Monitoring of the status of the
ST. LAWRENCE

BIOLOGICAL RESSOURCES

WATER | SEDIMENTS | SHORELINES | USES

STATUS OF FISH COMMUNITIES OF THE FRESHWATER AND BRACKISH WATERS OF THE ST. LAWRENCE

Status: Intermediate

Trend: Variable as a function of species and sectors

HIGHLIGHTS

More than 80 fish species are found in the freshwater and brackish waters of the St. Lawrence River and evaluation of the status of these fish stocks is complex. In order to paint a current picture of our understanding of the fish communities and aquatic habitats of the St. Lawrence, and to judge the evolution of these elements over the last 25 years, different status indicators were used: (1) Index of Biotic Integrity, (2) status of the stock of certain species subject to recreational and commercial fishing, (3) status of species under threat, (4) coastal zone fish biodiversity index and (5) relative abundance index for submerged aquatic vegetation. Analysis of these indicators highlights what are sometimes very different findings between species and sectors. Several rapid changes that have arisen during the last two decades in the characteristics of aquatic habitats and in the structure of fish communities testify to an evolving ecosystem that is tending to degrade in certain sectors. Over the years, several exploited fish stocks have seen periods of decline. While certain species have been able to re-establish themselves thanks to restrictive management measures, others have been slow to recover due to several factors other than pressures from fishing.

CONTEXT

Fish are commonly used to evaluate the health status of aquatic ecosystems in Europe and North America. They react to changes in the aquatic environment throughout their life cycle and are vulnerable to most anthropic pressures and to modifications of their habitat. Fish are generally easy to sample, widely distributed in a variety of aquatic habitats and arouse interest due to their significant historic value. Several species support fisheries (subsistence, recreational or commercial), which generate significant socioeconomic effects. Evaluation of the status of fish communities and their monitoring over time require systematic, comparable and rigorous data, collected over several years.

Canada

Plan d'action SAINT-LAURENT 2011-2026

Québec

Created in 1995 by the ministère des Forêts, de la Faune et des Parcs (MFFP) as part of the St. Lawrence Action Plan, the Réseau de suivi ichtyologique (RSI, fish monitoring network) tracks the status of fish communities, certain populations and their habitats in the fluvial portion of the St. Lawrence In addition, the Réseau d'inventaire des poissons de l'estuaire (RIPE, estuary fish monitoring network), created in 2009 by MFFP, was designed to supplement understanding of the upper estuary (Figure 1). The RSI uses gill nets in the pelagic zone and shore seines in the coastal zone to obtain fish samples. RIPE uses stationary traps in four sites distributed on the south and north shores of the estuary (Figure 1).

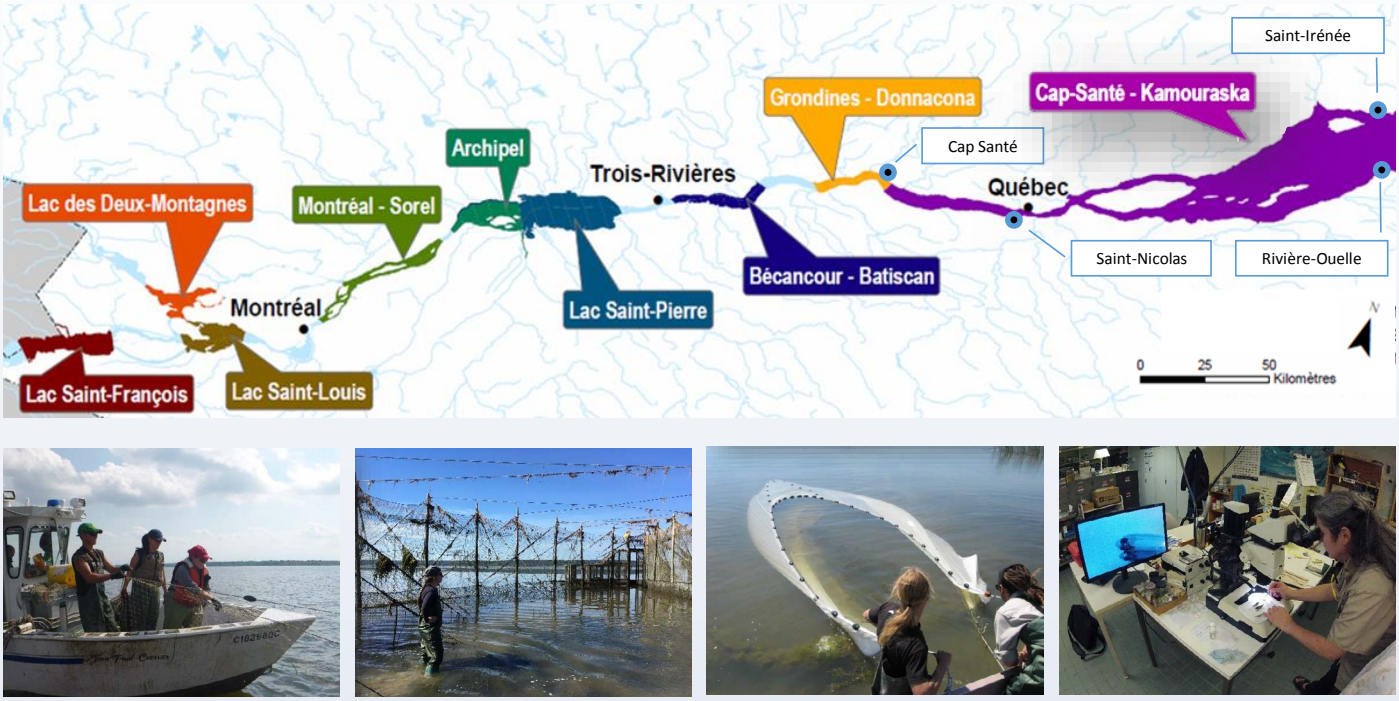

Figure 1. Principal sectors of the St. Lawrence River sampled as part of the Réseau de suivi ichtyologique (RSI, fish monitoring network) and the Réseau d'inventaire des poissons de l'estuaire (RIPE, estuary fish monitoring network). RSI sampling uses gill nets and shore seines in the fluvial portion of the St. Lawrence, while sampling under RIPE uses stationary traps in four sites on the estuary, located at Cap-Santé, Saint-Nicolas, Saint-Irénée and Rivière-Ouelle.

Numerous initiatives to acquire knowledge and inventories are added from time to time to the two main networks. These data sources were included in the analyses to evaluate the status of fish communities in the St. Lawrence and its habitats over the last 25 years.

A HETEROGENEOUS ECOSYSTEM

The portion of the St. Lawrence subject to this monitoring is a heterogeneous ecosystem, comprised of fluvial lakes, narrow sections and a brackish estuary. The physiographic and hydrological characteristics of these sectors are quite variable over space and time. This natural heterogeneity influences fish communities and habitats, in particular with regard to water flow patterns that differ greatly between sectors of calm and rapid water, and the presence of semidiurnal tides in its estuary portion. In addition, a great many tributaries flow into the St. Lawrence, bringing water with very distinctive and, at times, degraded natural physicochemical characteristics. Over a major part of its fluvial portion, the St. Lawrence is similar to a juxtaposition of several rivers, or water bodies, flowing side by side, each with a different signature, often identifiable over a very long distance. Moreover, the fluvial part of the St. Lawrence is artificially divided

in two by a navigation channel, funnelling the water flow in its centre.

It is primarily due to this physical heterogeneity, coupled with a great deal of anthropic perturbations acting at small and large scales, that so many contrasts in fish communities are observed from one sector to another. In addition, significant annual fluctuations in water levels are observed in the fluvial corridor. These habitat contrasts between the different sections and the dynamism of water levels greatly contribute to the complexity of evaluating the status of St. Lawrence fish communities.

FISH COMMUNITY STATUS INDICATORS

In order to provide a current portrait of the status of fish communities and aquatic habitats of the St. Lawrence and to judge the evolution of these elements, different status indicators were used: (1) Index of Biotic Integrity, (2) status of the stock of certain species subject to recreational and commercial fishing, (3) status of species under threat, (4) coastal zone fish biodiversity index and (5) relative abundance index for submerged aquatic vegetation.

Note that invasive aquatic species and the St. Lawrence striped bass population which are integral parts of this picture are detailed in separate publications (Paradis 2018, and Mainguy *et al.* 2018, respectively). Nevertheless they are taken into account in the conclusion and perspectives section.

1. INDEX OF BIOTIC INTEGRITY (IBI)

During several years, data from the RSI were used in particular to develop an index of biotic integrity (IBI) to evaluate that health status of fish communities. The IBI is composed of 12 descriptors reflecting various facets of the fish community (diversity, abundance, trophic level, tolerance to pollution, external anomalies, etc.; La Violette *et al.* 2003).

In order to ensure continuity with previous versions of this document, calculation of IBI was updated to compare the evolution over three time periods: (1) 1995–1997, (2) 2001–2006 and (3) 2007–2012. However, reduction in sampling efforts (in nets) and removal of seines during some sampling periods means that IBI cannot be calculated after 2012 by using the methodology developed by La Violette *et al.* (2003). Consequently, use of this indicator is limited.

The IBI results for the 1995–2012 period present a weak to intermediate health level for fish communities in the fluvial section (Figure 2). A comparison between the 1995–1997 and the 2007–2012 periods indicates some improvement in the values for this index. A 10% reduction in the number of river segments with a low IBI level and a 5% reduction of segments with a very low value were observed (Figure 2). However, during the 2007–2012 period, only 3% of river segments presented a status considered good.

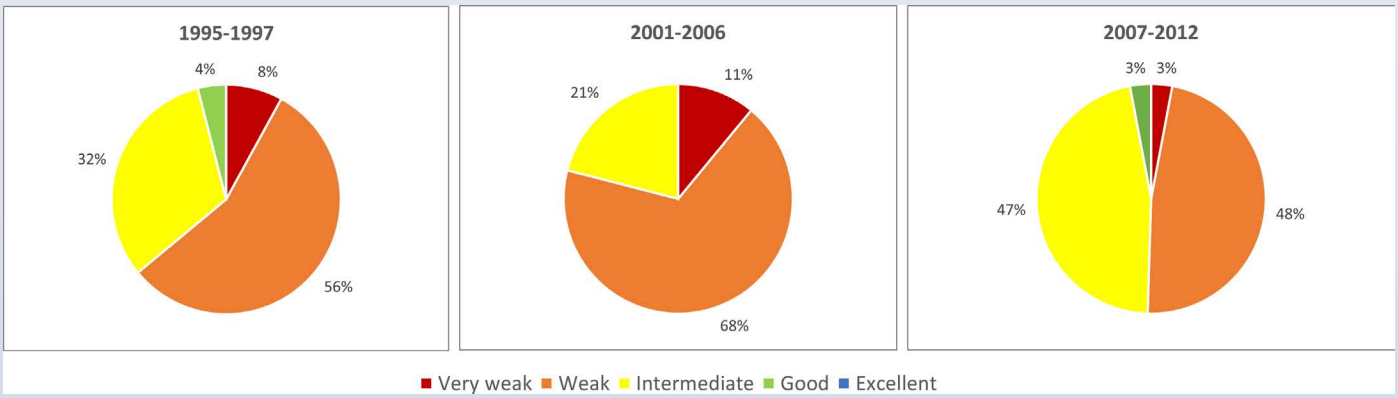

Figure 2. Proportion of IBI values calculated for different St. Lawrence River sectors (lac Saint-François, lac Saint-Louis, lac Saint-Pierre and its archipelago and Bécancour-Batiscan) for three sampling periods. For each sector, and IBI value was calculated by 5 km segment, separately for the north and south shores (bounded by the navigation channel).

While an approach using IBI is relevant in various types of waterways in Québec and elsewhere in the world to judge ecosystem health status, interpretation of IBI is delicate in a complex system like the St. Lawrence River. Moreover, a critical analysis of this index has demonstrated that it is not highly correlated with observed pressures on the St. Lawrence (Reyjol *et al.*, unpublished data), meaning it is not particularly adapted to the realities of this system. Use of several other indicators, analyzed separately, is necessary to adequately judge the status of St. Lawrence fish communities.

2. STATUS OF THE STOCK OF SOME EXPLOITED SPECIES

About 30 freshwater, anadromous[1] and catadromous[2] fish species are exploited by sport or commercial fishing in the St. Lawrence (Mingelbier *et al.* 2016). For the purposes of this document, only some species, representative of different sectors of the fluvial section and the estuary, will be addressed.

The status of the principal species fished in fluvial and estuary parts of the St. Lawrence is quite variable from one species to another, and in some cases between river sectors for the same species (Table 1). For some declining stocks, overfishing may explain a part of the decline. However, other factors may also be at play, related to the impact of human actions on fish habitats, on climate or the expansion of invasive aquatic species. The role of these factors and quantification of their effects on fish stocks are difficult to establish. Fortunately, in certain cases, it has been possible to determine the pressures that limit the re-establishment of fish populations. Here is a brief overview of the situation for some exploited species.

Table 1. Status of stocks of some St. Lawrence River fish species and non-exhaustive list of pressures and disturbances they suffer.

	Status of stock	Principal pressures	Management measures
Lake sturgeon (Downstream from Beauharnois)		• Fishing • Habitat fragmentation • Destruction of spawning beds	• Commercial fishery monitoring • Implementation of new commercial and sport exploitation methods • Development of spawning beds
Walleye		• Fishing • Habitat degradation	• Development of a management plan • Application of an exploitation size range (37–53 cm) applicable to sport and commercial fishing
Northern pike		• Fishing • Loss of floodplain spawning sites and of submerged aquatic vegetation • Water levels	• Re-evaluation of exploitation methods to come • Deployment of a collaborative, inter-ministerial action plan (*Stratégie d'intervention pour l'avenir du lac Saint-Pierre*)
American eel		• Fishing • Habitat fragmentation • Turbine mortality	• Development of a ministerial action plan • 50% reduction in commercial exploitation rate for silver eels through fishing permit buyback. • Installation of fishways
Yellow perch (Lac Saint-Pierre)		• Loss of floodplain spawning sites and of submerged aquatic vegetation • Fishing (currently closed)	• Sport and commercial fishing moratoriums • Stock status monitoring • Deployment of a collaborative inter-ministerial action plan (*Stratégie d'intervention pour l'avenir du lac Saint-Pierre*)

1 Live in the ocean but return to freshwater to spawn (e.g. tomcod).
2 Live in freshwater but return to the ocean to spawn (e.g. American eel)

Yellow perch

Yellow perch is an excellent example of a species whose status is quite variable, even diametrically different between the different sectors where it can be found in the St. Lawrence. Yellow perch stock is abundant in lac Saint-François and lac Saint-Louis and supports sustainable recreational fishing. (Mailhot *et al.* 2015). Downstream, the situation for this species is completely different, since yellow perch populations in lac Saint-Pierre and the section located between pont Laviolette and Saint-Pierre-les-Becquets have seen a major decline during the last two decades (Mailhot *et al.* 2015). This decline led to the imposition of a moratorium on commercial and sport yellow perch fishing in 2012 in la Saint-Pierre and in 2013 in the downstream sector (between pont Laviolette and Saint-Pierre-les-Becquets). The low concentration of young yellow perch following the closing of the fishery (Figure 3) justified the renewal of the moratorium in lac Saint-Pierre in 2017 and in the downstream sector in 2018 (Magnan *et al.* 2017 and 2018).

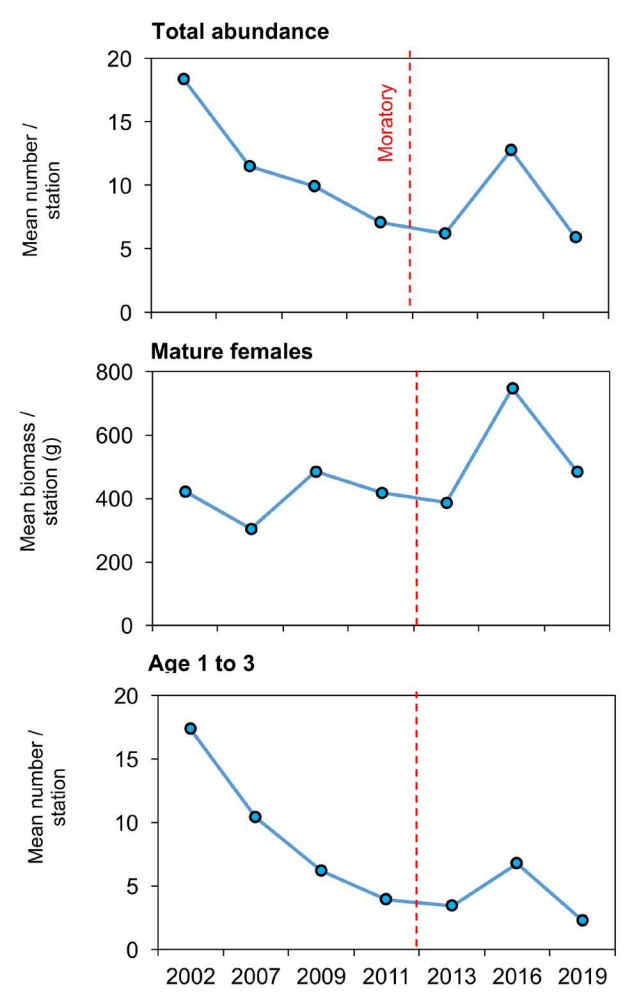

Figure 3. **Mean number of yellow perch, mean mass of reproductive females and mean number of young yellow perch between one and three years in lac Saint-Pierre from 2002 to 2019. The dotted vertical line marks the establishment of a moratorium on sport and commercial fishing in 2012 (from Paquin *et al.* 2018).**

Thanks to the halt in fishing, this yellow perch stock has now begun a slow re-establishment process, impeded by other factors primarily related to quality of habitat. This situation suggests that it is necessary to implement new solutions, other than fishing restrictions, including habitat restoration and water quality improvement (de la Chenelière *et al.* 2014, Magnan *et al.* 2017 and 2018).

Anthropic activities have had negative repercussions on aquatic habitats of the lac Saint-Pierre floodplain. Almost 5,000 ha of potential habitats for reproduction, fry rearing and growth in the floodplain have been modified, primarily due to intensification of farming practices during the last three decades (de la Chenelière *et al.* 2014, TCRLSP 2017). These habitats must be restored to re-establish the ecological functions of the floodplain which constitutes a reproduction habitat for yellow perch and many other fish species (e.g. northern pike, Foubert *et al.* 2018b, Foubert *et al.* accepted). Moreover, sectors where habitats are more frequently flooded have been identified as being priorities for the restoration of wetlands and the introduction of sustainable cultivation and agricultural practices (TCRLSP 2017).

A target for restoration of the most sensitive wildlife habitats of approximately 800 ha has been defined (TCRLSP 2017). Actions are in place as part of the Stratégie d'intervention pour l'avenir du lac Saint-Pierre [intervention strategy for the future of lac Saint-Pierre] with the goal of restoring priority habitats of the shoreline of the lake and to gain knowledge on developing sustainable agriculture in this area.

Other pressures apparently acting on yellow perch stock in lac Saint-Pierre over several years have also been demonstrated more recently, including the effect of pesticides and other contaminants on the immune and reproductive systems of yellow perch as well as on their survival potential (Bruneau *et al.* 2016, Giraudo *et al.* 2016, Landry *et al.* 2017, Khadra *et al.* 2019).

Walleye and sauger

The status of walleye stocks evaluated in 2010 indicated a decline in St. Lawrence River populations. In response to this finding, a walleye and sauger management plan was established in 2011 for all of Québec in order to improve the status of stocks and fishery quality. For the St. Lawrence, this plan involves the release of walleye less than 37 cm and greater than 53 cm caught in recreational and commercial fishing in order to protect juvenile fish and breeders. Walleye stocks have responded well to this management practice, as scientific fishing has revealed an increase in global abundance of the population, the abundance of mature females and the average length of walleye (Blais *et al.* 2016, Paquin *et al.* 2018). However, the situation for sauger is different from that of the walleye. Sauger levels, which were increasing between 2002 and 2011, now show a decline in lac Saint-Pierre (Paquin *et al.* 2018). The health status of the sauger population in lac Saint-Pierre is considered as being at risk of destabilization given the strong pressure on this species from sport fishing. If this trend continues, a prudent management approach will have to be recommended.

Lake sturgeon and Atlantic sturgeon

The lake sturgeon population located downstream from the Beauharnois dam is the largest in Canada. This population supports a commercial fishery, which has operated for more than 100 years. Following application of several management measures and improvement of spawning habitats, an increase in lake sturgeon populations was observed during the last decade throughout the St. Lawrence River. (Dumont *et al.* 2013). Recent observations have indicated the presence of the species on certain spawning beds that had been rarely or never documented previously, or considered abandoned (e.g. the following rivers: Chaudière, Montmorency, Richelieu, des Mille-Îles, du Sud), confirming that the lake sturgeon situation is improving after more than three decades of decline. However, this species remains vulnerable to fishing due to the particular characteristics of its life cycle (e.g. late sexual maturity). The species is also vulnerable to poaching due to its gregarious nature and high market value.

The Atlantic sturgeon is found further downstream, in the brackish portion of the St. Lawrence. It also supports a historic commercial fishery. For several years, monitoring appeared to indicate that populations were in good health. However, a recent analysis of all available data indicates that the population may be at risk due, in particular, to a trend of decline in subadults and breeders (L'Italien and Paradis 2019). Fortunately, in 2017 and 2018, quantities of juvenile Atlantic sturgeon reached historic highs, indicating that the coming years will see strong cohorts (L'Italien and Paradis 2019).

American eel

American eel used to be considered a very common species, well distributed throughout the watersheds connected to the St. Lawrence River and gulf. However, the number of juvenile eels migrating upstream to the Great Lakes is now estimated at less than 1% of average levels measured during the 1975–1985 period. The causes for this decline are multiple: habitat fragmentation, mortality during passage through hydroelectric turbines, commercial fishing, parasite infection and disease, contaminants, climate changes and ocean changes.

Despite re-establishment efforts made during the last two decades, in particular through commercial fishery permit buyback programs and the transfer of young eel into what had historically been very productive growth areas, the status of the eel is still of great concern in Québec. A provincial action plan is being developed in order to promote the growth and survival of eels in the region and to improve understanding of the species.

3. SPECIES UNDER THREAT

The St. Lawrence and its tributaries provide habitats for several threatened fish species. Under the Act respecting threatened or vulnerable species (ATVS), five St. Lawrence fish species are designated as vulnerable (American shad, river redhorse, the rainbow smelt population in the south estuary, log perch, channel darter and bridle shiner) and three species are designated as threatened (Northern brook lamprey, Eastern sand darter, and copper redhorse). Ten St. Lawrence species are also on the Québec list of wildlife species likely to be designated as threatened or vulnerable, including the American eel, lake sturgeon and Atlantic surgeon.

It is generally difficult to judge the evolution over time of the condition of species whose situation is threatened. However, intensification of data collection initiatives beginning in the early 2000s has allowed for a significant increase in the number of occurrences recorded for most of these species (Ricard at al. 2018).

In addition, new threatened statuses have been reported for several species, primarily in tributaries of the St. Lawrence, not in the fluvial segment. These new reports have considerably improved understanding of the distribution of threatened species and their preferred habitats.

Copper redhorse

The copper redhorse is a species endemic to Québec, considered to be endangered under the Species at Risk Act, and deemed threatened under the ATVS. In order to promote re-establishment of this unique population, several conservation initiatives have been deployed during recent decades. Between 2004 and 2018, approximately 3.6 million copper redhorse larvae and 230,000 alevins were introduced into the rivière Richelieu. This conservation stocking will be necessary until signs of natural reproduction judged sufficient are observed and the stock of breeders becomes self-sufficient. Since 2016, detection of young individuals in the St. Lawrence and the arrival of subadults at the Vianney-Legendre fishway (rivière Richelieu) are encouraging news because individuals of that size range were practically absent from several inventories done over the last 25 years within the copper redhorse distribution range (COSEPAC 2014).

Recently, development of species detection methods through environmental DNA (eDNA) has allowed for significant breakthroughs with regard to data acquisition on threatened species, including the copper redhorse. Although indirect, this detection method is much more sensitive than traditional catch methods. For example, at more than 3,600 sampling stations done between 1996 and 2018, only one copper redhorse was caught during the RSI in the lac Saint-Pierre archipelago in 2015. For comparative purposes, a sampling campaign in 34 stations, done in 2015 in habitats suitable for the species permitted detection of copper redhorse DNA at 26% of sampling sites. During the study, copper redhorse DNA was detected in the following sectors: rivière Richelieu, Montréal, Contrecœur and the lac Saint-Pierre archipelago. This matches the known distribution area of the species.

During the 2015 sampling, copper redhorse DNA was also detected in the lower portions of the Yamaska and Saint-François rivers (Figure 4). This eDNA detection, complementary to observations during telemetric monitoring, support the hypothesis of the presence of copper redhorse in the lower portion of the rivière Saint-François. However, the nature and extent of use of this habitat remain unknown.

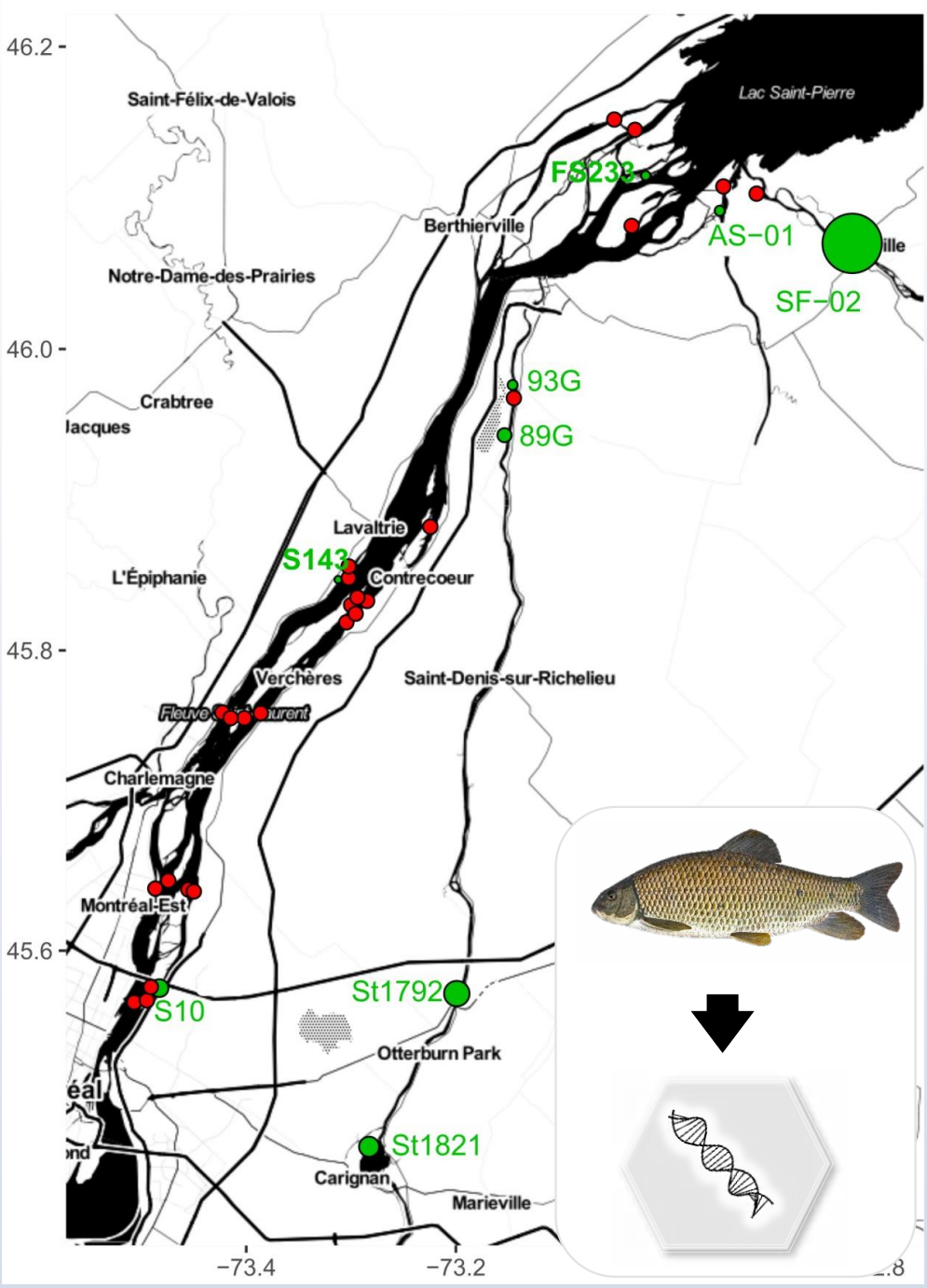

Figure 4. **Spatial distribution of sampling stations where copper redhorse DNA was detected in the water. A green circle indicates at least one positive amplification during analysis while a red circle indicates absence of DNA of the species under study. The size of the circle represents the quantity of DNA found in the water sample (Université Laval and MFFP, unpublished data).**

While it is harder to interpret than the direct capture of specimens, the eDNA detection method opens up very interesting perspectives, complementary to traditional inventory methods, in particular for rare species.

4. BIODIVERSITY INDICES AND COMMUNITY COMPOSITION

In order to monitor over time the evolution of diversity of fish in the coastal zone of the St. Lawrence, and analysis of seine-collected data during RSI was done (Foubert *et al.* 2018a). Calculated indices of diversity revealed new diversity hotspots, some of which had been unsuspected.

The total number of species sampled (species richness) showed higher values in the lac Saint-Pierre Archipelago (Figure 5a). In contrast, an index taking into account the taxonomic distance between species caught has presented a completely different diversity pattern indicating maximum values of diversity in the fluvial estuary (Figure 5b). This result underlines that even if the total number of species is less in the fluvial estuary than in the archipelago, the taxonomic diversity of fish, and consequently the diversity of ecological functions represented, is higher there. These analyses reveal that each index possesses interpretation limits and it is preferable, when describing the diversity of fish communities in the St. Lawrence, to use several complementary indices. For a given sector, calculated indices did not show clear tendencies over time among the different RSI sampling periods (Figure 5). However, changes in fish community structure in the coastal zone appeared after the arrival and establishment of round goby in the St. Lawrence (Morissette *et al.* 2018). The tessellated darter, a small benthic fish species, has seen a considerable decline following the arrival of the round goby in the St. Lawrence (Paradis 2018).

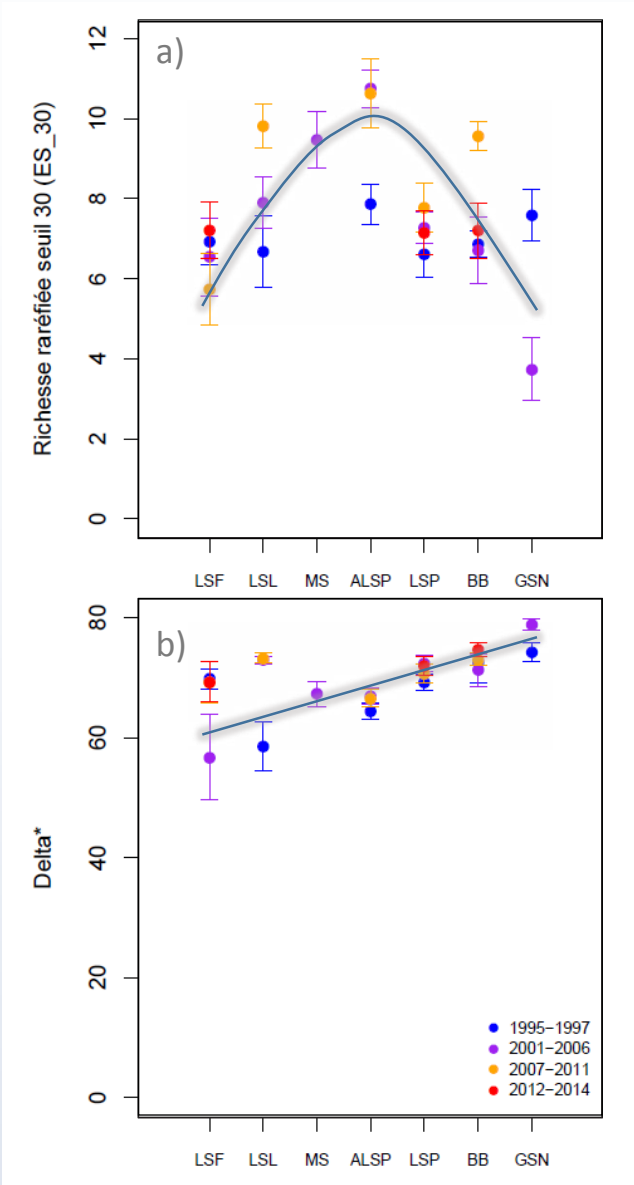

Figure 5. **Evolution over time of two biodiversity indices in the Shoreline zone in the fluvial segment of the St. Lawrence (sectors sampled are represented from upstream to downstream: LSF : Lac Saint-François; LSL : Lac Saint-Louis; MS : Montréal-Sorel; ALSP : Lac Saint-Pierre archipelago; LSP : Lac Saint-Pierre; BB : Bécancour-Batiscan; GSN : Grondines–Saint-Nicolas). Indices represent: (a) rarefied richness, i.e. the total number of species captured (specific richness), corrected for bias in the sampling effort and (b) Delta* which is a diversity index that takes into account the taxonomic distance between two individuals taken randomly (Foubert et al 2018a).**

Several changes in the structure of fish communities have also been observed in species caught in gill nets. In piscivorous fish, a reduction in the abundance of the Northern pike and an increase in smallmouth bass have been observed following arrival of the round goby (Morissette *et al.* 2018).

A modification in fish communities sampled via gill nets was also noted between 2001 and 2017 in lac Saint-Pierre and in the pont Laviolette–Saint-Pierre-les-Becquets sector (Magnan *et al.* 2017 and 2018). Among the greatest changes was an increase in the abundance of the mooneye, channel catfish and the shorthead redhorse, which are the dominant species in terms of biomass. These changes appear to reflect modifications in aquatic habitat arising in these sectors.

5. AQUATIC VEGETATION

Submerged aquatic vegetation plays an important role in aquatic ecosystems. Its presence generally indicates high quality habitat for fish. Vegetation offers a substrate for the laying of eggs by several fish species in addition to being greatly used as feeding habitats and acts as a refuge during young life stages.

In order to evaluate the status of submerged aquatic vegetation in the St. Lawrence, a new index was developed on the basis of vegetation data collected in a systematic fashion during the RSI. For each gill net sampling station, abundance of submerged aquatic vegetation was estimated visually on a semi-quantitative scale of 1 (no vegetation) to 5 (complete vegetation cover). The frequency of occurrence of each vegetation abundance rate was calculated for each year and each sector. These frequency of occurrences were then compared for each sector between two inventory periods, historic and recent (Figure 6).

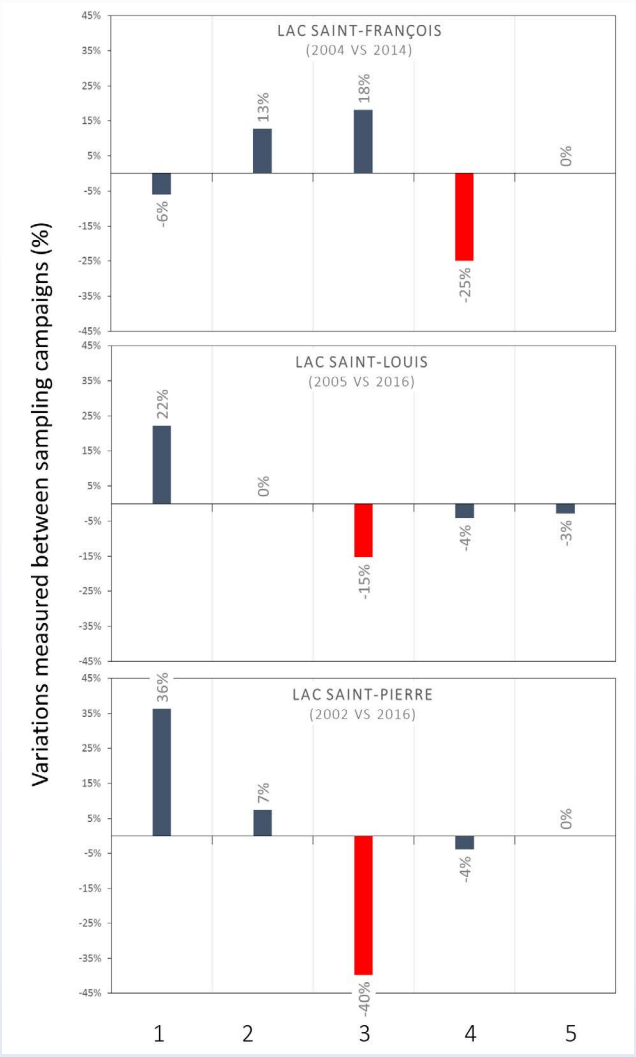

Figure 6. Evolution over time of the abundance of submerged aquatic plants in different sectors of the St. Lawrence River. The index is based on the visual characterization of vegetation at gill net sample stations during the RSI. Definition of abundance levels: (1) no plants; (2) sparse vegetation; (3) several plants; (4) complete vegetation cover without surface plants; (5) complete vegetation cover with surface plants.

Results show that the most important changes were observed in lac Saint-Pierre, in which the percentage of stations where submerged aquatic vegetation was found saw a marked decrease (Figure 6). Since 2002, the number of stations with several aquatic plants has dropped by 40% while the percentage of stations without aquatic vegetation increased by 36%. While

of a smaller range, this drop in presence of aquatic vegetation appears to also manifest in lac Saint-François and lac Saint-Louis. This reduction in the abundance of aquatic plants may have significant effects on fish communities and on fluvial lake dynamics. For lac Saint-Pierre, other studies have corroborated the recent loss of aquatic vegetation (Hudon *et al.* 2018, Morin *et al.* unpublished data).

For this water body, the most recent analyses indicate that, beginning in the early 2000s, changes observed in water quality in tributaries of lac Saint-Pierre have led to a significant reduction in submerged aquatic vegetation abundance (Giacomazzo *et al.* in press; Hudon *et al.* 2018). Moreover, the disappearance of vast aquatic vegetation areas in lac Saint-Pierre was accompanied by a proliferation of benthic cyanobacteria (Hudon *et al.* 2012). During the same period, the drop in growth of young yellow perch of the year together with a reduction in abundance of submerged aquatic vegetation, have led to a drop in abundance of the species in the system and reductions in fishery yields (Giacomazzo *et al.*, in press).

The new index on aquatic vegetation presented in this document must be interpreted with caution, since it is based on a visual assessment of the abundance of aquatic vegetation. Despite interpretation limits, the indicator has great potential for monitoring the status of fish habitats. Other, more accurate sampling methods using sonar are being developed and may contribute to a better understanding of the evolution of vegetation in the St. Lawrence over the next years.

CONCLUSIONS AND PERSPECTIVES

The status of St. Lawrence River fish communities is quite variable among sectors and species, and the use of several indicators is essential in order to represent all these gradations.

During the last decades, some fish species subject to fishing have seen declines. Fortunately, appropriate management measures have allowed, in certain cases, the re-establishment of populations at levels sustainable for exploitation (e.g. lake sturgeon and walleye). However, certain stocks exploited for recreational and commercial fishing have been slow to recover and continue to show signs of collapse or low levels, despite multiple measures implemented for their re-establishment (e.g. American eel and yellow perch in lac Saint-Pierre). This demonstrates that factors other than fishing must be considered (e.g. habitat quality and size, water quality, connectivity among habitats, presence of invasive species) and integrated into species management plans. To achieve this, wildlife concerns will have to be integrated into the practices for everyone connected to the St. Lawrence, so as to reduce pressures weighing on this ecosystem. Commitment from a broad range of stakeholders of the agricultural, municipal and industrial sectors will be necessary. By providing a common vision and coherent goals, measures can be implemented effectively and sustainably to preserve and restore the aquatic resources of the St. Lawrence River.

For threatened species, more intensive sampling, specifically focused on some of these species have revealed numerous occurrences during the last few years, in particular in the tributaries of the St. Lawrence. These new data highlight the essential role of the tributaries and the importance of updating wildlife information in these areas.

Despite the high variability shown by various indicators, the overall status of fish communities is judged as intermediate. The principal challenges to improve the status of fish communities in the following decade will include:

1) Improving the status of aquatic vegetation and the Saint-Pierre floodplain;

2) Increasing the level of abundance of some exploited species (e.g. American eel and yellow perch in lac Saint-Pierre);

3) Improving water quality and integrity of habitats used by the various threatened species.

Current and future challenges are not all associated with species decline or degradation and loss of habitat. Improvement of the status of lake sturgeon stocks and the successful reintroduction of the striped bass in the St. Lawrence testify to the resilience of the ecosystem and the possibility of regaining a potential that had been lost. In addition, several new spawning beds have been discovered during the last few years in different sectors. This greatly contributes to locating critical habitats for St. Lawrence River fish and to guide protection.

ACKNOWLEDGEMENTS

We would like to thank the many people—biologists, wildlife technicians, wildlife conservation officers, recreational and commercial fishers—who have contributed, over the years to the acquisition of knowledge about the fish of the St. Lawrence. We would like to especially underline the passion and devotion of the RSI and RIPE teams as well as the various partners who participate each year in fieldwork and laboratory work, which are essential to maintaining the understanding of the aquatic fauna of the St. Lawrence.

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PROGRAM TO MONITOR THE STATUS OF THE ST. LAWRENCE

Five governmental partners —Environment and Climate Change Canada, Fisheries and Oceans Canada, Parks Canada, the ministère de l'Environnement et de la Lutte contre les changements climatiques du Québec and the ministère des Forêts, de la Faune et des Parcs du Québec—as well as Stratégies St. Lawrence, a non-governmental organization active with riverfront communities, combine their expertise and efforts to report to the public on the status and long term evolution of the St. Lawrence River.