouagan	
	Pointe-des-Monts between Matane and Sainte-Anne-des-Monts							Moisie	
7. GULF	Sept-Îles			100		+ 400		Magpie, Romaine, Natashquan, Du Petit Mécatina	Cascapédia, Matapédia
	Strait of Belle Isle Cabot Strait								

●●●● Dividing line between fresh/brackish/salt water

Sources:
- Ministère de l'Environnement du Québec. *L'environnement au Québec, un premier bilan*. 1988.
- Lasserre, J.-C.. *Le Saint-Laurent, grande porte de l'Amérique*. Hurtubise HMH. 753 pp. 1980.
- Gouvernement du Canada. *L'état de l'environnement au Canada*. Multiple pages. 1991.



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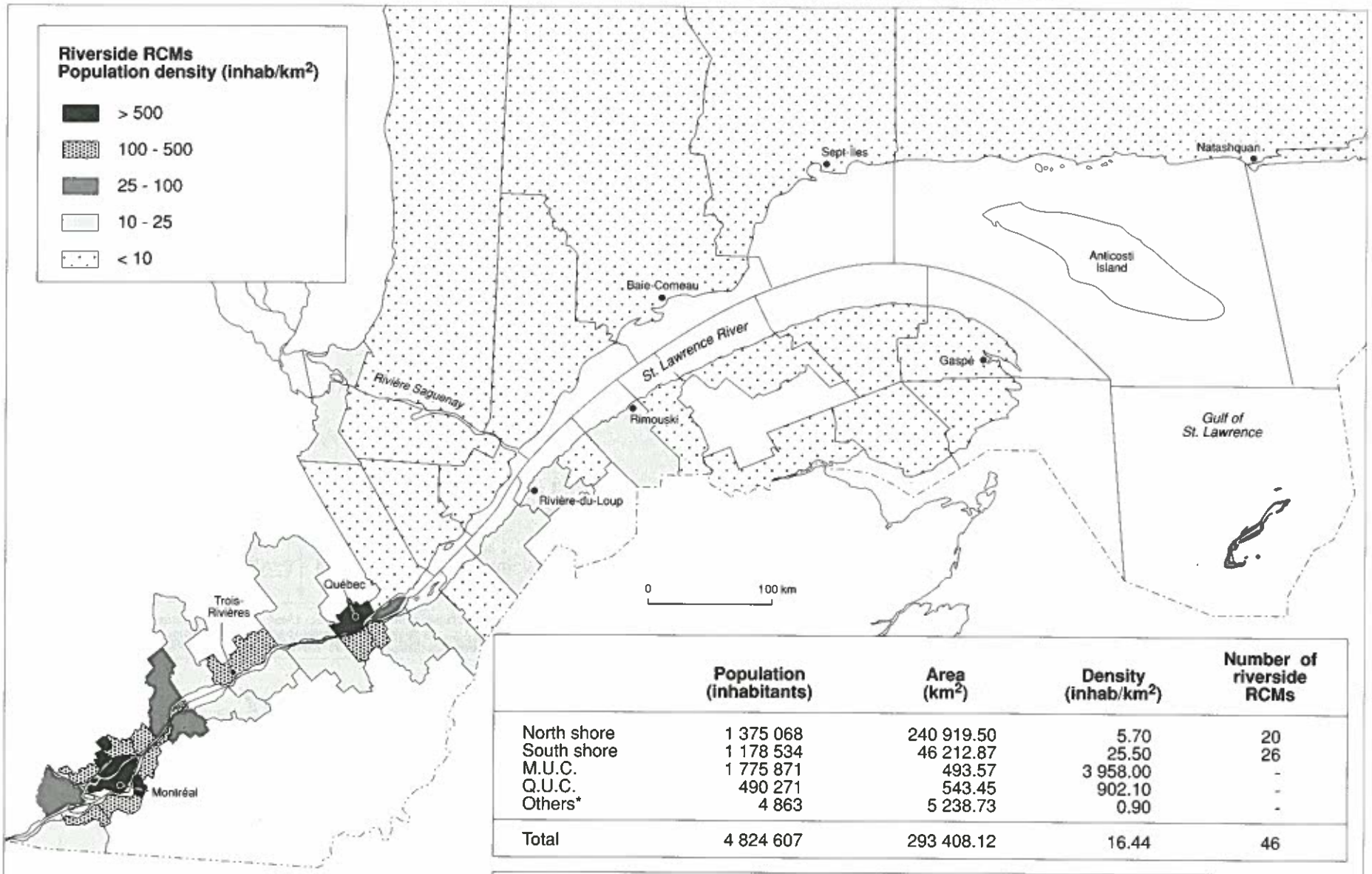
The St. Lawrence - Riverside Population (1991)



	Population (inhabitants)	Area (km²)	Density (inhab/km²)	Number of riverside RCMs
North shore	1 375 068	240 919.50	5.70	20
South shore	1 178 534	46 212.87	25.50	26
M.U.C.	1 775 871	493.57	3 958.00	-
Q.U.C.	490 271	543.45	902.10	-
Others*	4 863	5 238.73	0.90	-
Total	4 824 607	293 408.12	16.44	46
Québec	6 895 963	1 357 811.73	5.10	96

* Three north shore municipalities are not part of any RCM.

The population of riverside regional county municipalitites (RCMs) is equal to 70% of the total population of Québec.

Sources: • Statistics Canada. Census Divisions and Subdivisions, figures on population and dwellings, 1991. Catalogue 93-304. 1992.
• Map of RCMs from the ministère des Affaires municipales du Québec. 1983

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The St. Lawrence River - Riverside Indian Reserves

Current name (Former name)	Nation	Location (Census division)	Population in 1989		Area (km²) / type of territory*
			total	on territory	
North shore					
Kanesatake (Oka)	Mohawk	Deux-Montagnes	1 591	838	9.70 / s
Village-des-Hurons Wendake (Lorette)	Huron - Wendat	Québec	2 295	864	1.11 / r
Les Escoumins	Montagnais	Saguenay	341	186	0.39 / r
Betsiamites (Bersimis)	Montagnais	Saguenay	2 449	2 175	255.37 / r
Uashat / Maliotenam	Montagnais	Saguenay	2 263	1 814	6.08 / r
Mingan	Montagnais	Saguenay	357	347	38.88 / r
Natashquan	Montagnais	Saguenay	573	535	0.21 / r
La Romaine	Montagnais	Saguenay	723	706	0.40 / r
Pakua Shipi (Saint-Augustin)	Montagnais	Saguenay	132	1	0.04 / s
South shore					
Akwesasne (Saint-Régis)	Mohawk	Huntingdon	?	1 580 **	11.43 / r
Kahnawake (Caughnawaga)	Mohawk	Laprairie	6 839	5 995	50.59 / r
Odanak	Abenaki	Yamaska	1 196	263	6.07 / r
Wôlinak (Bécancour)	Abenaki	Nicolet	167	57	0.79 / r
Cacouna	Malecite	Rivière-du-Loup	229	0	0.0017 / r
Gaspé	MicMac	Gaspé	354	0	0 / nt
Gesgapegiag (Maria)	MicMac	Bonaventure	746	455	1.82 / r
Restigouche	MicMac	Bonaventure	2 262	1 477	36.42 / r
Total			**22 517**	**17 293**	**419.30**

Native community: Formerly called "Indian band". Regulated by the *Indian Act*. The name of each community is chosen by resolution of the band council.

***Type of territory:** Status of the territory inhabited by the community.
r = reserve: according to the *Indian Act*, an expanse of land owned by the Queen and set aside for the use and benefit of the band.
s = settlement: territory identified but without reserve status and inhabited by a community.
nt = no territory.

** Québec section only.

Sources: • Beaulieu, J. *Localisation des nations autochtones au Québec, Historique foncier*. Les Publications du Québec. 1986.
• Indian and Northern Affairs Canada. *Québec Indian Community Guide 1990*. Québec Region. 111 pp. 1990.

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The St. Lawrence River and its Main Tributaries - Average Annual Flow (m^3/s)

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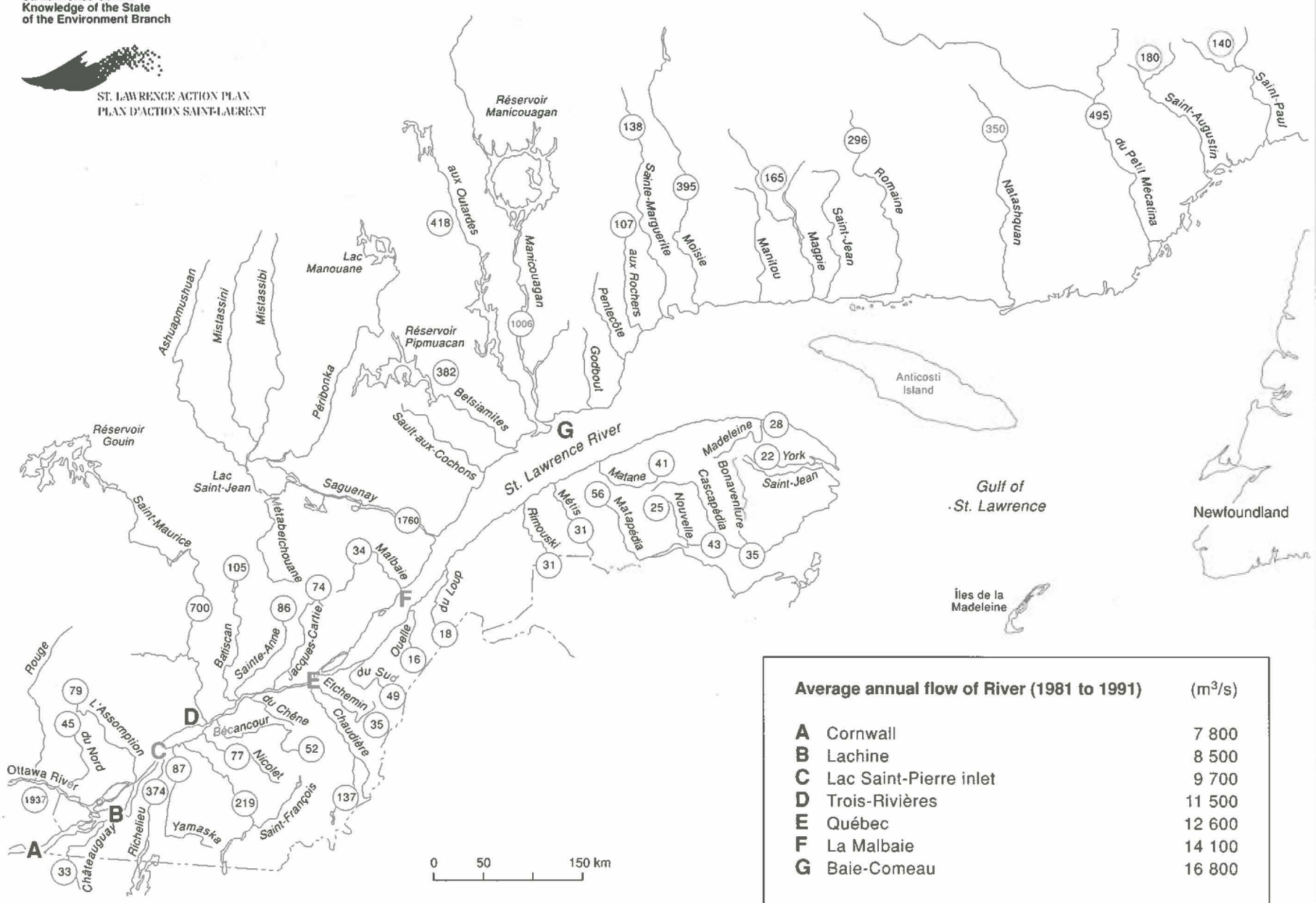


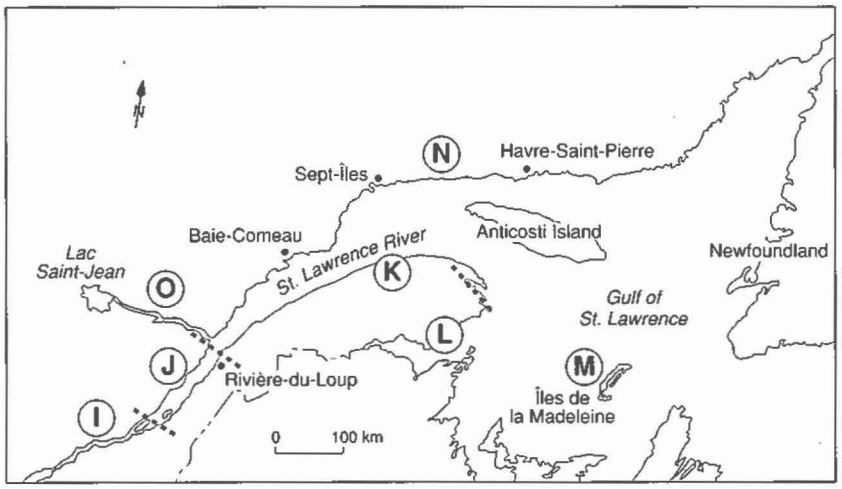
Average annual flow of River (1981 to 1991)		(m^3/s)
A	Cornwall	7 800
B	Lachine	8 500
C	Lac Saint-Pierre inlet	9 700
D	Trois-Rivières	11 500
E	Québec	12 600
F	La Malbaie	14 100
G	Baie-Comeau	16 800

Average annual flow at mouth of tributary (132)

Source: Ministère de l'Environnement du Québec, Direction du milieu Hydrique. 1989 and 1992.

INFO-FLASH 5

The St. Lawrence River - Average Volume of Dredged Sediment (m^3) from 1983 to 1991



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Dredging sectors (A)	Average volume dredged (m^3 / year) between 1983 and 1991	Number of years of dredging	Number of dredgings
A	0	0	0
B	20 000	1	1
C, D, E	0	0	0
F	10 741	7	10
G	40 679	5	12
H	65 108	9	32
I	147 289	9	30
J	86 327	9	45
K	77 279	9	153
L	31 352	9	113
M	88 870	9	85
N	82 929	7	19
O	29 235	4	5

★ Major dredging site in terms of average volume (> 50 000 m^3) between 1983 and 1991

The dredging necessary for maintenance of the St. Lawrence Seaway and access channels and in the construction and maintenance of harbour facilities was considered in calculating dredged volumes.

Sources: • Environment Canada. *Banque de données sur les dragages et la qualité des sédiments.* St. Lawrence Centre, Technology Development Branch. 1993.

The St. Lawrence River - Municipalities with Drinking Water Intakes (1991)

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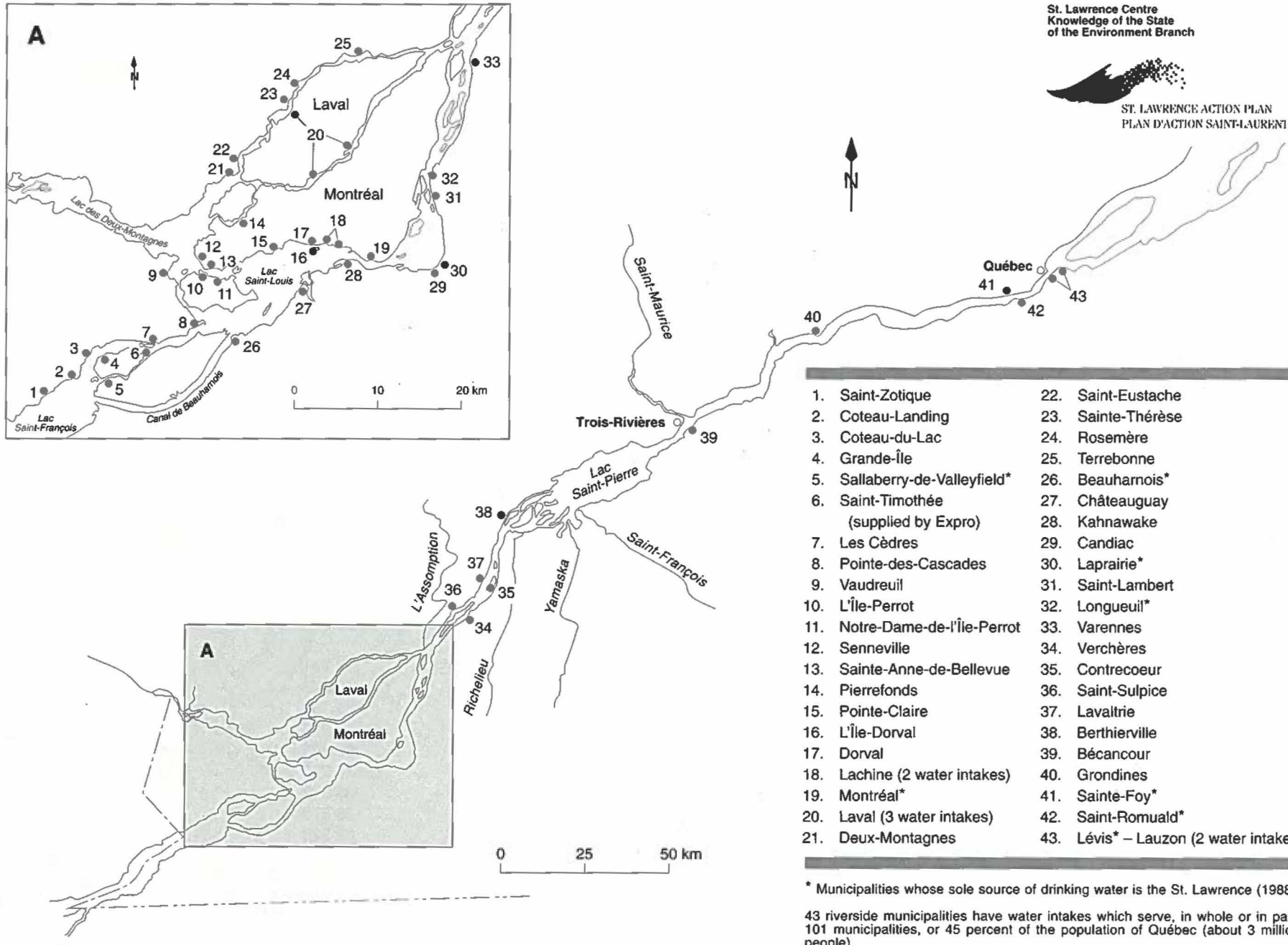


1. Saint-Zotique
2. Coteau-Landing
3. Coteau-du-Lac
4. Grande-Île
5. Sallaberry-de-Valleyfield*
6. Saint-Timothée (supplied by Expro)
7. Les Cèdres
8. Pointe-des-Cascades
9. Vaudreuil
10. L'Île-Perrot
11. Notre-Dame-de-l'Île-Perrot
12. Senneville
13. Sainte-Anne-de-Bellevue
14. Pierrefonds
15. Pointe-Claire
16. L'Île-Dorval
17. Dorval
18. Lachine (2 water intakes)
19. Montréal*
20. Laval (3 water intakes)
21. Deux-Montagnes
22. Saint-Eustache
23. Sainte-Thérèse
24. Rosemère
25. Terrebonne
26. Beauharnois*
27. Châteauguay
28. Kahnawake
29. Candiac
30. Laprairie*
31. Saint-Lambert
32. Longueuil*
33. Varennes
34. Verchères
35. Contrecoeur
36. Saint-Sulpice
37. Lavaltrie
38. Berthierville
39. Bécancour
40. Grondines
41. Sainte-Foy*
42. Saint-Romuald*
43. Lévis* – Lauzon (2 water intakes)

* Municipalities whose sole source of drinking water is the St. Lawrence (1988).

43 riverside municipalities have water intakes which serve, in whole or in part, 101 municipalities, or 45 percent of the population of Québec (about 3 million people).

More than 2 billion litres of water are drawn from the St. Lawrence every day.

Source: • Ministère de l'Environnement du Québec. Data bank. (MUNFLEUV.DBF). Direction des écosystèmes urbains, Direction Réseau hydrique et Directions régionales. 1989.

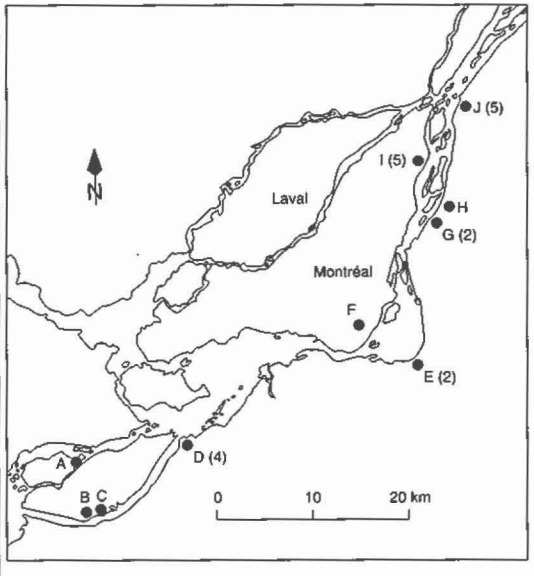
INFO-FLASH 7

The St. Lawrence River - Fifty Priority Industries

Plant provides X percent of manufacturing sector jobs in the municipality where it is located (1992).

Industry categories

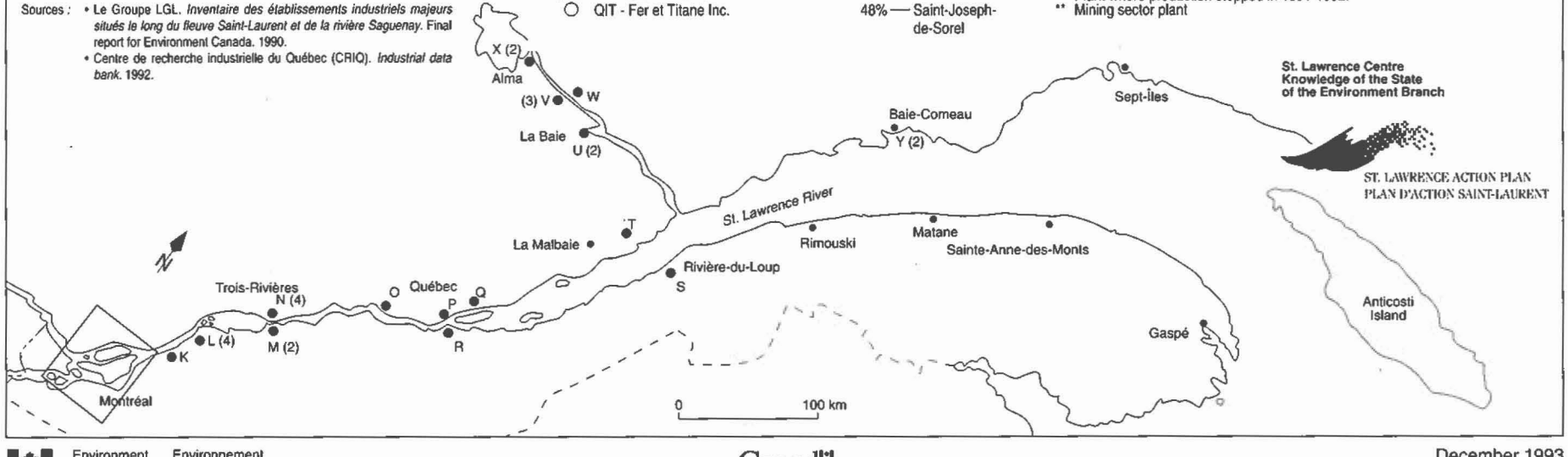
- △ Pulp and paper
- ▲ Petroleum
- ○ Metallurgy
- ● Surface treatment
- □ Chemicals
- ■ Other



A.	□	Expro Chemical Products Inc.	72%	Saint Timothée
B.	■	Dominion Textile Inc. (Beauharnois finishing plant)	24%	
C.	○	Canadian Electrolytic Zinc Ltd.	24%	Salaberry-de-Valleyfield
D.	○	Alcan Smelters and Chemicals Ltd. (Beauharnois plant)	93%	Melocheville
	△	Domtar Inc. (Beauharnois mill)	56%	Beauharnois
	□	PPG Canada Inc.	31%	
	○	Elkem Metal Canada Inc.*	-%	
E.	●	Locweld Inc.	9%	Candiac
	△	Perkins Papers Ltd.	8%	
F.	□	Monsanto Canada Inc.	4%	LaSalle
G.	●	Héroux Inc.	4%	Longueuil
	●	Pratt & Whitney Canada Inc. (plants Nos. 1, 2 and 5)	46%	
H.	□	Nacan Products Ltd.	2%	Boucherville
I.	○	Noranda Minerals Inc., CCR refinery	24%	Montréal-Est
	▲	Shell Canada Products Ltd.	14%	
	□	Petromont Co. Ltd.	15%	
	□	Kemtec Petrochemical Corporation Inc. (plants Nos. 1 and 2)	-%	
	▲	Petro-Canada Products Inc.	< 1%	Montréal
J.	□	Commercial Alcohols Ltd.*	-%	Varennes
	□	Albright & Wilson Amerique (Division of Tenneco Canada Inc.)*	-%	
	□	Nacan Products Ltd.	2%	
	□	Kronos Canada Inc.	22%	
	□	Petromont Inc.	13%	
K.	○	Sidbec-Dosco Inc.	65%	Contrecoeur
L.	○	Aciers Inoxydables Atlas Inc. (Division of Sammi-Atlas Inc.)	14%	Tracy
	■	Wood Preservation Industries Ltd.	< 1%	
	□	Tioxide Canada Inc.	5%	
	○	QIT - Fer et Titane Inc.	48%	Saint-Joseph-de-Sorel
M.	□	ICI Canada Inc. (Bécancour)	9%	Bécancour
	○	Aluminerie de Bécancour Inc.	39%	
N.	△	Canadian Pacific Forest Products Ltd.	-%	Trois-Rivières
	△	Stone-Consolidated Inc. (Wayagamack division)	14%	
	△	Kruger Inc. (Trois-Rivières mill)	19%	
	■	Reynolds Aluminum Co. of Canada Ltd. (Cap-de-la-Madeleine plant)	45%	Cap-de-la-Madeleine
O.	△	Domtar Inc. (Donnacona mill)	86%	Donnacona
P.	△	Daishowa Inc.	14%	Québec
Q.	△	Abitibi-Price Inc. (Beaupré mill)	99%	Beaupré
R.	▲	Ultramar Canada Inc.	16%	Saint-Romuald
S.	△	F.F. Soucy Inc.	23%	Rivière-du-Loup
T.	△	Donohue Inc. (Clermont mill)	95%	Clermont
U.	△	Stone-Consolidated Inc. (Port-Alfred division)	44%	La Baie
	○	Alcan Smelters and Chemicals Ltd. (Grande-Baie plant)	32%	
V.	△	Cascades (Jonquière) Inc.	5%	Jonquière
	△	Abitibi-Price Inc. (Kénogami mill)	12%	
	○	Alcan Smelters and Chemicals Ltd. (Arvida, Vaudreuil and Saguenay plants)	41%	
W.	■	Les Services T.M.G. Inc. (Niobec mine)**	100%	Saint-Honoré
X.	△	Abitibi-Price Inc. (Alma mill)	47%	Alma
	○	Alcan Smelters and Chemicals Ltd. (Isle-Maligne plant)	28%	
Y.	△	QUNO Corporation	38%	Baie-Comeau
	○	Canadian Reynolds Metals Co. Ltd. (Baie-Comeau plant)	58%	

* Plant where production stopped in 1991-1992.
** Mining sector plant

Sources :
- Le Groupe LGL. *Inventaire des établissements industriels majeurs situés le long du fleuve Saint-Laurent et de la rivière Saguenay*. Final report for Environment Canada. 1990.
- Centre de recherche industrielle du Québec (CRIQ). *Industrial data bank*. 1992.



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INFO-FLASH 8a

The St. Lawrence River - Protected Areas of Natural Shoreline from Montréal to Rimouski

Symbol	Protective Status	Agency Responsible	Number	Area (km²)
Federal jurisdiction (1307.3 km²)				
▲	Marine park*	Environment Canada (Canadian Parks Service) Ministère du Loisir, de la Chasse et de la Pêche	1	1138.0
●	National wildlife area	Environment Canada (Canadian Wildlife Service)	6	46.4
◉	Migratory bird sanctuary		18	80.9
○	Migratory bird staging area		1	42.0
Provincial jurisdiction (441.8 km²)				
■	Provincial conservation park	Ministère du Loisir, de la Chasse et de la Pêche du Québec	3	409.0
▣	Provincial recreation park and regional park		3	32.3
★	Ecological reserve	Ministère de l'Environnement du Québec	2	0.5
			TOTAL	1749.1

* *Joint federal-provincial jurisdiction*

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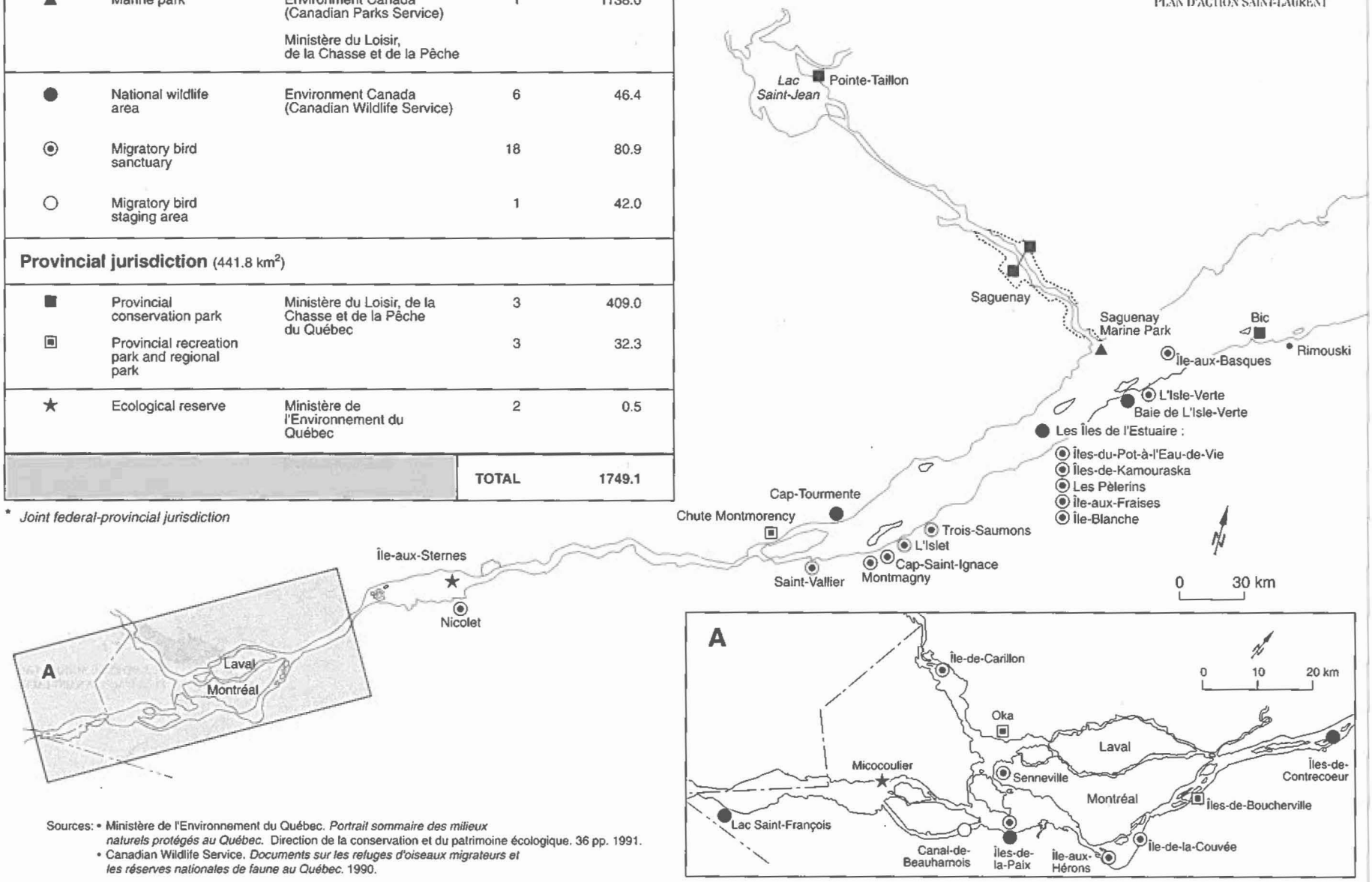

Sources: • Ministère de l'Environnement du Québec. *Portrait sommaire des milieux naturels protégés au Québec.* Direction de la conservation et du patrimoine écologique. 36 pp. 1991.
• Canadian Wildlife Service. *Documents sur les refuges d'oiseaux migrateurs et les réserves nationales de faune au Québec.* 1990.

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December 1993

INFO-FLASH 8b The St. Lawrence River - Protected Areas of Natural Shoreline from Rimouski to Blanc-Sablon

Symbol	Protective Status	Agency Responsible	Number	Area (km²)
Federal jurisdiction (775.5 km²)				
▲	National park	Environment Canada (Canadian Parks Service)	1+1 in park reserve	390.4
●	National wildlife area	Environment Canada (Canadian Wildlife Service)	2	7.0
⊙	Migratory bird sanctuary		11	331.1
○	Migratory bird staging area		2	47.0

Symbol	Protective Status	Agency Responsible	Number	Area (km²)
Provincial jurisdiction (6982.5 km²)				
■	Provincial conservation park	Ministère du Loisir, de la Chasse et de la Pêche du Québec	2	6.4
□	Wildlife area		2	6961.0
★	Ecological reserve	Ministère de l'Environnement du Québec	2	15.1
			TOTAL	**7758.0**

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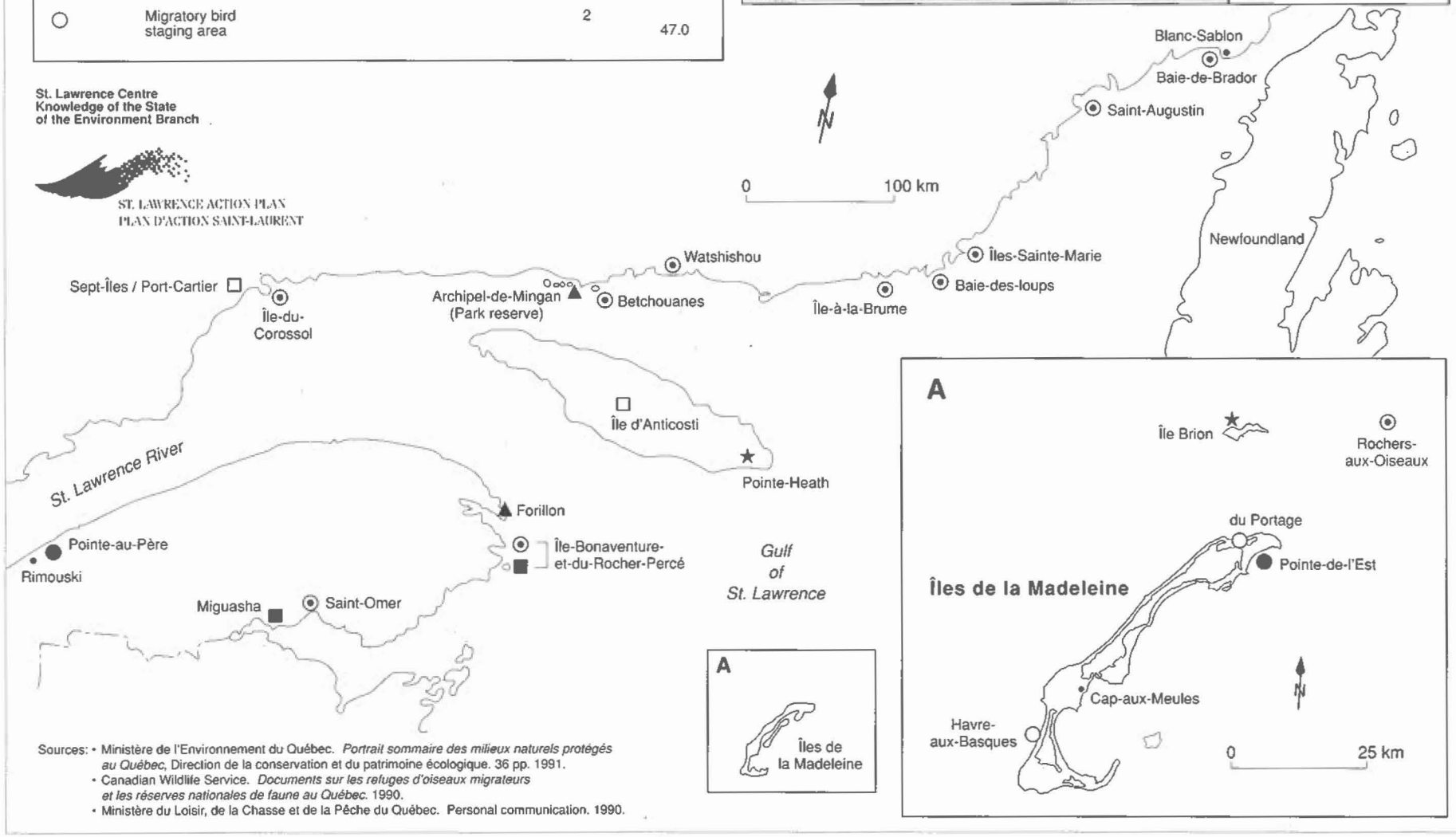
ST. LAWRENCE ACTION PLAN
PLAN D'ACTION SAINT-LAURENT



Sources:
- Ministère de l'Environnement du Québec. *Portrait sommaire des milieux naturels protégés au Québec*, Direction de la conservation et du patrimoine écologique. 36 pp. 1991.
- Canadian Wildlife Service. *Documents sur les refuges d'oiseaux migrateurs et les réserves nationales de faune au Québec*. 1990.
- Ministère du Loisir, de la Chasse et de la Pêche du Québec. Personal communication. 1990.

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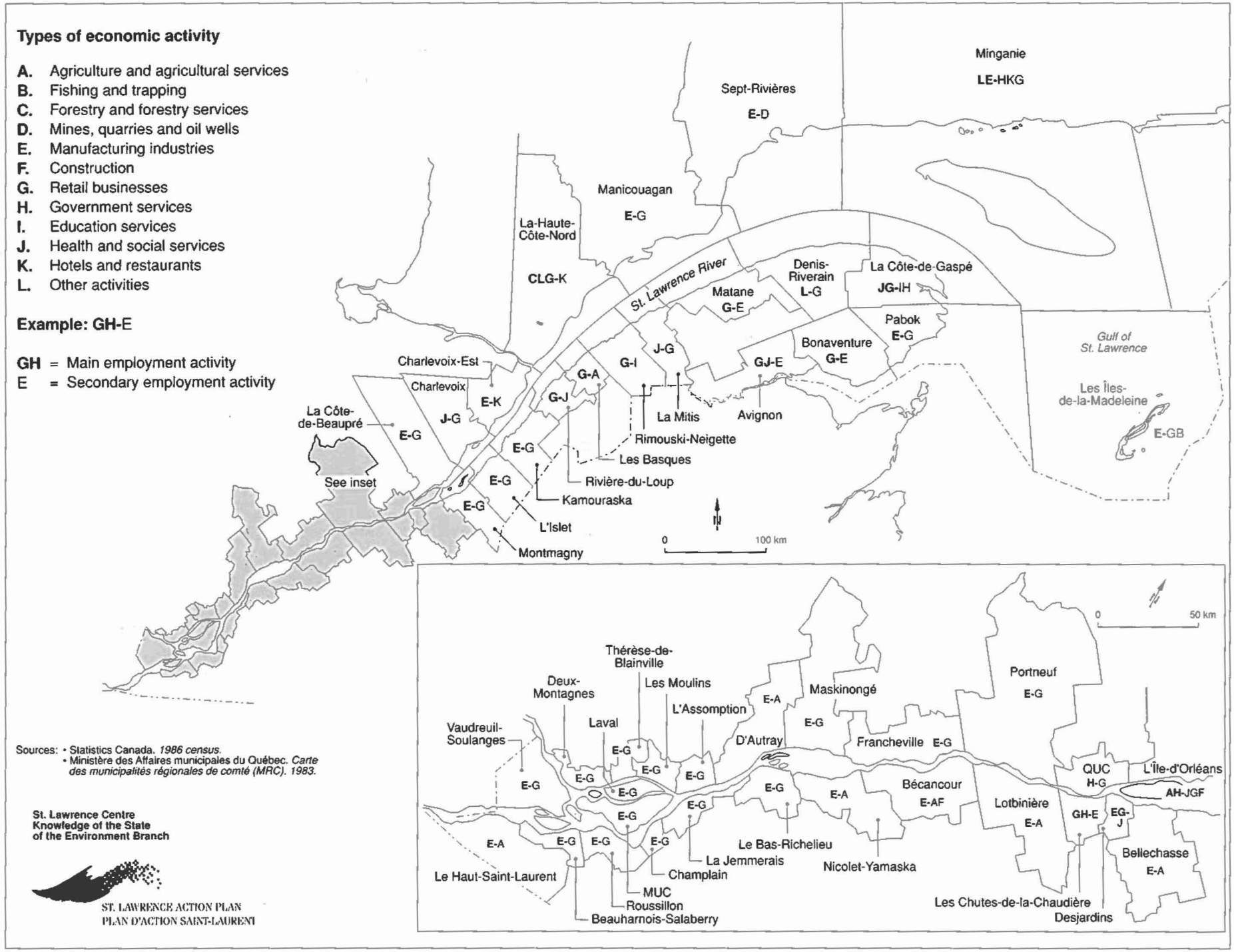
March 1993

INFO-FLASH 9

The St. Lawrence River - Main Economic Activities in Riverside RCMs (1986)



Sources: • Statistics Canada. *1986 census.*
• Ministère des Affaires municipales du Québec. *Carte des municipalités régionales de comté (MRC). 1983.*

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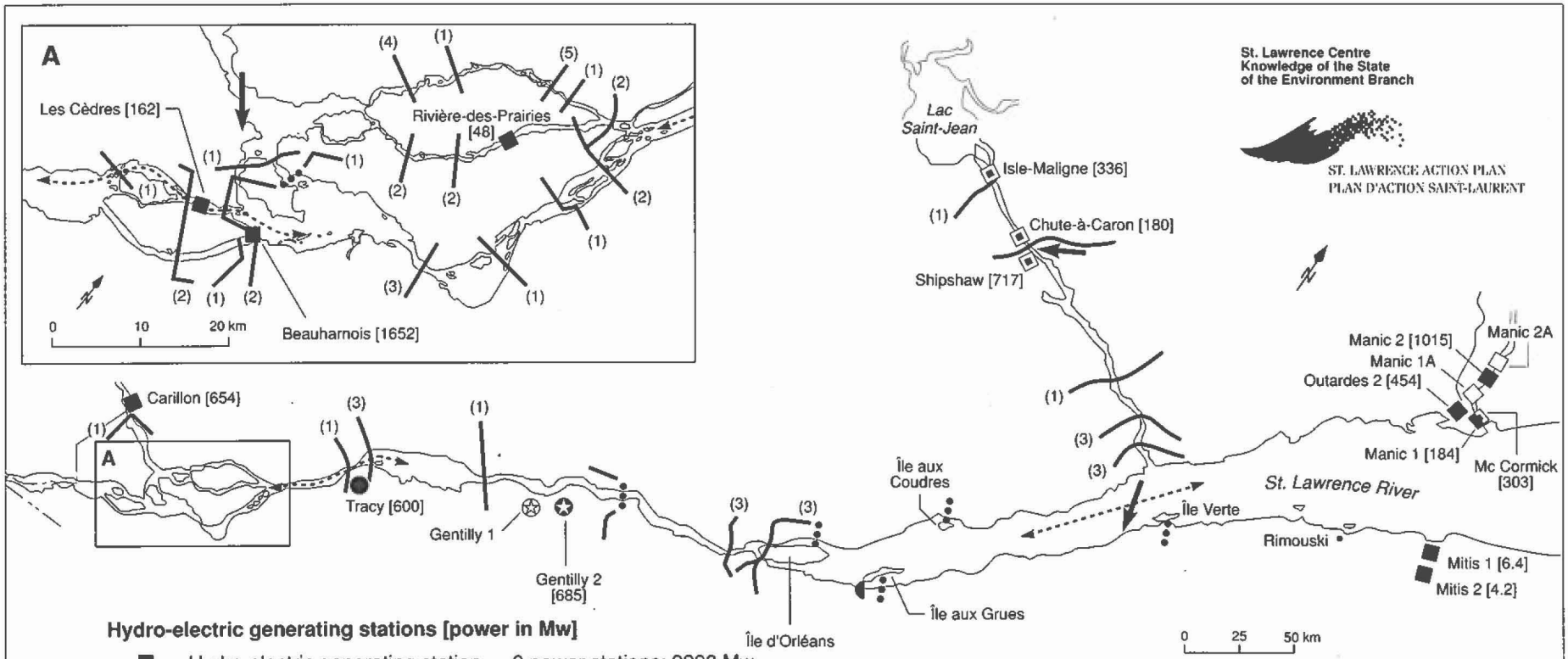
March 1993

The St. Lawrence River - Energy Production and Transmission



Hydro-electric generating stations [power in Mw]

- ■ Hydro-electric generating station — 9 power stations: 3998 Mw
- ▣ Hydro-electric generating station* — 4 power stations: 1554 Mw
- □ Hydro-electric generating station under study

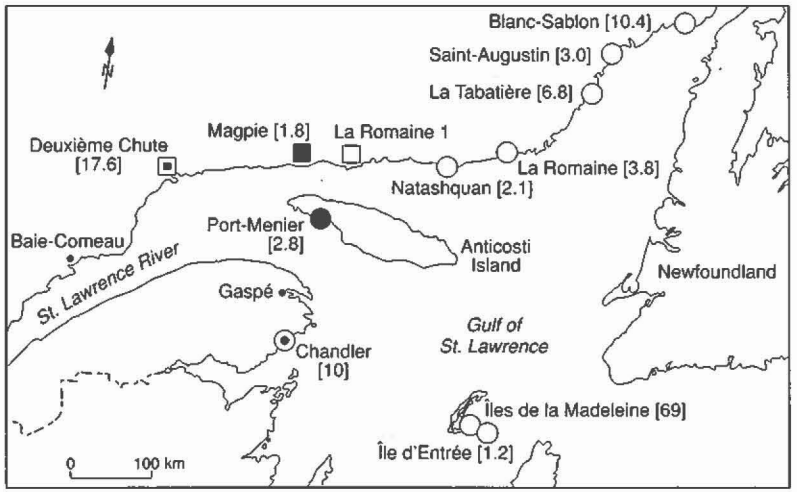
Thermal power stations [power in Mw]

- ● Classic generating station — 2 power stations: 602 Mw
- ⊙ Classic or diesel generating station* — 1 power station: 10 Mw
- ○ Diesel power generating station — 7 power stations: 96 Mw
- ◖ Non-functioning thermal power station
- ✪ Nuclear power generating station — 1 power station: 685 Mw
- ✪ Non-functioning nuclear power generating station*

Transmission lines

- ——— Aerial hydro-electric line — 53 lines
- ••••••• Underwater hydro-electric line — 5 lines
- ←----→ Future hydro-electric crossing
- ◄——— Point of arrival of line under study

* Station not owned by Hydro-Québec



Sources:
- Hydro-Québec. *Le Saint-Laurent. Mémoire présenté au comité directeur sur le développement et la mise en valeur du Saint-Laurent.* 1988.
- Hydro-Québec. *Proposition de plan de développement d'Hydro-Québec 1990-1992 – Horizon 1999.* 1990.
- Hydro-Québec. *Rapport annuel 1991.* 78 pp. 1992.

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The St. Lawrence River - Treatment of Wastewater from Riverside Municipalities (1992)

339 RIVERSIDE MUNICIPALITIES

29 (MUC, 1 plant)

22 are already served in whole or in part

6 are not being served, but will be in 1994

1 will not be served (septic tanks present)

7 (QUC, 2 plants)

7 are already wholly served

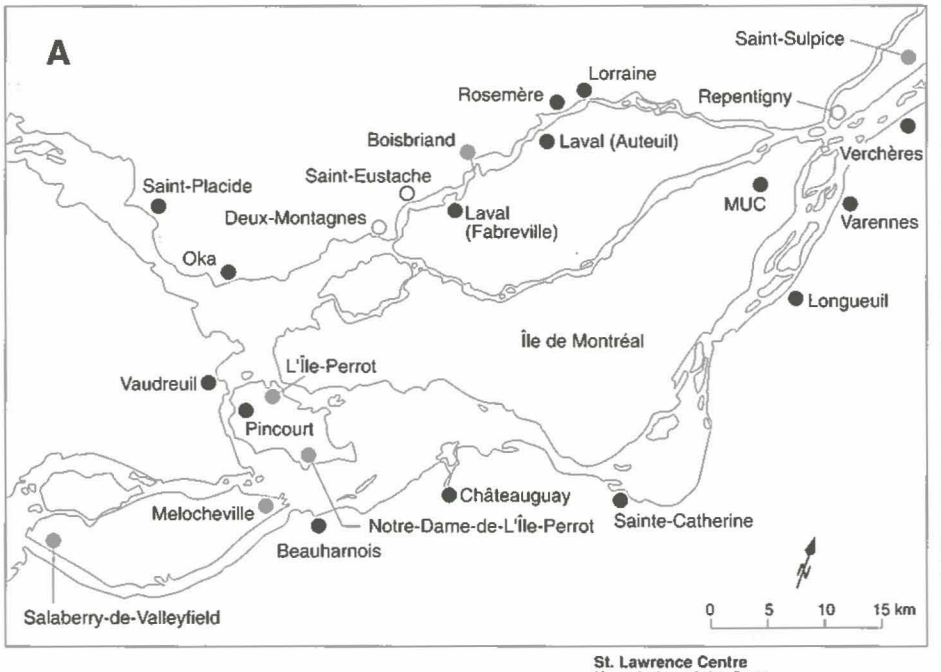
303 (Others)

116 are not part of the program*
- 91 are not eligible because they do not have sewer systems
- 25 have a sewer system

187 are part of the program (12-92):
- 12 have not signed any agreement
- 83 have signed an agreement in principle
- 92 have signed a completion agreement
  - 12 are not being served but will be by 1995, by one of the new or existing plants
  - 80 are already served in whole or in part by the 60 existing plants

N.B.: One treatment plant can serve a number of municipalities

* Water treatment program (PAEQ) of the ministère de l'Environnement du Québec.



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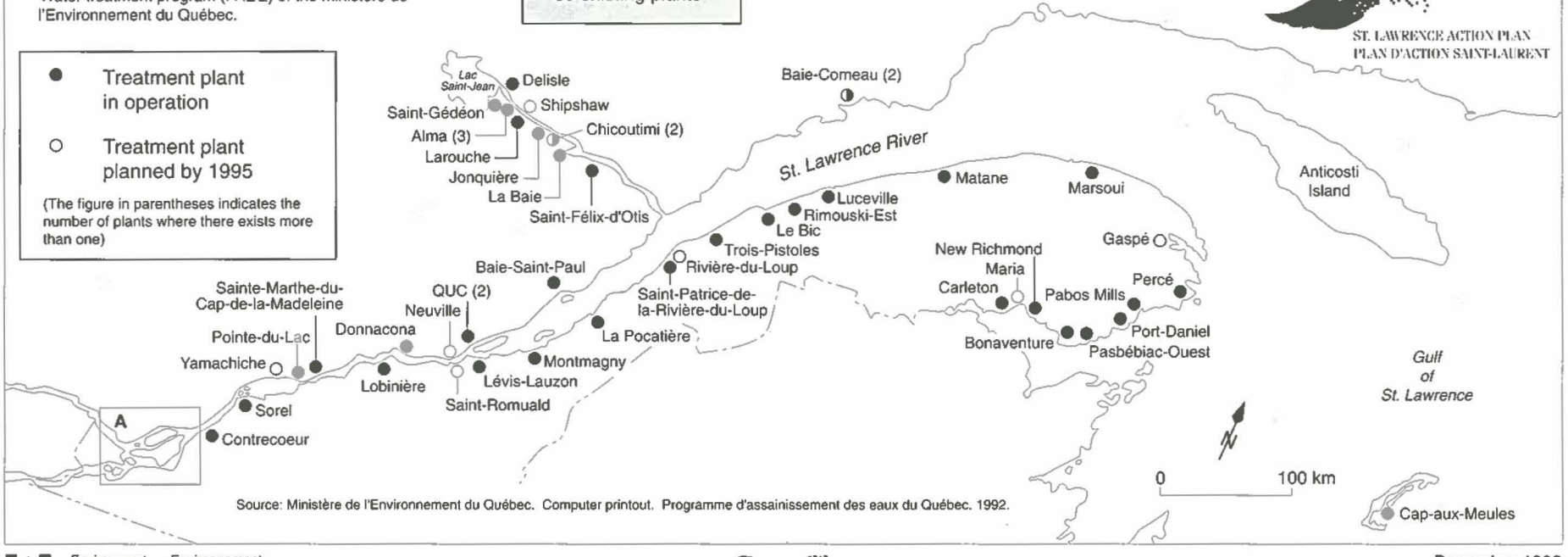
- ● Treatment plant in operation
- ○ Treatment plant planned by 1995

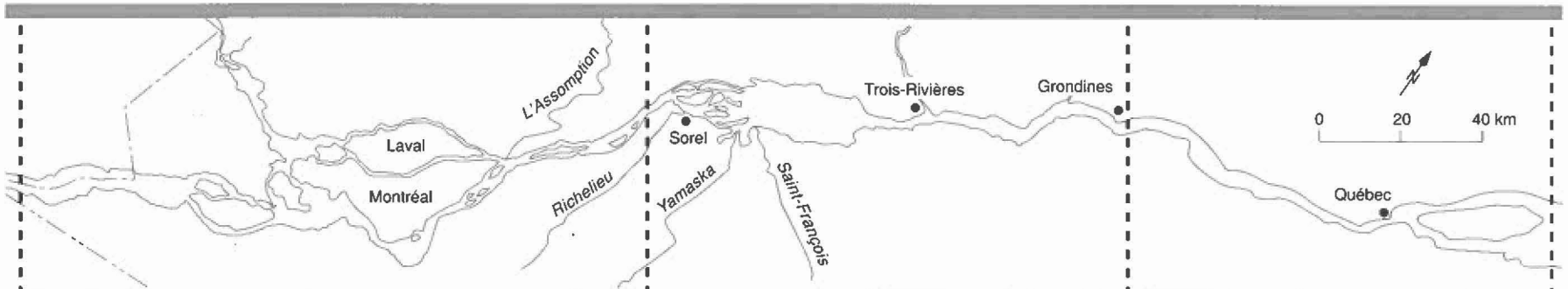
(The figure in parentheses indicates the number of plants where there exists more than one)



Source: Ministère de l'Environnement du Québec. Computer printout. Programme d'assainissement des eaux du Québec. 1992.

The St. Lawrence River - Overview of Freshwater Sports Fishing (1985)

MAIN SPECIES OF FISH BY SECTOR



MONTRÉAL SECTOR

	Tonnes/yr
Pike (including Muskellunge)	1 090
Yellow perch	870
Walleye	600
Bass	40

TROIS-RIVIÈRES SECTOR

	Tonnes/yr
Atlantic tomcod	300
Walleye	150
Yellow perch	80
Pike (including Muskellunge)	70

QUÉBEC SECTOR

	Tonnes/yr
Atlantic tomcod	50
Rainbow smelt	2
Walleye	2

	SPORTS FISHERMEN			FISHING ACTIVITY			FISHING PRESSURE	FISH HARVEST		
Region studied	Number/yr (>15 years)	% of fluvial sector	% of Québec	Number of fisherman-days	% of fluvial sector	% of Québec	Fisherman-day/hectare	Landed tonnes/yr	% of fluvial sector	% of Québec
Montréal sector (69 000 ha)	180 000	85	15	2 000 000	83	13	29	2 600	80	7
Trois-Rivières sector (55 000 ha)	30 500	14	3	390 000	16	3	7	600	18	2
Québec sector (42 000 ha)	1 500	1	<1	20 000	1	<1	0.5	60	2	<1
Total fluvial sector	**212 000**	**100**	**18**	**2 410 000**	**100**	**16**	**15**	**3 260**	**100**	**9**
Province of Québec	1 082 827	-	-	15 288 000	-	-	N.D.	35 403	-	-

N.B.: These figures represent estimates of the ministère du Loisir, de la Chasse et de la Pêche du Québec.

- In 1985, nearly 21% of Québecers aged 15 and older engaged in sports fishing in Québec at least once.
- Sports fishermen in the freshwater fluvial corridor represent 18% of all sports fishermen in Québec.
- They account for an annual total of 2.4 million fisherman-days, or 16% of all fishing in Québec.
- However, they harvested only 9% by volume of the sports fishing catch in Québec in 1985.

Sources: • Mailhot, Y. *Pêcheries sportives et commerciales du fleuve Saint-Laurent en eau douce : gestion, récolte et rendement.* Ministère du Loisir, de la Chasse et de la Pêche du Québec. Conference report. 1989.
• Ministère du Loisir, de la Chasse et de la Pêche du Québec and Fisheries and Oceans. *La pêche récréative au Québec en 1985.* 1985.

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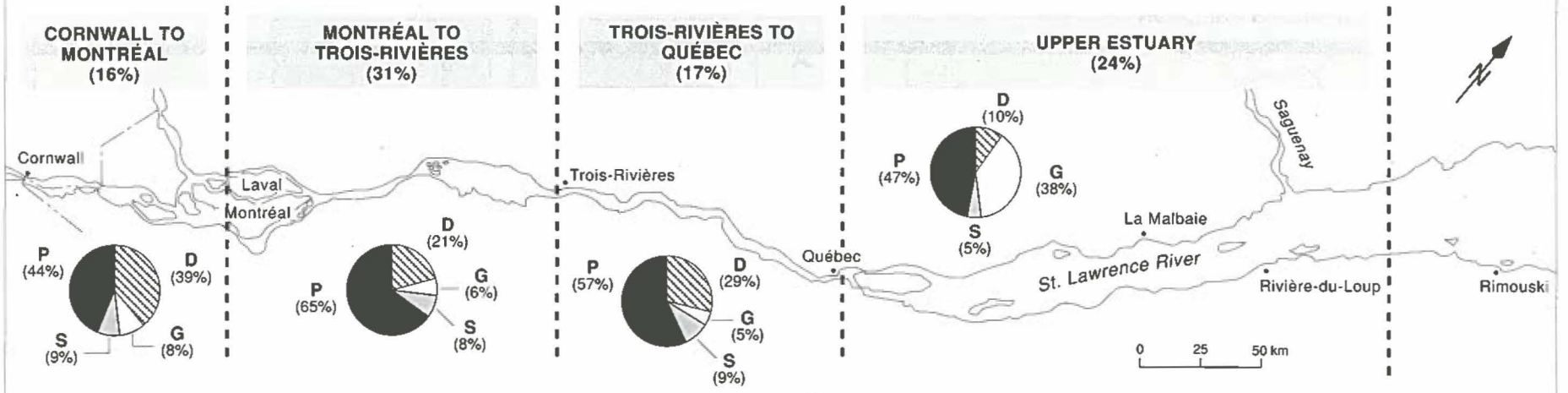
The St. Lawrence River - Waterfowl Hunting



P = Puddle ducks, D = Diving ducks, S = Sea ducks, G = Geese
Example: (16%) → % of total waterfowl harvest along the St. Lawrence River in this sector.

MAIN SPECIES OF WATERFOWL HARVESTED AT SHORELINE

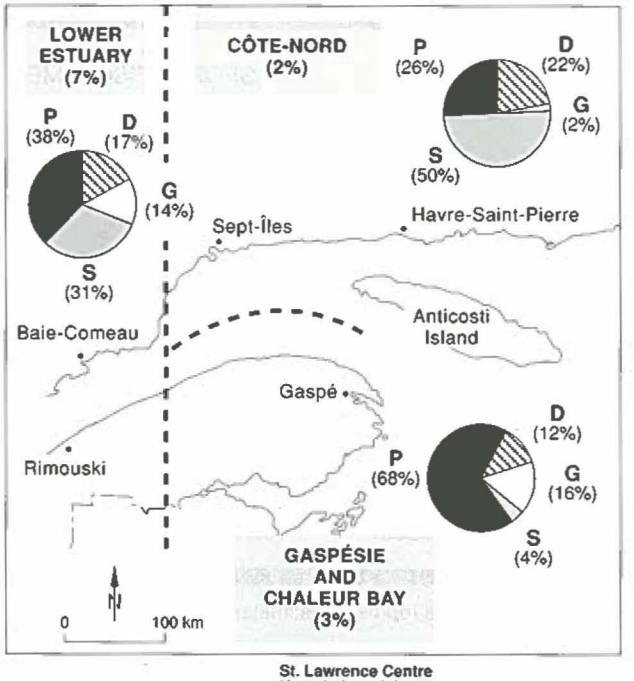
Group	Number of species harvested	Most-harvested species	Average % of total waterfowl harvested from 1977 to 1981
P Puddle ducks	9	Black duck	17.8
		Mallard	11.3
		Green-winged teal	9.2
		Pintail	4.5
		Blue-winged teal	4.0
		Other species	6.8
D Diving ducks	11	Lesser scaup	5.4
		Common goldeneye	5.2
		Greater scaup	4.1
		Ring-necked duck	2.3
		Other species	5.3
G Geese	4	Greater snow goose	9.0
		Canada goose	5.4
		Other species	0.2
S Sea ducks	7	Surf scoter	2.2
		Black scoter	2.1
		Oldsquaw	1.9
		Common eider	1.8
		Other species	1.5

QUÉBEC'S HUNTERS

The number of migratory bird hunting permits increased until 1980, when it reached a total of 75 178. From 1980 to 1987, sales of permits dropped steadily, until only 55 124 permits were sold in 1987, one percent of which were issued to non-Québec residents.

QUÉBEC'S HARVEST

The average annual waterfowl harvest in Québec from 1984 to 1987 was approximately 530 000 birds, mainly puddle ducks (314 000 - 59%), diving ducks (113 000 - 21%), geese (70 000 - 13%) and sea ducks (32 000 - 6%). Almost all harvesting of snow geese in Québec, and 65% of duck harvesting, occurs along the St. Lawrence River.



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Sources: • Environment Canada. *Les oiseaux migrateurs abattus au Canada pendant la saison de chasse de 1987.* Canadian Wildlife Service, Biology series No. 179. 41 pp. 1989.
• Environment Canada. *La sauvagine dans le système du Saint-Laurent.* Canadian Wildlife Service. 76 pp. plus appendix. 1985.

ST. LAWRENCE ACTION PLAN
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The St. Lawrence River - Action Plan Priority Vascular Plants (1994)

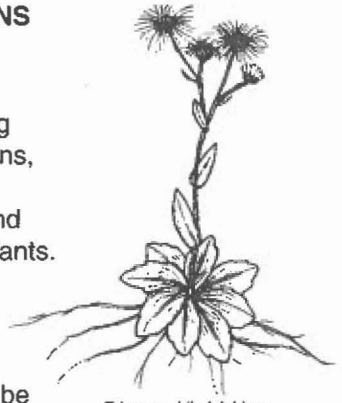
DEFINITIONS

Vascular:

Plant having vessels: ferns, horsetails, lycopods and flowering plants.

Priority:

Means that steps must be taken to better know and monitor populations of these species and to protect their habitats.

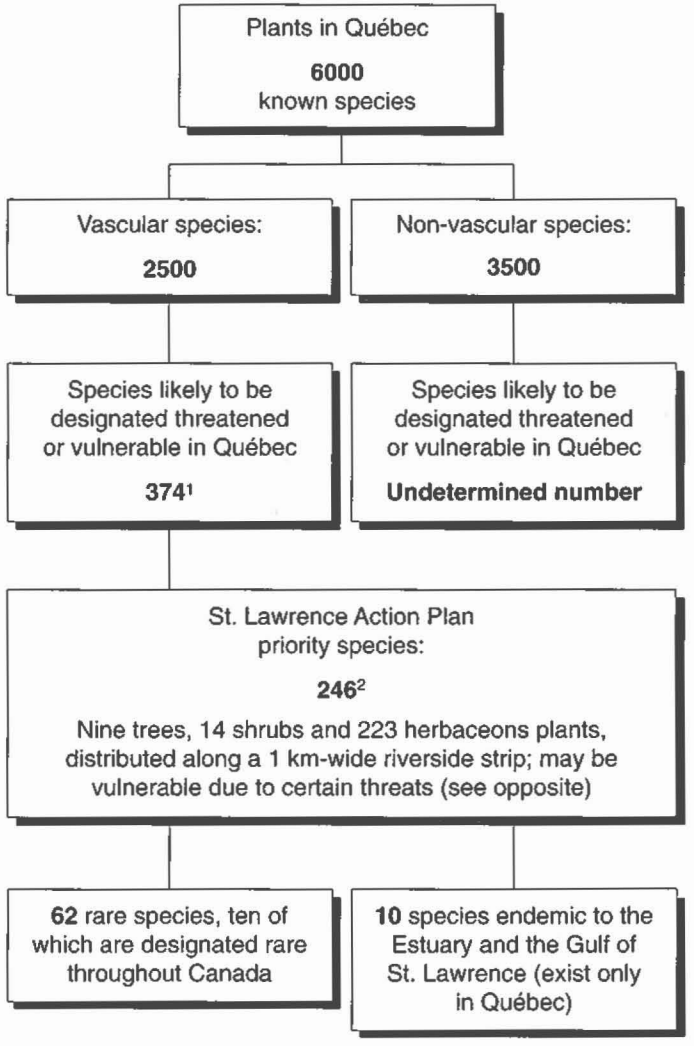


Erigeron philadelphicus ssp. provancheri

A. Sabourin

WHY PROTECT THREATENED OR VULNERABLE SPECIES?

- They may have major economic, recreational, cultural or aesthetic value.
- They are good indicators of the health of our environment and, consequently, our own health.
- They have great potential for maintaining biological genetic diversity for future generations.



Note: Consult Lavoie, 1992, for definitions of *threatened* and *vulnerable.*

HABITATS[4]

- Wetlands (fresh and salt water).
- Marginal environments (cliffs, islands, talus, calcereous rock).
- Forests.
- Open environments (marine barrens, rough pasture land and clearings).

THREATS[4]

- Encroachment on wetlands by:
  - backfilling for development;
  - drainage, channelling and diking of land for agricultural purposes.
- Pollution of environment with garbage and industrial, municipal, and agricultural wastewater.
- Cottages and recreational activities in the natural riparian environment.
- Deforestation of shoreline for forestry and agricultural activities.
- Road construction along shoreline.
- Changes in flow and water levels because of dams.
- Introduction of new species.

These threats can cause often irreversible changes to the biophysical conditions essential to the maintenance of species and their habitats, leading to a loss of habitat and the disappearance of many species.

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ST. LAWRENCE ACTION PLAN
PLAN D'ACTION SAINT-LAURENT

Sources: 1. Lavoie, G. *Plantes vasculaires susceptibles d'être désignées menacées ou vulnérables au Québec.* Direction de la Conservation et du patrimoine écologique. Ministère de l'Environnement du Québec. 180 pp. 1992.
2. Bouchard, H. and P. Millet. *The St. Lawrence River: Diversified Environments.* St. Lawrence Centre. Environment Canada, Québec Region. 97 pp. 1993.
3. Argus, G. W. and K. M. Pryer. *Rare Vascular Plants in Canada: Our Natural Heritage.* Canadian Museum of Nature. Ottawa. 148 pp. 1990.
4. Lemay, A. B. Analyse descriptive des milieux caractérisant les espèces menacées et vulnérables au Québec. Prepared for the ministère de l'Environnement du Québec. 61 pp. 1987.

The St. Lawrence River - Action Plan Priority Vertebrate Wildlife (1992)

CLASS	A. NUMBER OF PRIORITY SPECIES FOR THE ACTION PLAN	B. NUMBER OF SPECIES FOUND IN QUÉBEC	A / B (%)	SPECIES (English name)
Fish	11	190	6	American shad Striped bass Redfin pickerel Grass pickerel Rainbow smelt Lake sturgeon Atlantic sturgeon Brassy minnow Atlantic tomcod River redhorse* Copper redhorse*
Amphibia	2	19	11	Pickerel frog Northern chorus frog
Reptilia	5	16	34	Brown snake Northern water snake Map turtle Spiny softshell turtle* Blanding's turtle
Aves	11	364	3	Bald eagle Peregrine falcon* Horned grebe Least bittern* Red-headed woodpecker Loggerhead shrike* Piping plover* Yellow rail Caspian tern* Roseate tern* (or Dougall's tern) Sedge wren
Mammalia	3	88	3	St. Lawrence Beluga* Harbour porpoise* Harbour seal
Total	**32**	**674**	**5**	

* Protected species in Canada

HABITATS

- Aquatic environments: river, estuary, gulf
  - Littoral zone (shallow water)
  - Pelagic zone (deep water)
- Riparian wetlands (fresh and salt water)
- Marginal environments (cliffs, talus, calcereous rocks)
- Wooded and peaty riparian environments
- Island refuges
- Open riparian environments (marine barrens, rough pasture land, clearings)

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ST. LAWRENCE ACTION PLAN
PLAN D'ACTION SAINT-LAURENT

THREATS

- Encroachment on wetlands by:
  - backfilling for development
  - drainage, channelling and diking of land for agricultural purposes
- Pollution of environments with garbage and industrial, municipal and agricultural wastewater
- Cottages and recreational activities in the natural riparian environment
- Deforestation of shoreline for forestry and agricultural activities
- Road construction along shoreline
- Changes in flow and water levels because of hydro-electric dams
- Introduction of new species
- Commercial shipping and river dredging

THESE THREATS CAN CAUSE CHANGES, OFTEN IRREVERSIBLE, TO THE BIOPHYSICAL CONDITIONS ESSENTIAL TO THE MAINTENANCE OF SPECIES AND THEIR HABITATS, LEADING TO A LOSS OF HABITAT AND THE DISAPPEARANCE OF MANY SPECIES.

WHY PRESERVE ENDANGERED SPECIES?

- They may have major economic, recreational, cultural or aesthetic value
- They are good indicators of the health of our environment and, consequently, our own health
- They have great potential for maintaining biological genetic diversity for future generations

Sources: • Committee on the Status of Endangered Wildlife in Canada (COSEWIC). *List of species and their designated status.* 6 pp. 1991.
• Lemay, A.B.. *Analyse descriptive des milieux caractérisant les espèces menacées et vulnérables au Québec.* Prepared for the Ministère de l'Environnement du Québec. 61 pp. 1987.
• Ministère du Loisir, de la Chasse et de la Pêche du Québec. *Les espèces menacées d'extinction. Signaux d'alarme d'une nature en péril.* 23 pp. 1988.
• *Report of the task force on priority species of flora and fauna in the St. Lawrence River corridor.* Prepared for the St. Lawrence Action Plan. 10 pp. 1990.

The St. Lawrence River - Overview of Main Federal Sites

AGENCY RESPONSIBLE (Number of parcels of land)	USES
TRANSPORT CANADA (603)	- Navigational aids: lighthouses, lights, buoys, triangulation stations - Coast Guard harbours and wharfs, hydroplane wharfs - St. Lawrence shipping channel - Buildings and airports - Communications installations
PUBLIC WORKS CANADA (248)	- Buildings, land - Dry docks, slipways - Protection walls, breakwaters - Wharfs and wharf access roads
FISHERIES AND OCEANS (242)	- Fishing harbours - Pleasure boat harbours - Laboratories, research institutes - Various installations (slipways, breakwaters, buildings, land)
ENVIRONMENT CANADA (83)	- Historic sites and monuments - Forillon National Park and the Archipel-de-Mingan park reserve - Miscellaneous parks - National wildlife areas - Migratory bird sanctuaries - Chambly and Lachine canals - Buildings, miscellaneous land
NATIONAL DEFENCE (54)	- Canadian Forces bases - Armories, arsenals - Firing ranges - Various buildings and installations
CBC (47)	- Buildings, miscellaneous land - Transmitters, radio and television transmitting stations
INDIAN AND NORTHERN AFFAIRS (16)	- Indian reserves - Native communities
CANADA PORT CORPORATION (13)	- Ports of Montréal, Trois-Rivières, Québec, Sept-Îles and Baie-des-Ha!Ha! - Various wharfs and the Beauport flats
AGRICULTURE CANADA (6)	- Research stations, laboratories and experimental farms
CANADIAN NATIONAL (C.N.) (5)	- Marshalling yards - Montréal and Québec central stations - Repair shops
ST. LAWRENCE SEAWAY (4)	- Beauharnois and south shore canals - Champlain and Jacques-Cartier bridges (approaches and bridge structures)
ATOMIC ENERGY OF CANADA LTD (2)	- Gentilly nuclear power station - Laprade heavy water plant
ENERGY, MINES AND RESOURCES CANADA (2)	- Laurentian forestry centre - Sainte-Foy research station
NATIONAL RESEARCH COUNCIL OF CANADA (2)	- Research institutes
EIGHT OTHER FEDERAL DEPARTMENTS OR AGENCIES (252)	- Various buildings and land - Communications installations - Post offices - Penitentiaries

TOTAL : 1579* parcels, or approximately 1500 km²

* This figure is an approximation, since the federal lands database had to be completed using other sources of information. For each site so added, we accounted for only one parcel per site, when in reality it may consist of several more (the exact number being unavailable).

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Sources: • Gauthier & Guillemette Consultants. List of federal installations along the St. Lawrence. Document being prepared for Environment Canada. 1990.
• Environment Canada. Federal lands database. 1988.
• Fisheries and Oceans. Chart of small-craft harbours. 1984.

ST. LAWRENCE ACTION PLAN
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Environment Canada Environnement Canada

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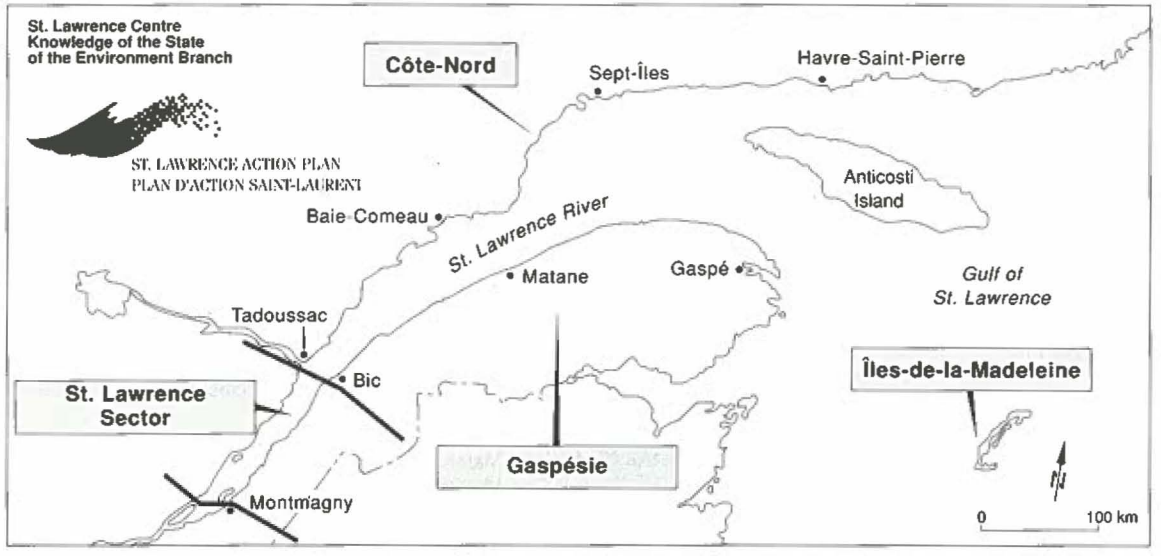
March 1993

The St. Lawrence River - Commercial Maritime Fishing (Economy)



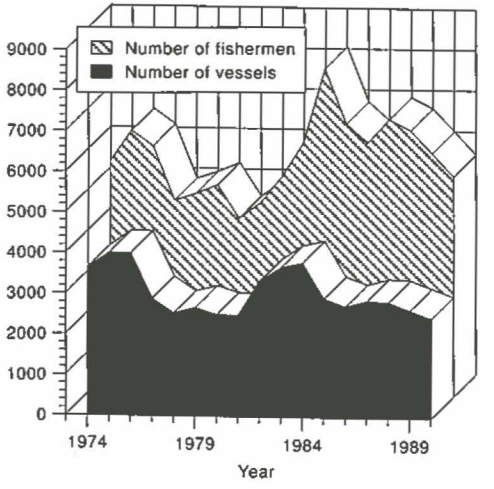
COMMERCIAL FISHING BY REGION – 1990

Region	St. Lawrence Sector	Côte-Nord	Gaspésie	Îles-de-la-Madeleine	TOTAL
Number of fishermen	70	1 658	2 473	1 218	5 419
(%)	(1%)	(31%)	(46%)	(22%)	(100%)
Number of licensed vessels	32	933	1 039	449	2 453
(%)	(1%)	(38%)	(43%)	(18%)	(100%)
Landings					
• Quantity in metric tonnes	828	12 878	39 928	20 696	74 330
(%)	(1%)	(17%)	(54%)	(28%)	(100%)
• Value in millions of dollars	2.5	18.8	36.0	16.8	74.1
(%)	(3%)	(25%)	(49%)	(23%)	(100%)
Number of buyers of marine products	6	30	56	10	102
(%)	(6%)	(29%)	(55%)	(10%)	(100%)
Maximum number of factory or fish plant employees	329	931	2 518	1 017	4 795
(%)	(7%)	(19%)	(53%)	(21%)	(100%)
Plant production in metric tonnes	10 611	5 281	16 824	10 686	43 402
(%)	(24%)	(12%)	(39%)	(25%)	(100%)

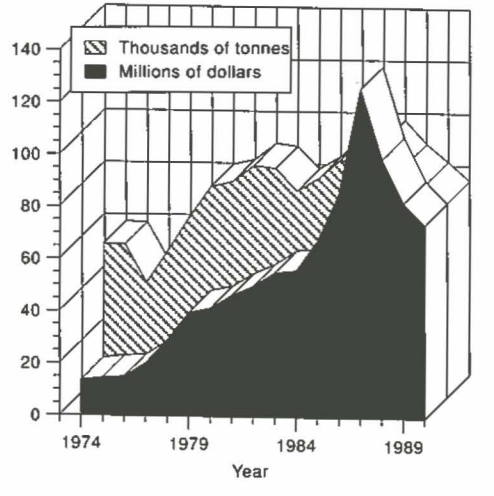
Sources: • Bérubé, Z. *La pêche maritime au Québec, 1956 -1985.* Bureau de la statistique du Québec. 386 pp. 1990.
• Les Publications du Québec. *Le Québec statistique, 59th edition.* 1028 pp. 1989.
• Fisheries and Oceans. *Quebec Marine Fisheries, Annual Statistical Review, 1988 -1990.* 265 pp. 1991.

DEVELOPMENT OF COMMERCIAL FISHING FROM 1974 TO 1990

NUMBERS: FISHERMEN AND VESSELS



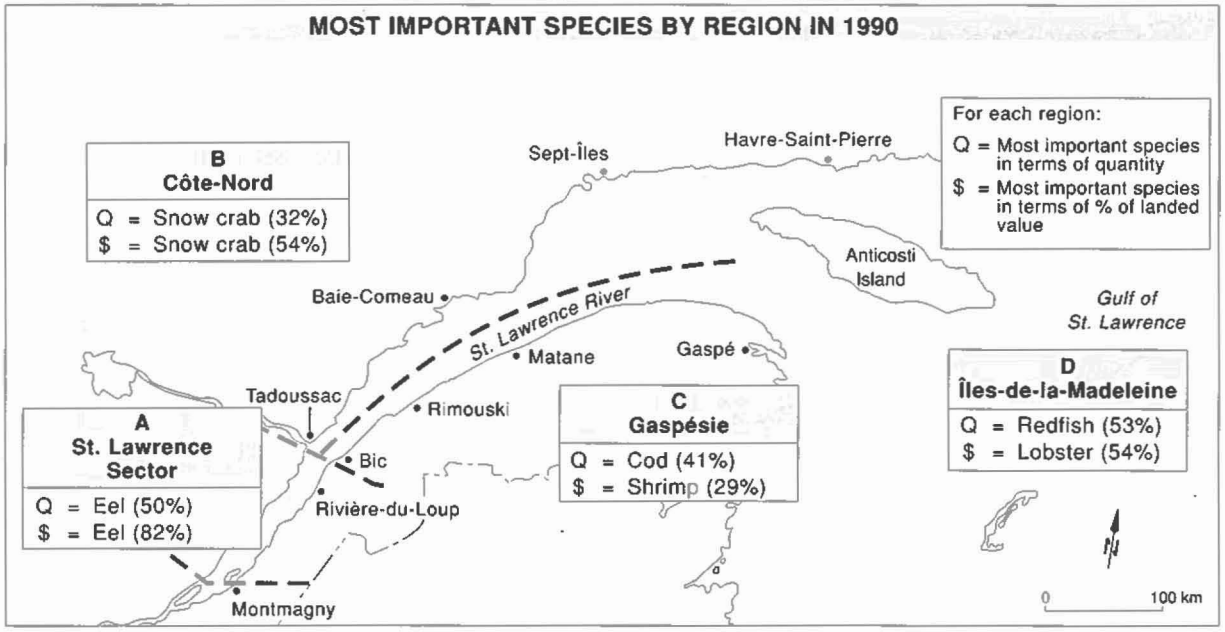
LANDINGS OF FISH, SHELLFISH AND CRUSTACEANS



INFO-FLASH 18

The St. Lawrence River - Commercial Maritime Fishing (Species Fished - 1990)

MOST IMPORTANT SPECIES BY REGION IN 1990



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MOST IMPORTANT SPECIES IN OVERALL REGIONS

	QUANTITY		LANDED VALUE	
1	Cod	30%	Snow crab	23%
2	Redfish	16%	Lobster	18%
3	Shrimp	13%	Cod	18%
4	Snow crab	9%	Shrimp	16%
5	Herring	8%	Scallops	5%
	Other species	24%	Other species	20%

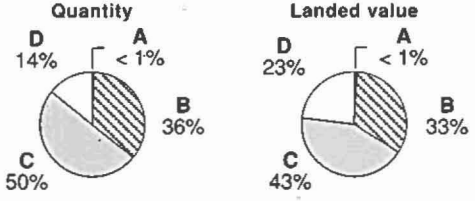
Source: Fisheries and Oceans. *Les pêches maritimes du Québec. Revue statistique annuelle, 1989-1990.* 281 pp. 1991.

FISHING DISTRIBUTION BY SPECIES – 1990

SHELLFISH AND CRUSTACEANS

33% of total volume (24 837 metric tonnes)
64% of total value ($47.4 million)

REGIONAL DISTRIBUTION



MOST IMPORTANT SPECIES

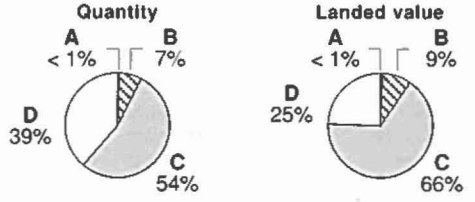
	Quantity	Value
Shrimp	39%	25%
Snow crab	28%	36%
Scallops	14%	8%
Lobster	13%	28%

Other species fished:
soft-shell clams, whelks, mussels, clams

GROUNDFISH

54% of total volume (40 097 metric tonnes)
29% of total value ($21.6 million)

REGIONAL DISTRIBUTION



MOST IMPORTANT SPECIES

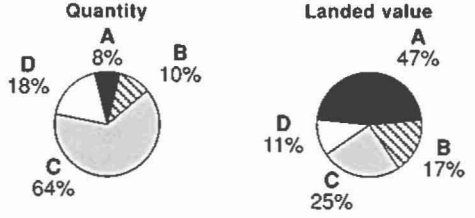
	Quantity	Value
Cod	56%	61%
Redfish	31%	14%
Plaice	7%	8%
Greenland halibut	5%	12%

Other species fished:
white hake, Atlantic halibut, Atlantic wolffish, lump fish, skate

PELAGIC AND ESTUARINE FISH

13% of total volume (9390 metric tonnes)
7% of total value ($5.0 million)

REGIONAL DISTRIBUTION



MOST IMPORTANT SPECIES

	Quantity	Value
Herring	67%	28%
Mackerel	21%	12%
Eel	4%	40%
Capelin	4%	4%

Other species fished:
smelt, salmon, other pelagic species (walleye, pike, bass, etc...)

A = St. Lawrence sector B = Côte-Nord C = Gaspésie D = Îles-de-la-Madeleine

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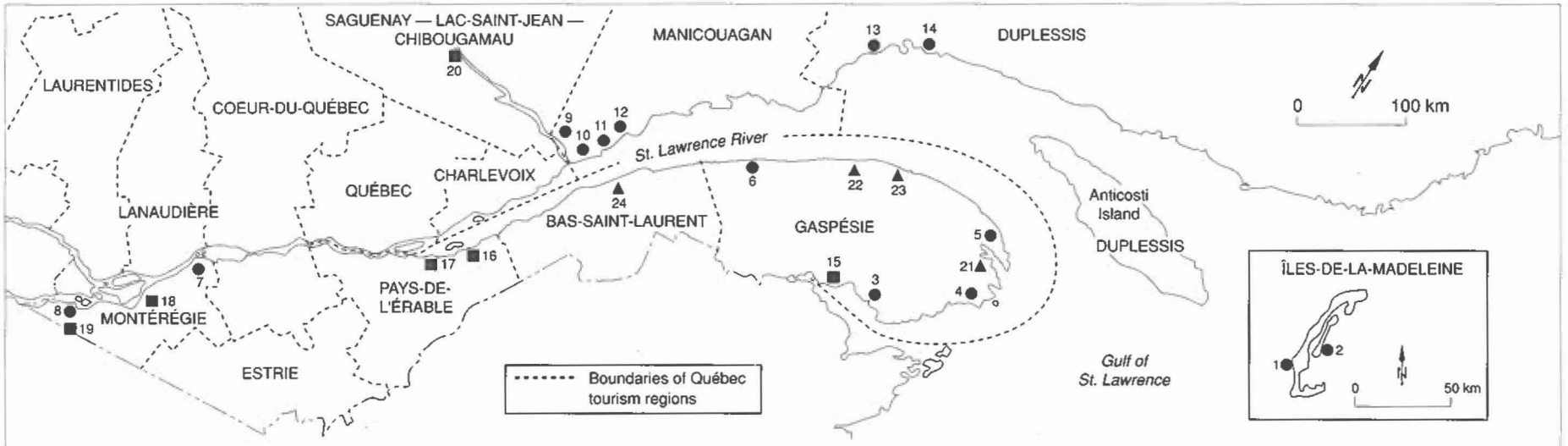
The St. Lawrence - Festivals Associated with the River (1991)



	Map symbol	Name of festival	Municipality	Tourism region	Season (month)
Festivals linked to a marine resource or to commercial or sports fishing	● 1	Fishermen's festival	Étang-du-Nord	Îles-de-la-Madeleine	Summer (July)
	2	Seafood festival	Havre-aux-Maisons	Îles-de-la-Madeleine	Summer (July)
	3	Fishing tournament	Saint-Siméon	Gaspésie	Summer (July)
	4	Regional, industrial and commercial exibition (focused on fishing)	Grande-Rivière	Gaspésie	Spring (May)
	5	Fish festival	Rivière-au-Renard	Gaspésie	Summer (June-July)
	6	Shrimp festival	Matane	Gaspésie	Summer (late June)
	7	Fish stew festival	Sorel	Montérégie	Summer (July)
	8	Trout festival	Valleyfield	Montérégie	Spring (June)
	9	Provincial salmon festival	Sacré-Coeur	Manicouagan	Summer (July)
	10	Blue whale festival	Grandes-Bergeronnes	Manicouagan	Summer (August)
	11	Esco-crab festival	Les Escoumins	Manicouagan	Spring (May-June)
	12	Clam festival	Rivière Portneuf	Manicouagan	Spring (June)
	13	Fishermen's festival	Port-Cartier	Duplessis	Summer (July)
	14	Capelin festival	Sept-Îles	Duplessis	Spring (May)
Festivals linked to a recreational activity (other than fishing) which involves water or a wildlife resource linked to water (ie., geese, ducks)	■ 15	Sailing festival	Carleton	Gaspésie	Summer (August)
	16	Festival of Saint-Hubert	Cap Saint-Ignace	Pays-de-l'Érable	Summer (early September)
	17	Snow goose festival	Montmagny	Pays-de-l'Érable	Fall (October)
	18	Sailing festival	Longueuil	Montérégie	Summer (July)
	19	Valleyfield regatta	Valleyfield	Montérégie	Summer (July)
	20	Alma rowing festival	Alma	Saguenay-Lac-Saint-Jean-Chibougamau	Summer (July)
Festivals tied to the history or geography of a site	▲ 21	Jacques-Cartier festival	Gaspé	Gaspésie	Summer (July)
	22	Hang-gliding festival	Mont Saint-Pierre	Gaspésie	Summer (July-August)
	23	Seagull festival	Sainte-Anne-des-Monts	Gaspésie	Summer (late June)
	24	Festival of the isles	Trois-Pistoles	Bas-Saint-Laurent	Summer (July)

Source: Société des fêtes et festivals du Québec. *Fêtes et festivals au Québec, carte routière et touristique 1991-1992.* 1990.

Another 67 festivals may be added to the 24 listed here as having been held in riverside municipalities in 1991.

These 67 festivals are not linked directly to the River, but at times feature river-related activities (ie., the canoe race on the ice at the Québec Carnaval).

These festivals are varied in nature and focus on such themes as:

- industrial, agricultural or commercial activities (other than fishing)
- song, theatre, film, poetry
- folklore, youth
- local or regional dishes
- a season (fall, winter, etc.)

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PLAN D'ACTION SAINT-LAURENT

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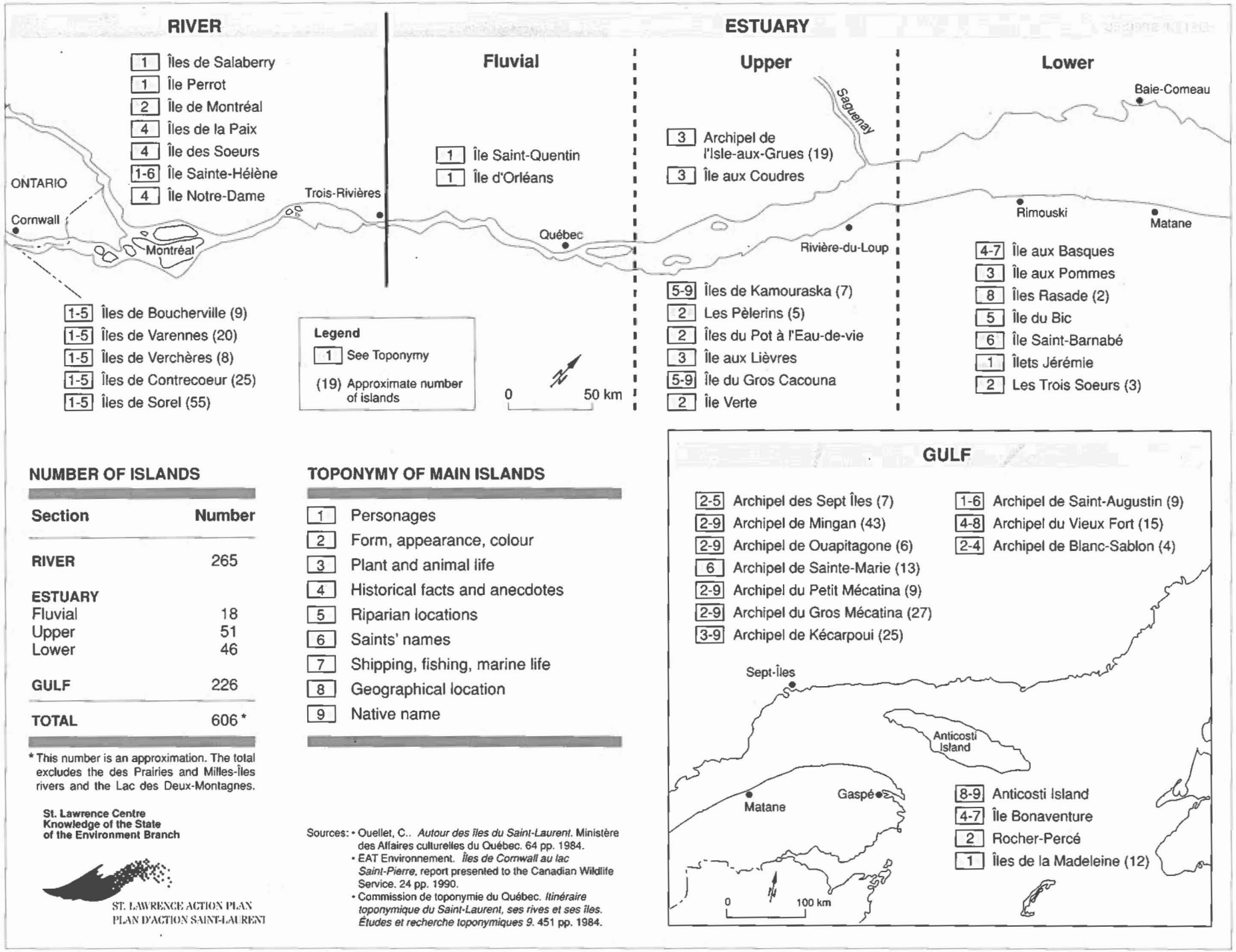
The St. Lawrence River - Main Islands and Archipelagos



NUMBER OF ISLANDS

Section	Number
RIVER	265
ESTUARY	
Fluvial	18
Upper	51
Lower	46
GULF	226
TOTAL	606 *

* This number is an approximation. The total excludes the des Prairies and Milles-Îles rivers and the Lac des Deux-Montagnes.

TOPONYMY OF MAIN ISLANDS

1 Personages
2 Form, appearance, colour
3 Plant and animal life
4 Historical facts and anecdotes
5 Riparian locations
6 Saints' names
7 Shipping, fishing, marine life
8 Geographical location
9 Native name

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Sources:
- Ouellet, C.. *Autour des îles du Saint-Laurent*. Ministère des Affaires culturelles du Québec. 64 pp. 1984.
- EAT Environnement. *Îles de Cornwall au lac Saint-Pierre*, report presented to the Canadian Wildlife Service. 24 pp. 1990.
- Commission de toponymie du Québec. *Itinéraire toponymique du Saint-Laurent, ses rives et ses îles. Études et recherche toponymiques 9*. 451 pp. 1984.

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The St. Lawrence River - Waterfowl from Cornwall to Tadoussac

LIST OF SPECIES

Geese (A)	Puddle ducks (B)	Diving ducks (C)	Sea ducks (D)
Snow goose	Black duck	Scaups, Ring-necks	Eiders
Brant	Mallard	Common goldeneye	Oldsquaw
Canada goose	Northern pintail	Mergansers	Scoters
	Northern shoveler		
	Gadwall		
	American widgeon		
	Wood duck		
	Green-winged teal		
	Blue-winged teal		

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ST. LAWRENCE ACTION PLAN
PLAN D'ACTION SAINT-LAURENT

ESTIMATED WATERFOWL POPULATION BY SECTOR BETWEEN 1974 AND 1978

TOTAL — RIVER

	Spring	Fall	Winter
A	395 120	211 260	-
B	54 430	136 350	6 475
C	80 860	215 630	25 640
D	193 520	102 510	184 236
Total	**723 930**	**665 750**	**216 351**

UPPER ESTUARY

	Spring	Fall
A	176 570	206 830
B	11 000	57 000
C	1 850	5 380
D	1 210	690
Total	**190 630**	**269 900**

MONTRÉAL — SOREL

	Spring	Fall
A	3 620	-
B	2 000	7 700
C	3 350	50
D	-	-
Total	**8 970**	**7 750**

LAC SAINT-PIERRE

	Spring	Fall
A	109 300	50
B	17 000	12 000
C	4 040	59 900
D	-	2 310
Total	**130 340**	**74 260**

LAC SAINT-PIERRE — QUÉBEC

	Spring	Fall
A	14 920	130
B	2 300	19 700
C	2 690	21 160
D	10	330
Total	**19 920**	**41 320**

LOWER ESTUARY

	Spring	Fall	Winter
A	69 000	250	-
B	11 000	12 000	420
C	1 960	1 340	4 406
D	18 550	3 000	301
Total	**100 520**	**16 590**	**5 127**

LAC DES DEUX-MONTAGNES

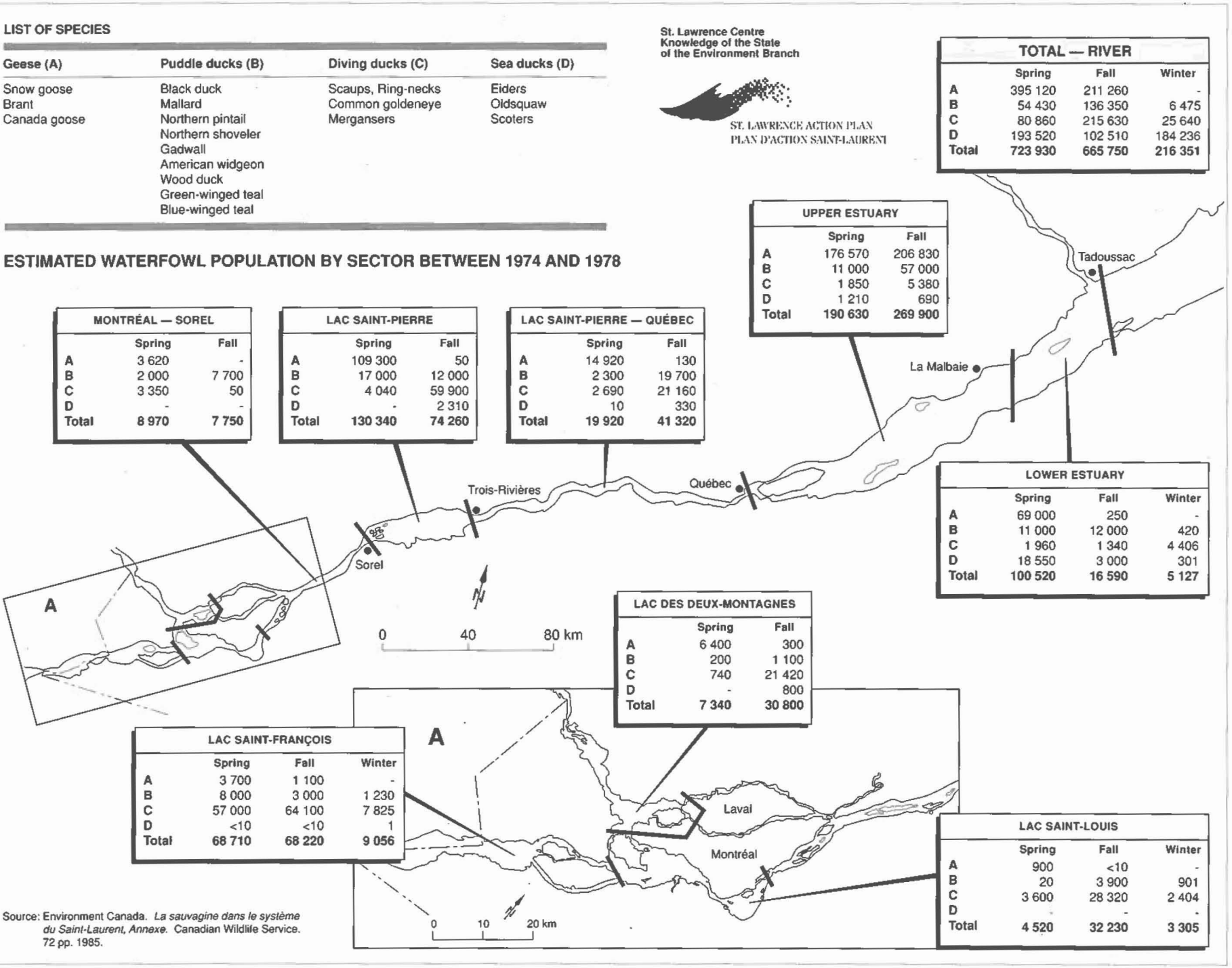
	Spring	Fall
A	6 400	300
B	200	1 100
C	740	21 420
D	-	800
Total	**7 340**	**30 800**

LAC SAINT-FRANÇOIS

	Spring	Fall	Winter
A	3 700	1 100	-
B	8 000	3 000	1 230
C	57 000	64 100	7 825
D	<10	<10	1
Total	**68 710**	**68 220**	**9 056**

LAC SAINT-LOUIS

	Spring	Fall	Winter
A	900	<10	-
B	20	3 900	901
C	3 600	28 320	2 404
D	-	-	-
Total	**4 520**	**32 230**	**3 305**



Source: Environment Canada. *La sauvagine dans le système du Saint-Laurent, Annexe.* Canadian Wildlife Service. 72 pp. 1985.

The St. Lawrence River - Waterfowl from Tadoussac to Blanc-Sablon

LIST OF SPECIES

Geese (A)	Puddle ducks (B)	Diving ducks (C)	Sea ducks (D)
Snow goose	Black duck	Scaups, Ring-necks	Eiders
Brant	Mallard	Common goldeneye	Oldsquaw
Canada goose	Northern pintail	Mergansers	Scoters
	Northern shoveler		
	Gadwall		
	American widgeon		
	Wood duck		
	Green-winged teal		
	Blue-winged teal		

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ST. LAWRENCE ACTION PLAN
PLAN D'ACTION SAINT-LAURENT

ESTIMATED WATERFOWL POPULATION BY SECTOR BETWEEN 1974 AND 1978

HAUTE CÔTE-NORD

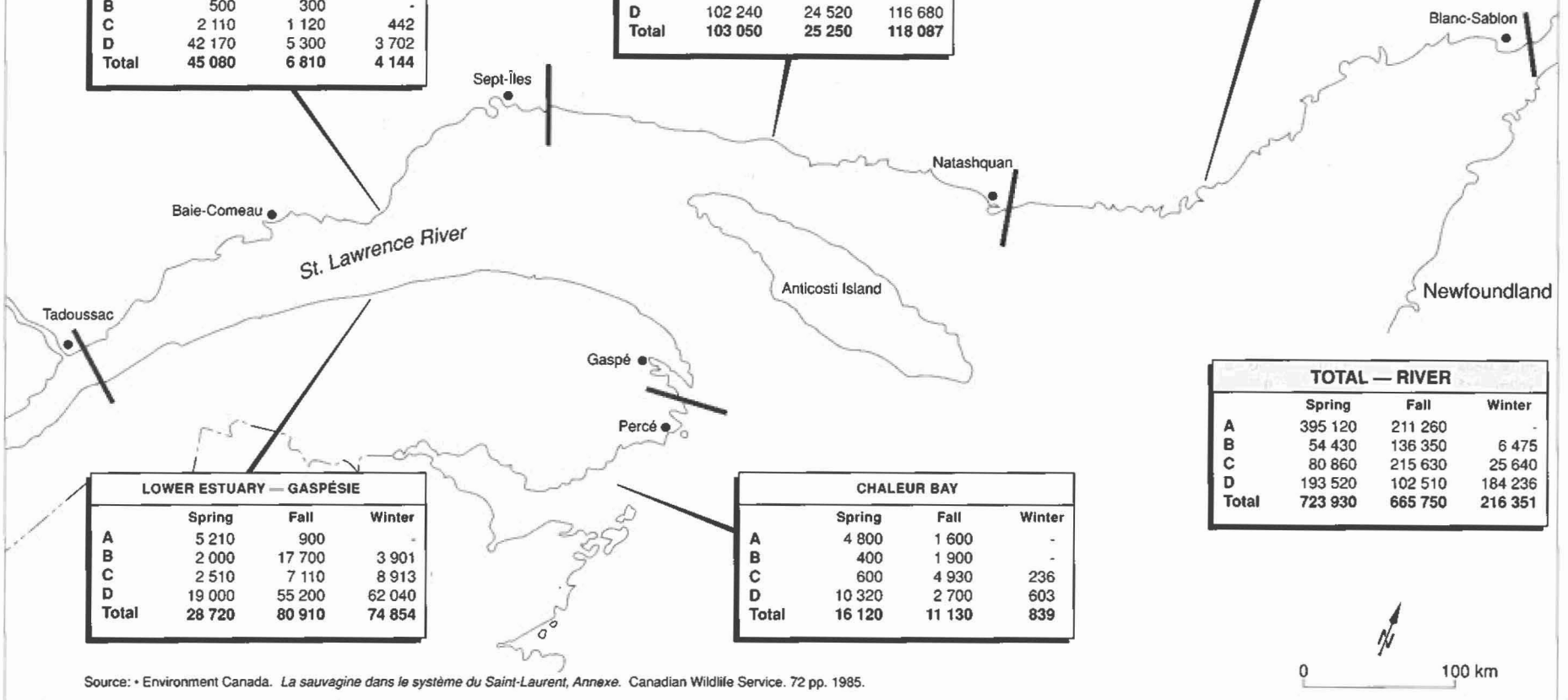
	Spring	Fall	Winter
A	300	90	-
B	500	300	-
C	2 110	1 120	442
D	42 170	5 300	3 702
Total	**45 080**	**6 810**	**4 144**

MOYENNE CÔTE-NORD

	Spring	Fall	Winter
A	400	-	-
B	-	-	3
C	410	730	1 404
D	102 240	24 520	116 680
Total	**103 050**	**25 250**	**118 087**

BASSE CÔTE-NORD

	Spring	Fall	Winter
A	-	-	-
B	<10	50	20
C	-	60	10
D	-	450	909
Total	**10**	**560**	**939**



LOWER ESTUARY — GASPÉSIE

	Spring	Fall	Winter
A	5 210	900	-
B	2 000	17 700	3 901
C	2 510	7 110	8 913
D	19 000	55 200	62 040
Total	**28 720**	**80 910**	**74 854**

CHALEUR BAY

	Spring	Fall	Winter
A	4 800	1 600	-
B	400	1 900	-
C	600	4 930	236
D	10 320	2 700	603
Total	**16 120**	**11 130**	**839**

TOTAL — RIVER

	Spring	Fall	Winter
A	395 120	211 260	-
B	54 430	136 350	6 475
C	80 860	215 630	25 640
D	193 520	102 510	184 236
Total	**723 930**	**665 750**	**216 351**

Source: • Environment Canada. *La sauvagine dans le système du Saint-Laurent, Annexe.* Canadian Wildlife Service. 72 pp. 1985.

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March 1993

INFO-FLASH 22 The St. Lawrence River - Characterization of Spawning Grounds from Cornwall to Montmagny

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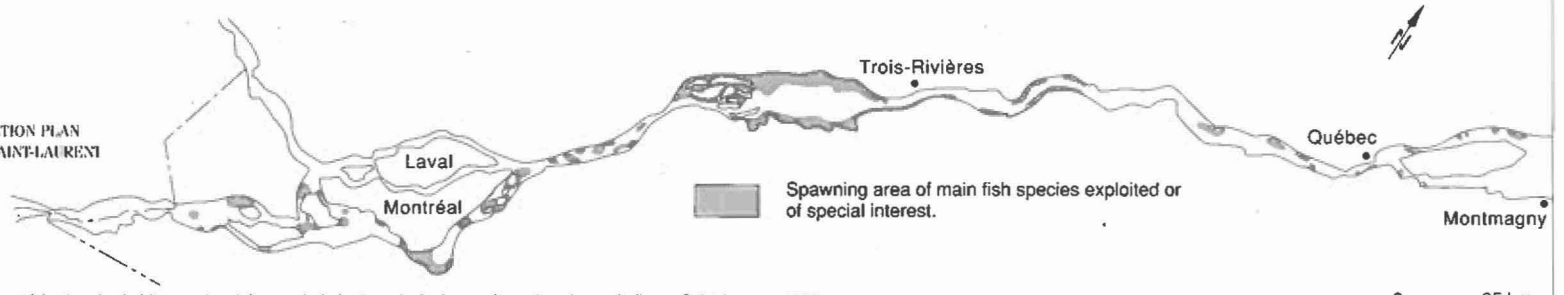
PLAN D'ACTION SAINT-LAURENT



Sources: • Gilles Shooner et ass. *Caractérisation des habitats recherchés pour la fraie des principales espèces de poisson du fleuve Saint-Laurent.* 1990.
• Gilles Shooner et ass. *Localisation des sites de reproduction des principales espèces de poisson du fleuve Saint-Laurent (Cornwall – Montmagny), Atlas.* May 1990.

SPECIES	LOCATION OF SPAWNING GROUNDS
1 Lake whitefish	
2 Rainbow smelt	
3 Rock bass	
4 Yellow perch	
5 White sucker	
6 Pumpkinseed	
7 Northern pike	
8 Brown bullhead	
9 Black crappie	
10 Longnose sucker	
11 Lake sturgeon	
12 American shad	
13 Walleye	
14 Channel catfish	
15 Sucker species	
16 Brook charr	
17 Atlantic tomcod	
18 Copper redhorse	

CARACTERIZATION OF SPAWNING HABITATS

Species	Current (cm/s)	Depth (m)	Substrate*	Vegetation**	Temperature (°C)
Lake whitefish	0 - 200	0.0 - 7.0	Sa GR	N	2 - 10
Rock bass	0 - 40	0.0 - 2.0	CSaGR	SH	15 - 21
Yellow perch	0 - 20	0.5 - 3.0	SCSaG	SHL, HESA	7 - 12
White sucker	0 - 110	0.3 - 2.3	SaGR	N	9 - 18
Pumpkinseed	0 - 20	0.1 - 0.3	CSaGR	SH	20 - 28
Northern pike	0 - 20	0.1 - 1.2	SC	SHL	4 - 15
Brown bullhead	0 - 60	0.1 - 1.2	SCSaG	HESA,SH	16 - 26
Black crappie	0 - 20	0.2 - 2.5	SSaG	HESA,SH	18 - 20
Longnose sucker	0 - 45	0.1 - 0.3	SaGSi	NC	5 - 18
Lake sturgeon	≥ 10	0.6 - 4.0	SaGR	N	8 - 18
American shad	≥ 20	0.5 - 2.0	SaGSi	N	12 - 18
Walleye	0 - 200	0.1 - 1.5	SaGR	NC	3 - 11
Channel catfish	0 - 60	0.6 - 1.8	SSa	SH	20 - 30
Brook charr	≥ 20	0.0 - 0.6	GSiR	N	5 - 10
Atlantic tomcod	≥ 10	0.0 - 4.0	SaG	N	0 - 4
Copper redhorse	moderate	1.5 - 2.0	SiR	US	≥18

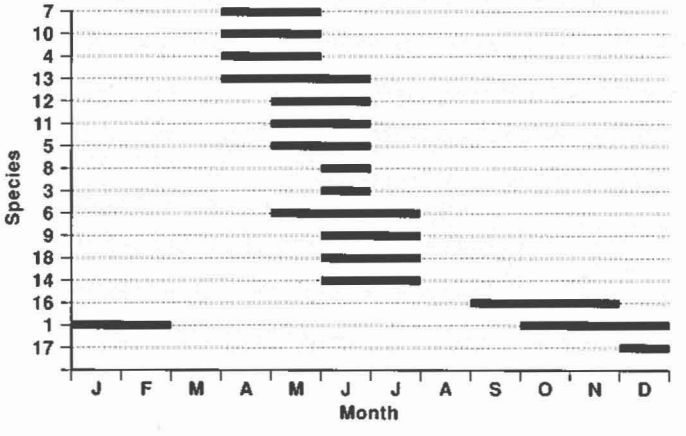
*** SUBSTRATE**

C	Clay
S	Silt
Sa	Sand
G	Gravel
Si	Shingle
R	Rock

**** VEGETATION**

N	No vegetation
NC	None or cleared
HESA	Herbaceous emergent semi-aquatic plants
SHL	Submerged herbaceous land plants
SHG	Submerged herbaceous graminoid land plants
US	Unspecified vegetation
SH	Submerged herbaceous plants

SPAWNING PERIOD



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The St. Lawrence River - Beaches (1987-1992)

HISTORY OF AUTHORIZED BEACHES IN THE BEACH ENVIRONMENT PROGRAM OF THE MINISTÈRE DE L'ENVIRONNEMENT DU QUÉBEC

	NAME OF BEACH	1987	1988	1989	1990	1991	1992
1	PARC BAIE DU VILLAGE	■	■	■	■	■	■
2	CAMP MONT-IMMACULÉE	□	■	■	■	■	■
3	MUNICIPALE DE SAINT-ZOTIQUE	■	■	■	■	■	■
4	PARC RÉGIONAL DES ÎLES	■	■	■	■	■	■
5	MUNICIPALE PREMIER BOULEVARD	■	■	■	■	■	■
6	CAMP LA VILLA NOTRE-DAME-DE-FATIMA	■	■	■	■	■	■
7	SAINTE-MADELEINE-DE-RIGAUD	■	■	■	■	■	■
8	PARC D'OKA	■	■	■	■	■	■
9	CAMP NOTRE-DAME	□	□	■	■	■	■
10	ROGER INC.	■	■	■	■	■	■
11	CAP SAINT-JACQUES (#1 and 2)	■	■	■	■	■	■
12	POINTE-AUX-CARRIÈRES	□	□	□	□	□	■
13	SAINT-SIMÉON	□	■	■	■	■	■
14	CLUB DE VOILE SAGUENAY	■	■	■	■	■	■
15	CAMPING DE LA DAM-EN-TERRE	■	■	■	■	■	■
16	COLONIE NOTRE-DAME	■	■	■	■	■	■
17	COMMUNAUTAIRE DE POINTE-LEBEL	□	■	■	■	■	■
18	PLAGE DE PENOUILLE (PARC FORILLON)	□	□	■	■	■	■
19	HALDIMAND	■	■	■	■	■	■
20	BEAU-BASSIN	■	■	■	■	■	■

■ Year in operation

BEACH ENVIRONMENT PROGRAM OF THE MINISTÈRE DE L'ENVIRONNEMENT DU QUÉBEC

Program to monitor the bacteriological quality of swimming water at sites, in accordance with ministère du Travail standards for:

- adequacy of supervision
- availability of safety equipment
- installation of look-out station
- demarcation of boundaries of supervised area
- means of emergency communication
- posted notices indicating beach boundaries and hours of supervision

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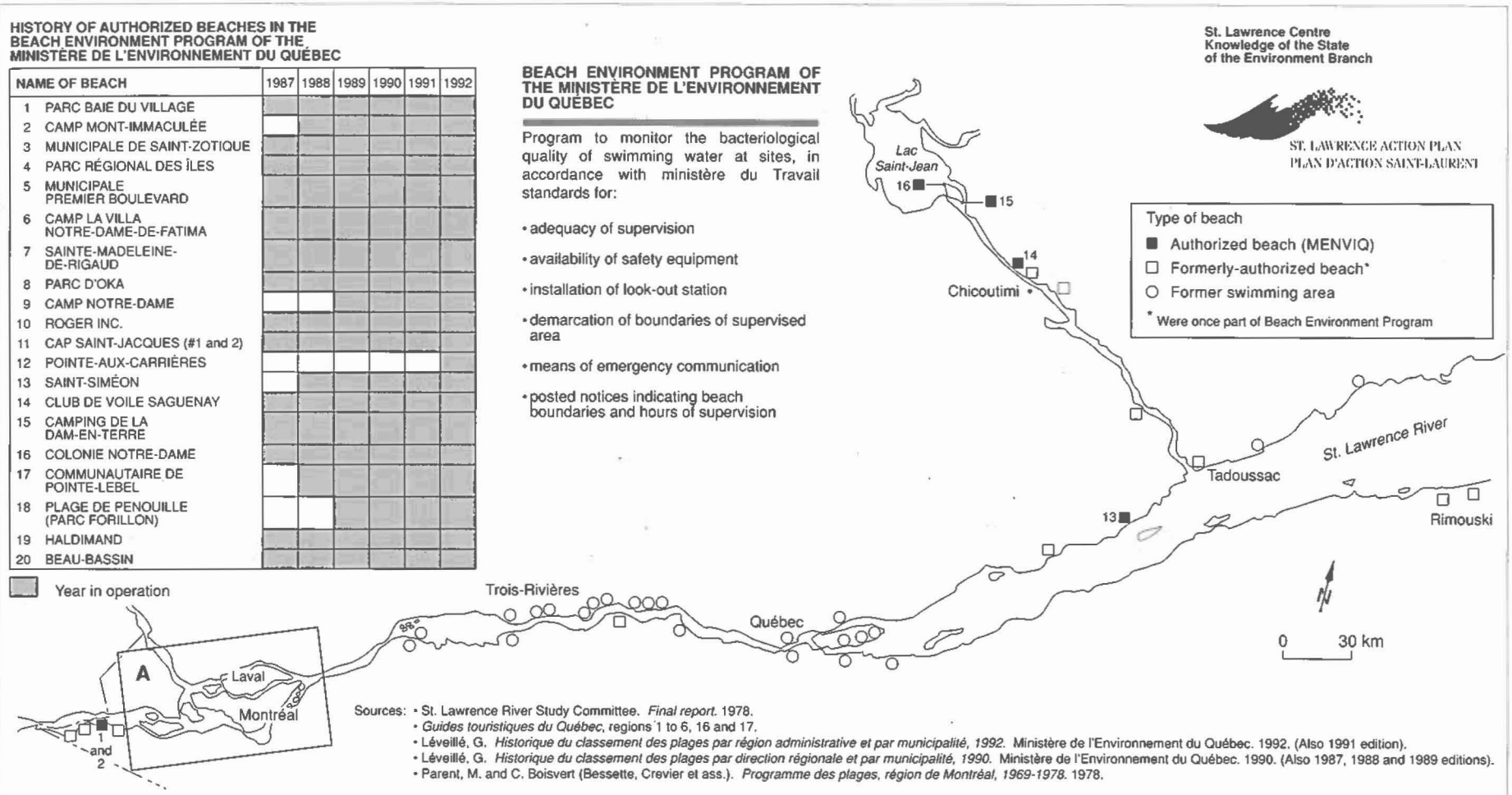
Type of beach
- ■ Authorized beach (MENVIQ)
- □ Formerly-authorized beach*
- ○ Former swimming area

* Were once part of Beach Environment Program



Sources:
- St. Lawrence River Study Committee. *Final report.* 1978.
- *Guides touristiques du Québec*, regions 1 to 6, 16 and 17.
- Léveillé, G. *Historique du classement des plages par région administrative et par municipalité, 1992.* Ministère de l'Environnement du Québec. 1992. (Also 1991 edition).
- Léveillé, G. *Historique du classement des plages par direction régionale et par municipalité, 1990.* Ministère de l'Environnement du Québec. 1990. (Also 1987, 1988 and 1989 editions).
- Parent, M. and C. Boisvert (Bessette, Crevier et ass.). *Programme des plages, région de Montréal, 1969-1978.* 1978.

The St. Lawrence River - Cultivated Land (1991)

RCM	RCM surface area (ha)	Cultivated land * (ha)	Cultivated land/ RCM area (%)
SOUTH SHORE			
Haut-Saint-Laurent	116 998	43 252	40
Beauharnois-Salaberry	46 171	28 780	62
Roussillon	42 153	17 723	42
Champlain	16 284	925	6
Lajemmerais	41 434	15 387	37
Bas-Richelieu	59 340	27 099	46
Nicolet-Yamaska	100 143	48 669	49
Bécancour	113 563	25 927	23
Lotbinière	164 727	33 586	20
Les-Chutes-de-la-Chaudière	41 864	4 643	11
Desjardins	25 377	7 812	30
Bellechasse	162 947	33 067	20
Montmagny	167 825	14 320	9
L'Islet	209 162	17 550	8
Kamouraska	192 932	28 146	15
Rivière-du-Loup	126 938	23 304	18
Les Basques	123 171	14 594	12
Rimouski-Neigette	257 516	18 235	7
Mitis	229 365	20 422	9
Matane	331 166	12 196	4
Denis-Riverin	512 621	1 336	<1
La-Côte-de-Gaspé	414 326	408	<1
Pabok	307 535	844	<1
Bonaventure	432 951	6 651	2
Avignon	364 543	4 276	1
Les-Îles-de-la-Madeleine	20 235	105	<1
Total SOUTH SHORE	**4 621 287**	**489 192**	**11**

RCM	RCM surface area (ha)	Cultivated land * (ha)	Cultivated land/ RCM area (%)
NORTH SHORE			
Vaudreuil-Soulanges	85 222	39 935	47
Laval	24 540	3 361	14
Deux-Montagnes	24 131	9 395	40
Thérèse-de-Blainville	20 442	4 806	24
Les Moulins	26 361	5 577	21
L'Assomption	25 318	9 567	38
D'Autray	118 806	37 077	31
Maskinongé	200 213	29 516	15
Francheville	112 786	24 237	21
Portneuf	392 439	26 008	7
L'île-d'Orléans	19 491	8 589	44
La-Côte-de-Beaupré	498 514	2 693	1
Charlevoix	375 663	4 108	1
Charlevoix-Est	237 513	2 896	1
Le-Fjord-du-Saguenay	4 550 266	21 131	<1
Lac Saint-Jean-Est	273 302	26 745	10
Haute-Côte-Nord	1 331 585	2 149	<1
Manicouagan	3 178 030	504	<1
Total NORTH SHORE	**16 115 909**	**223 024**	**1**

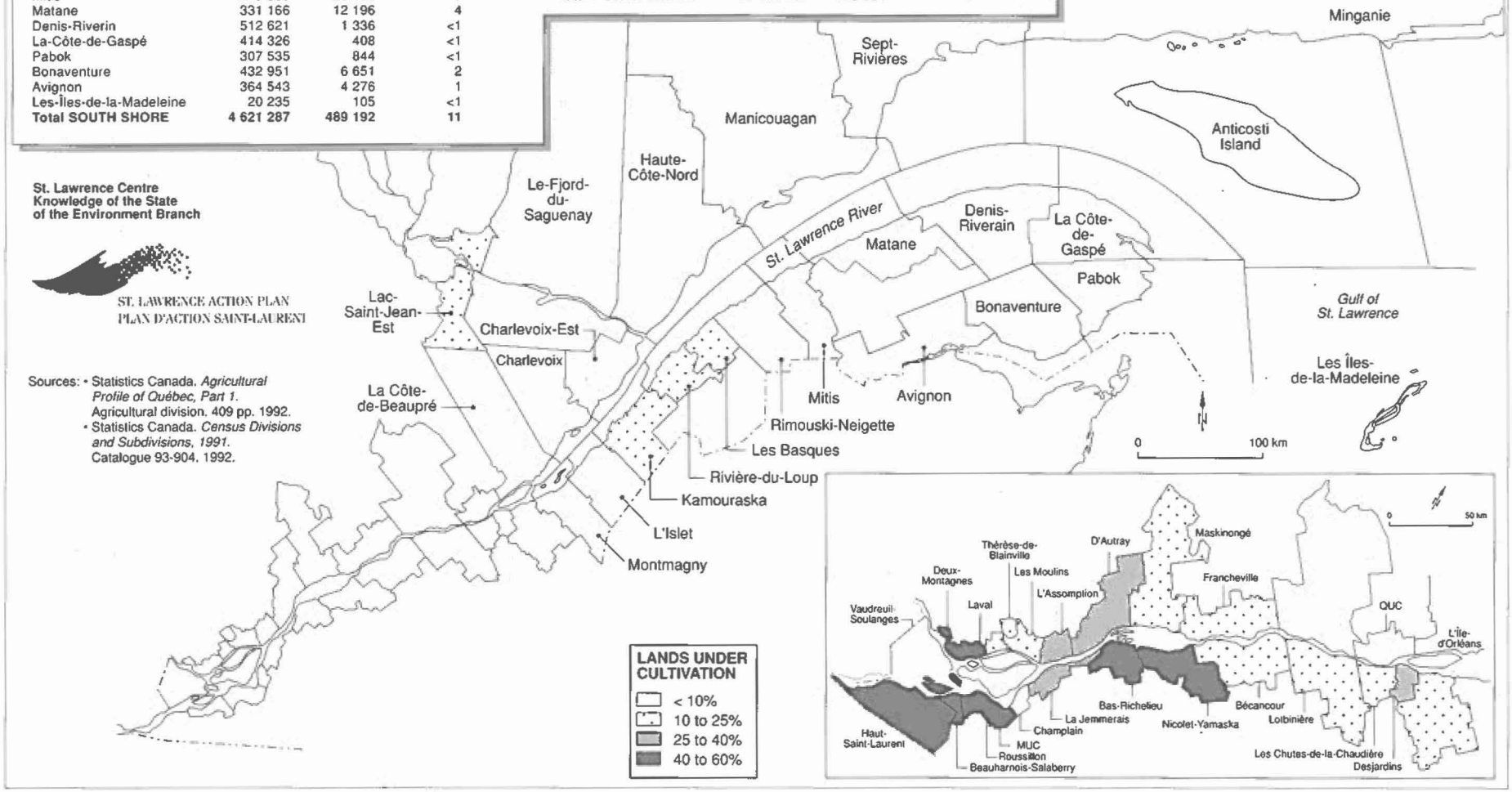
RCM	RCM surface area (ha)	Cultivated land * (ha)	Cultivated land/ RCM area (%)
MUC	49 357	458	1
QUC	54 345	4 207	8
TOTAL	**20 737 196**	**712 216**	**3**
TOTAL QUÉBEC	**135 781 173**	**1 638 453**	**1**

Sept-Rivières and Minganie RCMs are grouped together in a much larger territory that includes all of northern Québec; this is why they were not considered.

The cultivated lands of riverside RCMs represent 43 percent of all cultivated lands in Québec in 1991.

* Cultivated land: Total surface areas given over to field crops, fruit, vegetables, sod and tree nursery products.

RCM= Regional county municipalities.



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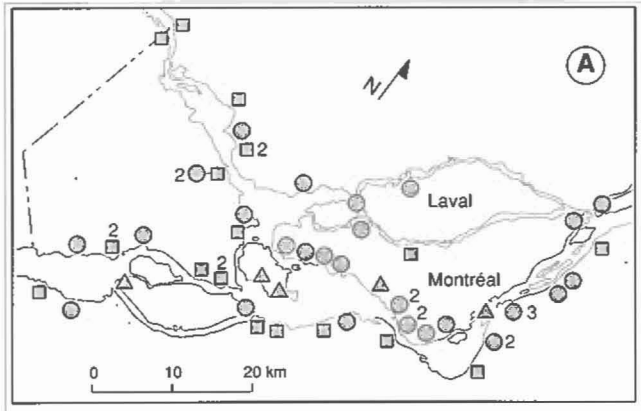
ST. LAWRENCE ACTION PLAN
PLAN D'ACTION SAINT-LAURENT

Sources:
- Statistics Canada. *Agricultural Profile of Québec, Part 1.* Agricultural division. 409 pp. 1992.
- Statistics Canada. *Census Divisions and Subdivisions, 1991.* Catalogue 93-904. 1992.

The St. Lawrence River - Pleasure Boating

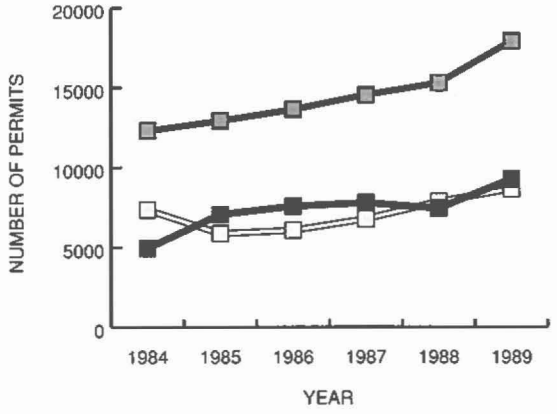


CENSUS OF SMALL PLEASURE CRAFT[1] BY TYPE AND SECTOR IN 1988

Type of craft	Sector A	B	C	Total
Dinghy	3 586	510	662	4 758
Keelboat	2 262	695	162	3 119
Multi-hull	421	57	172	490
Conventional open[2]	17 082	1 318	4 723	23 123
Conventional closed[2]	8 084	585	595	9 264
Others	1 303	12	25	1 340
Total	32 738	3 177	6 179	42 094

1. Any craft with a registered tonnage not exceeding 15 tonnes or any pleasure craft with a registered tonnage not exceeding 20 tonnes.
2. Conventional craft:
   - Open: any non-decked craft propelled by oars or motor (launch, kayak, canoe, seadoo)
   - Closed: any decked craft, with or without a cabin, and an outboard or external motor (cruiser, pilot boat).

GROWTH OF PERMITS IN QUÉBEC, 1984-1989



TYPE OF PERMIT
Transfer
New
Total

Sources:
- Ministère du Loisir, de la Chasse et de la Pêche du Québec. *Nautisme Québec 1987.* 56 pp. 1987.
- Canadian Coast Guard. Search and Rescue. *Analysis of 1988 Census Data.* 55 pp. 1988.
- Canadian Coast Guard. Ship Safety. Ship Operations. Personal communication.

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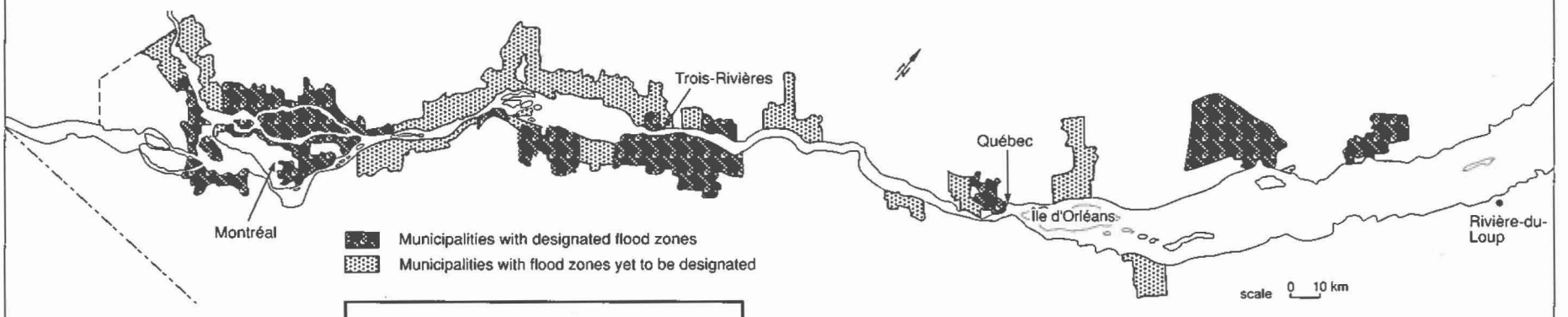
The St. Lawrence - Riverside Municipalities and Flood Zones

RIVERSIDE MUNICIPALITIES FROM MONTRÉAL TO RIVIÈRE-DU-LOUP WITH DESIGNATED FLOOD ZONES



DESIGNATED FLOOD ZONE (DFZ)

Zone susceptible to flooding (high water zone: 0-20 years + low water zone: 20-100 years) mapped and officially approved by the federal and provincial environment ministers.

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ST. LAWRENCE ACTION PLAN
PLAN D'ACTION SAINT-LAURENT

FEDERAL-PROVINCIAL AGREEMENT RELATIVE TO THE MAPPING AND PROTECTION OF FLOOD PLAINS

Period:
- 1986 to 1992 for mapping
- 1986 to 1997 for application of intervention policy.

Objective:
- To map zones susceptible to flooding.
- To establish a joint intervention policy aimed at reducing damage in designated flood zones and in provisional flood zones.

Intervention policy: Unless otherwise decided, in both designated and provisional flood zones:

- No federal or provincial installations shall be built
- No financial assistance shall be granted for existing or planned installations
- In the event of flooding, no indemnity shall be paid for damage to or loss of property or installations constructed after establishment of the flood zone
- The federal and provincial governments shall encourage authorities under their jurisdiction to prohibit the construction of installations, to impose restrictions or to impose indemnity measures against flooding.

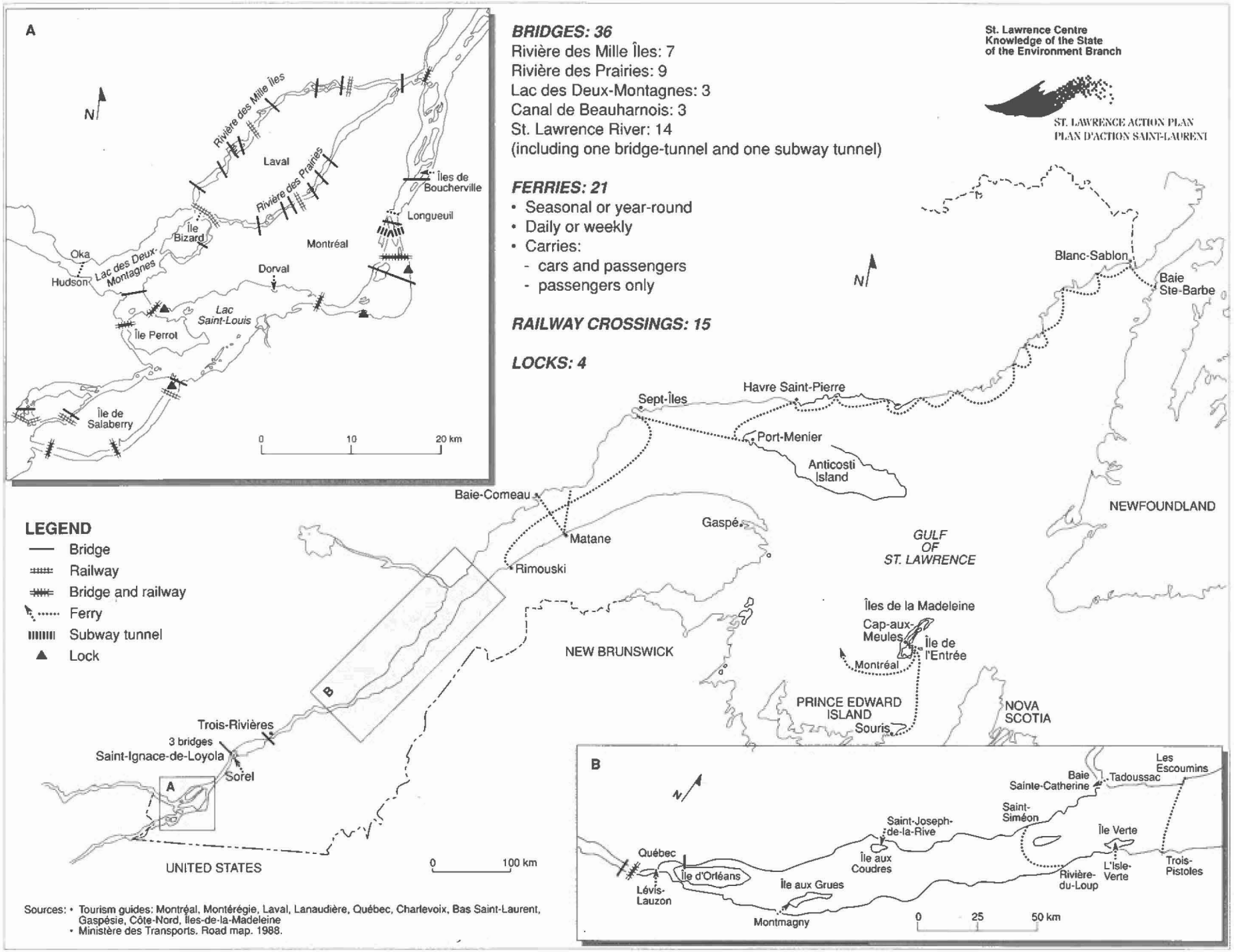
N.B.: There are exceptions and departures from this intervention policy.

NUMBER OF RIVERSIDE MUNICIPALITIES

FLUVIAL SECTOR	TARGETED BY THE FEDERAL-PROVINCIAL AGREEMENT			TOTAL
	Designated (D)	To be designated (TBD)	Total (D + TBD)	
Fluvial section	46	21	67	120
Fluvial Estuary	5	8	13	48
Upper Estuary	5	6	11	38
Lower Estuary	0	3	3	46
Gulf	0	4	4	87
Total	56	42	98	339

Source: *Agreement Between the Canadian and Québec Governments Relative to the Mapping and Protection of Flood Plains.* 20 pp. and 6 appendices.

The St. Lawrence River - Bridges, Ferries and Locks



Sources: • Tourism guides: Montréal, Montérégie, Laval, Lanaudière, Québec, Charlevoix, Bas Saint-Laurent, Gaspésie, Côte-Nord, Îles-de-la-Madeleine
• Ministère des Transports. Road map. 1988.

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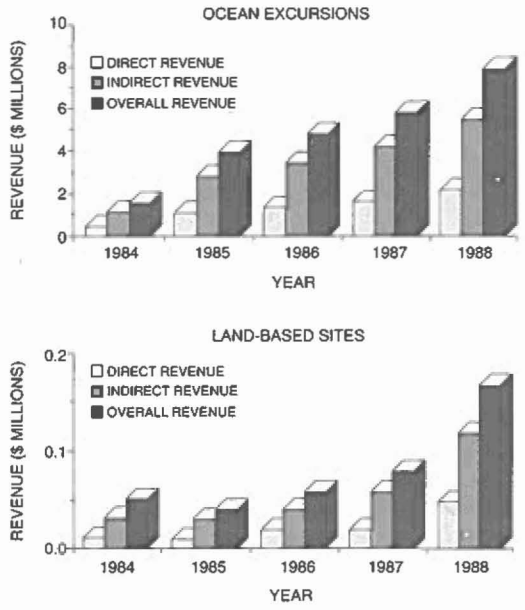
March 1993

The St. Lawrence River - Whale Watching from 1984 to 1988

ESTIMATED GROSS DIRECT, INDIRECT AND OVERALL REVENUE



DIRECT REVENUE: Cost of whale watching, at sea or at a land-based interpretation site

INDIRECT REVENUE: All economic spinoffs - hotels, restaurants, campgrounds, etc.

OVERALL REVENUE: Direct + indirect revenue

Beginnings of the whale-watching industry: Early 1970s

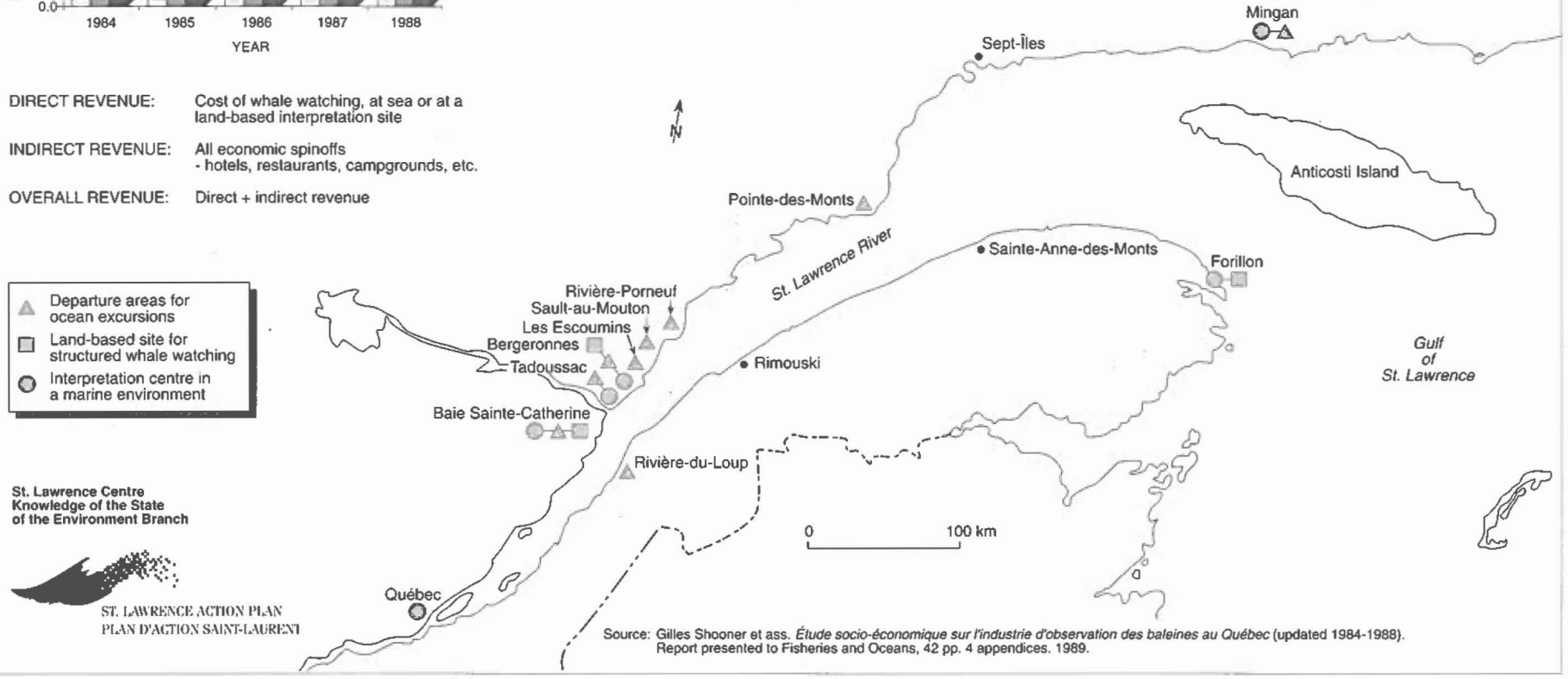
General observation period: Mid-May to end of October

About ten companies have offered ocean whale-watching excursions over the past five years. Tourists taking part in these excursions come from:

Québec: 52%
Europe: 24%
Other parts of Canada and the United States: 24%

DEVELOPMENT OF WHALE WATCHING

	1984	1985	1986	1987	1988
Number of whale-watching excursions	913	1 295	1 365	1 463	2 052
Number of passengers on ocean excursions	19 745	41 831	47 154	59 124	77 805
Number of visitors to land-based sites	7 670	6 510	9 059	11 116	32 000
Number of jobs linked directly to whale watching	34	53	59	67	125



Source: Gilles Shooner et ass. *Étude socio-économique sur l'industrie d'observation des baleines au Québec* (updated 1984-1988). Report presented to Fisheries and Oceans, 42 pp. 4 appendices. 1989.

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The St. Lawrence - Classified Provincial Sites and Districts (1986)

The **classification of cultural property** remains the most important measure of protection provided under the Québec Cultural Properties Act. The Act applies to property with an exceptional heritage value and a symbolic value to the people of Québec.

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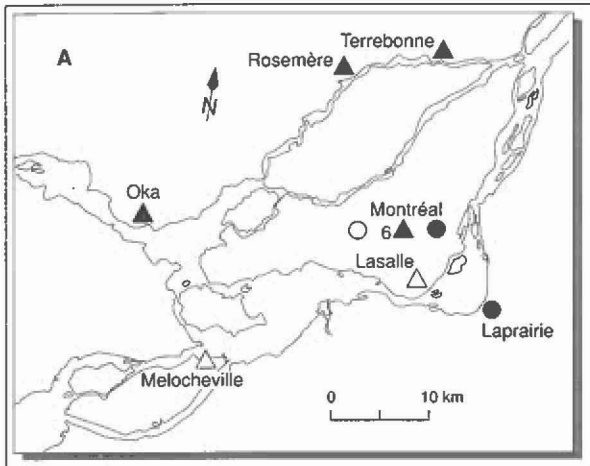

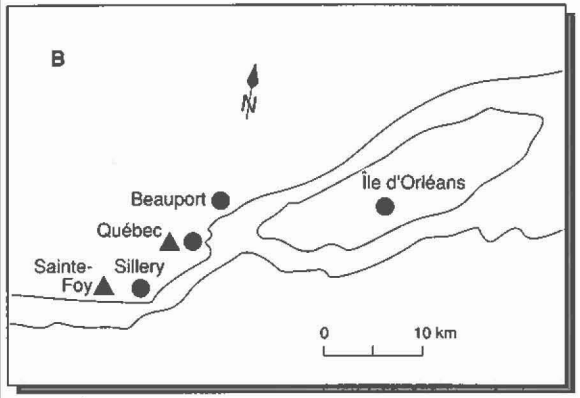

- Historic district
- Natural district
- Historic site
- Archaeological site

N.B.: The number which precedes the symbol indicates the number of related elements.

DEFINITIONS

Historic district: a municipality or part of a municipality so designated by the government because of the concentration of historic monuments or sites found there.

Natural district: a district, municipality or part of a municipality so designated by the government because of the aesthetic, legendary or scenic interest of its natural setting.

Historic site: under the Cultural Properties Act, this designation applies to sites where important events in Québec's history took place, or to areas containing historic property or monuments.

Archaeological site: a site where archaeological property (buildings or land bearing evidence of prehistoric or historic human occupation) is located.

Sources: • Ministère des Affaires culturelles du Québec. *Les biens culturels classés ou reconnus au 1er janvier 1981*. Direction générale du patrimoine. Dossier 50.109 pp. 1981.

• Ministère des Affaires culturelles du Québec. *Biens culturels classés ou reconnus, 1er janvier 1981 au 1er novembre 1986 ou omis dans le dossier 50*. Direction générale du patrimoine. Supplement to the dossier 50. 30 pp. 1986.

• Les Publications du Québec. *Le Québec Statistique*, 59e édition. 1028 pp. 1989.

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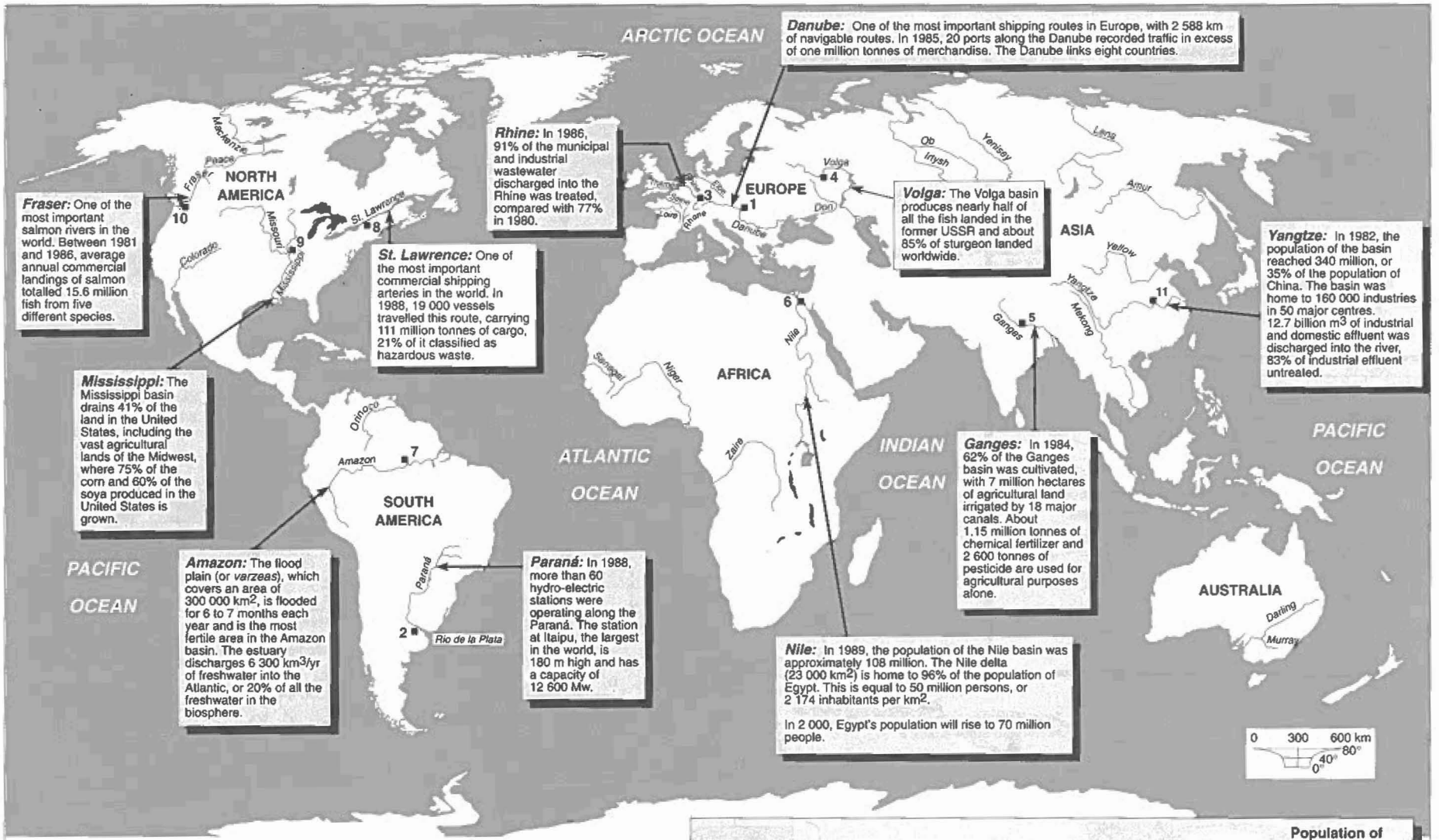
INFO-FLASH 30

The St. Lawrence Compared to Other Major Rivers - Riverside Cities and Points of Interest



Danube: One of the most important shipping routes in Europe, with 2 588 km of navigable routes. In 1985, 20 ports along the Danube recorded traffic in excess of one million tonnes of merchandise. The Danube links eight countries.

Rhine: In 1986, 91% of the municipal and industrial wastewater discharged into the Rhine was treated, compared with 77% in 1980.

Volga: The Volga basin produces nearly half of all the fish landed in the former USSR and about 85% of sturgeon landed worldwide.

Fraser: One of the most important salmon rivers in the world. Between 1981 and 1986, average annual commercial landings of salmon totalled 15.6 million fish from five different species.

St. Lawrence: One of the most important commercial shipping arteries in the world. In 1988, 19 000 vessels travelled this route, carrying 111 million tonnes of cargo, 21% of it classified as hazardous waste.

Yangtze: In 1982, the population of the basin reached 340 million, or 35% of the population of China. The basin was home to 160 000 industries in 50 major centres. 12.7 billion m^3 of industrial and domestic effluent was discharged into the river, 83% of industrial effluent untreated.

Mississippi: The Mississippi basin drains 41% of the land in the United States, including the vast agricultural lands of the Midwest, where 75% of the corn and 60% of the soya produced in the United States is grown.

Ganges: In 1984, 62% of the Ganges basin was cultivated, with 7 million hectares of agricultural land irrigated by 18 major canals. About 1.15 million tonnes of chemical fertilizer and 2 600 tonnes of pesticide are used for agricultural purposes alone.

Amazon: The flood plain (or *varzeas*), which covers an area of 300 000 km^2, is flooded for 6 to 7 months each year and is the most fertile area in the Amazon basin. The estuary discharges 6 300 km^3/yr of freshwater into the Atlantic, or 20% of all the freshwater in the biosphere.

Paraná: In 1988, more than 60 hydro-electric stations were operating along the Paraná. The station at Itaipu, the largest in the world, is 180 m high and has a capacity of 12 600 Mw.

Nile: In 1989, the population of the Nile basin was approximately 108 million. The Nile delta (23 000 km^2) is home to 96% of the population of Egypt. This is equal to 50 million persons, or 2 174 inhabitants per km^2.

In 2 000, Egypt's population will rise to 70 million people.

Major riverside city	River	Country	Population of metropolitan area
1. **Budapest**	Danube	Hungary	2 090 000
2. **Buenos Aires**	Rio de la Plata (mouth of the Paraná)	Argentina	9 948 000
3. **Cologne (Köln)**	Rhine	Germany	932 400
4. **Gorki**	Volga	Russia	1 392 000
5. **Kanpur**	Ganges	India	1 539 000
6. **Cairo**	Nile	Egypt	8 540 000
7. **Manaus**	Amazon	Brazil	635 000
8. **Montréal**	St. Lawrence	Canada	2 922 000
9. **St. Louis**	Mississippi	United States	2 938 400
10. **Vancouver**	Fraser	Canada	1 381 000
11. **Wuhan**	Yangtze	China	3 832 000

Other major riverside cities:

Hamburg, Germany (Elbe): 1 617 800 inhabitants

Kinshasa, Zaire (Zaire): 2 444 000 inhabitants

London, England (Thames): 6 755 000 inhabitants

Paris, France (Seine): 8 700 000 inhabitants

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ST. LAWRENCE ACTION PLAN
PLAN D'ACTION SAINT-LAURENT

Sources: • Environment Canada. *Grands Fleuves, Dossier statistique*, prepared by Géo-Recherche D.G. Inc. for the St. Lawrence Centre, 1991.
• Reader's Digest. *Guide to Places of the World: A Geographical Dictionary*. 1988.
• Other sources available at the St. Lawrence Centre upon request.

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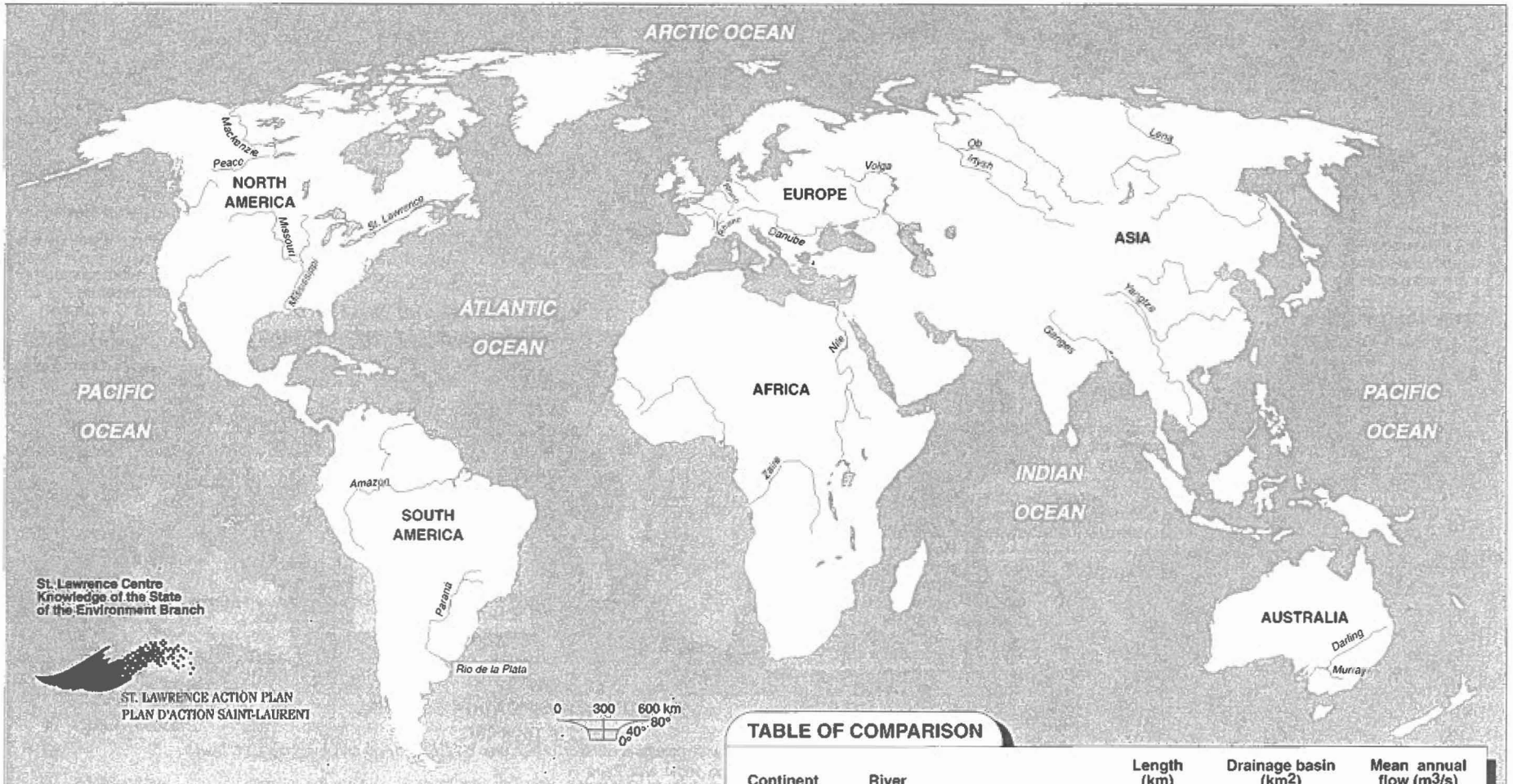
The St. Lawrence Compared to Other Major Rivers - Hydrographic Aspects



The St. Lawrence River

Source: Great Lakes

Outlet: Atlantic Ocean

Tributaries: About 244 tributaries flow into the Québec section of the River

Climate: Cold temperate with no dry season

Population: 80% of the population of Québec, about 5.2 million people, live in the drainage basin

RANKING

Length: 19th in the world

Area of drainage basin:
- 15th in the world
- 3rd in North America after the Mississippi and the Mackenzie rivers
- 2nd in Canada after the Mackenzie

Mean annual flow: 13th in the world

TABLE OF COMPARISON

Continent	River	Length (km)	Drainage basin (km^2)	Mean annual flow (m^3/s)
AFRICA	Nile	6 700	2 813 200	3 000
	Zaire (or Congo)	4 640	3 837 600	38 970
NORTH AMERICA	Mackenzie (and Peace)	4 230	1 812 200	9 710
	Mississippi (and Missouri)	6 020	3 242 200	12 820
	St. Lawrence (and Great Lakes)	**3 060**	**1 307 800**	**13 018**
SOUTH AMERICA	Amazon	6 570	6 175 000	174 890
	Paraná (and Rio de la Plata)	4 880	3 112 200	22 900
ASIA	Ganges	2 510	956 800	12 480
	Lena	4 390	2 498 600	16 100
	Ob (and Irtysh)	5 410	3 000 400	10 190
	Yangtze (or Blue River)	5 990	1 833 000	32 180
AUSTRALIA	Murray (and Darling)	2 750	1 060 800	-
EUROPE	Danube	2 850	774 800	6 420
	Rhine	1 320	251 800	2 200
	Rhone	812	98 000	1 500
	Volga	3 690	1 365 000	7 670

Sources:
- Environment Canada. *Grands Fleuves, Dossier statistique.* Prepared by Géo-Recherche D.G. Inc. for the St. Lawrence Centre. 1991.
- Kurian, G. T.. *Geo-Data: The World Almanac Gazetteer.* Gale Research Publishing: Detroit. 623 pp. 1983.

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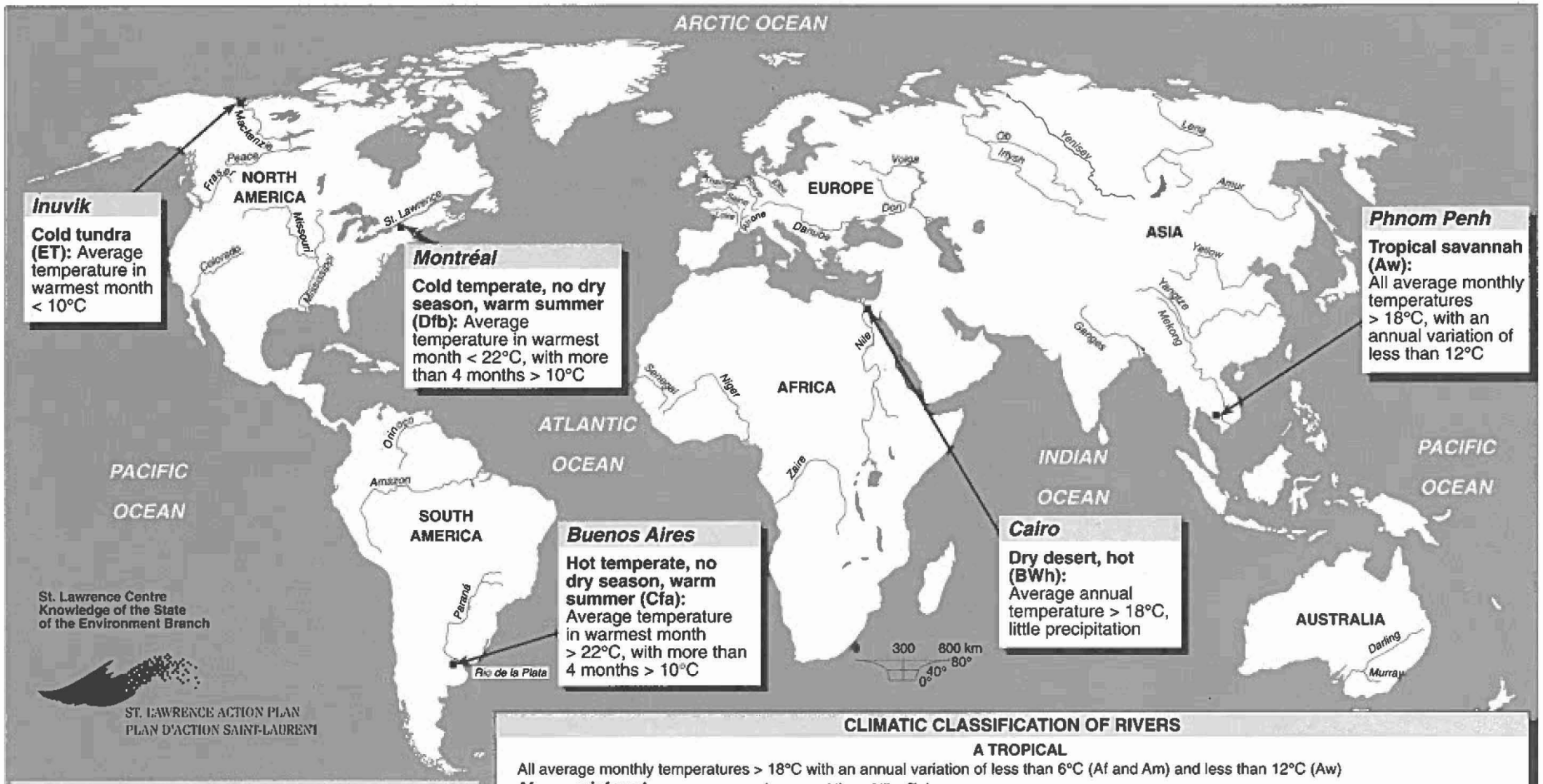
The St. Lawrence Compared to Other Major Rivers - Climate



Inuvik

Cold tundra (ET): Average temperature in warmest month < 10°C

Montréal

Cold temperate, no dry season, warm summer (Dfb): Average temperature in warmest month < 22°C, with more than 4 months > 10°C

Buenos Aires

Hot temperate, no dry season, warm summer (Cfa): Average temperature in warmest month > 22°C, with more than 4 months > 10°C

Cairo

Dry desert, hot (BWh): Average annual temperature > 18°C, little precipitation

Phnom Penh

Tropical savannah (Aw): All average monthly temperatures > 18°C, with an annual variation of less than 12°C

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PLAN D'ACTION SAINT-LAURENT

A river can travel through many different types of climate. For example, the Mekong River starts in a cold climate at an altitude of more than 1500 m (ETH) and flows successively through a cold temperate climate with no dry season (Dfc, Dfb), a hot temperate climate with a dry winter (Cwa), and empties into the China Sea, in an area whose climate is tropical savannah (Aw).

KÖPPEN'S CLIMATIC CLASSIFICATION:

The first two letters of this classification indicate the major climatic groups (**A, B, C, D**) and their sub-groups (**f, m, w, s, S, W, T**). A third letter may be added for increased precision. These letters are: **a: cool summer, b: warm summer, c: cool, short summer, d: cool, short summer and cold winter, H: high-altitude (> 1500 m) climate.**

CLIMATIC CLASSIFICATION OF RIVERS

A TROPICAL

All average monthly temperatures > 18°C with an annual variation of less than 6°C (Af and Am) and less than 12°C (Aw)

Af = **rainforest** → Amazon, Niger, Nile, Zaire
Am = **monsoon** → Amazon, Ganges, Orinoco
Aw = **savannah** → Amazon, Mekong, Niger, Nile, Orinoco, Paraná, Senegal, Zaire

B DRY

Average annual temperature may be: h = > 18°C (hot), k = < 18°C (cool)

BS = **steppes** → Amur, Colorado, Don, Yellow, Mississippi, Murray, Niger, Nile, Ob, Senegal, Volga
BW = **desert** → Colorado, Niger, Nile, Senegal

C HOT TEMPERATE

Average temperature in coldest month is between 18°C and -3°C; in warmest month > 10°C

Cw = **dry winter** → Amazon, Ganges, Yellow, Mekong, Paraná, Yangtze, Zaire
Cs = **dry summer (Mediterranean)** → Murray, Rhone
Cf = **no dry season** → Danube, Elbe, Fraser, Loire, Mississippi, Murray, Paraná, Rhine, Rhone, Seine, Thames, Yangtze

D COLD TEMPERATE

Average temperature in coldest month < -3°C; in warmest month > 10°C

Dw = **dry winter** → Amur, Yellow, Yenisey, Lena
Df = **no dry season** → Colorado, Danube, Fraser, Yellow, Yenisey, Lena, Mackenzie, Mekong, Mississippi, Rhone, Ob, **St. Lawrence**, Volga, Yangtze

E COLD

Average temperature in warmest month < 10°C

ET = **tundra or altitude** → Colorado, Yellow, Yenisey, Lena, Mackenzie, Mekong, Yangtze

Sources: • Environment Canada. *Grands Fleuves, Dossier statistique.* Prepared by Géo-Recherche D.G. Inc. for the St. Lawrence Centre. 1991.
• The Prentice-Hall. *American World Atlas*, plates on climate. 1984.

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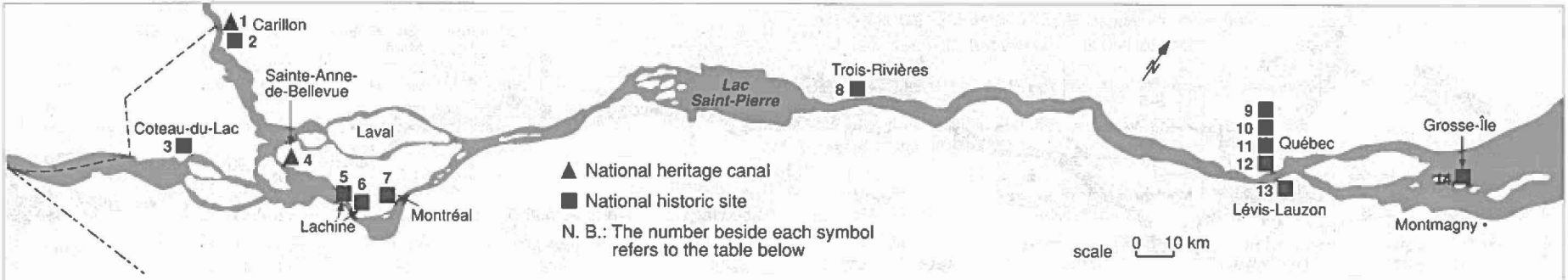
Decem,ber 1993

The St. Lawrence River - National Historic Sites (1991)



VISITS TO HISTORIC SITES IN 1991

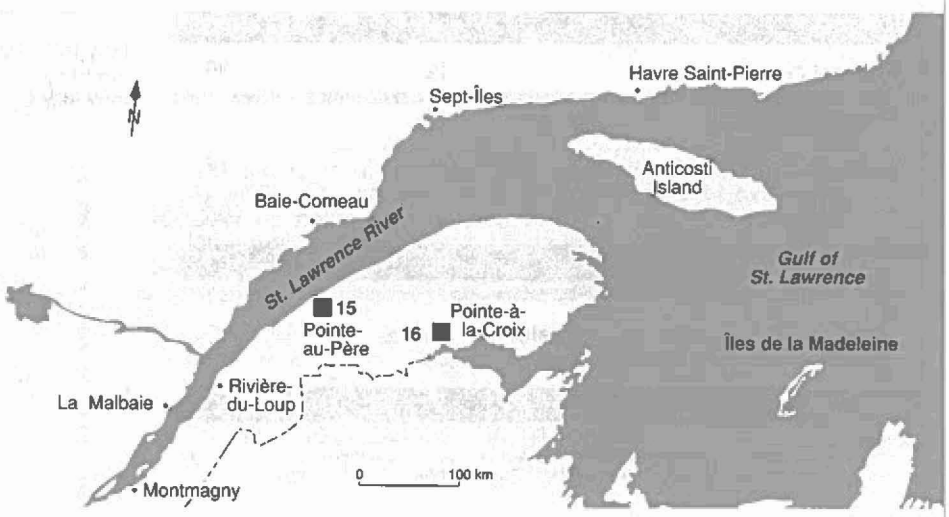
Name of site	Description	Number of visitors
1. **Canal de Carillon**	Military canal today used by pleasure craft.	39 117
2. **Caserne-de-Carillon**	Building representative of military architecture of the early 19th century.	N. D.
3. **Coteau-du-Lac**	Site of a military post and first lock canal in Canada.	38 203
4. **Canal de Sainte-Anne-de-Bellevue**	Shipping canal today used by pleasure craft.	128 113
5. **Canal de Lachine**	Shipping canal closed to navigation: currently under restoration.	N. D.
6. **The Fur Trade in Lachine**	Important 19th century Montréal and Lachine fur trade site.	41 259
7. **Sir George Étienne-Cartier**	Home of one of the Fathers of Confederation.	29 050
8. **Forges du Saint-Maurice**	Remains of the first smelting industry in Canada.	82 179
9. **Cartier-Brébeuf***	Site commemorating Jacques Cartier's exploration of the New World and the role of the Jesuits in the evangelization of the Amerindians.	81 606
10. **Fortifications of Québec**	Remains of military fortifications, including the Québec Citadel.	2 253 504
11. **Artillery Park**	Structures and installations closely linked to the defence system of Québec.	89 103
12. **The Old Port of Québec**	Interpretation centre for the timber and shipbuilding trades.	54 612
13. **Fort No. 1***	Remains of military structure built on Pointe-Lévis between 1865 and 1872.	27 219
14. **Grosse Île**	Quarantine station for European immigrants between 1830 and 1840.	6 184
15. **Pointe-au-Père Lighthouse**	Centre for piloting services and aids to navigation in the St. Lawrence estuary.	10 690
16. **Battle of the Restigouche**	Site commemorating the naval battle of 1760 in which New France fell to the British.	24 797
TOTAL		2 905 636

* National historic site legally classified as a national historic park; that is, protected and governed by the *National Parks Act*.

National historic sites are created by the Canadian Parks Service of Environment Canada to commemorate persons, locations or events of national historic significance with plaques or monuments. Selection is based on the recommendations of the National Historic Sites and Monuments Board, which advises the federal Environment Minister. The commemoration sites are not necessarily federally-administered.

National historic sites also designated as national historic parks highlight the significance of specific places which have played an important role in the country's history and illustrate an era or a certain aspect of our history. National historic parks have three characteristics:

- ***they are of national historic significance***
- ***they are protected and authentically interpreted on-site***
- ***they are federally-created, protected, interpreted and managed.***



Sources:
- Environment Canada. *Statistical Report 1991: National Parks, National Historic Sites, National Heritage Canals*. Canadian Parks Service. 103 pp. 2 appendices. 1992.
- Environment Canada. *State of the Parks Report*. Canadian Parks Service. 229 pp. 1991.
- Environment Canada. *Canada Parks Policy*. Canadian Parks Service. 1983.

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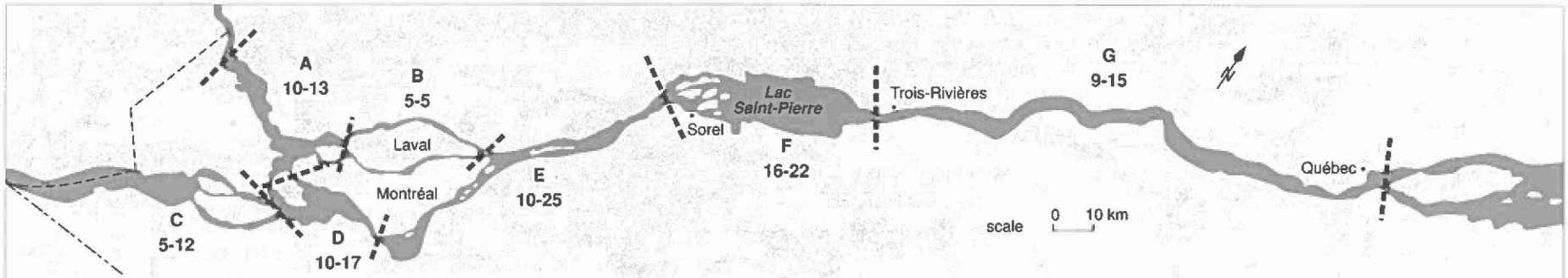
ST. LAWRENCE ACTION PLAN
PLAN D'ACTION SAINT-LAURENT

The St. Lawrence River - Increase in Boat Launching Ramps from 1982 to 1987



Body of water

A Lac des Deux-Montagnes
B des Prairies and Mille Îles rivers
C Lac Saint-François and Canal de Beauharnois
D Lac Saint-Louis
E Montréal to Sorel
F Lac Saint-Pierre and Îles de Sorel
G Trois-Rivières to Québec
H Downstream of Québec (north shore)
I Downstream of Québec (south shore)
J Saguenay River

Example

Number of launching ramps — Body of water → **E** **10-25** → in 1982 / in 1987

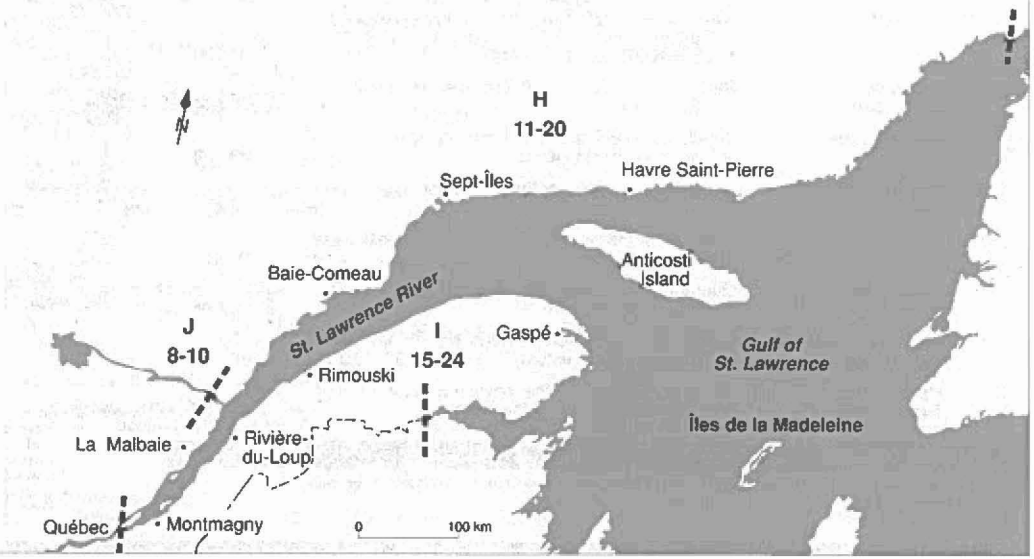
LAUNCHING RAMPS (zones A to J)

	1982	1987
Federal ramps	12	36
Provincial ramps	12	7
Municipal ramps	8	14
Private ramps	67	106
Total	99	163
Number of riverside municipalities with one or more launching ramps	80	119

Sources: • Ministère du Loisir, de la Chasse et de la Pêche du Québec. *Répertoire des marinas, quais pour petites embarcations et rampes de mise à l'eau.* 56 pp. 1987.
• Ministère du Loisir, de la Chasse et de la Pêche du Québec. *Randonnée nautique Québec 1982.* 42 pp. 1982.

The total number of launching ramps grew by **65%** between **1982** and **1987**. The largest increase, some **150%**, occurred in the fluvial corridor between Montréal and Sorel (zone E).

In **1987**, **65%** of launching ramps belonged to private organizations, **2%** were under federal jurisdiction, **7%** provincial, and **14%** municipal. In **1987**, **35%** of the **338** riverside municipalities had at least one launching ramp, compared to about **24%** in **1982**.



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Canada
March 1993

The St. Lawrence River - Cetacean Characteristics

Definition : **CETACEAN** (from the Greek *ketos*, meaning "big fish"). An order of marine mammals perfectly adapted to aquatic life because of their fish-shaped bodies, whose front members have become fins while the rear members have disappeared or are vestigial.

CETACEANS

ODONTOCETE (from the Greek *odous*, meaning "tooth").
Whales which catch their prey with their teeth.

MYSTICETE (from the Greek *moustax*, meaning "mustache" and *ketos*, or "big fish").
Whales which take in and filter water through their baleen plates to capture their prey.

ODONTOCETE

Common name *(species)*		Beluga* *(Delphinapterus leucas)*	Killer whale *(Orcinus orca)*	Pilot whale *(Globicephala melaena)*	Harbour porpoise* *(Phocoena phocoena)*	Sperm whale *(Physeter macrocephalus)*	Atlantic white-sided dolphin *(Lagenorhynchus acutus)*	White-beaked dolphin *(Lagenorhynchus albirostris)*	Northern bottle-nosed whale *(Hyperoodon ampullatus)*
Average length (metres)	♂	3.6 to 4.2	9	6	1.5	15	2.4	2.7	8.5
	♀	3 to 3.6	7	4.8	1.5	11	2.2	2.7	7.5
Average weight	♂	≃ 640 kg	8 tonnes	3.8 tonnes	40 to 80 kg	36 tonnes	130 to 230 kg	135 to 275 kg	5.5 tonnes
	♀	≃ 400 kg	4 tonnes	1.8 tonnes	40 to 60 kg	20 tonnes	130 to 230 kg	135 to 275 kg	4 tonnes
Average diving time in minutes		10 to 15	1 to 4	5 to 10	3 to 6	30 to 50 (90 maximum)	N. D.	N. D.	15 to 70
Food		fish, crustaceans, worms: 25 kg/d	fish, birds, marine mammals, shellfish	squid and occasionnaly fish: 34 kg/d	fish, crustaceans: 4.5 kg/d	large squid	squid and fish	fish, squid, crustaceans, shellfish	squid, herring

MYSTICETE

Common name *(species)*		Minke whale *(Balaenoptera acutorostrata)*	Fin whale* *(Balaenoptera physalus)*	Blue whale* *(Balaenoptera musculus)*	Humpback whale *(Megaptera novaeaugliae)*
Average length (metres)	♂	7 to 8	21 to 25	24 to 25	12
	♀	7 to 8	21 to 25	24 to 25	13
Average weight (tonnes)	♂	6 to 8	40 to 50	80 to 130	20 to 40
	♀	6 to 8	40 to 50	80 to 130	20 to 40
Average diving time in minutes		3 to 8 (20 maximum)	5 to 15	15 to 20 (50 maximum)	10 to 15
Food		fish, crustaceans	fish, crustaceans, 3 t/d	small crustaceans (krill) 5 t/d	fish, crustaceans

* The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has declared the **Beluga in danger of extinction**; the **Harbour porpoise** and the **Humpback whale** have been declared **endangered species**, while the **Blue whale** and the **Fin whale** have been declared **vulnerable**.

Only the Beluga lives year-round in the St. Lawrence. The other species are migratory and come here to feed before heading south.

The Sperm whale is an occasional visitor to the St. Lawrence: three were spotted in 1988 in the Détroit de Jacques-Cartier and two in 1991 just off Tadoussac. The Killer whale is rarely seen in large numbers. Each year a pod of four is seen on the Basse Côte Nord.

Sources: • Fontaine, P. H.. *Biologie et écologie des baleines de l'Atlantique nord.* Les éditions Thibeault. 135 pp. 1988.
• Fisheries and Oceans. *The Cetaceans of Canada.* 30 pp. 1988.
• Environment Canada. *La nature aux abois.* Les éditions Broquet. 220 pp. 1989.

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The St. Lawrence River - Examples of Food Chains

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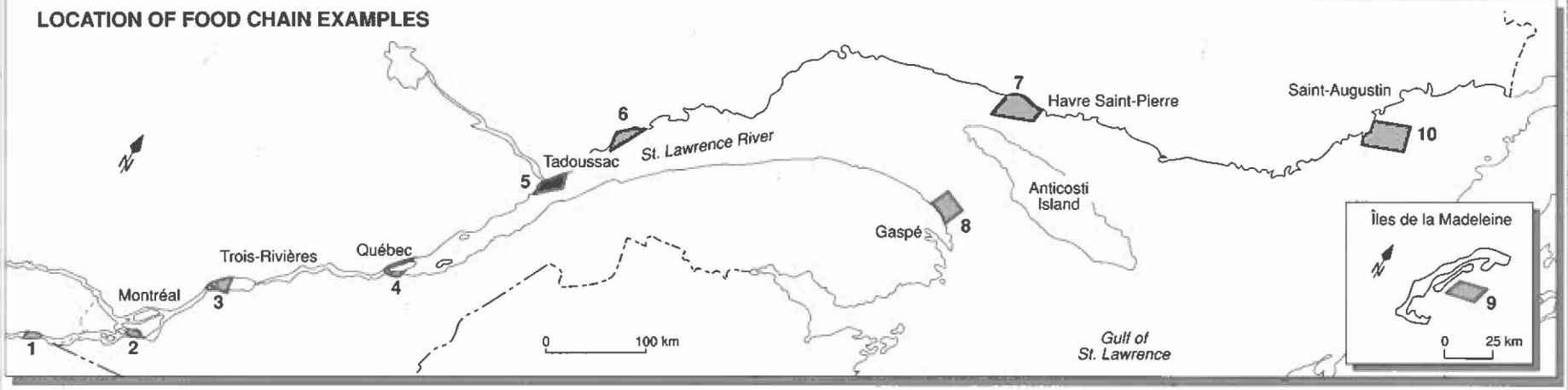
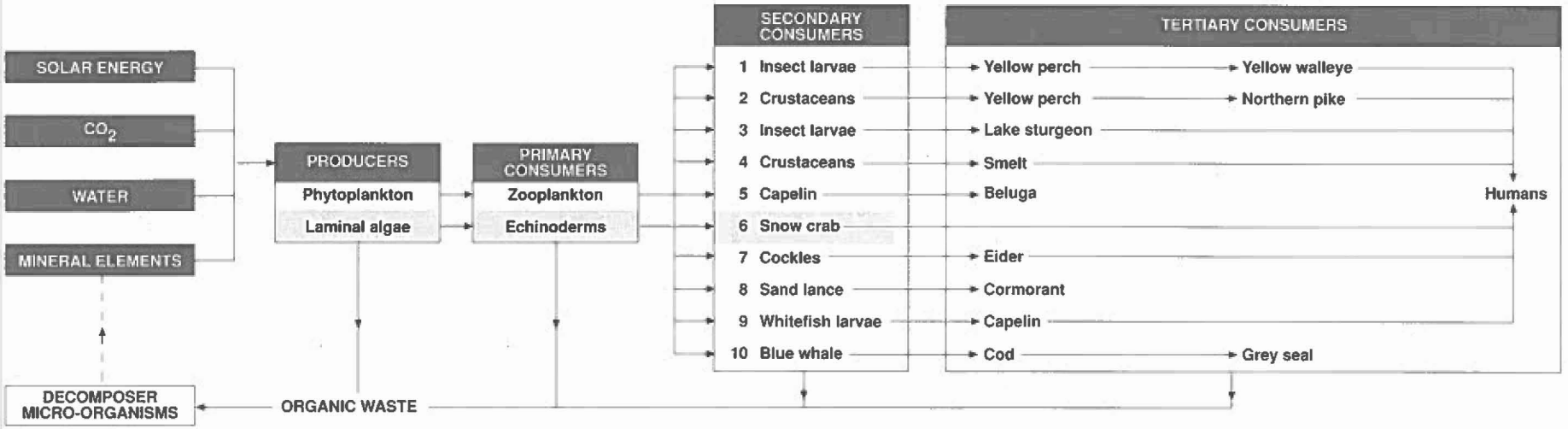
Living creatures are united by food links. These links make up the food chain, or the food web. The food chain ensures the circulation of matter and consequently the transfer of biochemical energy among the ecosystem's various organisms. The producers at the base of all food chains use solar energy, water, carbon dioxide and mineral elements to synthesize organic matter.

LOCATION OF FOOD CHAIN EXAMPLES





The toxic substances discharged into the environment can accumulate in living organisms. Concentrations of toxic substances, often miniscule in the aquatic environment, can therefore reach very high values in living organisms (bioconcentration). The concentration of toxic substances may continue to increase in an organism throughout its lifetime (bioaccumulation). It may also grow from one link to another in the food chain (bioamplification).

Sources: • Environment Canada. *Les toxiques dans le Saint-Laurent*. "St. Lawrence Update" collection. Conservation and Protection. St. Lawrence Centre. 8 pp. 1990.
• Ramade, F.. *Éléments d'écologie*. McGraw-Hill. 452 pp. 1987.
• Fisheries and Oceans. Fact Sheets. "Underwater World" collection. 1991.

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INFO-FLASH 37

The St. Lawrence River - Rest Areas, Belvederes and Observation Sites

Symbol	Infrastructure	Number at riverside	Jurisdiction
▲	Permanent rest areas	5	Ministère des transports du Québec
△	Seasonal rest areas	52	Ministère des transports du Québec
▭	Belvederes	24	Ministère des transports du Québec
●	Observation sites	22	Municipal
		2	MLCP (Chutes Montmorency Park and Park du Bic)
◉	At once belvederes and observation sites	2	Municipal
		107	

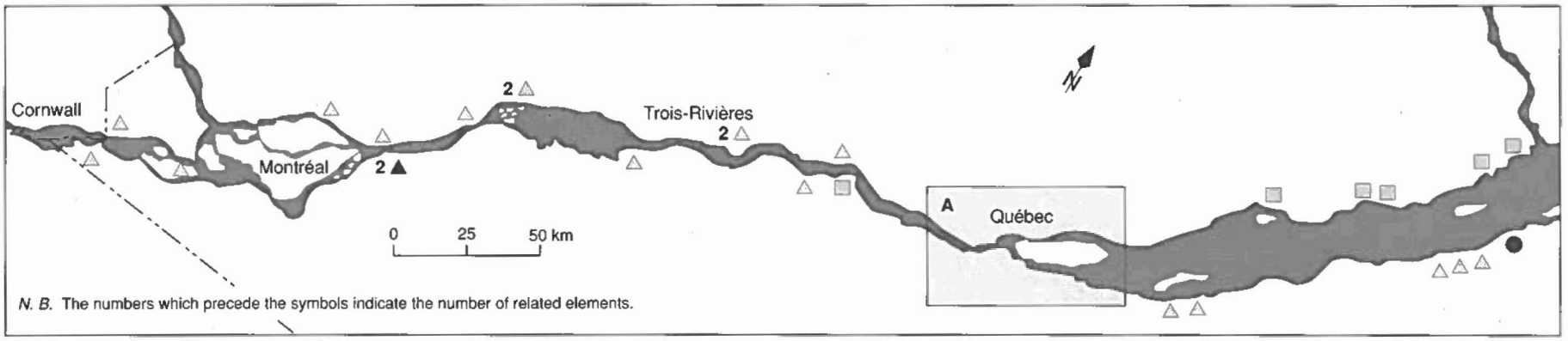
* These numbers do not include municipal riverside park infrastructures.

PERMANENT REST AREAS
Open year-round, these roadside stops offer picnic tables, snack bars and washrooms; accommodate thirty cars.

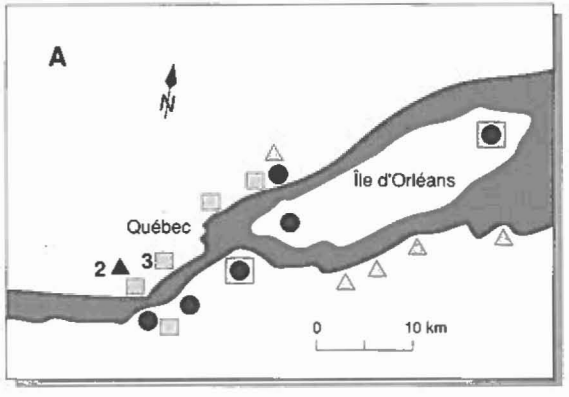
SEASONAL REST AREAS
Roadside stops offering the same services as permanent rest areas, but only open six to eight months of the year.

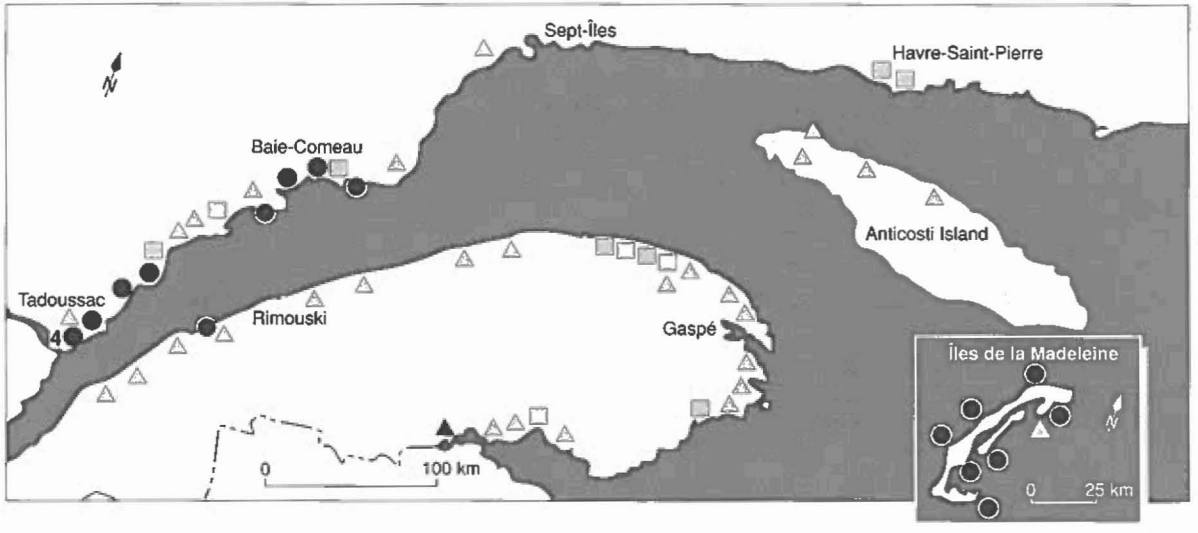
BELVEDERES
Former rest areas or by-pass with no infrastructure; safely accommodate three to four cars.

OBSERVATION SITES
Areas designed for observing the countryside, the plant and animal life; also serve as destinations for long walks and hikes.



N. B. The numbers which precede the symbols indicate the number of related elements.





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Sources: • Ministère du Transport du Québec. *Carte routière du Québec 1990-1991.* Les publications du Québec. 1991.
• Ministère du Tourisme du Québec and regional tourism associations. Québec tourism guides. 1991.

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The St. Lawrence River - Contamination of Molluscs by Algae

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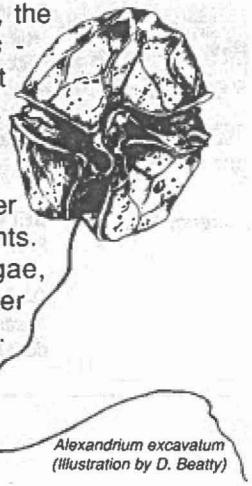
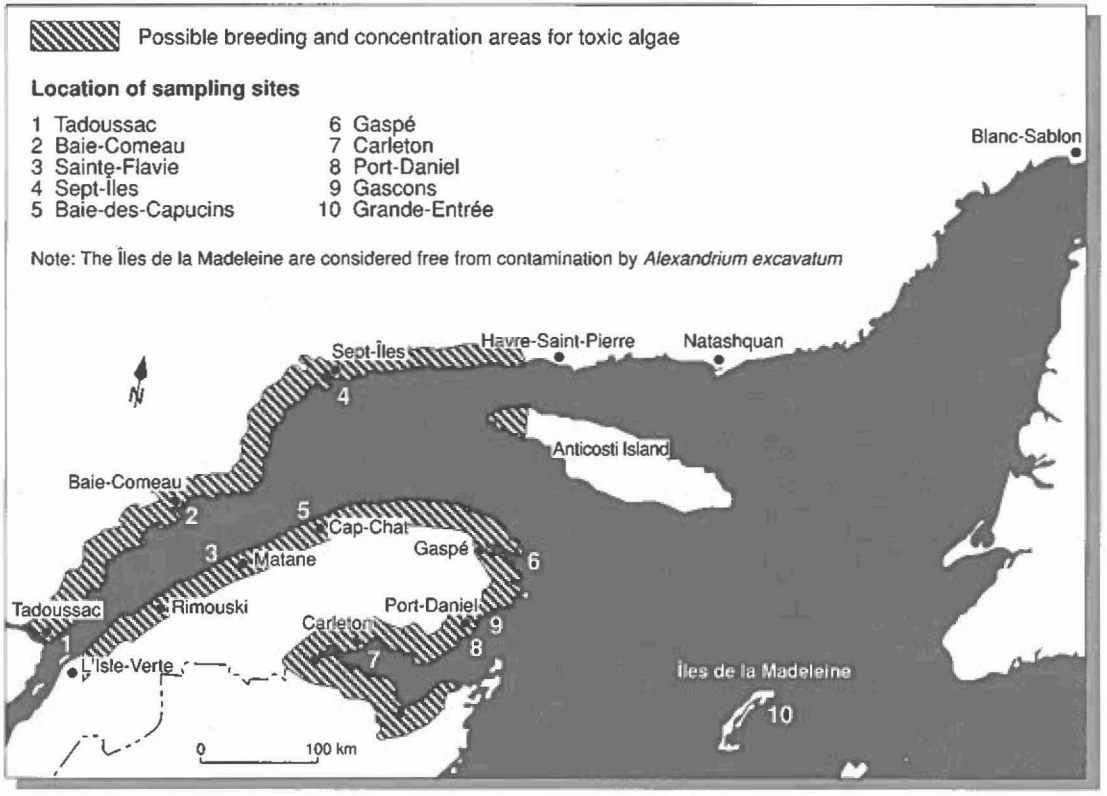
Certain types of microscopic algae are toxic. In the St. Lawrence, the *Alexandrium excavatum* - formerly called *Protogonyaulax tamarensis* - is the only toxic species of *Alexandrium* found in significant numbers. It lives year-round along the Côte-Nord, Gaspésie and the Îles de la Madeleine.

These algae breed and concentrate in areas according to the water temperature, variations in salinity, nutrient composition and currents. Bivalve molluscs, which feed by filtering water, absorb these algae, accumulate their toxins and become potentially hazardous. Other molluscs, both herbivores and omnivores, can also be contaminated. Every year in Québec, some thirty cases of poisoning are reported, the result of negligence on the part of harvesters ignoring the directives issued by Fisheries and Oceans.



Alexandrium excavatum
(Illustration by D. Beatty)

Possible consequences of mollusc contamination
- Danger for the health of consumers
- Financial loss for aquaculture



Following various studies, and in the hopes of countering this natural phenomenon, a research program was initiated by Fisheries and Oceans in 1989 with these aims:

1) To acquire new information on the ecology of algae;

2) To supply Fisheries and Oceans inspection services and mollusc producers with data which will enable them to predict the contamination of zones where molluscs are found;

3) To allow Fisheries and Oceans to open or shut down harvest zones;

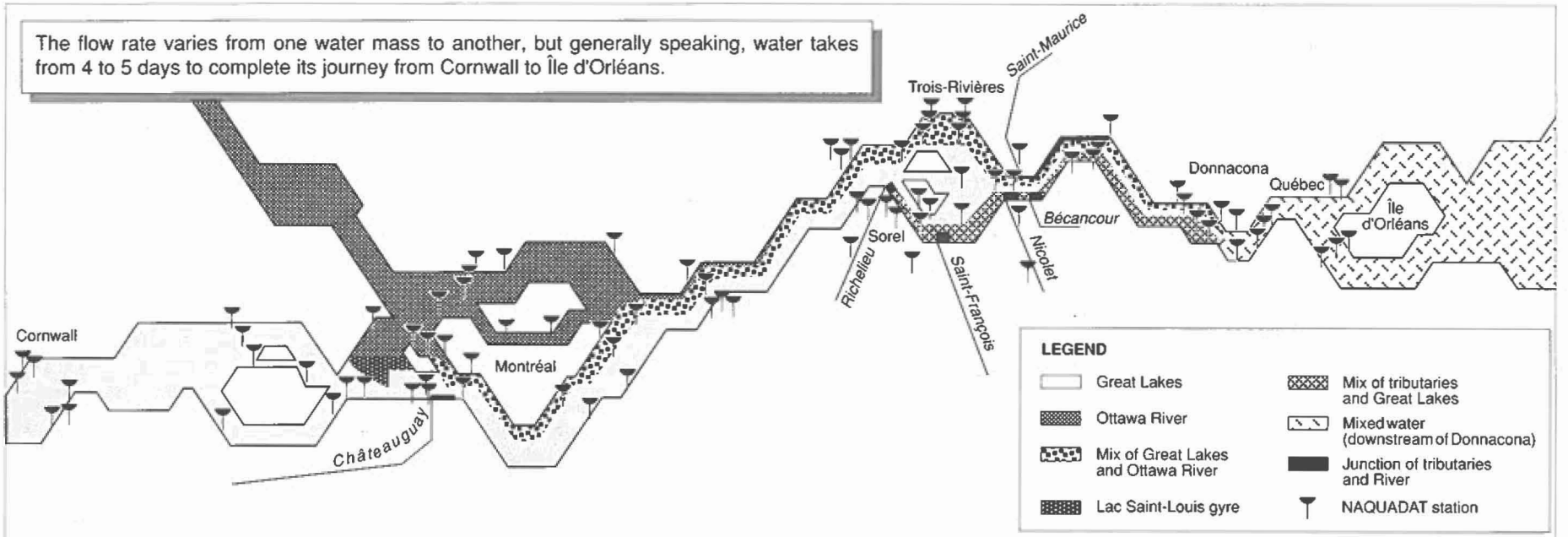
4) To determine the feasibility of establishing a warning system for producers and harvesters about the possibility of contamination.

As well, 10 water sampling sites allow toxic algae concentrations to be determined and analysed.

Sources: • Larocque, R. and A. D. Cembella. *Résultats du premier programme de suivi des populations de phytoplancton toxique dans l'estuaire et le Golfe du Saint-Laurent (Région du Québec).* Canadian Technical Report of Fisheries and Aquatic Sciences No. 1796. 42 pp. 1991.
• Fisheries and Oceans. *Fact sheet. Red Tides.* "Underwater World" collection. 1983.

The St. Lawrence River - Water Masses from Cornwall to Québec

The flow rate varies from one water mass to another, but generally speaking, water takes from 4 to 5 days to complete its journey from Cornwall to Île d'Orléans.



The St. Lawrence River is made up of many water masses, each distinguished by its natural physico-chemical characteristics. The largest water masses are the green waters of the Great Lakes, highly mineralized but only slightly turbid and low in nutrients, and the brown waters of the Ottawa River, characterized by their strong turbidity and low mineral content. Both meet in Lac Saint-Louis, where they gradually mix. Water masses can remain separate and distinct over long distances, depending on their properties. There are twelve water masses between Cornwall and Québec, six of which are formed by the junction of the River and its tributaries (fig. 1). The quality of these waters is currently being monitored. Some 100 sampling stations between Cornwall and Québec collect data on 140 parameters (physical, chemical, bacteriological, biological and hydrometric), and integrate them into the National Water Quality Data Bank (NAQUADAT) of Environment Canada.

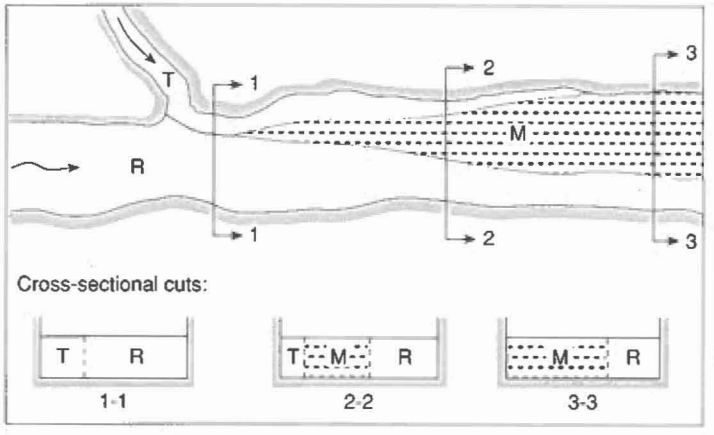


Figure 1 Schematic diagram of a tributary (T) mixing (M) into the St. Lawrence River (R)

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Sources : • Environment Canada. *Délimitation des principales masses d'eau du Saint-Laurent.* Guided by J.L. Verrette. Conservation and Protection. St. Lawrence Centre.15 pp. 1990.
• Environment Canada and *La revue maritime L'Escale. Le Saint-Laurent: usages et environnement.* Supplement to La revue maritime L'Escale. No. 30. August 1989.

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The St. Lawrence River - Quality of Shellfish Waters in 1993

Why is water quality so important for filtering molluscs?

Certain types of molluscs, such as mussels and whelks, feed by filtering water. The amount of water filtered by one mussel in one hour, for example, can represent up to 300 times its weight. These molluscs concentrate the plankton and organic matter around them; in this way, when the waters of a conchiferous bank are contaminated by fecal coliforms (bacteria from natural human and animal waste), the molluscs living there accumulate them. This concentration of fecal coliforms does not affect the molluscs which absorb them, but does render the molluscs unfit for human consumption. Their consumption can lead to certain sicknesses, such as serious intestinal disruptions.

FEDERAL-PROVINCIAL COMMITTEE FOR QUALITY CONTROL OF MOLLUSCS

FEDERAL JURISDICTION

Environment Canada

Sole intervenor in the bacteriological control of conchiferous banks. In Québec, this process is carried out under the Shellfish Water Quality Protection Program. It can recommend the closure of any zones not respecting standards set by the federal-provincial committee.

Fisheries and Oceans

Responsible for the quality control of products destined for export.
- Checks for toxins in molluscs which lead to paralytic poisoning
- Opens or shuts down shellfish zones according to the toxins found or bacteriological and chemical contamination
- Monitors those zones closed to harvesting.

PROVINCIAL JURISDICTION

Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec

Charged with ensuring the quality control of products for local and touristic distribution.

Ministère de l'Environnement du Québec

Intervenes in controlling municipal contamination sources through the Québec waters cleanup Programme.

SHELLFISH WATER QUALITY PROTECTION PROGRAM

A PROGRAM TO MONITOR THE BACTERIOLOGICAL QUALITY OF WATER WHERE BIVALVE MOLLUSCS, ESPECIALLY MUSSELS AND SOFT-SHELL CLAMS (CLAMS, COCKLES), ARE HARVESTED OR PRODUCED.

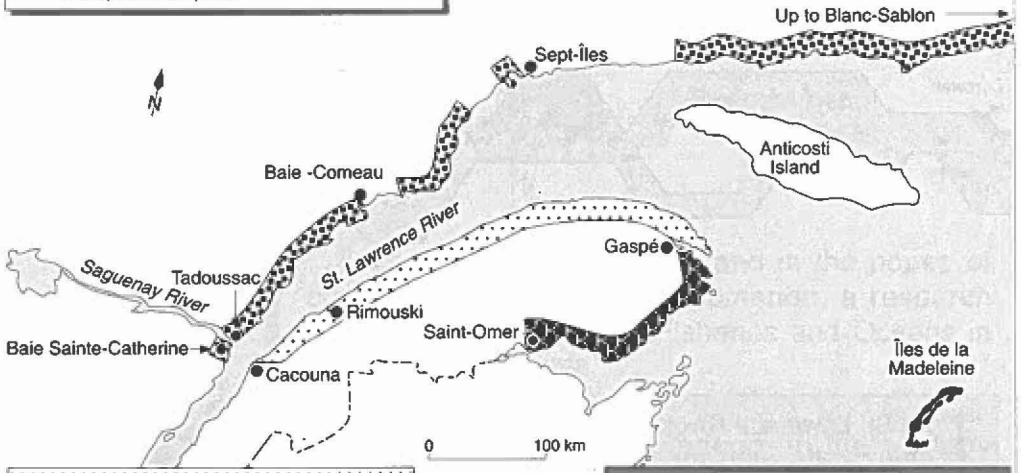
The function of this program:
- To evaluate the bacteriological quality of shellfish waters and mussel breeding beds according to very strict international standards
- To identify the sources of pollution that could contaminate these waters
- To categorize shellfish zones: open, closed or open conditionally on the basis of water analyses in these zones
- To find solutions allowing closed zones to be re-opened
- To promote the development of aquaculture
- To guarantee the quality of molluscs on local, national and international markets.

Sources: • Environment Canada. *Shellfish Water Quality Protection Program.* Information pamphlet. Environmental Protection Branch. Conservation and Protection. 1991.
• Environment Canada. *Recommandations de classification.* Water Quality Protection Program. Environmental Protection Branch. Conservation and Protection. 1993.

CLASSIFICATION OF THE 184 SHELLFISH ZONES EVALUATED IN 1993
(Number of zones open, closed or open conditionally, by region)

CLASSIFICATION

- **O** : Zone permanently open to harvest
- **OC** : Zone open conditionally *(closed from June 1 to September 30)*
- **C** : Zone permanently closed to harvest
- **T** : Zone classified OC or C but where harvesting is permitted solely for purposes of treatment at a specialized plant.



Charlevoix and Côte-Nord

	O	OC	C	Total	T
Number of zones	51	17	16	84	29
Percentage	61	20	19	100	87*

Bas Saint-Laurent

	O	OC	C	Total	T
Number of zones	4	2	22	28	11
Percentage	14	7	79	100	46*

Îles de la Madeleine

	O	OC	C	Total	T
Number of zones	17	1	2	20	3
Percentage	85	5	10	100	100*

Gaspésie

	O	OC	C	Total	T
Number of zones	12	7	33	52	22
Percentage	23	13	64	100	55*

INVENTORY OF SHELLFISH ZONES EVALUATED IN 1993

	O	OC	C	Total	T
Number of zones	84	27	73	184	65
Percentage	45	15	40	100	65*

* Calculated in relation to the total percentages of categories OC and C

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December 1993

The St. Lawrence River and Mussel Breeding

THE BLUE MUSSELL (*Mytilus edulis*)

Biology of the species

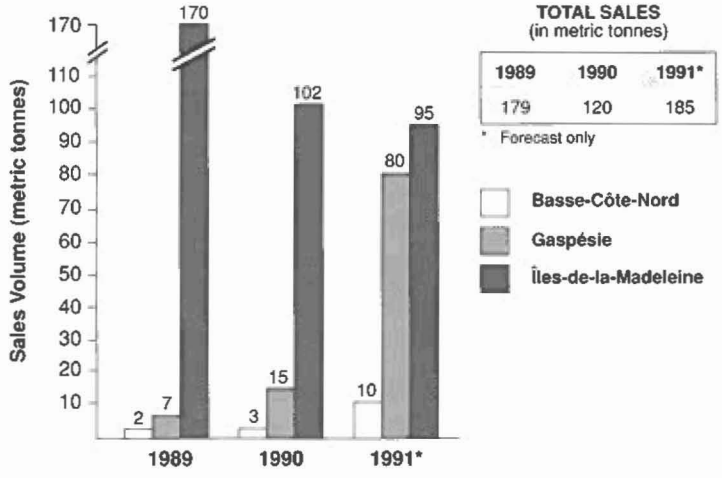
The blue mussel is a bivalve mollusc of the Mytilidae family. This organism is a bottom dweller that uses its branchiae to feed on suspended organic matter in the water by the process of filtration. It attaches itself to firm sea bottoms at levels no deeper than 10 metres, often grouping together into compact mussel banks. A mussel's growth is mainly influenced by the temperature of the water and the quality and quantity of food available.

Natural characteristics that facilitate mussel breeding

- Widely distributed along the coasts of the St. Lawrence Estuary and Gulf
- Resistant to variations in water temperature and salinity
- Filter-feeders require no structured feeding
- Gregarious nature allows a high-density breeding level to be maintained
- Habit of living attached to the earth (sessile) allows artificial supports to be employed instead of baskets or breeding cages.

What's more, the rapid growth and high meat yield of the cultivated blue mussel means a relatively short production cycle and the production of a high quality product whose commercial value is vastly superior to that of its harvested cousin, the natural or "wild" mussel.

TOTAL SALES OF BLUE MUSSELS BY REGION



TOTAL SALES
(in metric tonnes)

1989	1990	1991*
179	120	185

* Forecast only

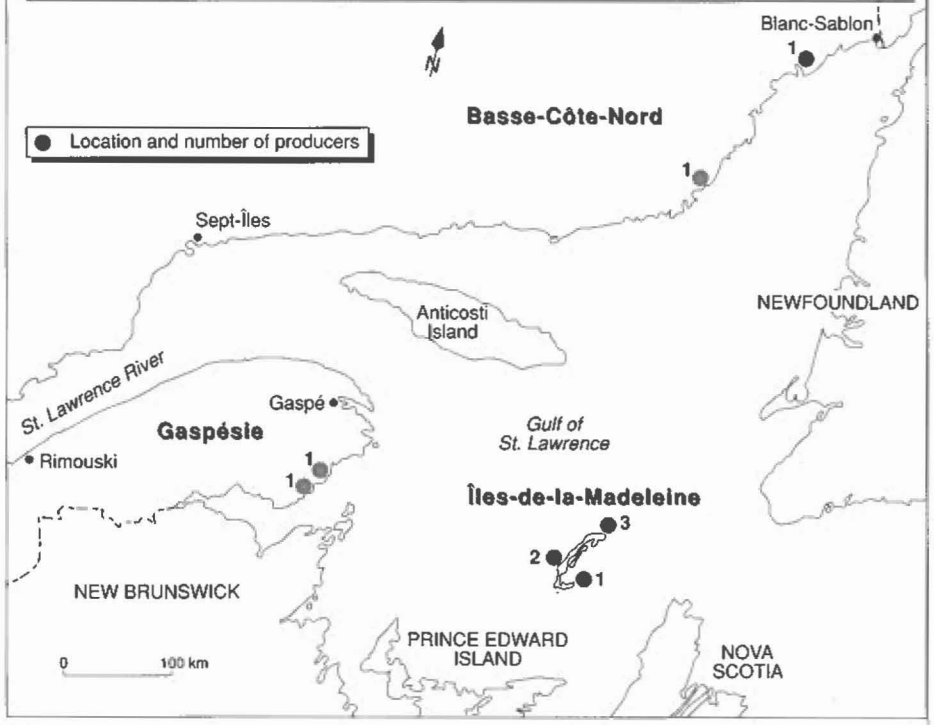
PORTRAIT OF MUSSEL BREEDING REGIONS IN 1991

10 producers share **12** permits.

Predicted sales volume is 185 metric tonnes, distributed as follows:

- 51% Îles-de-la-Madeleine
- 43% Gaspésie
- 6% Basse-Côte-Nord

	Number of producers	Number of permits	Production (t)
Basse-Côte-Nord	2	2	10
Gaspésie	2	2	80
Îles-de-la-Madeleine	6	8	95



Sources :
- Fisheries and Oceans. *Mussels Culture in Québec. Description of the Production Cycle and Financial Analysis of a Typical Mussel Firm.* Economic Services Branch. 37 pp., 3 appendices. 1987.
- Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec. Personal communication. 1991.

THE CONSUMPTION OF BLUE MUSSELS

Canadians consumed 3 348 t of mussels in 1989, 75% of which were eaten in the cities of Montréal, Toronto, Ottawa and Québec. Ninety percent of these mussels came from breeders on the east coast, primarily Prince Edward Island, with 2 440 t. It is estimated that 80 percent of mussels consumed are cultivated, the rest being natural or "wild" mussels.

Cultivated mussels in Québec (Gaspésie, Îles-de-la-Madeleine and Basse-Côte-Nord) represent only a small fraction of sales and are mainly eaten locally and, to some extent, in Montréal and Québec. Annual consumption in Québec was estimated at some 2 000 t in 1987 (both natural and cultivated mussels), of which only 3% came from Québec's mussel breeding entreprises.

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March 1993

The St. Lawrence River and the Tide

DEFINITIONS

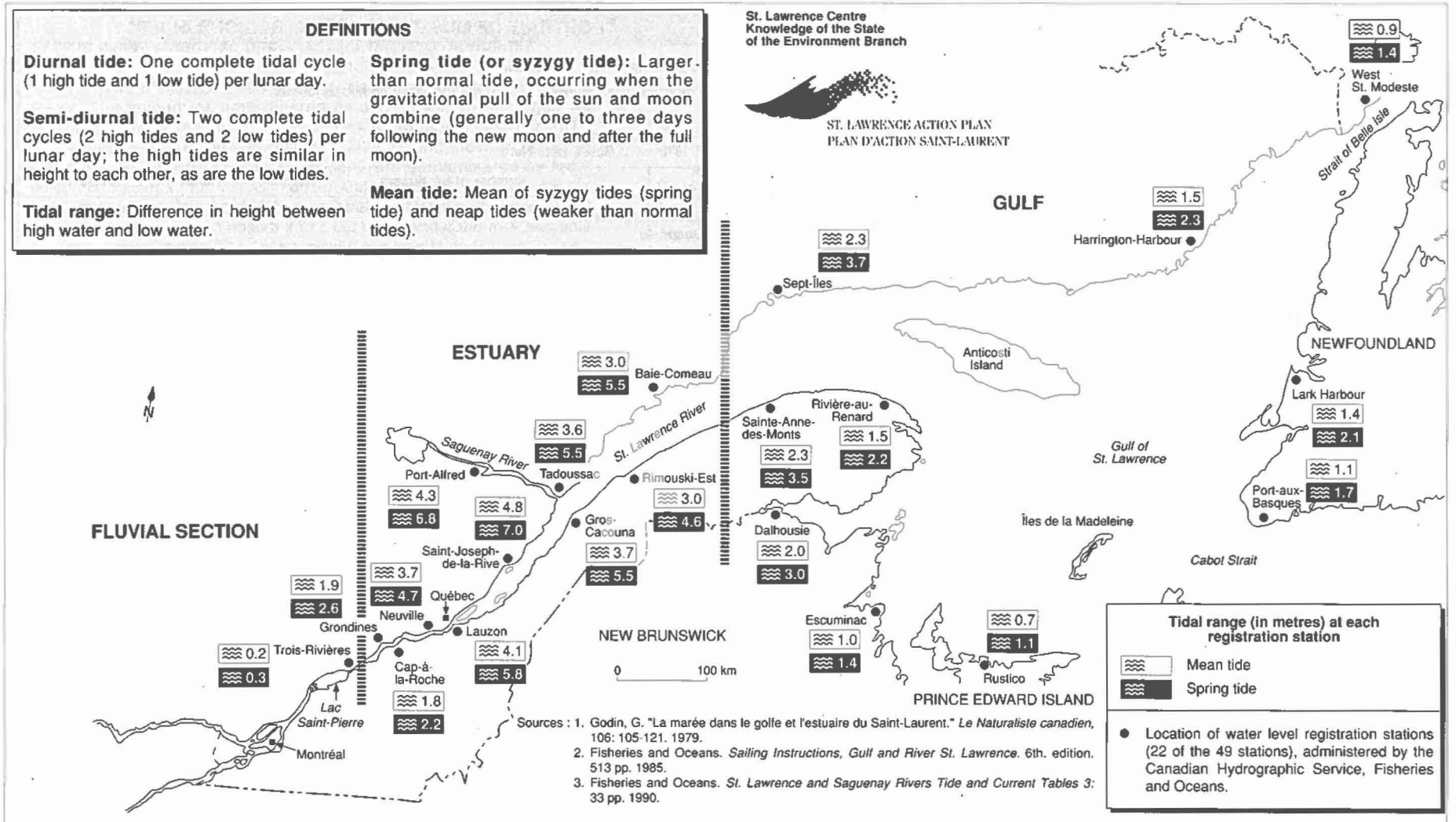
Diurnal tide: One complete tidal cycle (1 high tide and 1 low tide) per lunar day.

Semi-diurnal tide: Two complete tidal cycles (2 high tides and 2 low tides) per lunar day; the high tides are similar in height to each other, as are the low tides.

Tidal range: Difference in height between high water and low water.

Spring tide (or syzygy tide): Larger than normal tide, occurring when the gravitational pull of the sun and moon combine (generally one to three days following the new moon and after the full moon).

Mean tide: Mean of syzygy tides (spring tide) and neap tides (weaker than normal tides).



Sources : 1. Godin, G. "La marée dans le golfe et l'estuaire du Saint-Laurent." *Le Naturaliste canadien*, 106: 105-121. 1979.
2. Fisheries and Oceans. *Sailing Instructions, Gulf and River St. Lawrence*. 6th. edition. 513 pp. 1985.
3. Fisheries and Oceans. *St. Lawrence and Saguenay Rivers Tide and Current Tables 3*: 33 pp. 1990.

THE TIDE

The tide is the daily cycle of the sea's alternating rise and fall. This fluctuation is caused by the gravitational pull of the moon in relation to the Earth's rotation. In many regions, tides are mixed; that is, they are formed of a combination of diurnal and semi-diurnal tides (see above), whose relative phases and amplitudes change with location. The Atlantic Ocean is dominated by semi-diurnal tides.

THE EXTENSION OF THE TIDE

The Gulf

In the Gulf, the tide extending from Cabot and Belle Isle straits is mixed but mostly semi-diurnal in character. The circulation pivot of the tide waves is found at the extreme southwest of the Îles-de-la-Madeleine, where the tide is exclusively diurnal. The waves of the semi-diurnal tides that enter by the Cabot Strait circle around the Îles-de-la Madeleine and extend around the Gulf counter-clockwise. The semi-diurnal tide grows as it makes its way to the exterior toward the Gulf's perimeter. In the Cabot Strait, the high tide coincides with the low tide of the St. Lawrence Estuary. A much weaker semi-diurnal wave enters into the Gulf through the Strait of Belle Isle and extends along the north shore toward the St. Lawrence River.

The Estuary and the fluvial section

The tidal curve of the St. Lawrence is distinctive in respect to the narrowing and slope of the riverbed, as well as the increased friction, particularly upstream of Québec.

Tidal amplitude grows progressively, reaching three metres at Rimouski. As is the case in many estuaries, the speeds of the high and low tides differ as they progress upstream, the low tide travelling more slowly. "In this way, the low tide takes an average of 12.5 hours to extend from the Rivière-au-Renard to Trois-Rivières, whereas the high tide takes no more than nine hours on average to travel the same route."(1)

The tide progresses upstream in the River, where it is apparent until Lac Saint-Pierre. In fact, from Sept-Îles, the tidal component takes about one hour to travel to the mouth of the Saguenay River, five hours to reach Québec, and 10 hours to enter Lac Saint-Pierre.

INFO-FLASH 43

The St. Lawrence River - Overview of Freshwater Fishery in 1989

CHARACTERISTICS OF FISH HARVEST BY SECTOR IN 1989

Sector under study	Total catch (tonnes)	Active fishermen (number)
Montréal sector	75	14
Trois-Rivières sector	848	72
Québec sector	31	16
Fluvial corridor total	**954**	**102**

Less than 2% of the fish harvested for commercial purposes in the St. Lawrence River is fished in the freshwater fluvial corridor. The rest come from the Estuary and especially the Gulf. In 1989, four species comprised 80% of the River's freshwater catch: the Brown bullhead (26%), the Yellow perch (25%), the Lake Sturgeon (16%) and the American Eel (13%).

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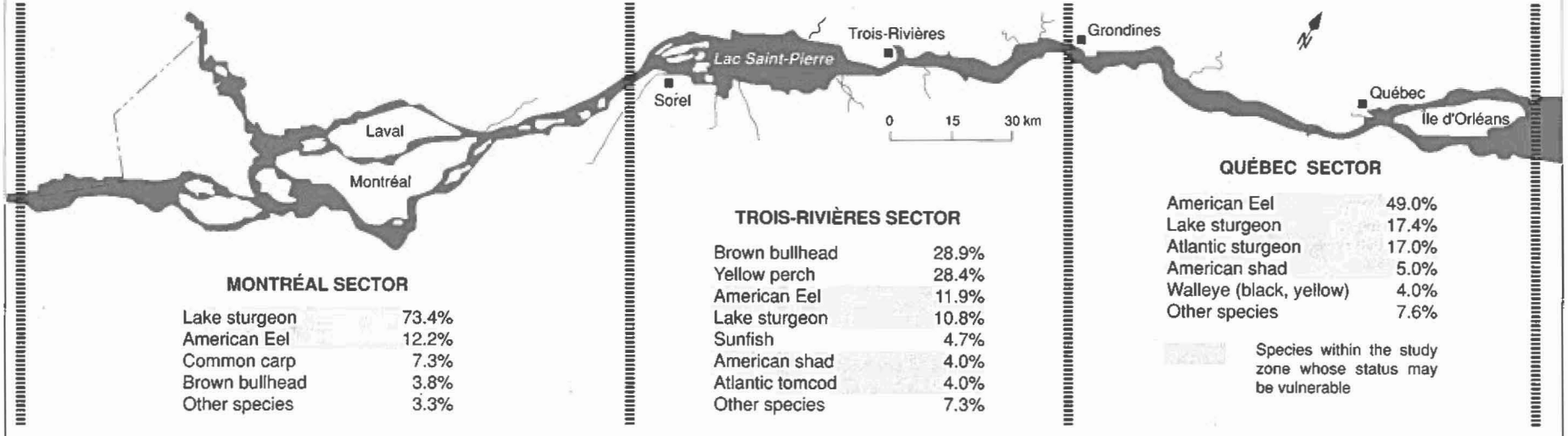
MAIN FISH SPECIES CAUGHT BY SECTOR IN 1989



MONTRÉAL SECTOR

Lake sturgeon	73.4%
American Eel	12.2%
Common carp	7.3%
Brown bullhead	3.8%
Other species	3.3%

TROIS-RIVIÈRES SECTOR

Brown bullhead	28.9%
Yellow perch	28.4%
American Eel	11.9%
Lake sturgeon	10.8%
Sunfish	4.7%
American shad	4.0%
Atlantic tomcod	4.0%
Other species	7.3%

QUÉBEC SECTOR

American Eel	49.0%
Lake sturgeon	17.4%
Atlantic sturgeon	17.0%
American shad	5.0%
Walleye (black, yellow)	4.0%
Other species	7.6%

Species within the study zone whose status may be vulnerable

POSSIBLE FACTORS FOR THE DECLINE OF SPECIES OF VULNERABLE STATUS

Species	Possible factors for decline
Lake sturgeon American shad	Changes to habitats due to the construction of dams around the Montréal archipelago, making circulation and access to spawning grounds more difficult. Over-exploitation of certain groups of lake sturgeon.
Atlantic tomcod Atlantic sturgeon	Changes to habitats due to the development of the River and its use for shipping. Heavy fishing of the Atlantic sturgeon between Portneuf and Pointe-Platon from 1956 to 1966.
American Eel	Absence of knowledge to explain the variations recorded over 20 years. The biology of the eel remains relatively unknown.

LAC SAINT-PIERRE
Last bastion of freshwater fishery

- 17 species of fish harvested in 1989
- 66% of Québec's commercial freshwater catch in 1989
  92% of Brown bullhead catch
  90% of Yellow perch catch
  45% of Eel catch
  38% of Lake sturgeon catch
- Average landings from 1986 to 1989
  some 750 000 kg (or 750 tonnes)
- The value of fish sales in 1989 was estimated at close to $1 million
- 40% of fishermen in the fluvial corridor (41 fishermen in 1989).

Sources : • Environment Canada. *Synthèse et analyse des connaissances sur les aspects socio-économiques du lac Saint-Pierre.* M.J.Auclair *et al*, and Conservation and Protection. St. Lawrence Centre. 188 pp. 1991.
• Fisheries and Oceans. *Identification des poissons d'intérêt économique en situation précaire dans le réseau Saint-Laurent et sélection des espèces pour des interventions immédiates.* Rapport technique canadien des sciences halieutiques et aquatiques. No.1810. 24 pp. 1991.

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March 1993

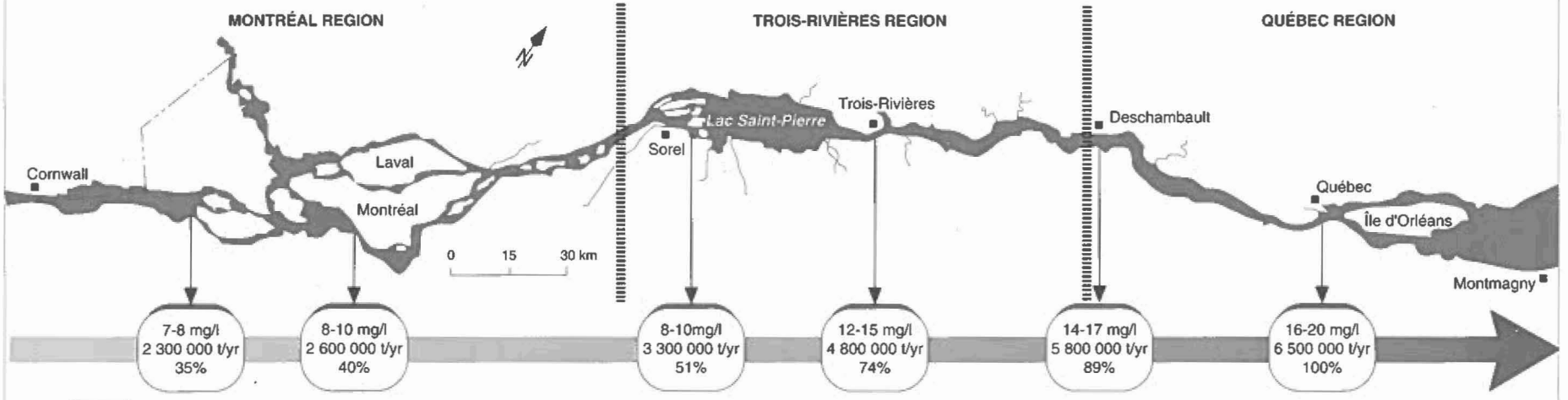
The St. Lawrence River - Total Suspended Solids from Cornwall to Québec

"Suspended solids are solid particles that float in liquid. They are found in natural waters and are the product of erosion, organic deposits and plankton. Human activities also discharge suspended solids into surface waters."(2)

Fine particles comprise most of the suspended solids that make their way into the St. Lawrence through the Great Lakes and tributaries. They reach the Upper Estuary (mixed fresh and salt water zone) where they may settle temporarily or for good.

Their movements are the result of complex processes associated with littoral transport, seasonal fluctuations in flow, waves, drifting ice and the phenomena of currents and tides.

ESTIMATION OF TOTAL SUSPENDED SOLIDS (calculation of long-term average)



mg/l
t/yr
%

Average concentration of total suspended solids* (or TSS)
Mean annual flow of TSS
Cumulative percentage of TSS

* Includes organic and inorganic suspended solids

GEOGRAPHIC DISTRIBUTION OF TSS

Source of TSS	Mean annual flow of TSS t/yr	% of TSS recorded in Québec
Great Lakes	500 000	8
International section	300 to 500 000	8
Inflow of Ottawa River	540 000	8
Québec tributaries	4 500 000	69
Urban and industrial effluents	240 000	4
Bottom transport (post-dredging) downstream of Lac Saint-Pierre	200 000	3
Total (rounded off)	**6 500 000**	**100**

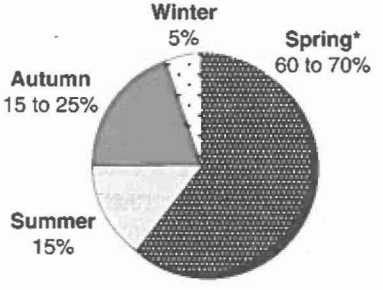
Note: The mean annual flow of TSS originating from the resuspension of sediment cannot be clearly determined.

QUÉBEC TRIBUTARIES

TSS distribution by region (in %)

Region	North shore	South shore	Total
Montréal	18	10	**28**
Trois-Rivières	20	37	**57**
Québec	4	11	**15**
Total	**42**	**58**	**100**

SEASONAL DISTRIBUTION OF TOTAL SUSPENDED SOLIDS



* Especially during spring freshet in April and May

Sources: 1. Hydrotech Inc. *Aspects quantitatifs, dynamiques et qualitatifs des sédiments du Saint-Laurent.* Environment Canada and ministère de l'Environnement du Québec. 185 pp. 1989.
2. *Dictionnaire usuel de l'environnement et de l'écologie.* Pub. by Guy Le Prat, Paris. 1982.

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ST. LAWRENCE ACTION PLAN
PLAN D'ACTION SAINT-LAURENT

Environment Canada Environnement Canada

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December 1993

The St. Lawrence River - Sedimentary Dynamics from Cornwall to Montmagny

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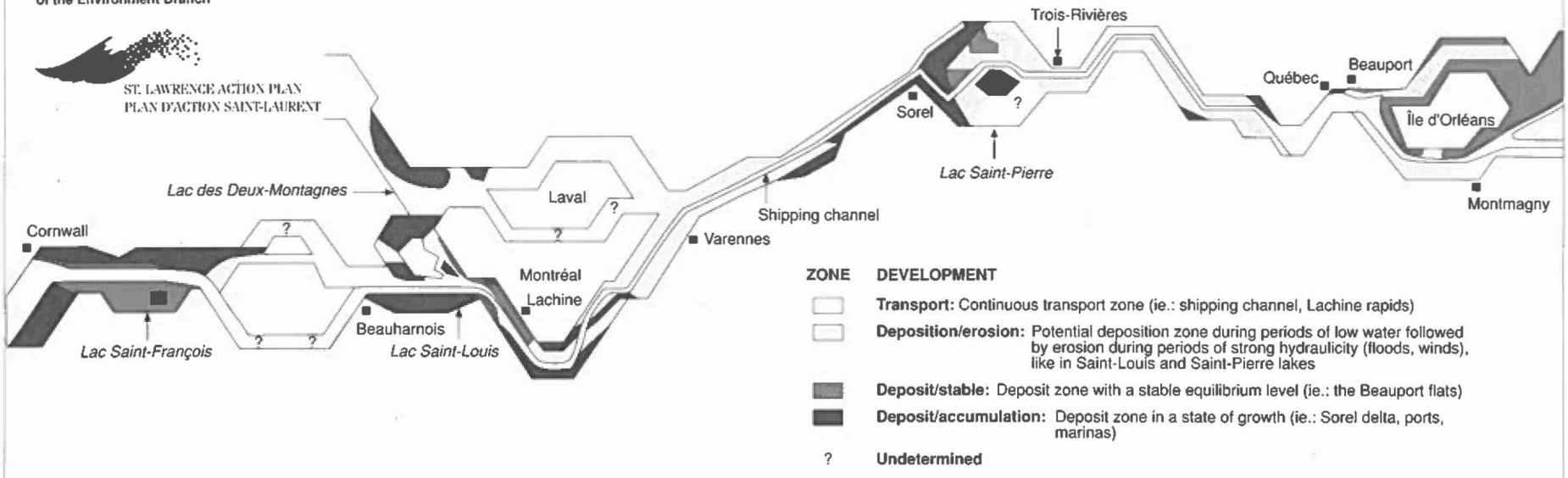
SCHEMATIC DIAGRAM OF SEDIMENTARY DYNAMICS



Sediment is defined as a "deposit of detrital, chemical or organic origin, which results from changes to rocks, the precipitation of dissolved or suspended matter in water or the continental or marine accumulation of organic matter."(2)

The dynamics of sediment (that is, the transport, accumulation, resuspension, etc.) is important on a few levels:

- **Quality of aquatic life and habitats**
  Sedimentary dynamics act on the relationships established between aquatic organisms and the environments which support them.
- **Formation of zones of pollutant accumulation**
  Pollutants attach themselves to solids and thereby tend to accumulate in zones of high sedimentation, which are found especially in areas with weak current speeds.
- **Human activities and infrastructures**
  During exchanges between water and solids, the dynamics of sediment affects the quality of water and beaches. They also make dredging necessary in the shipping channel and at marinas and ports in order to allow navigation.

CHANGES IN SEDIMENTARY DYNAMICS

"Generally speaking, sediment changes from the centre of the River to the shore. This is how, for example, the river centre can be a transport zone, whereas the areas nearer to shore are characterized by zones of deposition and accumulation; intermediary zones are distinguished by a game of deposition and erosion (seasonal or annual) or by stable deposits."(1)

MAIN AGENTS OF THE RIVER'S COMPLEX SEDIMENTARY DYNAMICS

- Flow characteristics associated with the main water masses
- Fluctuations in seasonal flows
- Tides
- Winds
- Ice
- Bathymetrics
- Alternating lakes and rapids
- Presence of flats and islands
- Dredging activities
- Infrastructures (dams, wharfs, marinas, etc.)

Sources : 1. Hydrotech Inc. *Aspects quantitatifs, dynamiques et qualitatifs des sédiments du Saint-Laurent.* Environment Canada and the ministère de l'Environnement du Québec. 185 pp. 1989.
2. Parent, S. *Dictionnaire des sciences de l'environnement.* Éditions Broquet Inc. 748 pp. 1990.

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March 1993

The St. Lawrence River and Ocean Dumping from 1976 to 1990

St. Lawrence Centre
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PLAN D'ACTION SAINT-LAURENT

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA)

Since 1987, activities associated with ocean dumping have been subject to the CEPA (chap. 22, part VI), which is the regulatory responsibility of Environment Canada. Ocean dumping, according to the CEPA, is "the deliberate disposal at sea from ships, aircraft, platforms or other anthropogenic structures, including disposal by incineration or other thermal degradation, of any substance, or the disposal of any substance by placing it on the ice in any area of the sea...". The disposal of waste at sea in Canadian territorial waters is regulated by a system of permits administered by the Environmental Protection Branch of Environment Canada. (1)

Factors which must be considered when granting an ocean dumping permit are related to:

- The characteristics and composition of substances to be dumped
- The characteristics of the dumping site and disposal method
- The potential effects on marine plant and animal life and on the sea's other uses
- The availability of alternative treatment or disposal methods for the waste.

OCEAN DUMPING ADVISORY COMMITTEE

This scientific committee brings together experts from Environment Canada (Environmental Protection Branch) and Fisheries and Oceans. The committee evaluates ocean dumping activities and makes recommendations to the regional director of Environmental Protection, the body which grants dumping permits.

Committee mandates

- To evaluate ocean dumping proposals from private and governmental agencies in the region
- To clarify the terms and conditions for granting permits in conformity with the Canadian Environmental Protection Act
- To determine the scientific research and technical needs which will ensure the effective application of the Act in Québec
- To establish a monitoring program for this activity at sea.

WASTE DUMPED AT SEA

Almost all waste dumped into the St. Lawrence (downstream of Anticosti Island) is dredged materials from the routine dredging of ports and shipping channels. This sediment is comprised mostly of sand or silt that is harmless to the environment. Less than an estimated 5% of sediment dumped into the River is contaminated with oils, greases, synthetic organic compounds or heavy metals.

PORTRAIT OF WASTE DUMPED AT SEA FROM 1976 TO 1990

All permits issues were for ocean dumping of dredged materials except one, for the dumping of fish

Average number of permits issued annually = 21

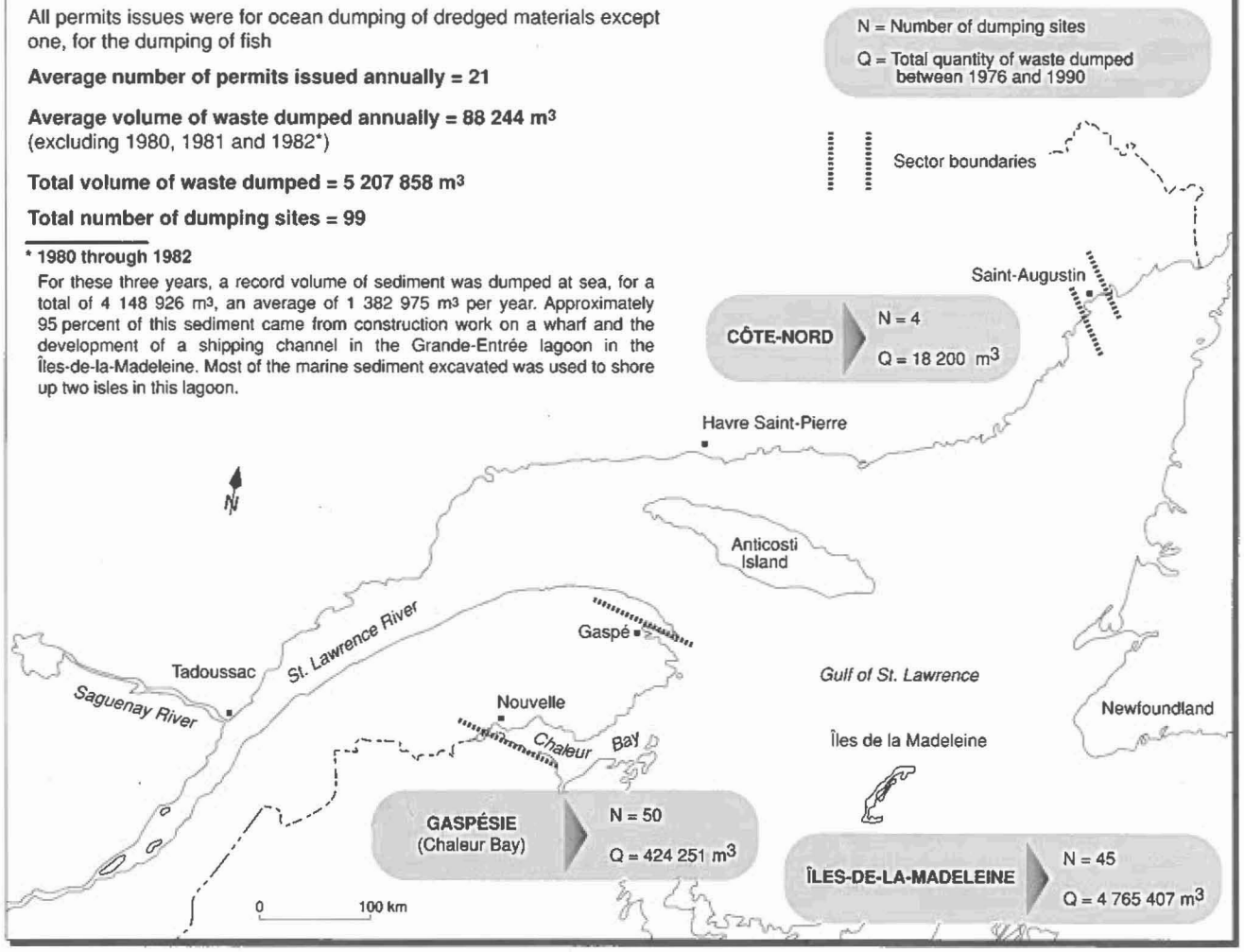
Average volume of waste dumped annually = 88 244 m³
(excluding 1980, 1981 and 1982*)

Total volume of waste dumped = 5 207 858 m³

Total number of dumping sites = 99

*** 1980 through 1982**

For these three years, a record volume of sediment was dumped at sea, for a total of 4 148 926 m³, an average of 1 382 975 m³ per year. Approximately 95 percent of this sediment came from construction work on a wharf and the development of a shipping channel in the Grande-Entrée lagoon in the Îles-de-la-Madeleine. Most of the marine sediment excavated was used to shore up two isles in this lagoon.



Sources :
- *Canadian Environmental Protection Act*, ch. 22, part VI. 1988.
- Environmental Protection Branch. *Ocean Dumping Control Act 1989-1990*. Annual report. Conservation and Protection. Environment Canada. 6 pp., 3 appendices. 1990.
- Chevalier, M. Environment Canada. Conservation and Protection. Personal communication. 1992.

INFO-FLASH 47

The St. Lawrence River - Land Use Between Cornwall and Tadoussac (1989)

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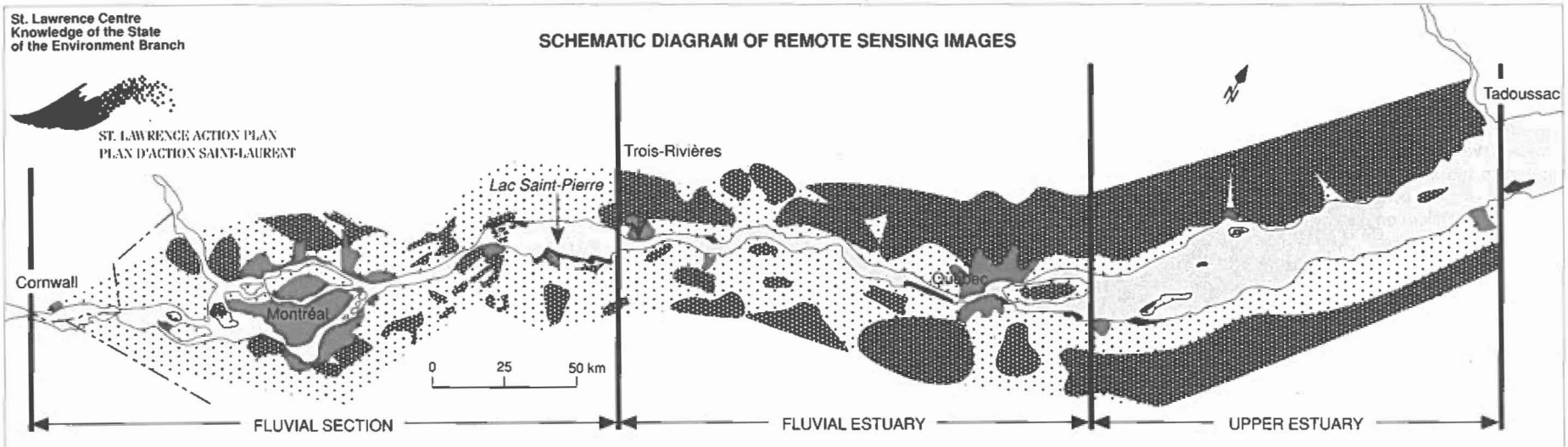
SCHEMATIC DIAGRAM OF REMOTE SENSING IMAGES



ESTIMATE OF SURFACE AREA (km²) OCCUPIED, BY CATEGORY OF LAND USE, ACCORDING TO RIVER SECTORS

CATEGORY	FLUVIAL SECTION	FLUVIAL ESTUARY	UPPER ESTUARY	TOTAL km²	TOTAL %
Wetlands	522	196	151	869	5.4
Forests					
• hardwood	638	424	359	1 421	
• mixed	462	510	1 261	2 233	
• coniferous	252	1 228	1 309	2 789	
Sub-total	1 352	2 162	2 929	6 443	39.7
Agricultural and wild land					
• prairie	1 222	408	180	1 810	
• grazing	577	360	314	1 251	
• grain/corn	1 360	520	231	2 111	
• abandoned farmland	693	763	520	1 976	
Sub-total	3 852	2 051	1 245	7 148	44.1
Developed and exposed soil					
• low density	571	273	43	887	
• high density	527	267	72	866	
Sub-total	1 098	540	115	1 753	10.8
Total	6 824	4 949	4 440	16 213	100.0

Sources :
- Photosur Géomat Inc. *Cartographie de l'utilisation des sols de Cornwall a Tadoussac par télédétection.* St. Lawrence Centre. 26 pp. 1991.
- Grenier, Anna. *Évaluation et raffinement de la cartographie de l'utilisation riveraine des terres de Cornwall a Tadoussac effectuée a l'aide des images TM géocodées.* St. Lawrence Centre. 29 pp. 1991.

Remote sensing images were used to obtain a representation of land use along the 10 km riverside strip between Cornwall and Tadoussac. These images permit the evaluation of the extent of the various land use categories, based on an analysis of the area's physical characteristics:

- wetlands (non-distinct aquatic grasses, marshes and swamps)
- forests (incl. bogs)
- agricultural areas (forage and annual)
- low-density developed areas (residential urban environments and small soil-bare surfaces)
- high-density developed areas (heavily urbanized areas and completely exposed land and roads).

Despite their ecological significance, wetlands, particularly those at Cap Tourmente, are not visible on this scale.

Fluvial Section

The surface areas of both agricultural and wild lands are two to three times larger than those found along the Fluvial and Upper estuaries. What's more, developed zones cover a much larger area than other sections of the River because of the presence of Montréal. Lac Saint-Pierre contains 358 km² of wetlands, or 67% of all wetlands in the fluvial section.

Fluvial Estuary

A marked transition in land use is seen in this section of the River. The areas occupied by agricultural and developed zones decrease in favour of forests, most notably coniferous forest, whose surface area is five times larger than the one at the shoreline of the fluvial section.

Upper Estuary

The surface area of agricultural and developed zones is decidedly smaller than those seen in other parts of the River. It makes up for this with its forests, which occupies 2 929 km² of land.

AREA OCCUPIED BY THE RIVER

Water occupies 1 100 km² at the fluvial section's level due to the presence of the Saint-François, Saint-Louis and Saint-Pierre lakes, and the Laprairie basin. This area decreases to 642 km² in the Fluvial Estuary. Note that in the Upper Estuary, the water reaches an expanse of 3 146 km² due to the marked widening of the St. Lawrence, which goes from 10 km downstream of Île d'Orléans to 30 km at Tadoussac.

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March 1993

The St. Lawrence River - Peatlands

DEFINITIONS AND CHARACTERISTICS OF PEATLANDS

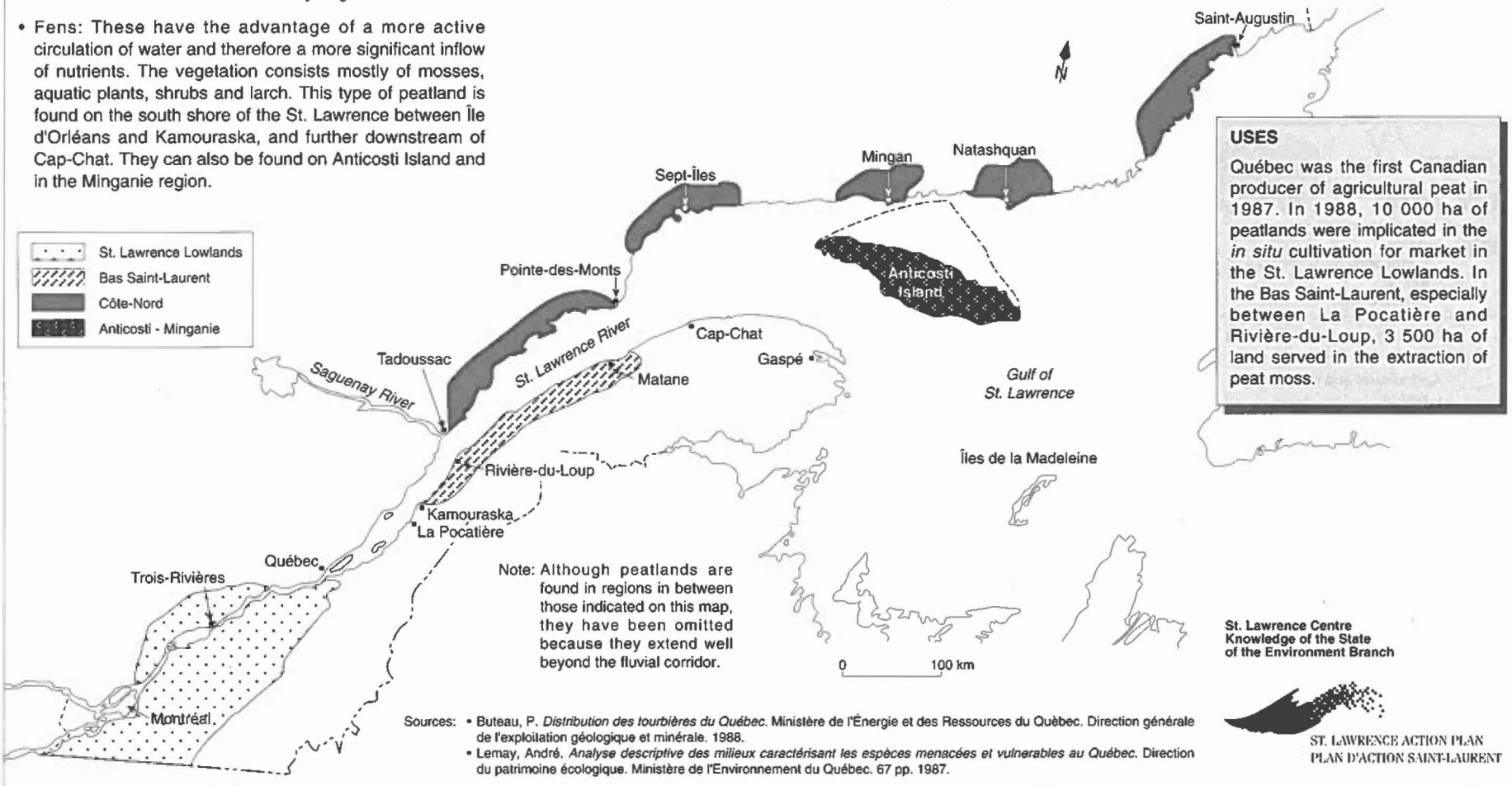
Peatlands are wetlands which develop during periods when the climate and drainage are favourable to the accumulation rather than the decomposition of organic matter. Water circulates badly and the groundwater remains close to the soil's surface, thereby creating anaerobic (without oxygen) conditions which slow down the activity of decomposer micro-organisms.

There are two types of peatlands:

- Bogs: These are fed directly at the surface by precipitation. The environment is an acidic one (pH <4). Vegetation consists mainly of sphagnum, lichens, ericaces and black spruce. The peatlands on the north shore of the St. Lawrence are almost exclusively bogs.
- Fens: These have the advantage of a more active circulation of water and therefore a more significant inflow of nutrients. The vegetation consists mostly of mosses, aquatic plants, shrubs and larch. This type of peatland is found on the south shore of the St. Lawrence between Île d'Orléans and Kamouraska, and further downstream of Cap-Chat. They can also be found on Anticosti Island and in the Minganie region.

Region	Resource inventoried (1) (MER)			Dominant trophic level (2)	Potential resource (3) (ha)	Surface area used (ha)
	Surface area (ha)	Total volume (x 10^6 m^3)	Fibrous peat (%)			
St. Lawrence Lowlands	51 492	1 029.88	4	B	107 800	10 000 (5)
Bas Saint-Laurent	8 615	206.76	24	B	9 000	3 500 (4)
Côte-Nord	78 750	1 580.00	40	B	130 000	500 (4)
Anticosti - Minganie	-	-	-	F	76 000	0
Total	138 857	2 816.64	-	-	322 800	14 000

(1) Deposits of peat more than 30 cm thick with a surface area of over 40 ha
(2) F: fen; B: bog
(3) Assessed on the basis of: preliminary estimates (MER), compilations (Hydro-Québec), compilations (SOQUEM), maps of inventoried forest (MER) and pedological maps (Ottawa and Québec)
(4) Peat moss extraction
(5) *In situ* cultivation for market



Note: Although peatlands are found in regions in between those indicated on this map, they have been omitted because they extend well beyond the fluvial corridor.

USES

Québec was the first Canadian producer of agricultural peat in 1987. In 1988, 10 000 ha of peatlands were implicated in the *in situ* cultivation for market in the St. Lawrence Lowlands. In the Bas Saint-Laurent, especially between La Pocatière and Rivière-du-Loup, 3 500 ha of land served in the extraction of peat moss.

Sources:
- Buteau, P. *Distribution des tourbières du Québec.* Ministère de l'Énergie et des Ressources du Québec. Direction générale de l'exploitation géologique et minérale. 1988.
- Lemay, André. *Analyse descriptive des milieux caractérisant les espèces menacées et vulnerables au Québec.* Direction du patrimoine écologique. Ministère de l'Environnement du Québec. 67 pp. 1987.

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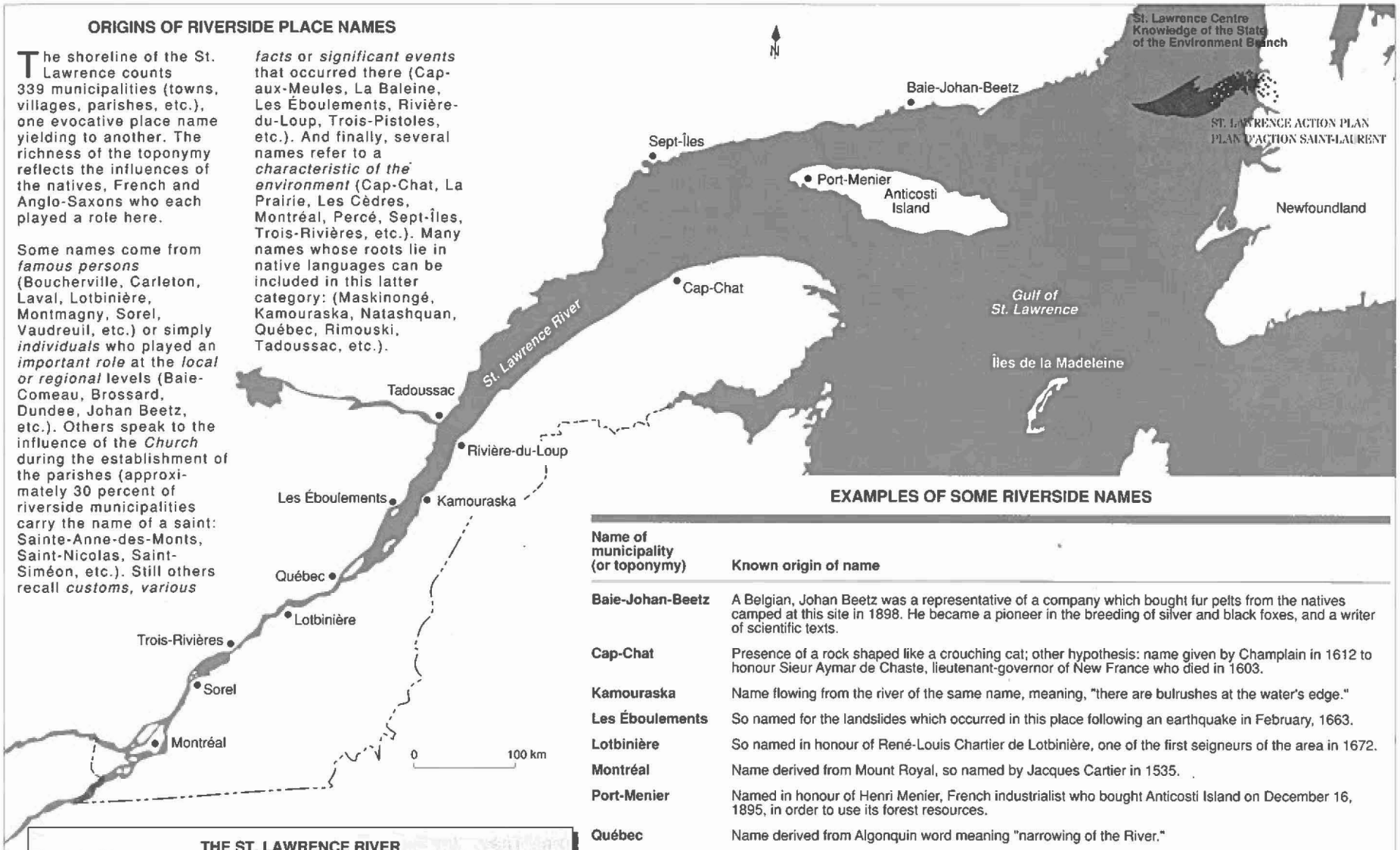
December 1993

The St. Lawrence River - Toponymy of Riverside Municipalities

ORIGINS OF RIVERSIDE PLACE NAMES

The shoreline of the St. Lawrence counts 339 municipalities (towns, villages, parishes, etc.), one evocative place name yielding to another. The richness of the toponymy reflects the influences of the natives, French and Anglo-Saxons who each played a role here.

Some names come from *famous persons* (Boucherville, Carleton, Laval, Lotbinière, Montmagny, Sorel, Vaudreuil, etc.) or simply *individuals* who played an *important role* at the *local or regional* levels (Baie-Comeau, Brossard, Dundee, Johan Beetz, etc.). Others speak to the influence of the *Church* during the establishment of the parishes (approximately 30 percent of riverside municipalities carry the name of a saint: Sainte-Anne-des-Monts, Saint-Nicolas, Saint-Siméon, etc.). Still others recall *customs, various facts* or *significant events* that occurred there (Cap-aux-Meules, La Baleine, Les Éboulements, Rivière-du-Loup, Trois-Pistoles, etc.). And finally, several names refer to a *characteristic of the environment* (Cap-Chat, La Prairie, Les Cèdres, Montréal, Percé, Sept-Îles, Trois-Rivières, etc.). Many names whose roots lie in native languages can be included in this latter category: (Maskinongé, Kamouraska, Natashquan, Québec, Rimouski, Tadoussac, etc.).



THE ST. LAWRENCE RIVER

Samuel de Champlain adopted this name for the River in the 17th-century accounts of his voyage. It is derived from the name of a bay on the Côte-Nord named Baie Saint-Laurent by Jacques Cartier on August 10, 1535, to honour this saint's feast day.

The miscomprehension of Cartier's narration by the first two translators (Spanish, 1552 and Italian, 1556) led to their attributing the name of this bay to the gulf and then the whole of the River. "Cartographers and writers of the 16th-century increasingly referred to the Spanish and Italian translations of the *Bref recit* of 1535-1536 rather than the original French."(1) The River was also named the "broad river of Hochelaga" (Cartier, 1535), and the "Canada river" (Jean Alfonse, pilot, 1544).

EXAMPLES OF SOME RIVERSIDE NAMES

Name of municipality (or toponymy)	Known origin of name
Baie-Johan-Beetz	A Belgian, Johan Beetz was a representative of a company which bought fur pelts from the natives camped at this site in 1898. He became a pioneer in the breeding of silver and black foxes, and a writer of scientific texts.
Cap-Chat	Presence of a rock shaped like a crouching cat; other hypothesis: name given by Champlain in 1612 to honour Sieur Aymar de Chaste, lieutenant-governor of New France who died in 1603.
Kamouraska	Name flowing from the river of the same name, meaning, "there are bulrushes at the water's edge."
Les Éboulements	So named for the landslides which occurred in this place following an earthquake in February, 1663.
Lotbinière	So named in honour of René-Louis Chartier de Lotbinière, one of the first seigneurs of the area in 1672.
Montréal	Name derived from Mount Royal, so named by Jacques Cartier in 1535.
Port-Menier	Named in honour of Henri Menier, French industrialist who bought Anticosti Island on December 16, 1895, in order to use its forest resources.
Québec	Name derived from Algonquin word meaning "narrowing of the River."
Rivière-du-Loup	Comes from a French vessel, Le Loup, which was forced to winter at the river mouth around 1659.
Sept-Îles	Writing in his accounts in 1535, Jacques Cartier refers to an archipelago of seven islands (which he names Îles Rondes) at the inlet of the bay.
Sorel	Comes from Pierre de Saurel, captain in the Carignan-Salières regiment, who was granted this land in 1672.
Tadoussac	Native word meaning "nipples," referring to the rounded and sandy hills which are found at this site.
Trois-Rivières	At this site, the Rivière Saint-Maurice flows into the St. Lawrence through the three main mouths resulting from the presence of several small islands.

Source : 1. Commission de toponymie du Québec. *Itinéraire toponymique du Saint-Laurent, ses rives et ses îles.* Études et recherches toponymiques, 9. 451 pp. 1984.

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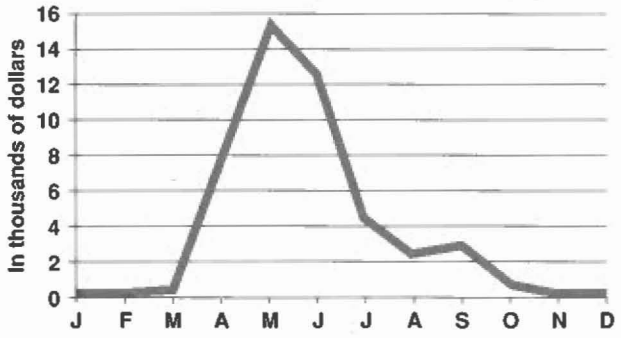
Canada

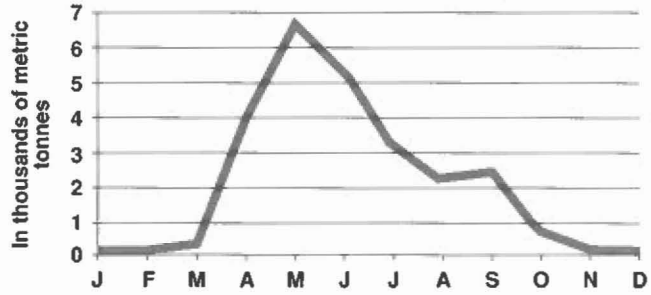
March 1993

The St. Lawrence River - Molluscs and Crustaceans for Human Consumption

Molluscs and crustaceans are aquatic invertebrates having a soft body generally protected by a shell or carapace. Included in this category are mussels and clams with a hard outer shell, as well as the squid, which has a horny internal shell. Lobsters and crabs belong to the crustacean family. They have a hard articulate and flexible carapace. The saltwater species shown here have a significant economic value because they are sought out for consumption.

MONTHLY DEVELOPMENT OF MOLLUSC AND CRUSTACEAN LANDINGS IN QUÉBEC IN 1990, MINUS REJECTS





In 1990, molluscs and crustaceans represented $47.5 million worth of the $74 million total value of the fish catch in Québec. Close to 55 percent of crustaceans are exported.

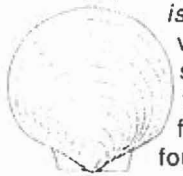
MOLLUSCS

Soft-shell clam *(Mya arenaria):* Measuring an average of 5 cm, the soft-shell clam lives in sandy and muddy sediment. They can be fished with a hydraulic dredge, but most fishermen gather them with a pick.

Clam *(Mercenaria mercenaria):* By the time it has finished growing, the clam can reach 13 cm. With a hard and thick shell, this bottom-dweller lives in sandy and muddy conditions. People generally gather clams at low tide using a pitchfork or simply their hands.

Oyster *(Crassostrea virginica):* Both the shape and the quality of the oyster is determined by its surrounding environment. On soft sea bottoms it takes a long and narrow shape, whereas on hard bottoms it becomes round and concave. Oysters are harvested with the help of a rake.

Scallop *(Placopecten magellanicus* and *Chlamys islandica):* Scallops come in two varieties, the giant or deep sea scallop, some 12 cm in diamater, and the Iceland scallop, which lives in fresher and deeper waters. They are found on gravel or rocks on the sea floor. Fishermen use boats trailing large-meshed dragnets made of metallic threads to catch them.



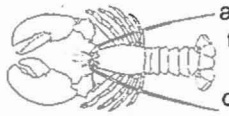
Blue mussel *(Mytilus edulis):* Measuring between 3 and 8 cm, its shell is lightweight and blue-black in colour. The blue mussel is commonly found attached by its filaments to rocks, wharfs and piles.

Whelk *(Buccinum undatum):* Measuring approximately 6 cm, whelks are found in all types of water at depths of up to 30 m. They are caught with baited traps.

Squid *(Illex illecebrosus):* A mollusc with an internalized shell, the squid's soft, muscular body is some 30 cm long. Most of the catch is exported, dried squid having opened up new markets in the Far East.

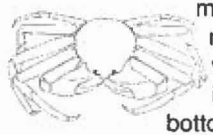
CRUSTACEANS

American lobster *(Homarus americanus):* They live at the rocky sea bottoms all along the east coast of North America. Lobsters are between 18 and 30 cm long and weigh from 0.23 to 0.91 kg, although they can weigh more than 20 kg. Although mainly scavengers, lobsters supplement their diet with fish. In Québec, they are caught in lobster pots baited with dead fish.



Northern shrimp *(Pandalus borealis):* Shrimp of a saleable size live at depths of 185 to 300 m, close to the clay sea bottoms rich in organic carbons. It is presumed that during the day, they remain at less than 5 m from the bottom, whereas at night, they climb the water column. Shrimp fishing takes place particularly in the northern part of the Gulf of St. Lawrence.

Snowcrab *(Chionoecetes opilio):* At full maturity, males are twice as large as females, measuring 13 cm around and weighing 0.7 kg. This crustacean is found on muddy or sandy sea bottoms, at a depth of 70 to 140 m. As a measure of population management, only males are harvested.



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Sources : • Fisheries and Oceans. *Annual Statistical Review: Marine Fisheries in Québec 1989-1990.* 281 pp. 1991.
• Fisheries and Oceans. *Maritime Fisheries Industry of Québec, Statistical Description.* 183 pp. 1985.

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March 1993

The St. Lawrence River and Types of Pollution

	Organic	Contaminants*	Fertilizers	Microbial	Visual or Aesthetic	Thermal
Associated Pollutants	• Organic matter (BOD)	• Organic: - resinous acids, fatty acids - oils and greases - pesticides - organochlorines - PAHs, PCBs, phenols, benzenes, toluenes, dioxins, furans... • Inorganic: - heavy metals (e.g. As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn, etc.) - cyanides, sulfates, sulphurs	• Nutritional or nourishing substances: - nitrogen - phosphorous	• Bacterias and viruses: - fecal coliforms - streptococcus - enterococcus - *Escherichia coli* - *Pseudomonas aeruginosa* - *Giardia lambia*	• Colourings (colour) • Odours • Suspended solids (turbidity) • Floating objects, debris, oily matter • Algae	• Hot waters
Sources	• Human-, animal- and industrial-source organic waste from agri-food industries, pulp and paper mills and municipalities	• Discharge of organic substances by agriculture, petroleum and chemical industries, pulp and paper mills, etc. • Discharge of inorganic substances by chemical, metallurgical, mining and surface treatment industries	• Domestic and agricultural wastes • Discharge of nitrogen products by manufacturers of explosives and fertilizers	• Human- and animal-source wastes lead to the appearance of pathogenic organisms in the water	• Pulp and paper mills, petroleum and textile industries • Discharges of untreated municipal wastewater • Farming activities	• Discharges of water used in industrial cooling processes
Environmental Impacts	• Reduction of water's oxygen content leads to disappearance of some fish species • Noxious odours • Enrichment of water's nutritional elements (nitrogen, phosphorous) causes the proliferation of aquatic vegetation	• Immediate or latent effects (can accumulate slowly in tissue and progressively act on living organisms) • Depending on the nature of the substance, the amount discharged and the species concerned, animal and plant species may be destroyed, thereby weakening a link in the food chain • Phenomenon of biomagnification may affect human beings	• Proliferation of algae and aquatic plants along the shorelines of farming regions. The decomposition of these plants leads to a reduced oxygen content in water and creates an unfavourable environment for aquatic wildlife • Can lead to a deterioration of the aesthetic quality of water bodies	• Creation of an environment favourable to the propagation of some infectious diseases: - Necessitates the treatment of water meant for consumption - Interferes with some recreational activities - Leads to the closing of mollusc-gathering zones	• Makes the practise of some recreational activities unappealing • Some types of aesthetic pollution, such as suspended solids, can destroy spawning grounds	• Artificial warming leads to disturbances in the existing ecosystems
Areas Most Affected	• Rivers in the agricultural zone of the St. Lawrence valley • Bays and lakes that receive urban effluent and wastes from agri-food industries and pulp and paper mills	• Mining areas • Rivers crossing large-scale intensive farming areas • Sites of major industrial discharges • Rivers subject to the combined effects of industrial and farm wastes	• South shore of the St. Lawrence, especially at the mouth of the River's main tributaries	• Sewer water discharge points into water courses for isolated dwellings and municipalities • Intensive animal-raising areas	• Urban regions in proximity of discharge points for many industries and municipalities • Rivers crossing intensive-farming zones	• Sewer water discharge points for certain industries using cooling processes (e.g. nuclear power stations, metallurgical industries)

* Some contaminants are toxic, especially PCBs, heavy metals, dioxins and furans.

St. Lawrence Centre
Knowledge of the State of the Environment Branch

Sources: • Government of Canada. *The State of Canada's Environment.* 1991.
• Various publications of the ministère de l'Environnement du Québec.

ST. LAWRENCE ACTION PLAN
PLAN D'ACTION SAINT-LAURENT

Environment Canada Environnement Canada

Canada

March 1993

St. Lawrence River - Relative Importance of PAHs (1990-1991)

PAH LOADS AND CONCENTRATIONS IN THE RIVER (1990-1991)

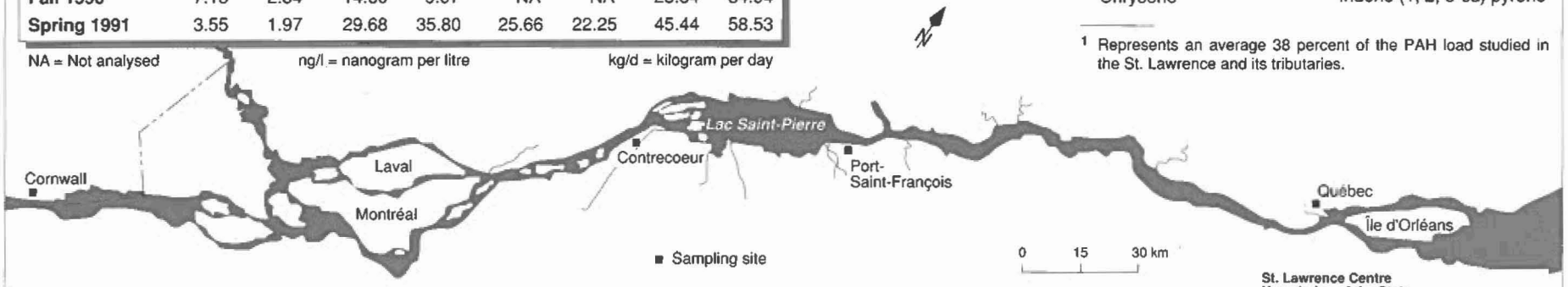
	Cornwall		Contrecoeur		Port-Saint-François		Québec	
	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)
Summer 1990	5.61	3.85	9.29	7.44	14.92	11.17	14.51	10.71
Fall 1990	7.15	2.84	14.60	9.07	NA	NA	25.84	34.94
Spring 1991	3.55	1.97	29.68	35.80	25.66	22.25	45.44	58.53

NA = Not analysed ng/l = nanogram per litre kg/d = kilogram per day

PAH COMPOUNDS STUDIED

- Phenanthrene[1]
- Anthracene
- Fluoranthene
- Pyrene
- Benzo *(a)* anthracene
- Chrysene
- Benzo *(b)* fluoranthene
- Benzo *(k)* fluoranthene
- Benzo *(a)* pyrene
- Dibenzo *(a,h)* anthracene
- Benzo *(ghi)* perylene
- Indeno (1, 2, 3-*cd*) pyrene

[1] Represents an average 38 percent of the PAH load studied in the St. Lawrence and its tributaries.



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PAHs = POLYCYCLIC AROMATIC HYDROCARBONS

Pollution by contaminants[4] (organic category)

Production and use

PAHs are produced by all types of incomplete combustion of a biomass (e.g. wood) and fossil fuels (e.g. diesel fuel, motor gasoline, carbon). They are generally found in soot, coal tar, distillates and various kinds of oils discharged in industrial effluent. PAHs are also produced naturally by a biomass (micro-organisms, algae) and by geological phenomena (e.g. volcanic eruptions), although at admittedly lower concentrations than those generated by human activities.

Main sources today

It is estimated that approximately 1300 tonnes of PAHs are emitted annually in Québec (atmospheric, hydric and solid sources), of which more than 66 percent comes from aluminum smelters. Other major sources are: wood heaters, forest fires, the burning of agricultural refuse, transportation, incineration and industrial processes.

Characterization and potential effects

PAHs are included on the list of priority substances established by Environment Canada and Health and Welfare Canada. The significance and the nature of the risks represented by these substances will be assessed according to the Canadian Environmental Protection Act sometime before February 11, 1994.

Due to their low solubility, PAHs are closely associated with the inorganic and organic matter in suspended sediments and bottom sediments.

From among the dozen PAH compounds studied, benzo *(a)* pyrene and dibenzo *(a,h)* anthracene are considered carcinogenic. This explains the increased incidences of liver and other organ tumours in fishes living in PAH-contaminated water.

Quality criteria recognized by the ministère de l'Environnement du Québec:

- Raw water (domestic water intake): 2.8 ng/l
- Aquatic organism contamination: 31.1 ng/l
- Aquatic life (acute toxicity): 300 000 ng/l

[4] Refers to info-flash No. 51 on types of pollution.

REPORT ON PAHs IN THE ST. LAWRENCE ACCORDING TO SOURCE, OCTOBER 1990

(calculated in water and suspended solids)

Sources	%
Tributaries (measured for 10 major tributaries)	17
Great Lakes (measured at Cornwall)	8
Atmospheric contribution (estimate)[2]	52
Other sources (estimate)[3]	23

[2] Atmospheric contribution may be lower in spring and summer.

[3] Industrial and municipal effluents, spills of petroleum products, surface runoff, macrophytes and resuspension of bottom sediments.

Note: Percentages were calculated in relation to total PAHs recorded at Québec.

Sources:
- NRCC. *Polycyclic Aromatic Hydrocarbons in the Aquatic Environment: Formation, Sources, Fate and Effects on Aquatic Biota.* NRC Associate Committee on Scientific Criteria for Environmental Quality. National Research Council of Canada. No. 18981. 209 pp.
- LGL. *Rejets de HAP à l'environnement - 1990.* Prepared for Environment Canada, Conservation and Protection, Environmental Protection Branch. (In production).
- Ministère de l'environnement du Québec. *Critères de qualité de l'eau.* 423 pp. 1990.
- Seuss, M. J. "The Environmental Load and Cycle of Polycyclic Aromatic Hydrocarbons" in *Sci. Total Enviro.*, 6: *239-250.* 1976.
- Pham, T. St. Lawrence Centre, Environment Canada. Ecotoxicology and Ecosystem Assessment Branch. Personal communication. 1992.

The St. Lawrence River - Relative Importance of PCBs (1991)

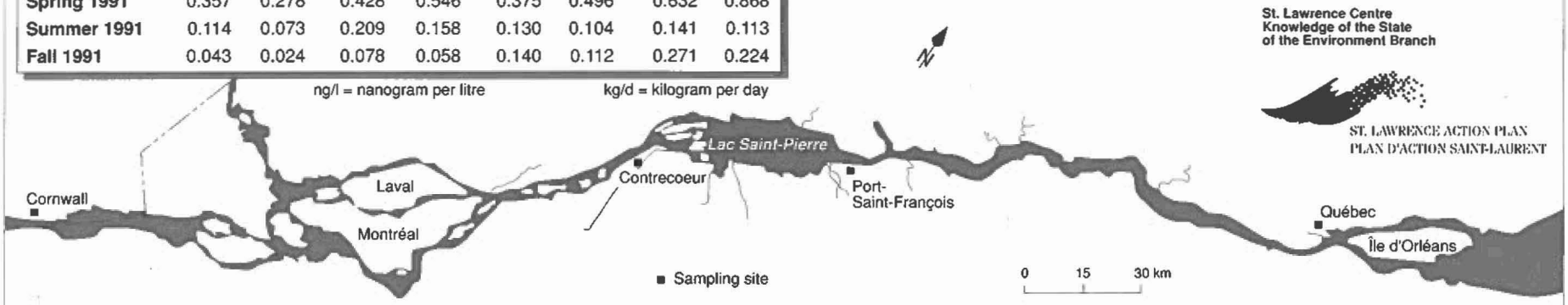
PCB LOADS AND CONCENTRATIONS IN THE RIVER (1991)

	Cornwall		Contrecoeur		Port-Saint-François		Québec	
	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)
Spring 1991	0.357	0.278	0.428	0.546	0.375	0.496	0.632	0.868
Summer 1991	0.114	0.073	0.209	0.158	0.130	0.104	0.141	0.113
Fall 1991	0.043	0.024	0.078	0.058	0.140	0.112	0.271	0.224

ng/l = nanogram per litre kg/d = kilogram per day

CONGENERICS OF PCBs STUDIED

In all, 13 congenerics were analysed: congenerics 77, 101, 105, 118, 126, 128, 138, 153, 169, 170, 180, 183 and 194. These represent some 25 percent of the total 209 known congenerics.



PCBs = POLYCHLORINATED BIPHENYLS

Pollution by contaminants[1] (organotoxins)

Production and use

In 1980, Canada banned the manufacture, import and use of PCBs, except in closed electrical equipment like transformers. PCBs had been very widely used at the industrial level in electrical equipment (transformers and capacitors) because of their capacity to evacuate heat (cooling property) and their insulating properties. Other uses include: hydraulic fluids, heat exchangers and lubricants. PCBs were used in the production of rubber, synthetic resins, plastics, paints, textiles and inks. They were also used as solvents for the spreading of insecticides, as dust-suppressant agents on unpaved roads, etc. And even though they are largely out of use today, PCBs persist throughout the global environment.

Main sources today

In Québec, the main sources of PCBs are industrial wastes, leaching at contaminated sites and leakage due to faulty transformer seals. As for the River, a certain amount of PCBs also comes in atmospheric contributions due to the open-air combustion of PCB-containing waste (e.g. municipal incinerators, fires).

Characteristics and potential effects

PCBs consist of 209 congenerics. These are very stable compounds and therefore difficult to decompose. They are among the most persistent contaminants in the environment.

They basically concentrate on suspended matter and sediments since these are insoluble. PCBs bioaccumulate in the fatty tissues of aquatic organisms (plankton, macro-invertebrates, fish and especially marine mammals). In fact, PCBs can be found everywhere, even in terrestrial mammals (including humans), as well as in arctic and antarctic regions. Some PCBs are also thought to have teratogenic and mutagenic properties, and may be carcinogenic.

Quality criteria recognized by the ministère de l'Environnement du Québec:

- Raw water (domestic water intakes) and contamination of aquatic organisms: 0.079 ng/l
- Aquatic life (chronic toxicity): 1 ng/l
- Aquatic life (acute toxicity): 2 000 ng/l

[1] Refers to info-flash No. 51 on types of pollution.

REPORT ON PCBs IN THE ST. LAWRENCE ACCORDING TO SOURCE, 1991

(calculated in water and suspended solids)

	May	*August*	*Nov.*
Sources	%	%	%
Tributaries (measured for 5 major tributaries)	17	4	6
Great Lakes (measured at Cornwall)	32	65	11
Industries (liquid effluent from 4 of the Action Plan's 50 priority plants)	6	47	24
Other sources (estimate)*	45	-16	59

* Atmospheric deposits, surface runoff, macrophytes and resuspended bottom sediments. A negative result indicates that PCBs were retained between Cornwall and Québec, probably by macrophytes.

Note: Percentages were calculated in relation to total PCBs recorded at Québec.

Sources:
- Quémerais, B. Environment Canada, St. Lawrence Centre, Ecotoxicology and Ecosystems. Personal communication. 1992.
- CCEM. *Canadian Water Quality Guidelines*. 1991.
- Government of Canada. *The State of Canada's Environment*. 1991.
- Ministère de l'Environnement du Québec. *Critères de qualité de l'eau*. 423 pp. 1990.

Environment Canada Environnement Canada

Canada

March 1993

The St. Lawrence River - Lac Saint-Pierre Zone of Prime Concern (ZIP)*

A VARIED NATURAL ENVIRONMENT

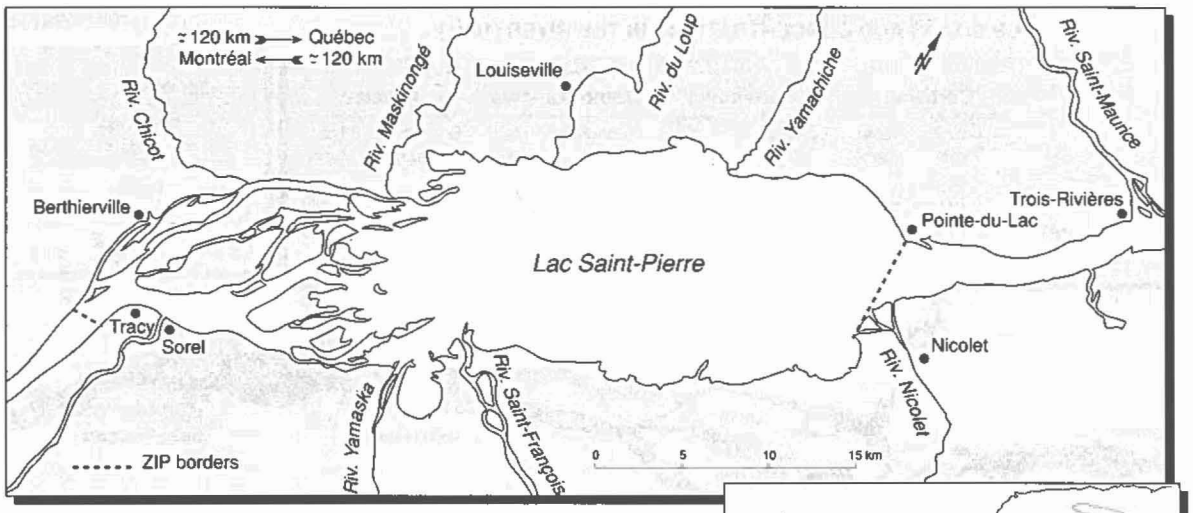
- A fluvial lake with a surface area of 480 km2 and an archipelago of some 100 islands.
- Québec's largest freshwater flood plain (18 000 ha).
- Holds 20 percent of the St. Lawrence wetlands (39 000 ha).
- Home to 79 freshwater fish species and 145 bird species.
- A major springtime staging area for ducks and geese.
- The largest heronry in North America (over 800 nests).

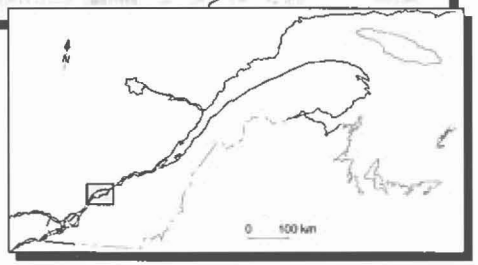
HUMAN POPULATION AND ACTIVITIES

- In 1991: 21 riverside municipalities counted 74 630 persons.
- Sorel-Tracy: Major industrial centre, 4 Action Plan plants (metallurgy, chemicals).
- Farmlands: 60 percent of the territory.
- Last bastion of commercial freshwater fishing in Québec in 1991: 42 permits, 585 tonnes; one million dollars in direct economic spinoffs.
- Sports fishing (1986): 24 000 fishermen, 304 tonnes; five million dollars in direct economic spinoffs.
- Waterfowl hunting: 400 hunters, 55 000 ducks bagged per year.
- Waterfowl-watching (1989): 30 000 visitors, 25 000 observation days.
- Chalets: 2400 located on islands, shores and at the mouths of tributaries.

MAIN PROBLEMS

- Physical alteration of habitats.
- Conflicts of use:
  - Land: between habitat conservation and farming and recreational needs.
  - Species: e.g. fishing of yellow perch commercially or for sport.
- Generalized bacterial pollution.
- Toxic substances identified in all compartments of the ecosystem.
- Resource over-exploitation (Lake sturgeon).
- Erosion of banks worsened by vessel circulation (lapping).
- Discharges of pollutants from 4 Action Plan priority plants.





* These zones are known as "ZIPs" for "zones d'intérêt prioritaire."

SOLUTIONS IN ACTION

ST. LAWRENCE ACTION PLAN (1988-1993)

- Protection component: Four priority plants subject to the Action Plan's cleanup objectives.
- ZIP program of the St. Lawrence Centre's Pollution Prevention Bureau: environmental assessment of the ZIP and consultation in partnership with Stratégies Saint-Laurent (NGO umbrella group).

MASTER PLAN FOR THE CONSERVATION AND REHABILITATION OF THE LAC SAINT-PIERRE REGION (1983)

The plan calls for the development of sectoral conservation plans and environmental rehabilitation in collaboration with various non-governmental organizations (NGOs). For example, the sectoral plan for habitats and wildlife developed in 1988 is administered by the ministère du Loisir, de la Chasse et de la Pêche du Québec. The work of implementing this plan was distributed among seven programs: habitat acquisition (see example below), wildlife development, territorial assignment, management of wildlife populations and management of information standardization, use, dissemination and acquisition.

Acquisition and development project for 700 hectares of habitat on the north shore of the lake at Saint-Barthélemy and Saint-Joseph de Maskinongé seeks to harmonize agriculture and the conservation of aquatic life habitats.

Planned investment: $ 1 800 000.

Project coordinator: Ministère du Loisir, de la Chasse et de la Pêche du Québec.

Other partners: Environment Canada's Canadian Wildlife Service, Ducks Unlimited Canada, Fondation de la Faune du Québec, Fondation Héritage Faune, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, Association de Chasse et de Pêche de Maskinongé.

Sources:
- Auclair, M.J., D. Gingras, J. Harris and A. Jourdain. *Synthèse et analyse des connaissances sur les aspects socio-économiques du lac Saint-Pierre : Rapport technique. Zone d'intérêt prioritaire no 11.* Environment Canada, St. Lawrence Centre. 153 pp. 1991.
- Burton, J. *Le lac Saint-Pierre, Zone d'intérêt prioritaire no 11, Document d'intégration.* Environment Canada, St. Lawrence Centre. 98 pp. 1991.
- Ministère du Loisir, de la Chasse et de la Pêche du Québec. *Résumé des programmes d'action, Plan de conservation et de mise en valeur des habitats et de la faune de la région du lac Saint-Pierre.* 10 pp. 1988.

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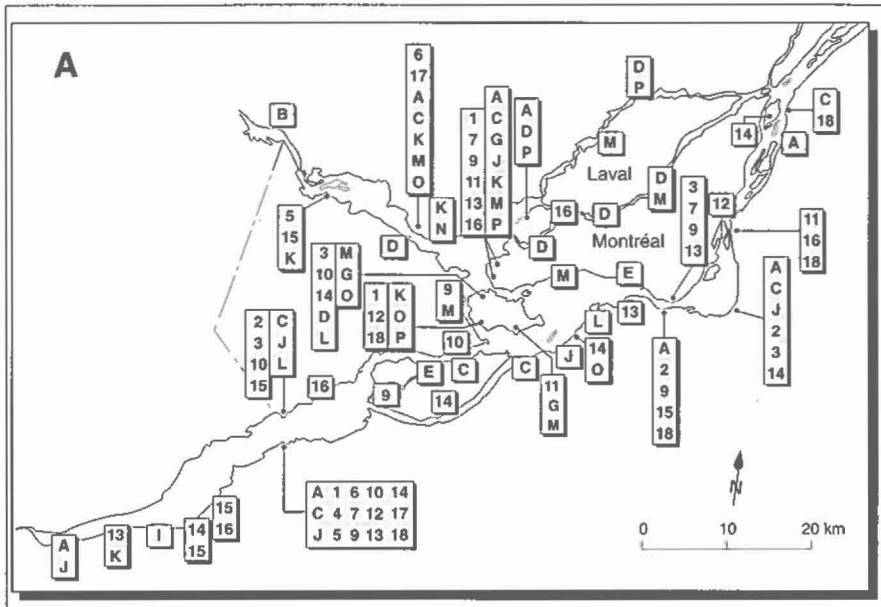
March 1993

The St. Lawrence River - Amphibians and Reptiles



AMPHIBIAN (from *amphibia*, meaning "to live in two elements"):
A vertebrate whose aquatic larvae metamorphoses into an adult with on-land aptitude. Its skin is not scaley, but contains mucus or venomous glands. Respiratory system is branchial in larvae, pulmonary in adults and cutaneous for both. Amphibians are terrestrial and freshwater creatures who cannot tolerate saltwater.

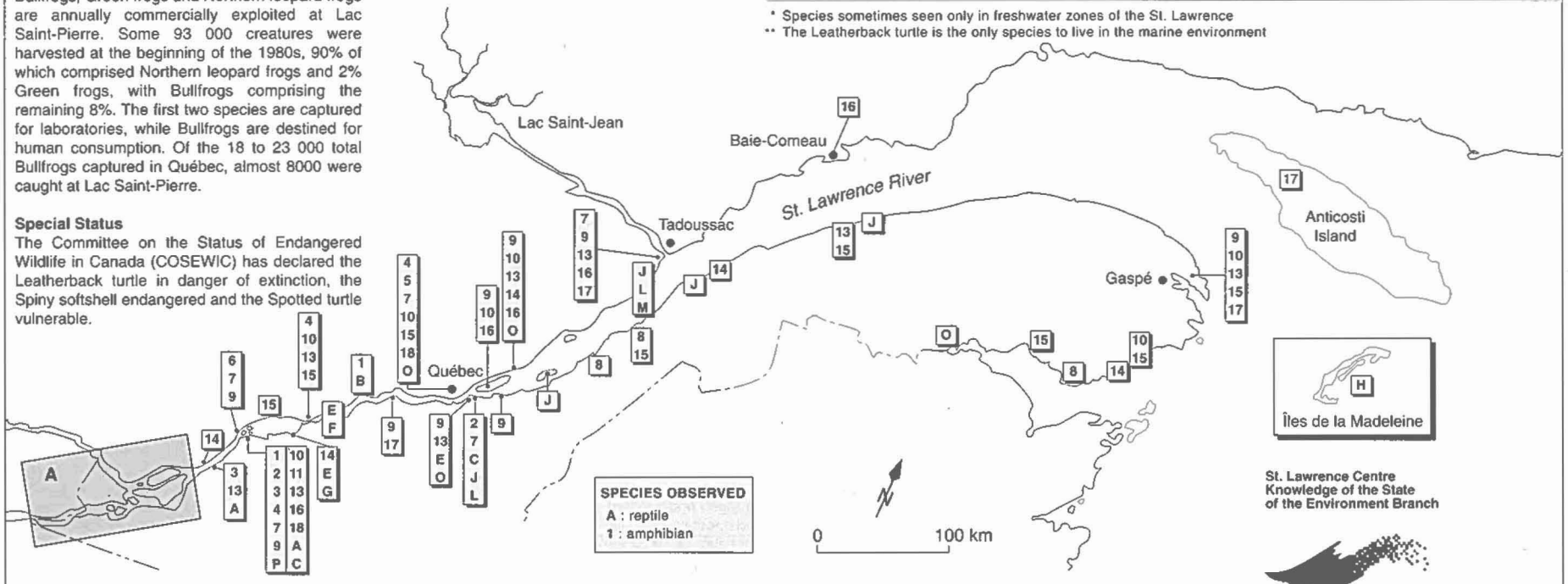
REPTILE (from *reptilis*, meaning "creeping"):
A vertebrate of varying internal temperature, reptiles breathe air from birth. They gave rise to birds and mammals during the evolution of species. Their skin is covered in scales which can ossify, as it has in the case of the turtle. Most reptiles are sedentary creatures with no social structure. Unlike amphibians, they possess no aquatic larval stage.

AMPHIBIANS	REPTILES
1 Mudpuppy (*Necturus maculosus*)*	A Snapping turtle (*Chelydra serpentina*)*
2 Eastern newt (*Notophtalmus viridescens*)	B Musk turtle (*Sternotherus odoratus*)
3 Blue-spotted salamander (*Ambystoma laterale*)	C Painted turtle (*Chrysemys picta*)*
4 Yellow-spotted salamander (*Ambystoma maculatum*)	D Map turtle (*Graptemys geographica*)*
5 Two-lined salamander (*Eurycea bislineata*)	E Wood turtle (*Clemmys insculpta*)
6 Four-toed salamander (*Hemidactylium scutatum*)	F Spotted turtle (*Clemmys guttata*)
7 Eastern redback salamander (*Plethodon cinereus*)	G Spiny softshell (*Apalona spinifera*)*
8 Dusky salamander (*Desmognathus fuscus*)	H Leatherback turtle (*Dermochelys coriacea*)**
9 American toad (*Bufo americanus*)*	I Blanding's Turtle (*Emydoidea blandingii*)
10 Spring peeper (*Hyla crucifer pseudacris*)	J Common garter snake (*Thamnophis sirtalis*)*
11 Tetraploid gray treefrog (*Hyla versicolor*)	K Northern water snake (*Nerodia sipedon*)
12 Northern chorus frog (*Pseudacris triseriata*)	L Redbelly snake (*Storeria occipitomaculata*)
13 Wood frog (*Rana sylvatica*)	M Brown snake (*Storeria dekayi*)
14 Pickerel frog (*Rana palustris*)*	N Smooth green snake (*Opheodrys vernalis*)
15 Northern leopard frog (*Rana pipiens*)	O Ringneck snake (*Diadophis punctatus*)
16 Green frog (*Rana clamitans*)	P Milk snake (*Lampropeltis triangulum*)
17 Mink frog (*Rana septentrionalis*)	
18 Bullfrog (*Rana catesbeiana*)	

* Species sometimes seen only in freshwater zones of the St. Lawrence
** The Leatherback turtle is the only species to live in the marine environment

Resource Exploitation
Bullfrogs, Green frogs and Northern leopard frogs are annually commercially exploited at Lac Saint-Pierre. Some 93 000 creatures were harvested at the beginning of the 1980s, 90% of which comprised Northern leopard frogs and 2% Green frogs, with Bullfrogs comprising the remaining 8%. The first two species are captured for laboratories, while Bullfrogs are destined for human consumption. Of the 18 to 23 000 total Bullfrogs captured in Québec, almost 8000 were caught at Lac Saint-Pierre.

Special Status
The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has declared the Leatherback turtle in danger of extinction, the Spiny softshell endangered and the Spotted turtle vulnerable.



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Sources: • Bider, Roger and Matte, Sylvie. *Atlas des amphibiens et des reptiles du Québec, rapport préliminaire.* Société d'Histoire Naturelle de la vallée du Saint-Laurent and MLCP. 354 pp. 1990.
* Data base of the Centre de données du patrimoine naturel du Québec. (According to data integrated up to November, 1992).
* Langlois, C., L. Lapierre, M. Léveillé, P. Turgeon and C. Ménard. *Synthèse des connaissances sur les communautés biologiques du lac Saint-Pierre.* St. Lawrence Centre, Environment Canada. 212 pp. 1992.

Environment Canada Environnement Canada
Canada
December 1993

The St. Lawrence River - Contaminants and Water Quality Criteria

DEFINITIONS:

Criterion: Threshold concentration based on the deleterious effects of a contaminant (toxicity, organolepticity, aesthetics) which, in excess amounts, can lead to the total or partial loss of the water's specific uses.

Contaminant: Solid, liquid or gaseous material, a micro-organism, a sound, a vibration, a radiance, a heat, an odour, a radiation, or any combination of these, liable to somehow alter the quality of the environment.

WATER QUALITY CRITERIA

Good water quality is essential for the sound health of both humans and biological resources, as well as for the safe practice of recreational activities.

In this context, agencies charged with managing water resources must develop discharge requirements that control the various sources of pollution. Two approaches are generally employed to set these requirements: the technological approach (best technology available), and the environmental approach (development of environmental objectives for discharges based on criteria). In Québec, for example, discharge objectives are generally determined according to an understanding of the qualitative and quantitive characteristics of the receiving water, the source of pollution and the level of water quality desired, determined according to the potential uses of this environment. In order to help reach these objectives, various agencies have defined water quality criteria relative to its specific uses. The main organizations charged with setting these criteria are: the Canadian Council of Environment Ministers (CCEM), Environment Canada, Health and Welfare Canada, the provincial ministers of the environment and health, the International Joint Comission (IJC), the United States Environmental Protection Agency (U.S. EPA), the environmental protection departments of the American states, the World Health Organization (WHO), and the European Economic Community (EEC).

Quality criteria also serve as a reference point of the health of the environment, although the "absence of criterion for a specific parameter does not mean the parameter has no effect or is not dangerous for the use concerned."(1) It is possible to develop criteria for those toxic substances which have none using research work which evaluates the toxicity or other harmful effects of a substance.

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DISTRIBUTION BY USE OF CONTAMINANTS WITH WATER QUALITY CRITERIA

In Québec, the MENVIQ has selected the water uses listed in the table below. The MENVIQ also collected use-based criteria for 355 parameters. These criteria may be descriptive (especially for the water's aesthetic quality), or focus on overall toxicity (targeting the protection of aquatic life in particular), or numerical (specific to one substance or one use). These criteria reflect "the state of knowledge on the harmful effects of contaminants and are generally expressed in terms of a concentration which, if exceeded, may mean the total or partial loss of the use to which the water corresponds." (1)

TYPES OF CONTAMINANTS	USES					
	Raw water destined for domestic consumption	Consumption of aquatic organisms	Aquatic life		Recreational activities	
			acute toxicity	chronic toxicity	Direct contact	Aesthetic aspects
Inorganic	X	X	X	X	X	X
Organic	X	X	X	X	X	X
Physical	X			X	X	X
Bacteriological	X	X			X	
Radiological	X					
Number of contaminants inventoried by the MENVIQ with established quality criteria	281	87	100	195	30	8

EXAMPLES OF CONTAMINANTS:

INORGANIC: metals (silver, copper, lead, etc...), nitrates, chlorides, cyanides, fluorides, phosphorous, sulfates, etc.
ORGANIC: resinous acids, trihalomethanes, benzenes, phenols, PAHs, PCBs, dioxins, oils and greases, pesticides, etc.
PHYSICAL: colour, odour, transparency, temperature, turbidity, suspended solids, etc.
BACTERIOLOGICAL: fecal coliforms, enterococcus
RADIOLOGICAL: caesium, iodes, radium, strontium, tritium.

DEFINITIONS OF USES

Human health				
Raw water destined for domestic consumption:	**Consumption of aquatic organisms:**	**Aquatic life and related terrestrial wildlife:**	**Direct-contact recreational activities:**	**Aesthetic aspects of recreational activities:**
Surface waters used for domestic purposes and drinking water, and by aquatic organisms (as opposed to treated water regulated by a drinking water standard)	Surface waters used for consumption of aquatic organisms and where no water intakes exist	All types of aquatic life at all stages of development. Toxicity criteria refer to the concentration of a contaminant to which aquatic organisms may be exposed, whether for a short period of time with very little or no mortality (**acute toxicity**), or indefinitely, with no harmful effects (**chronic toxicity**)	Recreational activity where the whole body is in regular contact with the water (swimming, sail boarding, water skiing). Some criteria for occasional-contact activities (sailing, canoeing, fishing, etc.) may be included in this category	Riverside development (camping, rest areas, parks, etc.)

Sources: 1. Ministère de l'Environnement du Québec. *Critères de qualité de l'eau.* Service d'évaluation des rejets toxiques and Direction de la qualité des cours d'eau. 432 pp. 1990a.
2. Guay, I. *Les critères de qualité de l'eau au Québec: Définitions et application.* Ministère de l'Environnement du Québec, Service d'évaluation des rejets toxiques. 1992.

Environment Canada Environnement Canada
Canada
March 1993

Biotechnology and the St. Lawrence River

DEFINITION

Biotechnologies: "The sum of the methods, processes and techniques which, applied to micro-organisms, human, animal or vegetable cells, or fractions thereof, aims to design, develop and produce new molecules and cells, new organisms and processes, or even to improve existing ones, in view of exploiting these at the industrial level through the production or improvement of goods and services, and then putting them on the market." (2)

POTENTIAL ADVANTAGES AND DISADVANTAGES OF BIOTECHNOLOGIES FOR THE RIVER

"Biotechnologies may constitute a solution to the River's environmental problems and offset the disadvantages of existing physico-chemical or mechanical cleanup techniques. They may be good bio-indicators of ecosystems, an instrument of measurement or cleanup tool, and may also become a preventive tool." (1)

Advantages

- Based in natural processes (enzymatic conversion, fermentation, etc.).
- Consume little energy and treated pollutants are transformed into biomass (compounds biodegradable in the environment).
- Less costly than conventional methods because there is no need for expensive industrial infrastructures.
- Faster in certain cases: for ie., accelerate the natural treatment process of wastewater.

Limitations

- Use is currently limited, especially in the case of organic pollution.
- Require a more rigorous control (temperature, oxygen, nutrients, etc.) due to the use of living organisms which are very sensitive to ambient conditions.
- Not as fast in certain cases: for ie., biodegradation of contaminated soil.

FIELDS OF APPLICATION

Objective

Improvement of environment quality (control at source, cleanup) — ***Monitoring of environment quality***

How?

DEVELOPMENT OF LESS-POLLUTING PROCESSES	DEVELOPMENT OF METHODS AND TOOLS TO TREAT MUNICIPAL AND INDUSTRIAL EFFLUENT	DEVELOPMENT OF METHODS AND TOOLS TO CLEAN CONTAMINATED MUD AND SOIL (detoxification)	DEVELOPMENT OF MONITORING INSTRUMENTS AND DISCHARGE CONTROLS	DEVELOPMENT OF TOOLS TO ASSESS THE STATE OF ECOSYSTEMS
Examples of research completed or in progress				
• Biological bleaching of wood pulp using the Trametes versicolor mushroom. (3) • Development of a bioherbicide based on a microscopic mushroom. (3) • Preparation and marketing of a liquid biofertilizer made from algae. (2)	• Study of processes involved in anaerobic digestion of industrial effluent (those from pulp and paper), using special reactors. (3) • Development or adaptation of tools to control or affect certain processes: hydrogen probes, genetic probes, bioreactors. (3) • Development of biofilters for the micro-biological capture of metals in effluent. (3)	• Research into the degradation of polychlorinated pesticides and PCBs: development and control of bacterial cultures specialized in pollutant biodegradation, study of enzymatic processes that convert these drifting, non-toxic compounds, which may then be degraded using biological processes. (3) • Development of a solid-phase bioreactor to biologically treat soil and mud contaminated with toxic substances. (3)	• Development of BOD biosensors to monitor the quality of effluent from the petrochemical industry and pulp and paper mills. (3) • Development of piezoelectric crystal immunocaptors to detect contaminants in the soil and water. (3) • Development of the PEEB (Potential Ecotoxic Effects Barometer), which integrates various bioassays and which is currently applied to the analysis of effluent discharged by the 50 priority industrial plants (SLC, Ecotoxicology and Ecosystems Assessment Branch).	• Development of bio-tools: micro-bioassays and bio-indicators allow the impact of toxins on the ecosystem to be assessed; for example: - Bioprobe MFO-MT serves to detect toxic attacks of organic (multi-function oxidases, MFO) and inorganic (metallothioneines, MT) origin. (4) - Genotoxicity bioassays to detect attacks by toxins on genetic heredity. (4) - Use of bio-indicators (young Cyprinidae) to assess the bioaccumulation of toxins in the River. (4)

EXAMPLE OF BIOTECHNOLOGY BEING APPLIED IN ONE OF THE ACTION PLAN'S FIFTY PRIORITY INDUSTRIES

Shell Canada Products Ltd. of Montréal-Est has been using an aerobic biodegradation treatment since 1991 to clean hydrocarbon-contaminated clayey soil. The project in progress is the result of collaboration between Shell Canada Products Ltd., Groundwater Technology Canada Ltd., the Biotechnology Research Institute (BRI) of the National Research Council of Canada and the St. Lawrence Centre. To decontaminate soil, an environment favourable to the proliferation of bacteria already present in the soil is created - bacteria with the natural hydrocarbon-degrading properties necessary to transform hydrocarbons into biodegradable by-products. A monitoring methodology developed at the BRI is also applied to assess the effectiveness of the process. Initial estimates indicate that 3 400 m³ of soil could be treated over six months. Following treatment, soil may be used for other purposes, incl., erection of another firm or greenspace development, for example.

Sources: 1. Baribeau, T. *Notes pour l'exposé du directeur exécutif du CSL, à l'occasion de la réunion annuelle du réseau canadien de Biotechnologie aquatique Aquatech'91.* 1991.
2. Biotechnology Research Institute, National Research Council of Canada. *Annual reports: 1987/1988, 1988/1989, 1989/1990.*
3. Conseil de la Science et de la technologie. *Les biotechnologies: un choix stratégique pour le Québec.* 91 pp. 1991.
4. Van Collie, R. *L'écotoxicologie au Centre Saint-Laurent.* Environment Canada, St. Lawrence Centre, Ecotoxicology and Ecosystems Assessment Branch. 42 pp. 1989.

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PLAN D'ACTION SAINT-LAURENT

Environment Canada Environnement Canada

Canada

March 1993

The St. Lawrence River - Commercial Saltwater Fishing Gear

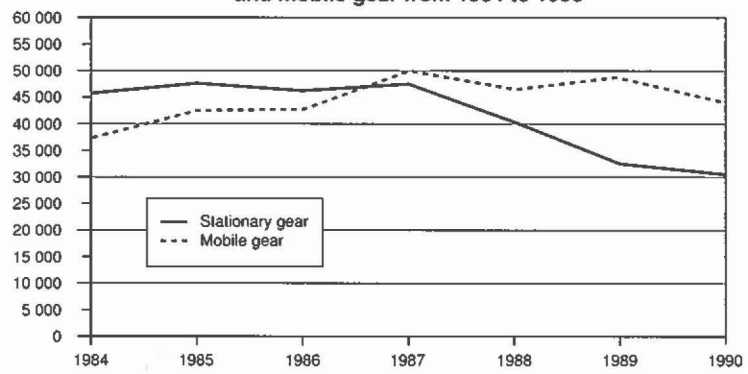
The saltwater fishery, which accounted for some 10 200 jobs in 1989, is practised with the help of a variety of instruments or gear. From Cap-Tourmente to Blanc-Sablon, and from Bas Saint-Laurent to the Gaspésie, a variety of factors influence the kind of fishing gear used, including the species desired and its habitat, and the type of vessel used. The gear itself can be either stationary or mobile.

Stationary gear, which can either be positioned at one location or employed from a fixed vessel, includes baited line fish hooks (jigs, boulters), traps, groups of stakes (fascines) or nets. Shovels and rakes are also considered stationary gear.

All mobile gear, with the exception of the scallop dragger, refers to nets trailed by one or more boats.

The trawl and gill net are the type of gear most frequently used aboard vessels of more than ten tonnes (one tonne equals 2.83 m^3).

Volume of landings (in metric tonnes) using stationary and mobile gear from 1984 to 1990



FISHING GEAR	MAIN SPECIES HARVESTED*	LANDINGS IN 1990** (in metric tonnes)
STATIONARY GEAR		
Crabpots	snowcrab, other crabs	6 970
Traps (1) excluding snowcrab	cod, lobster	3 457
Fascine (2)	capelin, herring, shad, eel	673
Gill nets (3)	mackerel, smelt, salmon, halibut, cod, herring, turbot	12 225
Boulters	halibut, cod	3 303
Rakes, shovels	clams, softshell clams, oysters	676
Trap	cod	594
Jig	cod, mackerel, squid	2 100
MOBILE GEAR		
Shrimp trawl	shrimp	10 641
Bottom trawl (4)	halibut, cod, plaice, redfish, shrimp	16 350
Pelagic stern trawl	herring, mackerel, redfish, haddock, capelin	10 823
Scallop dragger	scallops	3 596
Seine	cod, hake, plaice	2 800
		74 208

* The list of species is not exhaustive.

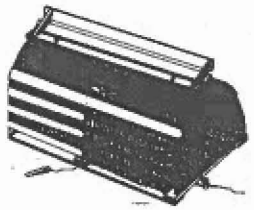
** Landings designate the quantity of fish, molluscs and crustaceans, excluding waste.

Note: The numbers in parentheses refer to illustrations at right.

Sources: • Fisheries and Oceans. *Maritime Fisheries Industry of Québec: Statistical Description.* 183 pp. 1985.
• Fisheries and Oceans. *Annual Statistical Review: Marine Fisheries in Québec 1989-1990.* 273 pp. 1991.

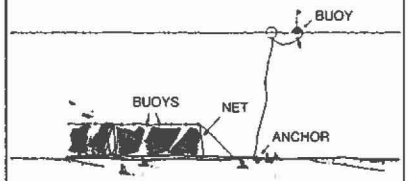
EXAMPLES OF FISHING GEAR

(1) LOBSTER TRAP



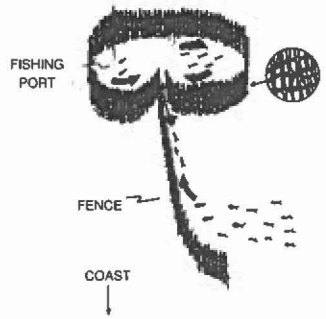
Source: Fontaine and Coll. (1981)

(3) GILL NET



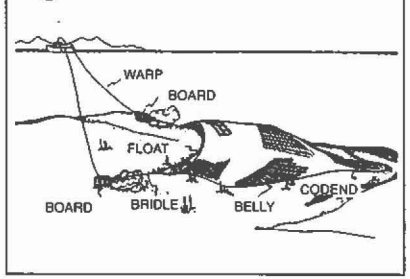
Source: M. Levasseur (1982)

(2) FASCINE FISHING



Source: M. Levasseur (1982)

(4) BOTTOM TRAWL



Source: M. Levasseur (1982)

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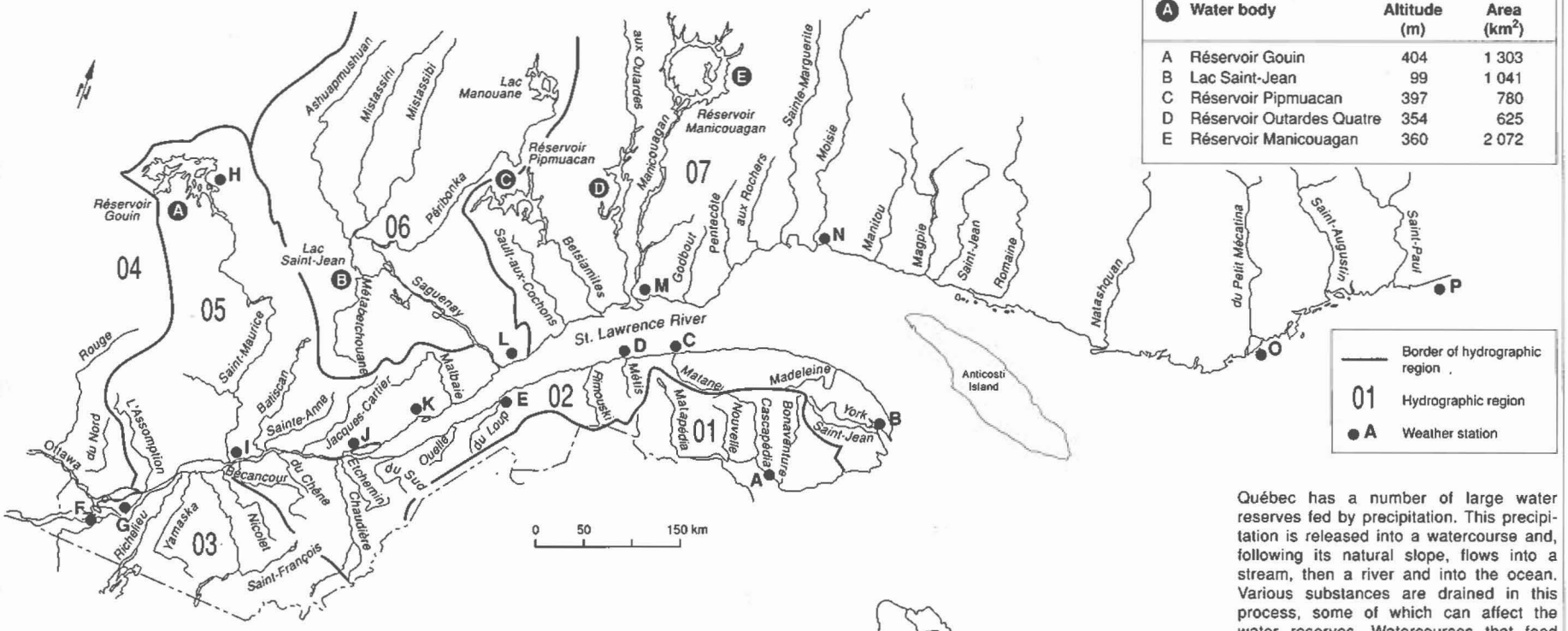
The St. Lawrence River - Drainage Basin Hydrology



Water body		Altitude (m)	Area (km²)
A	Réservoir Gouin	404	1 303
B	Lac Saint-Jean	99	1 041
C	Réservoir Pipmuacan	397	780
D	Réservoir Outardes Quatre	354	625
E	Réservoir Manicouagan	360	2 072

Border of hydrographic region

01 Hydrographic region

● A Weather station

METEOROLOGICAL CHARACTERISTICS, BY STATION, FOR EACH HYDROGRAPHIC REGION

Region	Station*	Altitude (m)	Average annual precipitation** (1951-1980) Snow (cm)	Total (cm)	Average number of days of precipitation	Average temperature °C January	July	No-freeze period
01	A Caplan	23	252	102.5	147	-9.6	17.7	141
02	B Gaspé	30	195	90.3	125	-9.9	21.1	145
	C Matane	30	242	102.1	163	-8.7	21.8	177
	D Mont-Joli	52	305	94.8	157	-16.0	16.0	93
	E Rivière-du-Loup	148	261	102.4	155	-12.1	19.7	126
03	F Valleyfield	46	343	117.4	175	-12.1	19.1	137
04	G Montréal	57	264	92.5	108	-11.6	18.7	132
05	H Réservoir Gouin	404	347	87.9	151	-12.3	17.4	133
	I Trois-Rivières	53	317	101.2	112	-12.8	16.7	138
	J Québec	73	389	89.8	163	-11.6	17.3	137
	K Baie-Saint-Paul	15	396	107.2	149	-13.2	16.8	119
06	L Grandes Bergeronnes	61	378	99.5	134	-11.1	16.3	127
07	M Baie-Comeau	69	427	112.5	155	-14.0	15.2	114
	N Sept-Îles	55	321	96.7	125	-10.6	17.3	123
	O Harrington-Harbour	8	421	123.5	176	-11.0	12.5	134
	P Blanc-Sablon	19	481	116.0	187	-10.4	11.1	106

* Environment Canada weather stations

** Total precipitation includes snow and rain (10 cm of snow represents 1 cm of water)

ST. LAWRENCE DRAINAGE BASIN

Québec has a number of large water reserves fed by precipitation. This precipitation is released into a watercourse and, following its natural slope, flows into a stream, then a river and into the ocean. Various substances are drained in this process, some of which can affect the water reserves. Watercourses that feed into one stream or river are said to be part of the same drainage basin.

Québec's hydrographic network is divided into three drainage basins. Ungava Bay's covers almost 492 000 km², those of James Bay and Hudson Bay extend over 518 000 km², whereas the drainage basin of the St. Lawrence occupies a surface area of more than 673 000 km².

Divided into seven hydrographic regions, as defined in 1960 by the Minister of Natural Resources on the basis of topographical studies, Québec's portion of the St. Lawrence drainage basin includes some 244 tributaries.

Sources:
- *Le Québec statistique.* Publications du Québec. 1029 pp. 1989.
- Environment Canada. *Water,* Fact Sheet No. 2. Inland Waters Directorate. Ottawa. 1990.
- Ministère de l'Environnement du Québec. *L'environnement au Québec, un premier bilan.* Government of Québec. 1989.

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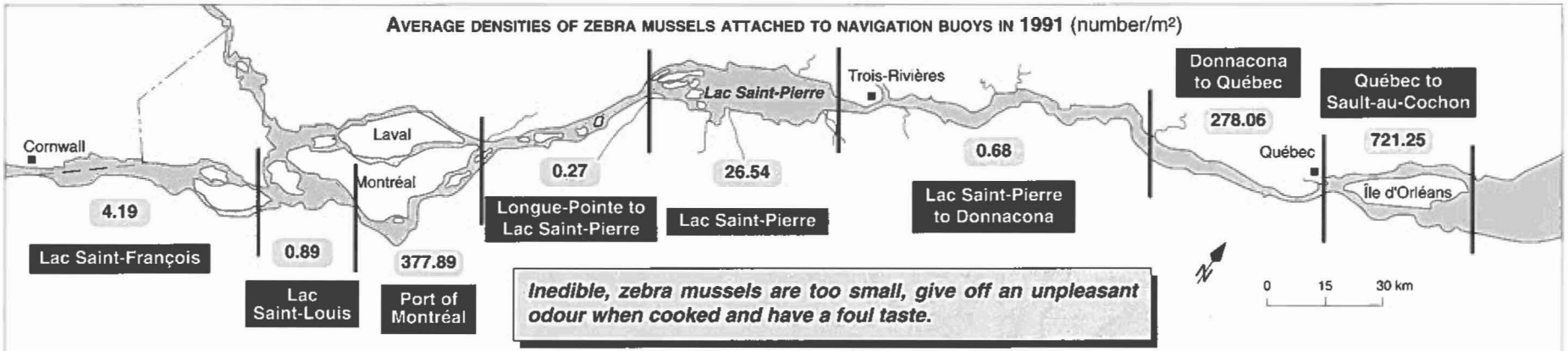
The St. Lawrence River - Arrival of the Zebra Mussel



Inedible, zebra mussels are too small, give off an unpleasant odour when cooked and have a foul taste.

ORIGINS AND ARRIVAL

The zebra mussel has its roots in the Caspian Sea. It was seen for the first time in North America in 1988 in Lake St. Clair, Ontario where it is believed to have been introduced in 1985 by the emptying of a European vessel's ballast waters. Zebra mussels were first spotted in the St. Lawrence River in 1989.

BIOLOGY AND ECOLOGY

The zebra mussel, *Dreissena polymorpha*, is a freshwater bivalve mollusc which can reach 4 cm in length and which has an average lifespan of three years. It is a sedentary, filtering organism that consumes bacteria, plankton and organic waste particles. A single female can produce up to 40 000 eggs per year.

Zebra mussels can colonize several different types of habitats. Species dispersal is promoted by strong currents which carry away larvae. Because adults live affixed to a hard substrate, they are often found on ship hulls, buoys, pipes, fishing nets, rocks, reefs and even on other organisms such as molluscs or crayfish. They live in colonies, sometimes at very high densities (300 000/m² in Lake Erie). They have few natural predators except for a few diving duck species and mollusc-eating fish.

ECOLOGICAL AND ECONOMIC IMPACTS

Several problems can be traced to the arrival of the zebra mussel to the Great Lakes:

Disruption of the food chain: Mussels consume large quantities of phytoplankton, which may disturb the food networks of many species, and thereby hinder commercial and sports fishing. Zebra mussels may also interfere with the reproductive ability of many species of fish that use reefs as spawning grounds because they attach themselves to and cover the reefs.

Toxic transmission: Zebra mussels rapidly bioaccumulate organic pollutants in their tissue; at concentrations, in fact, 180 000 times higher than those found in the environment. Because they concentrate the water's toxins, they may serve as bio-indicators of the quality of the aquatic environment. The mussels may eventually transmit these toxins to humans who consume fish or ducks.

Obstruction of municipal and industrial water intakes: This problem may severely reduce water flows.

Hindrances to various recreational activities: Zebra mussels may prevent cooling waters from entering pleasure boat motors, and lead to overheating. The accumulation of sharp-edged shells on the beach can lead to injuries to bathers.

It is estimated that zebra mussels will cost Canada and the United States between four and five million dollars over the next decade due to fishery losses and because of the costs associated with the cleanup of the water systems. Among the chemical methods that efficiently control the proliferation of these mussels, chlorination is the only one permitted in Canada. However, no method can be said to have no impact on the environment. Biological control methods are still being developed.

St. Lawrence Perspectives

Calcium content, water pH levels, depth, currents, temperature and type of substrate found in certain areas of the St. Lawrence promote the establishment of the zebra mussel. For example, in the La Prairie basin and all around Île d'Orléans, can be found rocky and gravelly bottoms at a depth suitable for zebra mussel colonization. Even in the absence of these types of water bottoms, they may be present if other types of molluscs are found there. Factors which can limit their dispersal and overpopulation in the River are the absence of hard natural substrates and the increasing salinity downstream of Île d'Orléans. However, sandy river bottoms can be colonized by an exotic mussel species called the Quagga which has begun to invade the River. In 1992, these were spotted in the Saint-François and Saint-Louis lakes, and in the Sorel region.

The results of studies conducted between Beauharnois and Baie-Saint-Paul by the St. Lawrence Centre show that zebra mussel densities rose between 1990 and 1991. The largest increases were recorded from Québec to Sault-au-Cochon (5778%), from Donnacona to Québec (3972%) and in the Port of Montréal (472%).

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Sources: • Doyon, N., B. Cusson, J. Fontaine, C. Ménard and L. Lapierre. *Revue documentaire sur la biologie et l'écologie de la moule zébrée* Dreissena polymorpha. St. Lawrence Centre, Environment Canada. 58 pp. 1992.
• Fontaine, J. and L. Lapierre. *Distribution et abondance des moules zébrées fixées sur les bouées illuminées du fleuve Saint-Laurent (1991).* St. Lawrence Centre, Environment Canada. (In production).

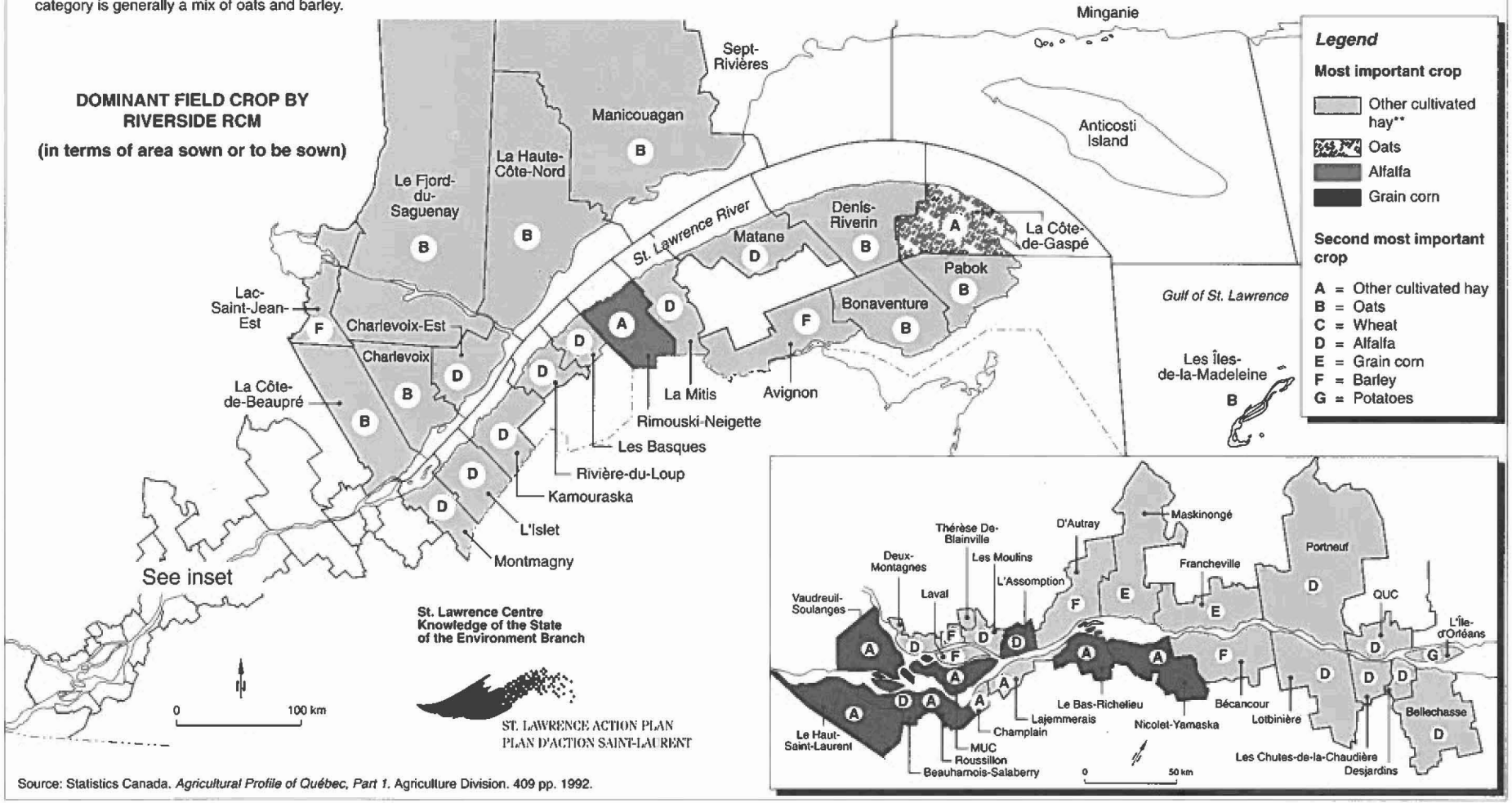
The St. Lawrence River - Main Field Crops (1991)

SURFACE AREA (ha)* OF MAIN FIELD CROPS SOWN OR TO BE SOWN IN 46 RIVERSIDE REGIONAL COUNTY MUNICIPALITIES (RCMs)**

	Other cultivated hay**	Alfalfa	Grain corn	Barley	Oats	Wheat	Mixed cereals**	Silage corn	Potatoes	Soya
Riverside RCMs	246 417	115 657	115 401	86 169	47 809	17 644	11 463	11 343	11 319	9 928
Québec	644 106	217 548	293 758	157 387	96 348	37 461	25 668	31 756	17 515	25 271
RCM/Québec (%)	38	53	39	55	50	47	45	36	64	39
Main productive RCMs	1. Lotbinière 2. Bellechasse 3. Kamouraska	1. Kamouraska 2. Nicolet-Yamaska 3. Rimouski-Neigette	1. Vaudreuil-Soulanges 2. Nicolet-Yamaska 3. Le Haut-Saint-Laurent	1. D'Autray 2. Bellechasse 3. Nicolet-Yamaska	1. Lac-Saint-Jean-Est 2. Le Fjord-du-Saguenay 3. Rivière-du-Loup	1. Lajemmerais 2. D'Autray 3. Le Bas-Richelieu	1. Kamouraska 2. Nicolet-Yamaska 3. Le Haut-Saint-Laurent	1. Le Haut-Saint-Laurent 2. Beauharnois-Salaberry 3. Nicolet-Yamaska	1. D'Autray 2. L'Île-d'Orléans 3. Le Fjord-du-Saguenay	1. Vaudreuil-Soulanges 2. Roussillon 3. Le Bas-Richelieu

* These areas were determined by combining data on the 46 riverside RCMs. Data was estimated in cases where this information is confidential. The Manicouagan and Minganie RCMs are part of a much larger territory that includes all of northern Québec, which is why they are not considered here. Farming in this northern territory is a marginal activity.

** "Field crops" are crops farmed on a large scale. The main fodder crop (or hay) is alfalfa. The "other cultivated hay" category includes all other types of annual fodder crop; clover, for example. The "mixed cereals" category is generally a mix of oats and barley.



Source: Statistics Canada. *Agricultural Profile of Québec, Part 1.* Agriculture Division. 409 pp. 1992.

The St. Lawrence River - Main Types of Livestock Production (1991)

OVERVIEW OF MAIN TYPES OF ANIMAL FARMING IN 46 RIVERSIDE REGIONAL COUNTY MUNICIPALITIES (RCMs)

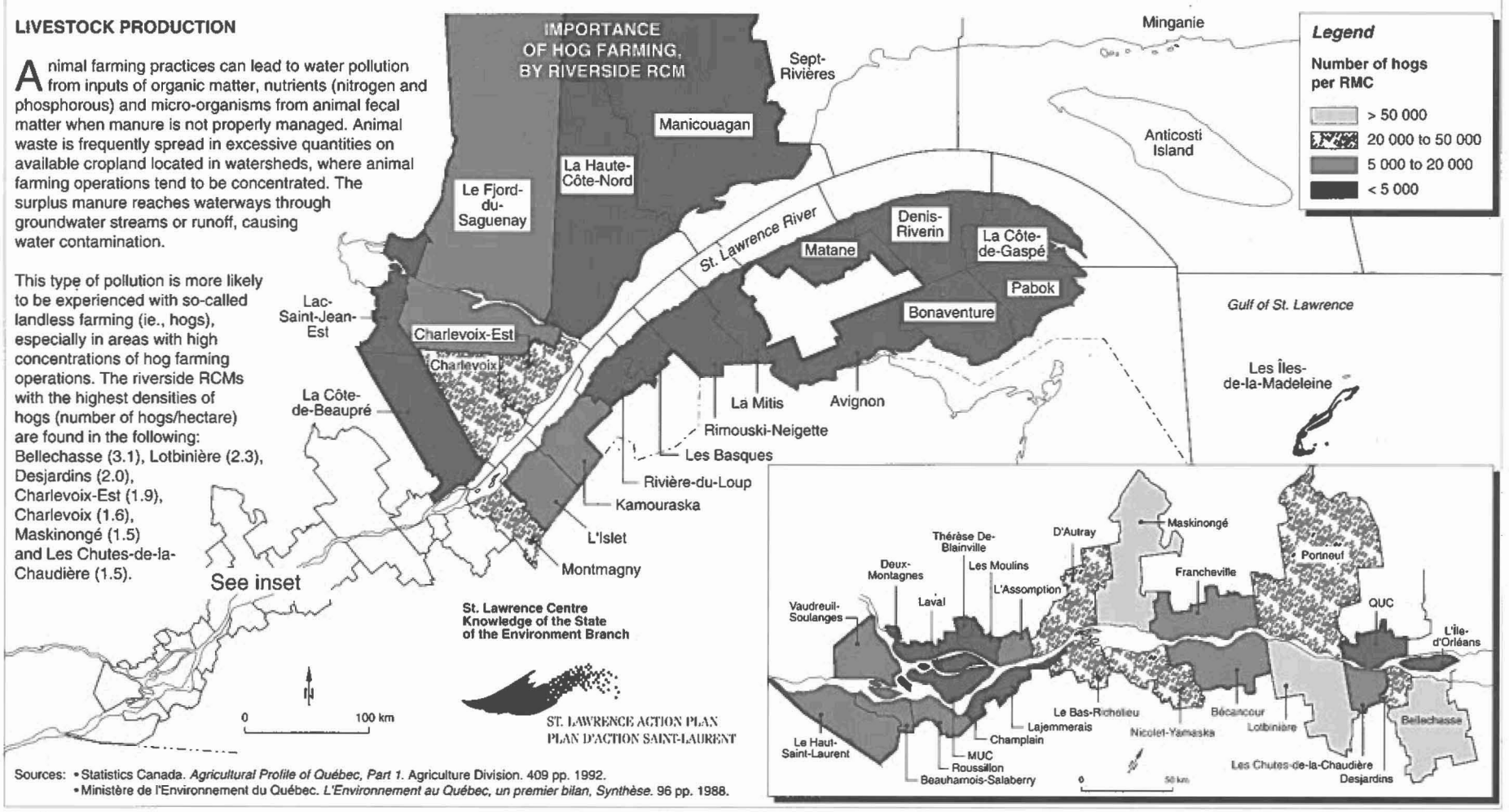
	Poultry		Hogs		Beef and veal		Sheep and lamb	
	Number of respondent farms	Number of animals	Number of respondent farms	Number of animals	Number of respondent farms	Number of animals	Number of respondent farms	Number of animals
Riverside RCMs	1 375	8 149 421	1 246	846 273	9 229	575 585	403	55 524
Québec	3 611	23 035 296	3 614	2 909 251	22 388	1 445 906	1 117	121 253
RCM/Québec (%)	38	35	34	29	41	40	36	46
Relative importance (%):	1. D'Autray	19	1. Bellechasse	27	1. Lotbinière	8	1. La Mitis	13
Number of animals raised per RCM	2. Bellechasse	14	2. Lotbinière	20	2. Bellechasse	8	2. Kamouraska	11
	3. Maskinongé	8	3. Maskinongé	8	3. Nicolet-Yamaska	6	3. Rimouski-Neigette	9
X 100	4. Nicolet-Yamaska	7	4. Nicolet-Yamaska	6	4. Le Haut-Saint-Laurent	6	4. L'Islet	7
Number of animals raised in riverside RCMs	5. L'Islet	6	5. D'Autray	4	5. Kamouraska	5	5. Lac-Saint-Jean-Est	6
	Total	**54**	**Total**	**65**	**Total**	**33**	**Total**	**46**

Note: The Sept-Rivières and Minganie RCMs are part of a much larger territory that includes all of northern Québec, which is why they are not considered here. Animal farming in this northern territory is a very marginal activity.

LIVESTOCK PRODUCTION

Animal farming practices can lead to water pollution from inputs of organic matter, nutrients (nitrogen and phosphorous) and micro-organisms from animal fecal matter when manure is not properly managed. Animal waste is frequently spread in excessive quantities on available cropland located in watersheds, where animal farming operations tend to be concentrated. The surplus manure reaches waterways through groundwater streams or runoff, causing water contamination.

This type of pollution is more likely to be experienced with so-called landless farming (ie., hogs), especially in areas with high concentrations of hog farming operations. The riverside RCMs with the highest densities of hogs (number of hogs/hectare) are found in the following: Bellechasse (3.1), Lotbinière (2.3), Desjardins (2.0), Charlevoix-Est (1.9), Charlevoix (1.6), Maskinongé (1.5) and Les Chutes-de-la-Chaudière (1.5).



Sources: • Statistics Canada. *Agricultural Profile of Québec, Part 1.* Agriculture Division. 409 pp. 1992.
• Ministère de l'Environnement du Québec. *L'Environnement au Québec, un premier bilan, Synthèse.* 96 pp. 1988.

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December 1993

The St. Lawrence River - Farmlands and Pesticide Treatments (1991)

AREA OF FARMLAND SPRAYED WITH PESTICIDES FOR 46 RIVERSIDE REGIONAL COUNTY MUNICIPALITIES (RCMs)

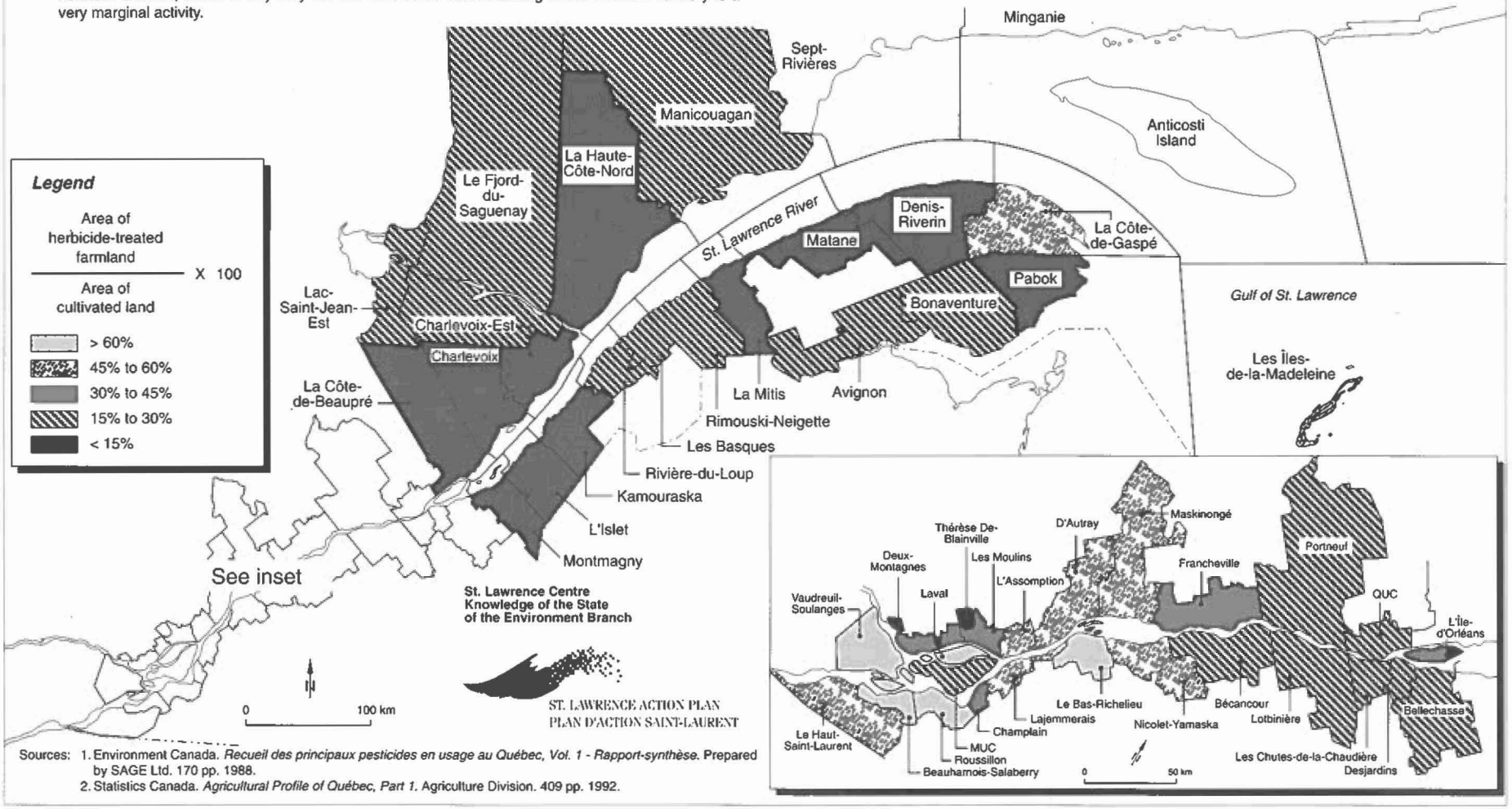
	Herbicides (ha)	Insecticides or fungicides (ha)	Herbicides/ Cultivated land (%)	Insecticides or fungicides/ Cultivated land (%)
Riverside RCMs	250 499	43 221	35	6
Québec	564 330	96 285	34	6
RCM/Québec (%)	44	45	-	-

Note: Cultivated lands cover a surface area of 712 216 hectares of the 46 riverside RCMs and 1 638 453 hectares of all of Québec. These areas include land for field crops, fruit, vegetables, sod and nursery stock. The Sept-Rivières and Minganie RCMs are part of a much larger territory that includes all of northern Québec, which is why they are not considered here. Farming in this northern territory is a very marginal activity.

PESTICIDES

"Pesticides are chemical or biological substances that are used to destroy or control those organisms generally termed *pests*, whose activities go against what humans consider their best interests."[1] Pesticides include herbicides (which are used to destroy undesirable plants), insecticides (used to kill certain insects), and fungicides (used to prevent and check illness caused by parasitic fungi). Pesticides employed in farming serve principally to treat cultivated land.

PROPORTION OF CULTIVATED LAND TREATED WITH HERBICIDES, BY RIVERSIDE RCM



Sources: 1. Environment Canada. *Recueil des principaux pesticides en usage au Québec, Vol. 1 - Rapport-synthèse.* Prepared by SAGE Ltd. 170 pp. 1988.
2. Statistics Canada. *Agricultural Profile of Québec, Part 1.* Agriculture Division. 409 pp. 1992.

The St. Lawrence River - Relative Importance of Diazinon (1991)

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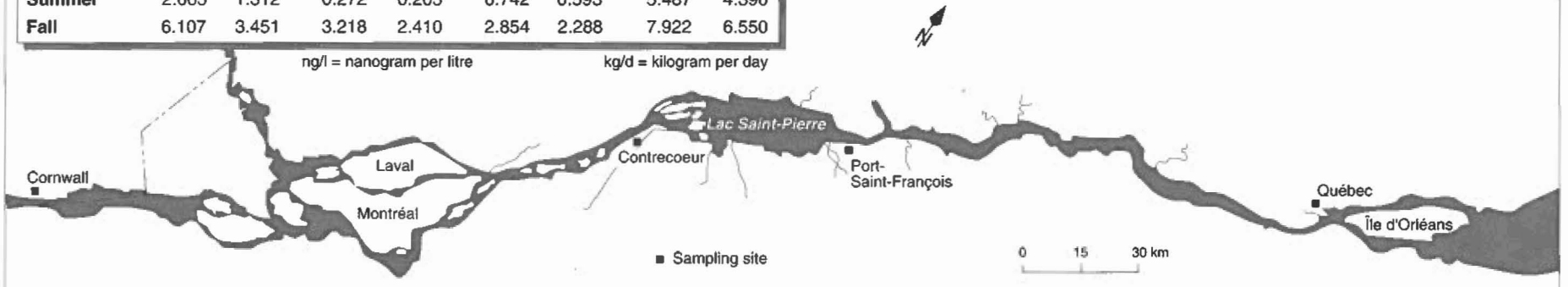
DIAZINON LOADS AND CONCENTRATIONS IN THE RIVER (1991)[3]

	Cornwall		Contrecoeur		Port-Saint-François		Québec	
	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)
Spring	0.044	0.034	3.955	5.051	3.870	4.918	7.584	10.419
Summer	2.065	1.312	0.272	0.205	0.742	0.593	5.487	4.390
Fall	6.107	3.451	3.218	2.410	2.854	2.288	7.922	6.550

ng/l = nanogram per litre kg/d = kilogram per day



DIAZINON

Pollution by contaminants* (organic category)

Production and use

Diazinon is an organophosphorous pesticide, a "wide spectrum insecticide and acaricide (controls acarids like spiders, mites and ticks that damage crops and related products) used to protect crops, especially fruit trees, corn, tobacco and potatoes. Small quantities of this product are used to treat ornamental plants, domestic animals, lawns, gardens; also used in homes, food processing plants and warehouses."[1] Diazinon is reapplied a few times throughout the growing season, from the end of May to mid-June, then again in mid-July and throughout the month of August.

Main sources today

"We think diazinon's main pathway into the aquatic environment is through farmland runoff. Excluding accidental spills and drifting sprays, farm runoff appears to be the source of most of the diazinon present in water systems."[1] According to the study conducted by Lemieux *et al.*[3] in 1991, diazinon loads generally increase from Cornwall to Québec, especially in springtime, and would seem to indicate significant sources of diazinon in Québec.

The load more than doubles between Port-Saint-François and Québec. Losses occur between Cornwall and Contrecoeur in spring and fall, despite an increase in the suspended solids with which diazinon is most often associated.

Characteristics and potential effects

According to Environment Canada (1988), diazinon is considered moderately toxic for mammals, fish and aquatic invertebrates, and highly toxic for birds. Its persistence is average in water (six months to one year), in soil (seven to 18 months), and also in aquatic organisms.

Quality criteria recognized by the ministère de l'Environnement du Québec:

- Raw water (domestic water intake): 20 000 ng/l
- Aquatic life (chronic toxicity): 3 ng/l.

* Refers to Info-flash No. 51 on types of pollution.

REPORT ON DIAZINON IN THE ST. LAWRENCE ACCORDING TO SOURCE, 1991

(calculated in water and in suspended solids)

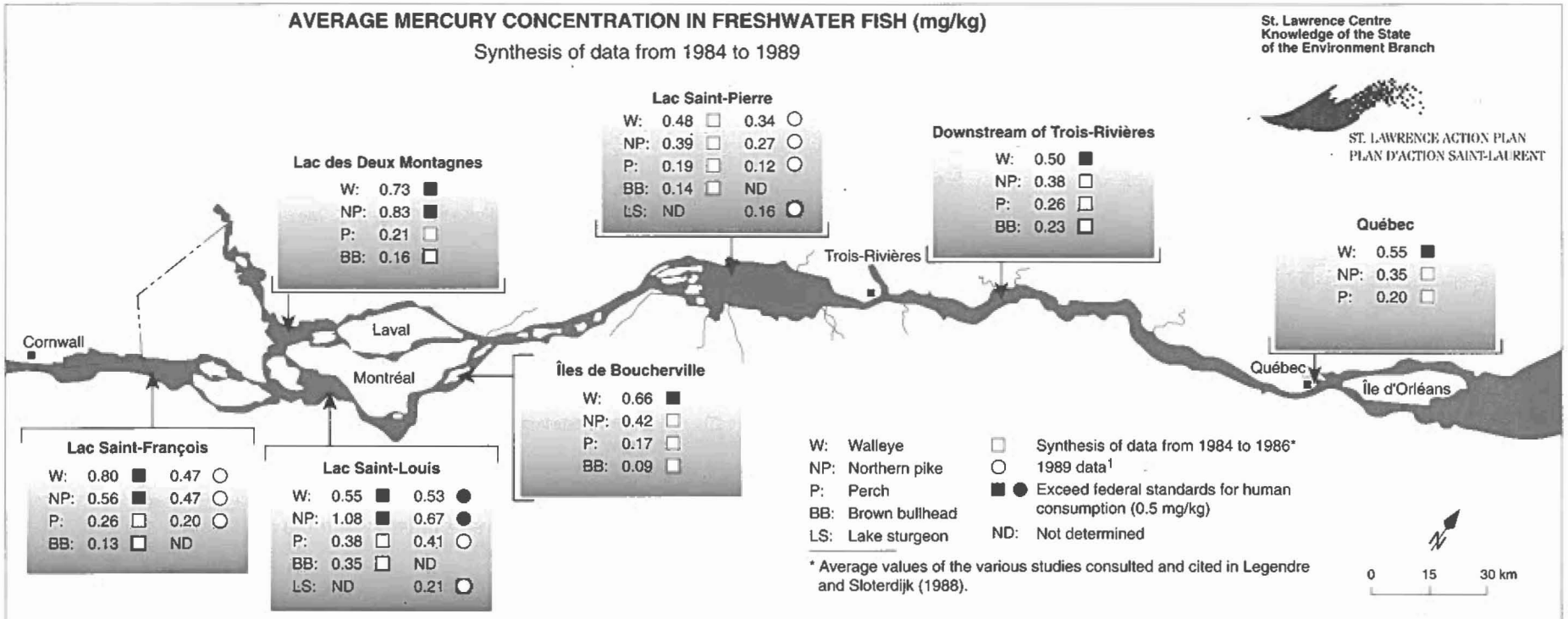
	May	*August*	*Nov.*
Sources	%	%	%
Lake Saint-Pierre tributaries (measured for 4 tributaries)**	4	4	2
Ottawa River	16	11	11
Great Lakes (measured at Cornwall)	<1	30	53
Other sources (estimate)***	80	55	34

** Tributaries studied: Richelieu, Yamaska, Saint-François, Nicolet.
*** Tributaries not examined, atmospheric deposits, surface runoff, resuspension of bottom sediments.

Note: Percentages were calculated in relation to the total diazinon recorded at Québec.

Sources:
1. Canadian Council of Environment Ministers. *Canadian Water Quality Guidelines.* Update (September 1989), appendix V. 1989.
2. Environment Canada. *Recueil des principaux pesticides en usage au Québec, Vol. 1 - Rapport-synthèse.* Unpublished internal report prepared by SAGE Ltd. 170 pp. 1988.
3. Lemieux, C., B. Quémerais and K. R. Lum. *Tendances temporelles de l'atrazine et du diazinon dans le fleuve Saint-Laurent et certains de ses tributaires.* Environment Canada, St. Lawrence Centre. Presented at the Canadian Association on Water Pollution Research and Control, 8th Eastern Region Conference. 1992.
4. Ministère de l'Environnement du Québec. *Critères de la qualité de l'eau.* 423 pp. 1990.

The St. Lawrence River - Mercury Contamination of Adult Fish



MERCURY ACCUMULATION IN THE AQUATIC ENVIRONMENT

Inorganic mercury exists in its natural state in the environment. It is also introduced into the aquatic environment through the discharge of various industrial and municipal wastes, and can accumulate in large quantities in sediment.

Inorganic mercury becomes methylmercury on contact with the bacteria present in bottom sediments. This is an organic compound more easily assimilated by aquatic organisms such as fish and crustaceans, and which bioaccumulates all along the food chain. Contamination varies significantly as a function of fish species and depending on location. What's more, the mercury concentrated in fish tissue grows with the age and size of the fish. Piscivorous fish are generally more contaminated than benthic organism eaters or insect eaters, mainly because of their diets.

The presence of mercury in organic form in the aquatic ecosystem can inhibit photosynthesis and phytoplankton growth, leading to the death of fish or to an inability to reproduce. Mercury is highly toxic and small doses can be fatal to humans. "Prolonged exposure to small doses can lead to neurological and renal disorders, and lead to significant weight loss."[2] "Since the early 1970s, better control of industrial-source mercury has slowed methylmercury contamination, but the diversity of sources means we must remain vigilant."[4]

It is difficult to establish a link between recorded contaminant concentrations in adult fish and a specific pollution source or sector because fish are so mobile. Nonetheless, we can still get an overall picture of contaminants in the ecosystem, and analysis of fish tissue is important for the protection of human consumers.

Fish species studied

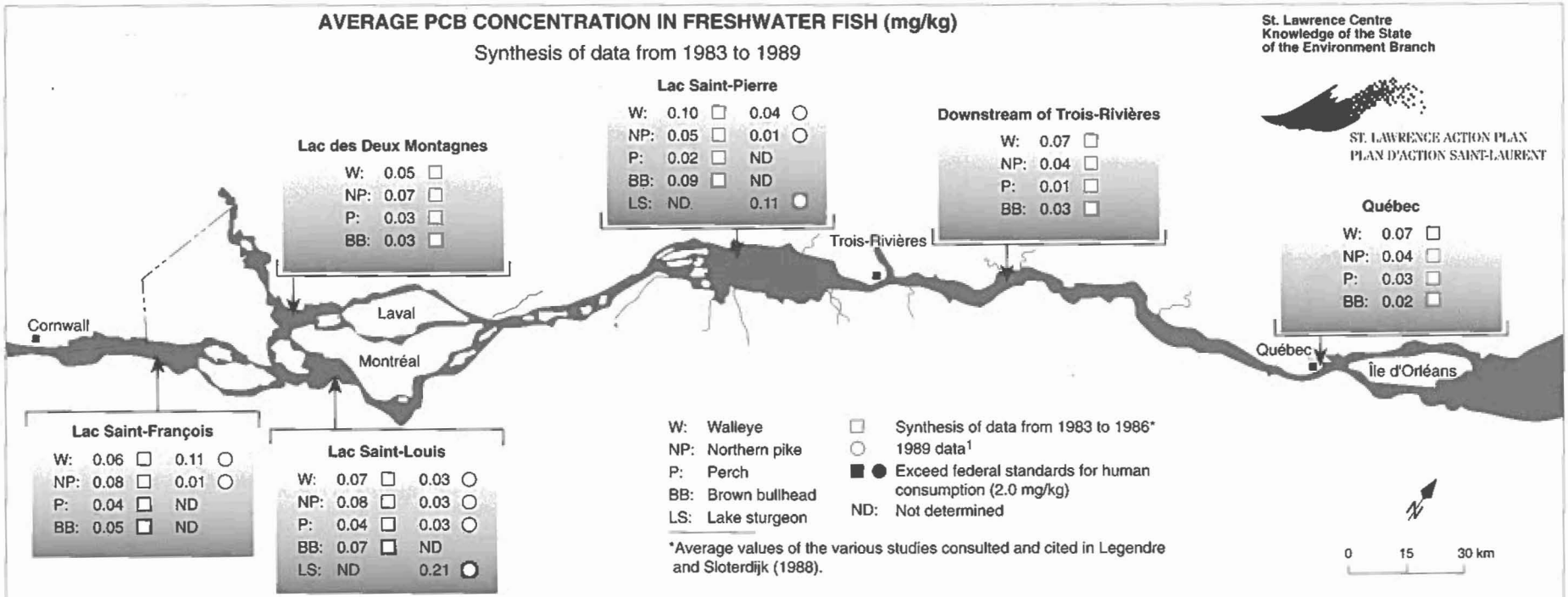
The above four species are fished both commercially and for sport. In 1989, the Brown bullhead and perch represented 51 percent of the commercial freshwater catch. Piscivorous (fish-eating) fish such as pike and walleye can grow to a considerable size. Bottom feeders (ie., Brown bullhead) eat benthic organisms such as molluscs, worms and insect larvae. Fish that eat mostly insect larvae, like perch, are typically small in size.

Standards for human consumption

Health and Welfare Canada (HWC) has set a maximum allowable concentration of 0.5 mg/kg of mercury for fish products destined for market. HWC has also issued recommendations on frequency of consumption: for fish harvested from the River, a maximum four meals of walleye or pike per month are recommended (a meal being equivalent to 230 grams of fresh fish), and eight meals per month for perch or bullhead.[4] This consumption limitation is based on global contamination levels of fish: all species consumed in a month should be considered.

Sources: 1. St. Lawrence Centre. Aquatic Environment Contamination. Unpublished data. 1994.
2. Government of Canada. "Cradle-to-grave management of toxic chemicals." In *The State of Canada's Environment*, chapter 21. 1991.
3. Legendre, P. and H. Sloterdijk. *Synthèse de la contamination des poissons adultes du fleuve par le mercure, les BPC, le DDE, le mirex et les HCB*. Preliminary version. St. Lawrence Centre, Conservation and Protection, Environment Canada. 1988.
4. Ministère de la Santé et des Services sociaux and ministère de l'Environnement du Québec. *Guide de consommation du poisson de pêche sportive en eau douce*. 80 pp. 1992.
5. Sloterdijk, H. *Accumulation des métaux lourds et des composés organochlorés dans la chair des poissons du fleuve Saint-Laurent*. Comité d'étude sur le fleuve Saint-Laurent, ministère du tourisme, de la Chasse et de la Pêche. 181 pp. 1977.

The St. Lawrence River - PCB Contamination of Adult Fish



PCB ACCUMULATION IN THE AQUATIC ENVIRONMENT

PCBs are synthesized organochlorines whose presence in the environment is due solely to human activity. PCBs main sources are industrial waste, leaching at contaminated sites, and the incineration of products containing PCBs. Even though they have been restricted for use in hydraulic and electric equipment since 1980, PCBs are still found in varying concentrations in the aquatic environment.

PCBs are stable and insoluble in water, but highly soluble in fatty substances. In the aquatic environment, they basically concentrate on suspended solids and sediments. They are rapidly absorbed by aquatic organisms, where they accumulate specifically in fatty tissue. PCB concentrations in fish vary depending on the species and in relation to their trophic status (fish, benthic organism or insect eaters), their diets and the amount of fat in their tissue. Differences in PCB concentrations are possible even between species of the same trophic level, and can be explained by their fat content. Eel and sturgeon accumulate much larger amounts of PCBs than do walleye or pike because the former have higher fat levels.

PCBs are toxic even in very low concentrations and can be lethal for certain aquatic animals such as fish. Symptoms typical of animal poisoning by PCBs include liver cancer and a low reproductive rate. Humans can suffer long-term health problems if they ingest PCBs in substantial and regular amounts via foods such as fish and seafood. These substances accumulate in the liver and fatty tissues. PCB poisoning in humans is manifested in deteriorating eyesight, hearing loss, skin lesions, neurological disorders and liver problems, among other things.

It is difficult to establish a link between recorded contaminant concentrations in adult fish and a specific pollution source or sector because fish are so mobile. Nonetheless, we can still get an overall picture of contaminants in the ecosystem, and analysis of the fish tissue is important for the protection of human consumers.

Fish species studied

The above four species are fished both commercially and sport. In 1989, the Brown bullhead and perch represented 51 percent of the commercial freshwater catch. Piscivorous (fish-eating) fish such as pike and walleye can grow to a considerable size. Bottom feeders (ie., Brown bullhead) eat benthic organisms such as molluscs, worms and insect larvae. Fish that eat mostly insect larvae, like perch, are typically small in size.

Standards for human consumption

Health and Welfare Canada (HWC) has set a maximum allowable concentration of 2.0 mg/kg of PCBs for fish products destined for market. HWC has also issued recommendations on frequency of consumption: for fish harvested from the River, a maximum four meals per month of walleye or pike are recommended (a meal being equivalent to 230 grams of fresh fish), and eight meals per month for perch or bullhead.[3] This consumption limitation is based on global contamination levels of fish: all species consumed in a month should be considered.

Sources: 1. St. Lawrence Centre. Aquatic Environment Contamination. Unpublished data. 1994.
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3. Ministère de la Santé et des Services sociaux and ministère de l'Environnement du Québec. *Guide de consommation du poisson de pêche sportive en eau douce.* 80 pp. 1992.
4. Paul, M. and D. Laliberté. *Réseau de surveillance des substances toxiques 1983 : teneurs en BPC, p,p' DDE, HCB, heptachlore, aldrine, mirex et HAP de six bassins versants du Québec méridional.* Direction des relevés aquatiques, ministère de l'Environnement du Québec. Report No. 85-12. 78 pp. 1985.
5. Sloterdijk, H. *Accumulation des métaux lourds et des composés organochlorés dans la chair des poissons du fleuve Saint-Laurent.* Comité d'étude sur le fleuve Saint-Laurent, ministère du tourisme, de la Chasse et de la Pêche. 181 pp. 1977.

The St. Lawrence River - Relative Importance of DDT (1990-1991)

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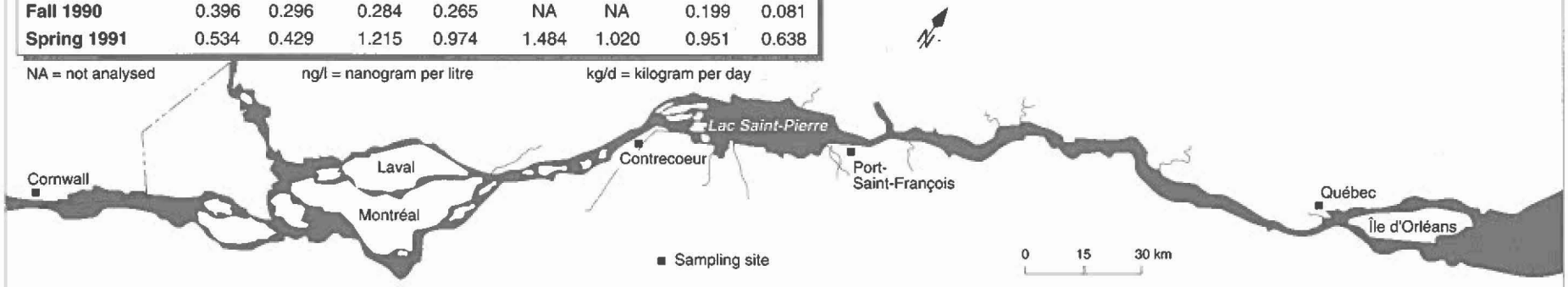
LOADS AND CONCENTRATIONS OF DDT IN THE RIVER (1990-1991)[3]

	Cornwall		Contrecoeur		Port-Saint-François		Québec	
	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)	Concentration (ng/l)	Load (kg/d)
Summer 1990	0.602	0.454	0.926	0.709	1.030	0.730	0.462	0.390
Fall 1990	0.396	0.296	0.284	0.265	NA	NA	0.199	0.081
Spring 1991	0.534	0.429	1.215	0.974	1.484	1.020	0.951	0.638

NA = not analysed ng/l = nanogram per litre kg/d = kilogram per day



DDT: DICHLORODIPHENYL-TRICHLOROETHANE
Pollution by contaminants* (organic toxin category)

Production and use

DDT is an organochlorinated insecticide that was widely used in the 1950s and 1960s to protect crops and trees from the damage of pests and to control rat populations. In 1964, worldwide production of DDT grew to 1.6 x 10^5 tonnes, 50 percent of which was made in the United States. A few years later,the negative effects of DDT on wildlife, coupled with fears of its risks for human health, led to tight restrictions on use of this product. In the early 1970s, DDT was either partially or completely banned in most western European countries and in North America. From 1979 to 1989, it was restricted for use in controlling bat and rat populations, and then only in cases where other products had failed. In Canada, DDT has not been registered for use since 1989, meaning its use is strictly forbidden. However, DDT is still being used in a number of developing countries (in South America, and in China and India).

Main sources today

The main existing sources of DDT come from the residual traces of applications before it was banned for use in Canada, and from airborne deposits from various regions of the world where DDT use is still permitted. Aerial spraying of this product has greatly contributed to its introduction into the aquatic environment.

Characteristics and potential effects

Although DDT is very stable, some time after its application it becomes two derivatives: DDE and DDD, which are even more persistent than DDT in its original form. Due to their chemical properties (persistence, water-insoluble, fat-soluble), DDT and its derivatives tend to accumulate in sediment and to be rapidly absorbed by organisms in the aquatic environment, where they are bioaccumulated and bioconcentrated. Numerous studies on DDT have provided clear and irrefutable evidence of the chemical's harmfulness to wildlife. In regions where DDT was widely used, its disastrous effects on fish and birds (deformities, eggshell thinning, reproductive failure) have been recorded. Invertebrates are generally more sensitive to DDT than are fish.

Quality criteria recognized by the ministère de l'Environnement du Québec:

- Raw water (domestic water intake) and contamination of aquatic organisms: 0.024 ng/l
- Aquatic life (chronic toxicity): 1 ng/l.
- Aquatic life (acute toxicity): 1100 ng/l (fresh water) and 130 ng/l (salt water)

* Refers to Info-flash No. 51 on types of pollution.

REPORT ON DDT IN THE ST. LAWRENCE ACCORDING TO SOURCE, MAY 1991
(calculated in water and in suspended solids)

Sources	%
Tributaries (measured for 5 major tributaries)**	33
Great Lakes (measured at Cornwall)	32
Airborne deposits (estimate)	4
Other sources (estimate)***	31

** Tributaries studied: Richelieu, Yamaska, Saint-François, Nicolet and Ottawa.
*** Tributaries not examined, surface runoff and soil erosion (especially in farming regions).

Note: Percentages were calculated in relation to the total amount of DDT recorded at Québec.

DDT compounds studied

o,p'-DDT; p,p'-DDT

Sources: 1. Canadian Council of Environment Ministers. *Canadian Water Quality Guidelines. 1991.*
2. Ministère de l'Environnement du Québec. *Critères de la qualité de l'eau.* 423 pp. 1990.
3. Pham, T., K. Lum and C. Lemieux. "The Occurrence, Sources and Distribution of DDT in the St. Lawrence River (Canada)." Article submitted for publication in *Chemosphere.* 1993.

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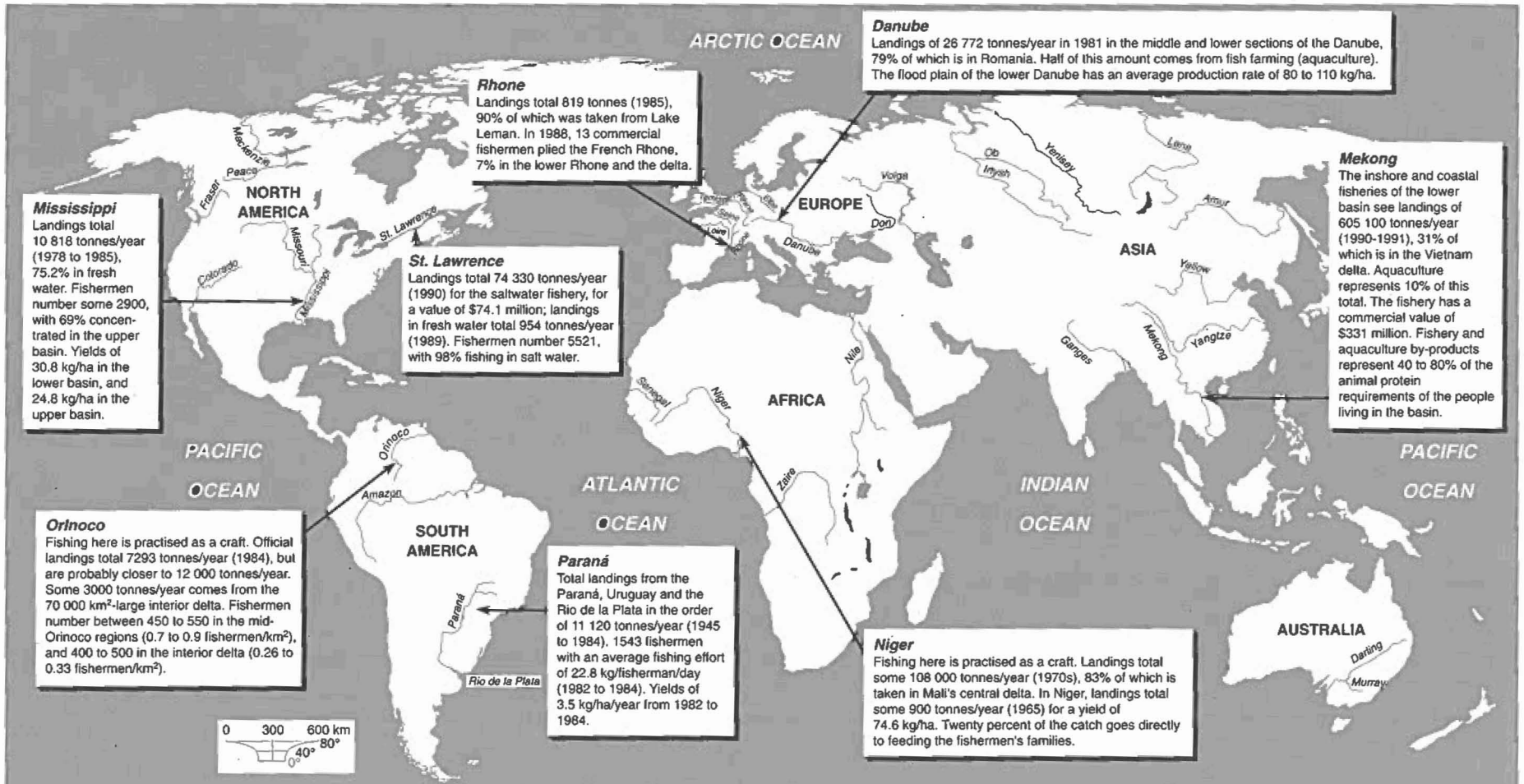
The St. Lawrence Compared to Other Major Rivers - Overview of Commercial Fishing



Danube

Landings of 26 772 tonnes/year in 1981 in the middle and lower sections of the Danube, 79% of which is in Romania. Half of this amount comes from fish farming (aquaculture). The flood plain of the lower Danube has an average production rate of 80 to 110 kg/ha.

Rhone

Landings total 819 tonnes (1985), 90% of which was taken from Lake Leman. In 1988, 13 commercial fishermen plied the French Rhone, 7% in the lower Rhone and the delta.

Mississippi

Landings total 10 818 tonnes/year (1978 to 1985), 75.2% in fresh water. Fishermen number some 2900, with 69% concentrated in the upper basin. Yields of 30.8 kg/ha in the lower basin, and 24.8 kg/ha in the upper basin.

St. Lawrence

Landings total 74 330 tonnes/year (1990) for the saltwater fishery, for a value of $74.1 million; landings in fresh water total 954 tonnes/year (1989). Fishermen number 5521, with 98% fishing in salt water.

Mekong

The inshore and coastal fisheries of the lower basin see landings of 605 100 tonnes/year (1990-1991), 31% of which is in the Vietnam delta. Aquaculture represents 10% of this total. The fishery has a commercial value of $331 million. Fishery and aquaculture by-products represent 40 to 80% of the animal protein requirements of the people living in the basin.

Orinoco

Fishing here is practised as a craft. Official landings total 7293 tonnes/year (1984), but are probably closer to 12 000 tonnes/year. Some 3000 tonnes/year comes from the 70 000 km²-large interior delta. Fishermen number between 450 to 550 in the mid-Orinoco regions (0.7 to 0.9 fishermen/km²), and 400 to 500 in the interior delta (0.26 to 0.33 fishermen/km²).

Paraná

Total landings from the Paraná, Uruguay and the Rio de la Plata in the order of 11 120 tonnes/year (1945 to 1984). 1543 fishermen with an average fishing effort of 22.8 kg/fisherman/day (1982 to 1984). Yields of 3.5 kg/ha/year from 1982 to 1984.

Niger

Fishing here is practised as a craft. Landings total some 108 000 tonnes/year (1970s), 83% of which is taken in Mali's central delta. In Niger, landings total some 900 tonnes/year (1965) for a yield of 74.6 kg/ha. Twenty percent of the catch goes directly to feeding the fishermen's families.

ESTIMATED NUMBER OF FISH SPECIES, BY DRAINAGE BASIN

River	Number of species of fish	Species specifics
Amazon	2000	30 percent have yet to be described
Colorado	100	33 indigenous, 67 introduced
Danube	100	30 commercially valuable
Fraser	83	47 freshwater, 36 saltwater, 14 commercially valuable
Ganges	141	-
Mackenzie	53	Only indigenous species
Mississippi - Missouri	306	260 freshwater, 46 saltwater, 10 commercially valuable
Murray	50	39 indigenous, 11 introduced
Orinoco	318	60 commercially valuable
Rhine	61	44 indigenous, 16 introduced
Rhone	70	-
St. Lawrence	**195**	**76 freshwater, 119 saltwater, 47 commercially valuable**
Senegal	113	Freshwater species only
Volga	88	74 indigenous, 14 introduced

ANNUAL FISH AND SEAFOOD CONSUMPTION IN 1985 (kg/inhab.)*

Germany	6.4	Japan	37.2
Australia	8.1	Netherlands	10.4
Austria	4.9	Portugal	39.8
Canada	**7.2**	United Kingdom	15.0
Denmark	45.6	Sweden	17.4
United States	7.1	Switzerland	7.0
France	17.9	Turkey	7.3

* Consumption is expressed in edible weight; that is, in the net weight of marine products, obtained by subtracting those parts not typically eaten (shell, scales, skin, head, bone, viscera).

The rivers selected to help overview commercial fishing in fluvial drainage basins are those for which we had data at the time this info-flash sheet was being produced .

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Sources:
- Organization for Economic Cooperation and Development (OECD). *Statistiques de la consommation des denrées alimentaires.* Paris: OECD Publications. 530 pp. 1988.
- Fisheries and Oceans. *Proceedings of the International Large River Symposium (LARS).* Canadian Special Publication of Fisheries and Aquatic Sciences 106. 629 pp. 1989.

Environment Canada Environnement Canada

Canada

December 1993

The St. Lawrence River - Sedimentation of Fluvial Lakes

FLUVIAL LAKES AND SEDIMENTATION

Moving from upstream to downstream between Cornwall and Québec, the St. Lawrence River widens to form three fluvial lakes: Saint-François, Saint-Louis and Saint-Pierre. These lakes include two independent, lateral water masses, separated by a central zone (main channel). Most of the river flows through this middle zone, without interference from the lateral sections. Current speed generally reaches 2 to 3 m/s in the main channel, and between 0.05 and 0.2 m/s in the lateral water masses, where the water is retained for between 2 and 12 days, depending on the lake.

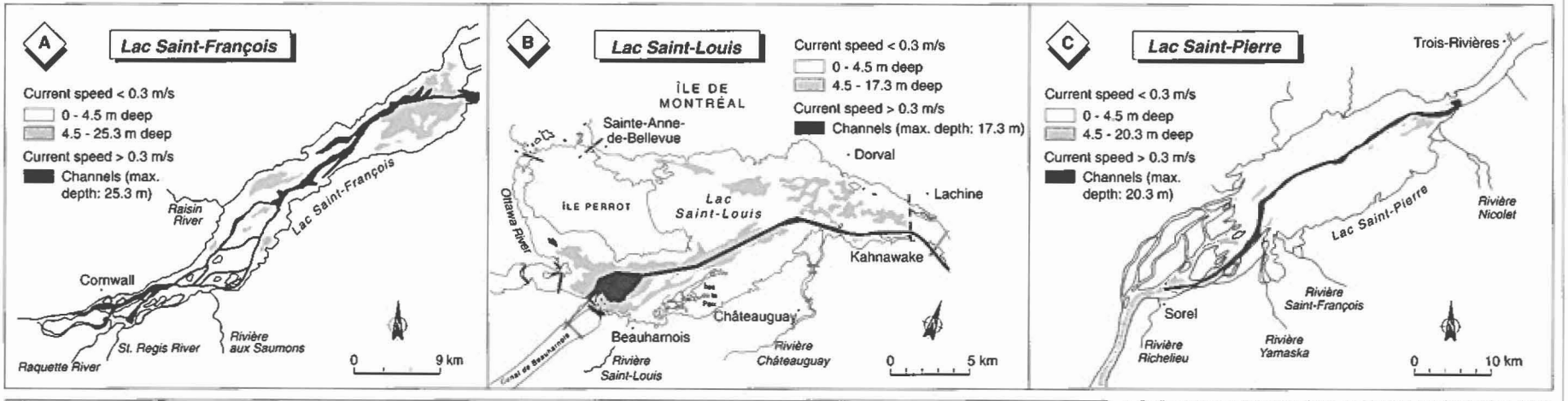
According to a study by Carignan *et al.* (1993) on the sedimentary dynamics of fluvial lakes, 11 of the 23 sites studied on these three lakes showed net accumulations of sediment. The rate of sediment accumulation varies from one lake to another and from the interior of one lake to another. Sedimentation accounts for between 4% and 8% of the total annual load moving through Lake Saint-François; for 1% in Lake Saint-Louis; and for 3% in Lake Saint-Pierre. In the stretch between Cornwall and Trois-Rivières, sedimentation represents about 6% of the total mass of suspended solids deposited at Trois-Rivières (4 800 00 t/yr).

CHARACTERISTICS OF FLUVIAL LAKES

	Area (km²)			Area (km²) of net sediment accumulation zones***	Average depth (m)	Retention time of water masses in lateral sections (days)	Average net sediment accumulation rate (silt and clay only)		
	Zones (channel banks)*	Channels**	Total				cm/yr	kg/m²	tonnes/yr
Saint-François	176	59	235	**28**	5.1	12.0	0.14 to 1.66	3.2	90 000
Saint-Louis	105	35	140	**15**	3.4	1.9	0.59 to 1.16	3.1	47 000
Saint-Pierre	249	153	402	**18**	2.7	3.2	1.2	8.9	160 000

* Zones where current speeds are < 0.3 m/s.
** Zones where current speeds are > 0.3 m/s
*** Zones where depths are > 4.5 m. These zones are included in the channel bank zones.

BATHYMETRY AND ZONES OF SEDIMENT ACCUMULATION[1] IN FLUVIAL LAKES



1. Sediment generally accumulates at sites that are deeper than 4.5 m and located outside of the main channel. These zones are shown as gray areas in the above maps.

Source: Carignan, R., S. Lorrain and K. Lum. "Sediment Dynamics in the Fluvial Lakes of the St. Lawrence River: Accumulation Rates, and Residence Time of Mobile Sediments." Article submitted for publication in *Geochemica Cosmos Chemica Acta*. 1993.

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