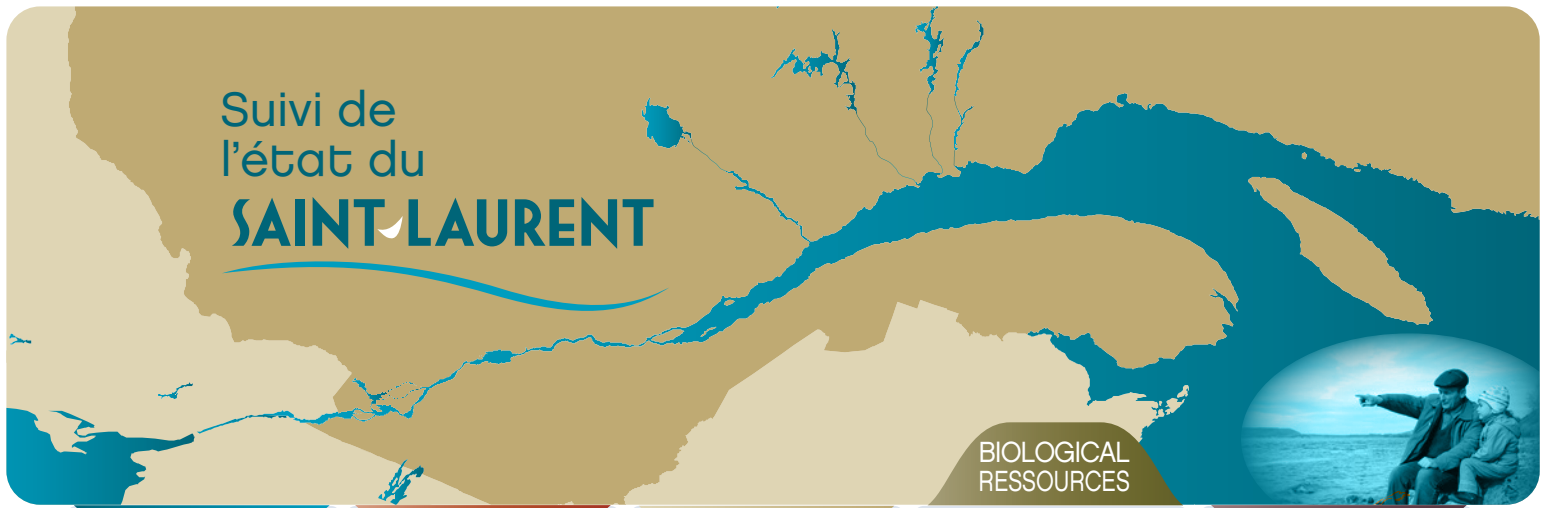


Suivi de l'état du SAINT-LAURENT



BIOLOGICAL RESSOURCES

WATER

SEDIMENTS

SHORELINES

USES



Aquatic invasive species in the Freshwater section of the St. Lawrence River

Current status: Intermediate – Poor*

Trend: Stable*

HIGHLIGHTS

This fact sheet provides a summary statement of the changes in the situation of invasive aquatic-animal species (IAASs) in the freshwater portion of the St. Lawrence River over the last 20 years. The situation in the St. Lawrence River subsequent to the invasion of various IAASs has been rated **Intermediate – Poor**. The main explanation for this situation is rapid colonization by round goby in all of the sectors sampled, demographic expansion of tench and rudd, detection of the spiny water flea, catch of a grass carp (one of the four species of Asian carps) in May 2016, and detection of DNA of this species at several sampling stations along the St. Lawrence River. The risk of these new exotic species propagating in the St. Lawrence River and its tributaries is considered high. Prevention, early detection, protection of inland waters and prompt implementation of action plans to control and eradicate IAASs in the St. Lawrence River remain priority actions.

CONTEXT

An IAAS is defined as an animal (e.g., fish, benthic invertebrate, or zooplankton) that can successfully establish itself when introduced outside its natural distribution range and whose spread entails significant ecological, economic, and social impacts. IAAS impacts on ecosystems are often major and irreversible, representing a real threat to biodiversity, particularly for endangered and vulnerable species and to the integrity of aquatic ecosystems. These impacts can also affect a number of important socioeconomic areas, such as recreational, commercial, and subsistence fisheries as well as a variety of recreational/tourism activities. By negatively affecting the quality and attraction of such activities, IAASs result in lost incomes and generate major, recurrent expenditures for prevention and IAAS eradication, when possible.

* These observations vary according to species and sectors.

Characteristics

Species considered invasive share some attributes that facilitate their establishment (i.e., reproduction and the survival of young and adult stages in a habitat or specific area) and their spread to a new environment. Such species are generally tolerant to different environmental conditions, grow and reproduce rapidly, and are highly adaptable to different environments. Such species often have few or no predators or competitors that would limit their numbers within the host community.

Vectors of Introduction and Spread

IAASs can be introduced into a new environment and spread in different ways. The mechanism that allows a species to migrate from its point of origin to a new area, whether intentional or not, is referred to as a *vector of introduction*. Usually, human activity is the vector of IAAS introduction. The main human vectors of introduction include commercial shipping and recreational boating (IAASs transported in ballast water or fish tanks), aquaculture, the aquarium trade, intentional release for spiritual purposes, sport and commercial fishing, and the baitfish trade. These vectors can also promote IAAS introduction to and spread in unconnected water bodies, such as inland waters (lakes and rivers). Human vectors of spread enable IAASs to reach areas beyond their natural capabilities.

Monitoring Programs

As part of the St. Lawrence Action Plan, various indicators have been developed by federal and provincial departments to monitor aquatic invasive species in the St. Lawrence River system. These indicators were developed based on data from monitoring programs on: 1) aquatic invasive species in the marine environment; 2) aquatic invasive plants in freshwater wetlands; and 3) freshwater IAASs. This fact sheet presents an overview of the work carried out by the Ministère des Forêts, de la Faune et des Parcs (MFFP) related to monitoring IAASs in the freshwater portion of the St. Lawrence River.

KEY MEASURES

Context

Several freshwater IAASs have been sampled in the St. Lawrence River (Table 1). Nevertheless, the quantity and quality of the available data for each of these species are variable in time and space. As a result, it is difficult to design a robust index that can be used to determine the state of freshwater IAASs throughout the St. Lawrence River. In order to bridge this gap, an index was designed using a well-known invasive aquatic species: the round goby. This indicator, therefore, provides a partial representation of the IAAS situation in the freshwater portion of the St. Lawrence River.

Round Goby Index

This index is calculated using the frequency of occurrence of round goby in the stations sampled with a shoreline seine under the Fish Monitoring Network (FMN), a systematic inventory program conducted by MFFP in the St. Lawrence River. The various sampling years were divided into four periods, making it possible to determine changes in time and space. The index is based on analyzing data from 1536 sampling stations carried out over the 22 years from 1995 to 2016 and covering a significant portion of the coastal freshwater habitats on the St. Lawrence River (Figure 1). The index uses five categories of state ranging from very good to poor. The limits used for each category are subjective.

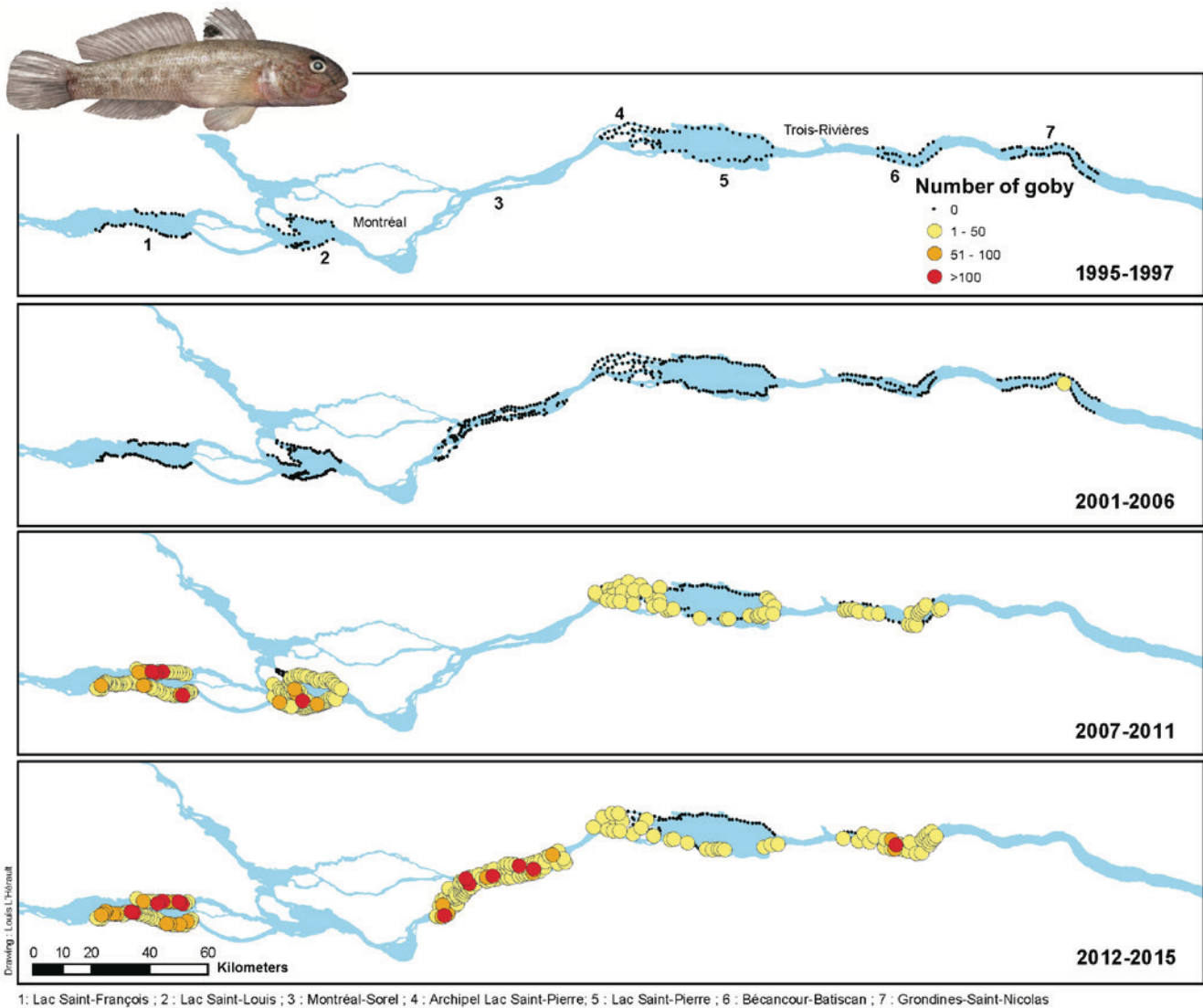


Figure 1. Round goby distribution in the St. Lawrence River per inventory period of MFFP's Fish Monitoring Network (FMN).

ROUND GOBY: A SENTINEL SPECIES

The round goby is an invasive aquatic species that has spread stunningly since the 1990s in the Great Lakes–St. Lawrence River basin, the Baltic Sea, and several large European rivers. Native to the Ponto-Caspian region, which covers the Black Sea and the Caspian Sea, the round goby was introduced into North America in the 1990s in ballast water discharged from transoceanic vessels. This aggressive, prolific fish often becomes the dominant species in shoreline benthic environments. It presents a direct threat to several native fish species, particularly small benthic feeders with whom the goby compete for food. The changes in the food web brought about by the round goby often give rise to concerns about energy, nutrient, and contaminant flows (Armellin et al., 2017) and could act as disease vectors (parasites, botulism, and viral hemorrhagic

septicemia). Several publications have provided accounts of the impacts of the round goby in our waters (Reyjol et al., 2010; Brodeur et al., 2011; Kipp and Ricciardi, 2012). Nevertheless, there is not yet an overall picture of the species' distribution and changes in its abundance since its detection in the St. Lawrence River. The index, developed within the framework St. Lawrence Action Plan, aims at filling this gap.

DATA SOURCE

The FMN uses a standardized and reproducible approach to sample data pertaining to fish populations with a view to assessing the state of health of fish communities in the St. Lawrence River. Given the river's size, it will take several years to inventory the various fluvial portions between the Ontario border and the upper estuary. Four sampling cycles were carried out between 1995 and 2016. The FMN sampling plan was designed to cover both lentic and lotic habitats in each of the sectors on both sides of the navigable channel. When developing this index, only the stations sampled with a shoreline seine (lentic habitats) were used, given the enhanced effectiveness of this net for sampling round goby. The seine fishing stations were distributed along the shore at a target depth of 0.5 m.

RESULTS

The first mention of round goby in the St. Lawrence River dates back to 1997 at the Aquarium du Québec scientific fishing station in Saint-Nicolas. Catches were afterwards reported in Lac Saint-François in 2000 and in the Montréal area in 2004. In 2006, nine years after the first mention of the species in the St. Lawrence River, round goby were detected for the first time by the FMN in the Grondines–Saint-Nicolas sector (Figure 1). The round goby then very rapidly colonized all of the fluvial portions and was already present in 58% of the station sampled from 2007 to 2011 (Figure 2).

Following this phenomenal demographic expansion, the abundance of round goby in the St. Lawrence River has stabilized and currently accounts for a frequency of occurrence of 56% in sampling stations, which corresponds to an index rating of moderate to poor (Figure 3).

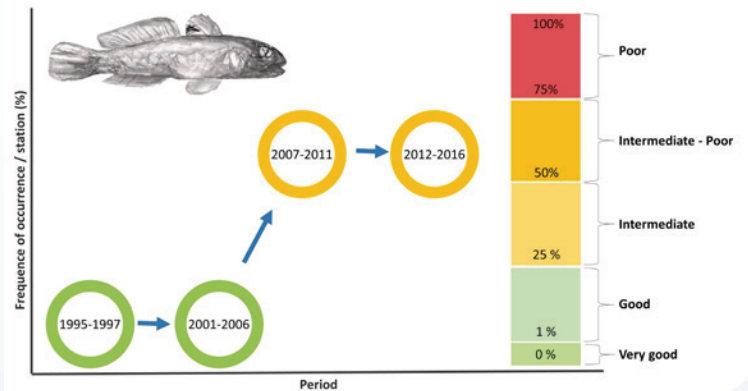


Figure 3. Changes in goby index over time.

Although the round goby is established throughout the fluvial portion, the greatest abundance is found in the upstream sectors of the St. Lawrence River. In Lac Saint-François, the average number of round goby caught per station rose from 34 in 2009 to 41 in 2014, making it the water body with the highest density of all of the sectors sampled (Figure 4). The opposite trend has been observed in Lac Saint-Pierre and its archipelago, where the round goby population has decreased in recent years. The factors accounting for these divergences remain unknown. The successful spread of round goby has long been associated with the presence of the zebra mussel, which is its preferred prey in its natural distribution range. This assumption might account for the differences between the sectors, given that Lac Saint-François has the highest densities of zebra mussels. Nevertheless, analysis of the stomach contents of round goby specimens taken from Lac Saint-François revealed that the species has a very diversified diet and that zebra mussels constitute an alternative prey (unpublished MFFP data). Moreover, the analysis demonstrated that round goby abundance did not correlate to the biomass of zebra or quagga mussels in the St. Lawrence River (Kipp and Riccardi, 2012). The observed differences in abundance are probably due to species habitat preferences, but the precise factors accounting for them (e.g., aquatic plants, turbidity, substrate, etc.) have yet to be determined.

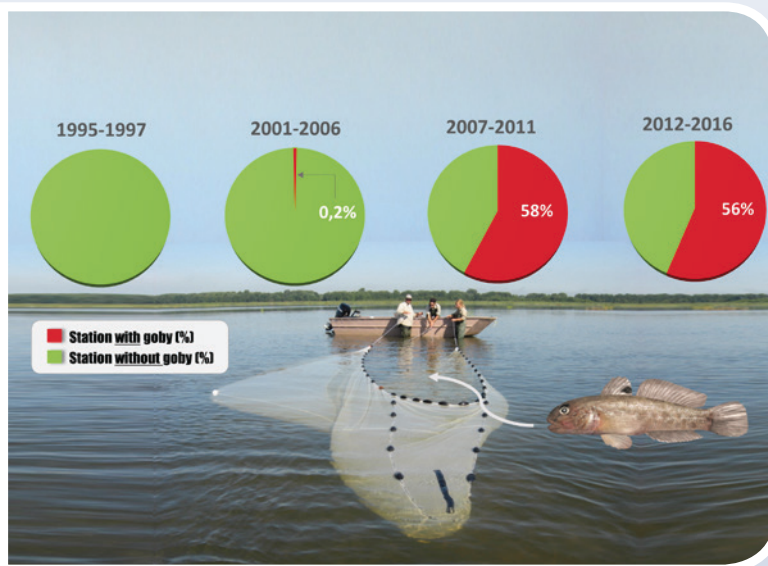


Figure 2. Frequency of occurrences of the round goby in seine sampling stations at different inventory periods of MFFP's Fish Monitoring Network.

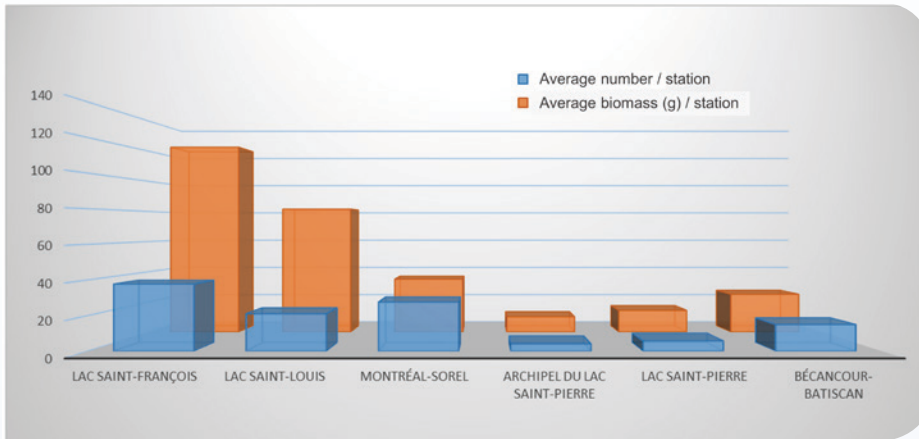


Figure 4. Differences in abundance of round goby in different sectors of the St. Lawrence River (sampling period: 2007—2016).

Less is known about the state of the round goby's situation in the St. Lawrence River's tributaries than in its fluvial portion. Goby was detected for the first time in the Rivière Richelieu in 2011. A 2016 inventory revealed that round goby had colonized the downstream section of the Rivière Richelieu, that is, from the Saint-Ours dam to the river's mouth (Vachon, N.; MFFP; pers. comm.). There is no record of round goby upstream from the dam. The presence of round goby have been attested to in certain tributaries of Baie Lavallière on the south shore of Lac Saint-Pierre (Gravel, R.; MFFP; pers. comm.). Little information is available about the distribution of round goby in other tributaries of the St. Lawrence River.

St. Lawrence River (Figure 5). Although a causal link has not been accurately established, fierce dietary competition between the two benthic species has probably contributed to the decline of the tessellated darter. Because of the similar habitats and behaviors of the various small percid species, other species in this group are likely to experience declines, in particular the channel darter (vulnerable species) and the eastern sand darter (endangered species). Since both of these species are rarely caught, it is difficult to establish trends related to the dynamics of their populations with respect to the arrival of the round goby. Other impacts of the round goby invasion, in particular on the diversity of benthic invertebrates in the St. Lawrence River, have also been demonstrated (Kipp and Riccardi, 2012).

IMPACTS

The round goby has considerably altered the trophic structure of the St. Lawrence River. It has become an important prey for piscivorous species in the St. Lawrence River, representing from 21% to 64% of the diet of sauger, smallmouth bass, and yellow perch. However, large predators, such as pike and walleye, rapidly drop goby from their diet due to its poor energy source (Reyjol et al. 2010; Brodeur et al. 2011). The impacts of round goby on fish biodiversity in the St. Lawrence River have also been demonstrated. The tessellated darter, a small benthic species of fish, has experienced a considerable decline since the arrival of the round goby in the

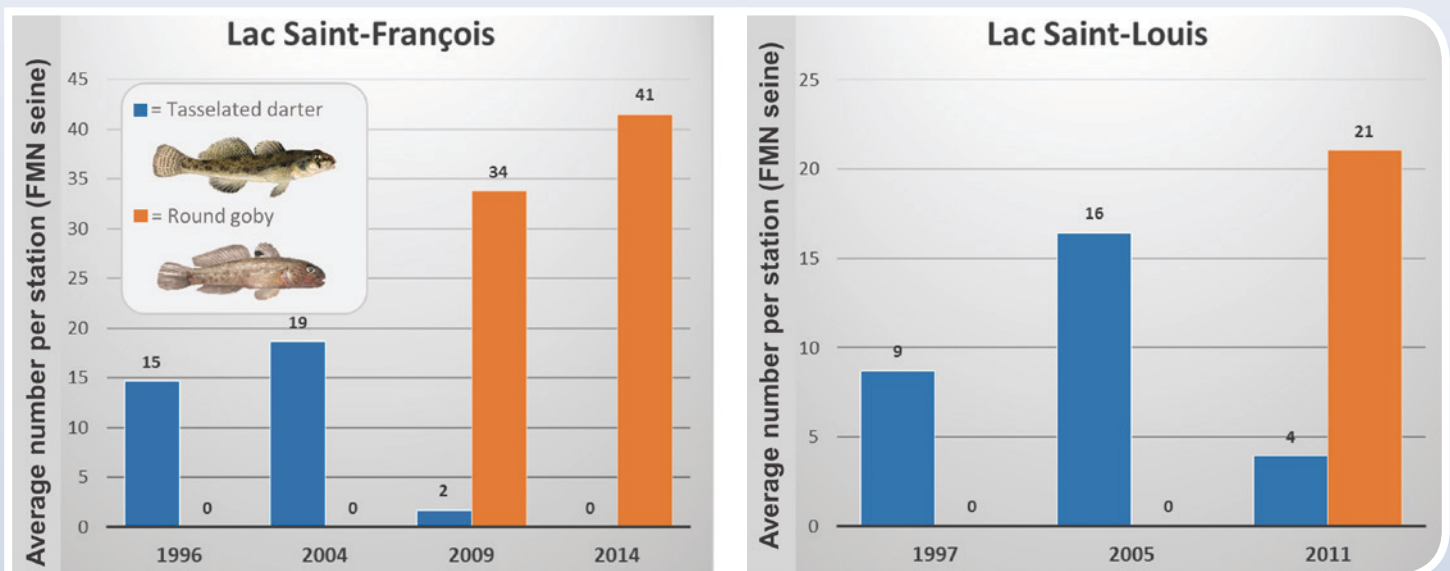


Figure 5. Changes in abundance of round goby and tessellated darter in the St. Lawrence River over time.

PERSPECTIVES

Although the round goby was used to develop an index based on the quality and quantity of available data, it is important to consider the detection and recent demographic trends of the other IAASs inventoried in the St. Lawrence River (Table 1).

The oldest of exotic species in the St. Lawrence River—the common carp—is now considered naturalized. The abundance of this species has been on the rise in the St. Lawrence River in recent years. Although it was introduced into Québec in 1910, the common carp has had and continues to have impacts on the fish communities and habitats in the St. Lawrence River. The extent of this impact, however, remains relatively unknown.

Historically confined to the Rivière Richelieu, the tench has experienced significant demographic increase and expansion in its distribution range in recent years. Changes in tench abundance are well known thanks to a network of commercial fishermen serving as index fishermen in detecting IAASs (Pelletier et al., 2012). Tench abundance in the catches of index fishermen has risen sharply in the last few years from 84 in 2011 to more than 4000 in 2015 (Pelletier and Gagnon, 2015). Although the majority of tench reported by commercial fishermen were caught in Lac Saint-Pierre, the species has been detected by the FMN and sport fishers have also reported it in the Montréal–Sorel section, in Lac Saint-Louis, and in the Rivière Saint-François (at Drummondville), causing concern about tench spreading all throughout the St. Lawrence River and its tributaries.

Table 1. Main invasive aquatic-animal species sampled in the freshwater portion of the St. Lawrence River.

Take note that this is a partial list and does not include all of the IAASs attested to in the St. Lawrence River.

Invasive Aquatic Species	First Sighting in Quebec	Origin	Trend (1995–2017)	Note
Common carp	1910 ¹	Eurasia, German imports	Increasing	Considered naturalized.
Zebra mussel	1989 ²	Ponto-Caspian region	Stable in the shoreline zone and declining in the benthic zone when overlapping with the quagga mussel.	Accidentally introduced to the Great Lakes via transoceanic shipping.
Rudd	1990 ³	Ponto-Caspian region	Increasing	Accidentally introduced to Lac Champlain. Increasing in its distribution range.
Tench	1991 ⁴	Europe, Asia	Increasing	Accidentally introduced to the Richelieu River. Significantly increasing in its distribution range and in abundance.
Quagga mussel	1992 ²	Ponto-Caspian region	Increasing	Accidentally introduced to the Great Lakes via transoceanic shipping.
Round goby	1997 ⁴	Ponto-Caspian region	Stable for several years	Common throughout the river sections.
Asian clam	2009 ⁵	Southeast Asia	Increasing until 2012. Collapse in 2013; unknown since.	Accidentally introduced into the Bécancour sector of the St. Lawrence River. Collapse of the population subsequent to the closure of Gentilly 2 power station, but some living individuals were found in 2013.
Spiny water flea	2014 ⁴	Ponto-Caspian region	Unknown	Presence of the species attested to in Lac Saint-François and the Haut-Richelieu.
Grass carp	2016 ⁴	Asia, northern China, Siberia	Unknown	Species detected in the St. Lawrence River, but no known existence of an established population.

References: **1** McCrimmon, H.R., 1968, *Carp in Canada*, Fisheries Research Board of Canada, Bulletin 165; **2** Costan, G., de Lafontaine, Y. 2000. Présence de la moule zébrée dans le Saint-Laurent: à suivre..., Fact sheet produced under the 2000 St. Lawrence Action Plan: http://www.bape.gouv.qc.ca/sections/mandats/prise_eau/documents/DA19.pdf; **3** Guide Vision d'identification pour le Réseau de détection des espèces aquatiques exotiques envahissantes du Saint-Laurent: <http://sbisrvntweb.uqac.ca/archivage/030024026.pdf>; **4** Ministère des Forêts, de la Faune et des Parcs: <http://mffp.gouv.qc.ca/faune/especes/envahissantes/index.jsp>; **5** Simard, M. A., Paquet, A., Jutras, J., Robitaille, Y., Blier, P. U., Courtois, R., et Martel, A. L. (2012). "North American range extension of the invasive Asian clam in a St. Lawrence River power station thermal plume," *Aquatic Invasions*, Vol. 7 1: 81-89: http://www.aquaticinvasions.net/2012/AI_2012_1_Simard_etal.pdf

The recent detection of a new invasive zooplanktonic species—the spiny water flea—is also a cause for concern. Presence of the species was attested in Lac Saint-François and the Haut-Richelieu. However, as few species-specific surveys have been carried out, it is difficult to establish with precision the distribution of the spiny water flea in the St. Lawrence River.

The catch of a grass carp in summer 2016 in the Contrecoeur sector and the detection of eDNA of this species at 16 sampling sites along the St. Lawrence River and the downstream portions of the Rivière Richelieu and Rivière Saint-François are of particular concern for the years to come (Figure 6). To illustrate, Asian carp (grass carp, silver carp, bighead carp, and black carp), which invaded the Mississippi River in the 1960s, have significantly disrupted ecosystems. In particular, they have compromised sport and commercial fishing, recreational boating, and public safety,

and have occasionally resulted in health hazards as the result of episodes of massive mortality. There is a high risk of invasion of the St. Lawrence River, which is an ideal habitat for these species, which are native to major Asian rivers. To address this threat, the Gouvernement du Québec adopted a program in 2016 to control Asian carp.

Moreover, since certain IAASs can be spread unintentionally as the result of trade and the use of baitfish, MFFP has announced that a new regulation prohibiting the use of live bait in Québec for sport fishing that would come into effect on April 1, 2017.

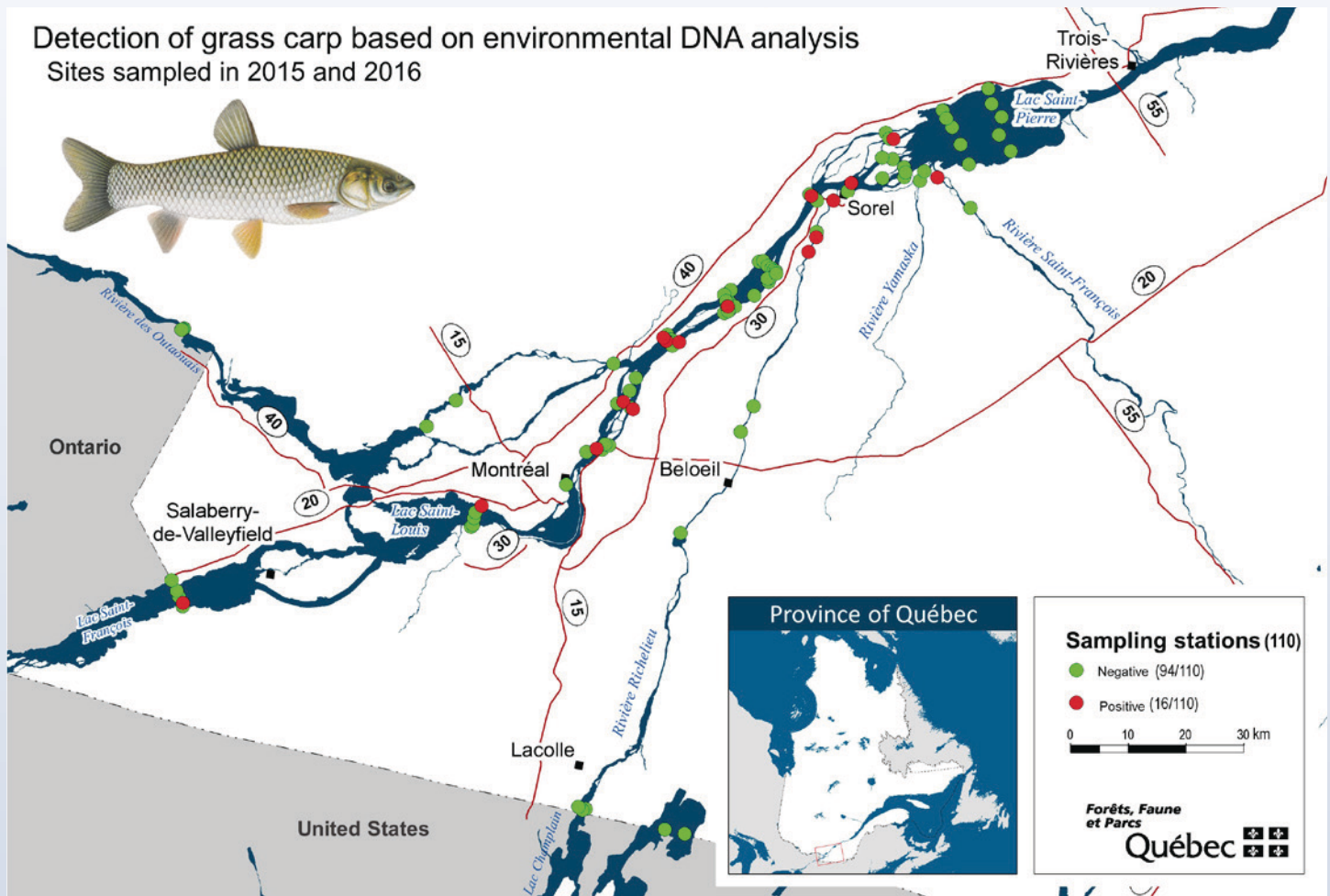


Figure 6. Spatial distribution of sampling stations where environmental DNA analyses have been performed in order to detect grass carp (MFFP and Université Laval, 2017). Laval, 2017).

CONCLUSION

Overall, the results for the last 20 years of monitoring show that the number and abundance of IAASs established in the St. Lawrence River have continually increased. In the case of the round goby, its abundance rapidly increased after its initial detection and has recently reached an apparently stable plateau. Once an IAAS has become established in an ecosystem, its eradication is difficult or even impossible to achieve. Preventing the introduction and establishment of IAASs is the most effective and least costly approach to controlling them. A precautionary approach makes it possible to avoid the considerable costs associated with their eradication, control, and management. While it may be difficult to reduce the risks related to natural spreading, it is nevertheless possible to better manage certain human activities that are conducive to the introduction and spread of these undesirable species through awareness activities, voluntary measures, or regulatory tools. In this regard, the new regulation governing the use of baitfish in Québec—in force since April 1, 2017—stands out as a tangible prevention measure (Paradis and Brisson-Bonenfant, 2017).

FOR MORE INFORMATION

<http://carpesasiatiques.gouv.qc.ca>

<https://www.mffp.gouv.qc.ca/faune/especes/envahissantes/cladocere.jsp>

<http://mffp.gouv.qc.ca/faune/peche/poissons-appats.jsp>

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The early detection of IAASs is also crucial in the fight against these invaders. Detecting their presence as soon as they appear in an ecosystem makes it possible to rapidly act to prevent their establishment and reduce the risks of their spreading into other environments such as inland waters. Implementing and maintaining monitoring programs as well as the involvement of various collaborators are essential to maximize the possibilities of detecting a species when it first appears. Once a species has been detected, it is important to be able to count on a rapid intervention plan providing a structured approach to controlling or confining the invader. Lastly, scientific research on IAASs remains an essential element in controlling them. It provides a means for developing or improving detection and control methods as well as for better understanding the impact of such species on ecosystems.

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STATE OF THE ST. LAWRENCE

MONITORING PROGRAM

Five government partners - Environment and Climate Change Canada, Fisheries and Oceans Canada, Parks Canada, Quebec's Ministry of Sustainable Development, Environment and Climate Change and the Department of Forests, Wildlife and Parks Of Quebec - and Stratégies Saint-Laurent, a non-governmental organization active in riparian communities, share their expertise and efforts to report to the public on the status and long-term evolution of the St. Lawrence River.

For more information on the state of the St. Lawrence monitoring program, please visit our website:
http://planstlaurent.qc.ca/en/state_monitoring.html

Writing

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