



WATER

SEDIMENTS

SHORELINES

BIOLOGICAL RESOURCES

USES

FRESHWATER FISH COMMUNITIES

Background

Fish communities have been selected as an indicator for assessing the state of the St. Lawrence River ecosystem since they reflect many environmental stresses, both on a spatial and a temporal scale. Fish possess several attributes of a good environmental indicator: extensive information is available on the biology and needs of many species; they integrate changes and disturbances that occur in the food

chain; they are easy to collect and identify; and they lend themselves to the measurement of chronic or acute conditions caused by toxic substances. They are also of interest to decision-makers and the general public because of their economic and recreational value.

The most recent systematic studies of fish communities in the Quebec portion of the freshwater section of the St. Lawrence were done nearly 30 years ago and were limited to certain sectors



Lake Saint-Pierre archipelago



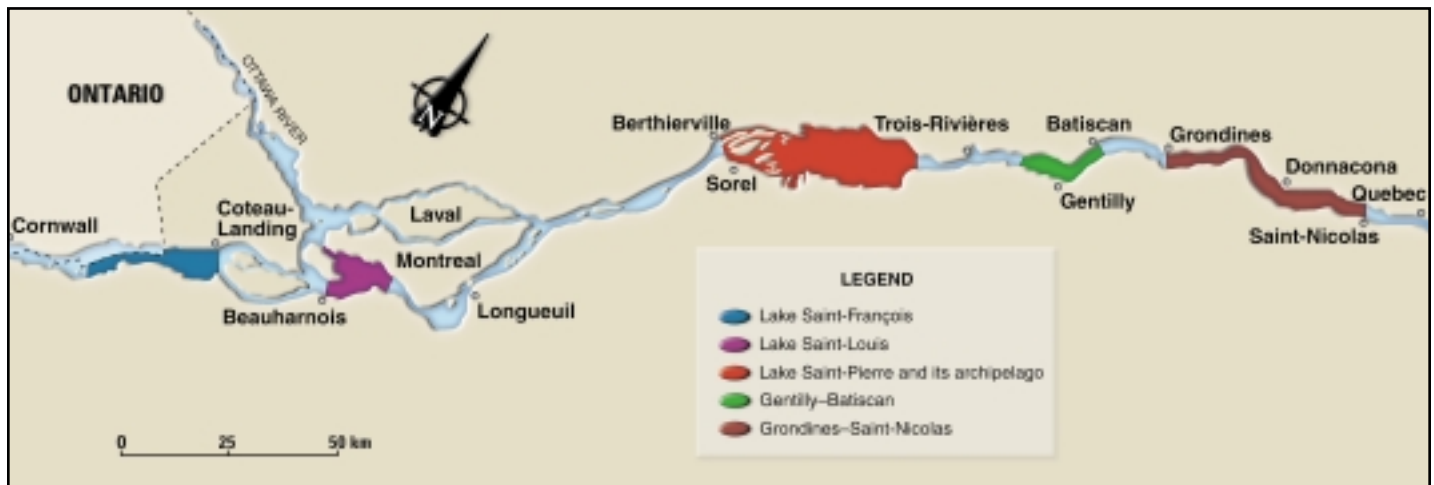
Photo: Sylvain Desloges, FAPAO

Gill net fishing

of the St. Lawrence River and to species inventories. Moreover, the only time series data available on fish community abundance is from the Aquarium de Québec fishery station, and cover a period of approximately 30 years. From a spatial perspective however, the usefulness of this data is obviously quite limited. Consequently, with the data available, it was not possible to draw any definitive conclusions concerning the state of the St. Lawrence ecosystem or the changes affecting it over time — hence the importance of establishing a Fish Monitoring Network (FMN). Although there are still a number of stresses that threaten the St. Lawrence ecosystem, numerous rehabilitation initiatives have been undertaken over the years: municipal and industrial wastewater treatment, improvement of farming practices, habitat restoration, discontinuing of the military artillery

Photo: Normand Carliépy, Lake Saint-Pierre Biosphere Reserve

Figure 1. Fish Monitoring Network sampling sectors for the St. Lawrence River: 1995-1997



firing in Lake Saint-Pierre, etc. While some species have increased in number, others have declined (copper redhorse, lake sturgeon), or even disappeared (striped bass). Regardless of whether these fluctuations are caused by natural or human factors, it is important to be able to measure them in order to monitor changes over time and in different locations. Given the various looming environmental threats (climate change, lower water levels, invasions of exotic species, etc.), the information obtained through this monitoring program will undoubtedly prove to be vital for decision making.

During the first FMN sampling program, which was conducted from 1995 to 1997, fish communities were sampled in five different sectors upstream from Quebec City: Lake Saint-François, Lake Saint-Louis, Lake Saint-Pierre and its archipelago, as well as Gentilly-Batiscan and Grondines-Saint-Nicolas (Figure 1). The objective of this program was to collect, using a standardized and reproducible scientific method, quantitative data on these communities that could be used to assess the overall health of the St. Lawrence River.

Overview of the Situation

Biodiversity

In total, 58 of the 102 known species in the freshwater section of the St. Lawrence were observed in our samples. The most diversified sectors were the Lake Saint-Pierre archipelago and Lake Saint-Louis, where up to 38 fish species

were counted (Figure 2). This large number of species mainly reflects the wide variety of habitats found in these two sectors. For Lake Saint-Louis, other factors must also be considered, including the overlapping of several fish migration routes, milder climatic conditions and seasonal variations in water levels. The sectors with the least number of species were Grondines-Donnacona, the north

Figure 2. Number of fish species in the St. Lawrence River: 1995-1997. Each point (■) designates a segment, i.e., a group of stations spread over a distance of 5 km.

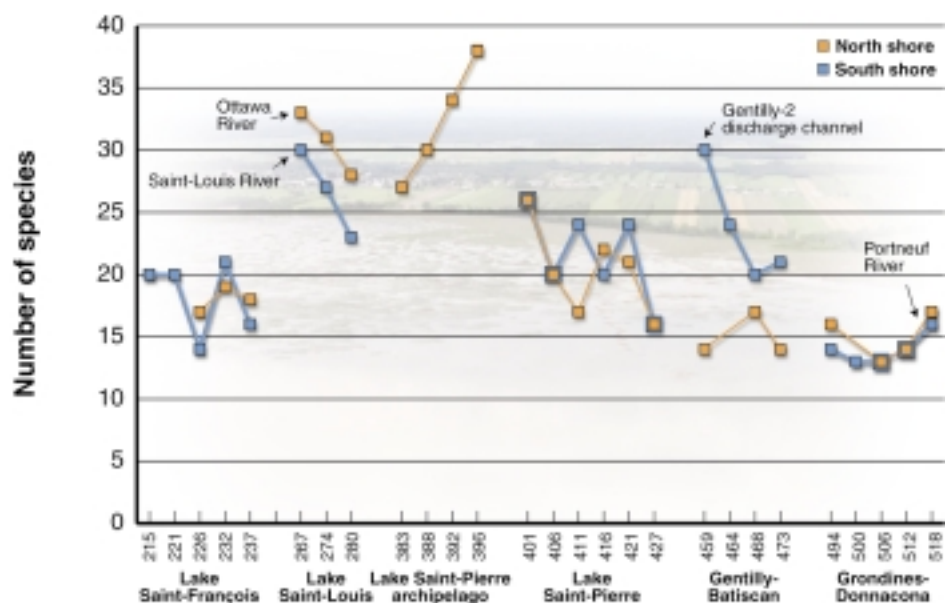




Photo: Yves Mailhot, FAPAQ

South shore of the Gentilly-Batiscan sector

shore of Gentilly-Batiscan and Lake Saint-François, where fewer than 20 species were counted in each. The low fish diversity in the Grondines-Donnacona sector is attributable primarily to the harsh conditions caused by the large tidal movement. A noticeable decline in aquatic and riparian plant communities is also evident downstream from Grondines. On the north shore in the Gentilly-Batiscan sector, the reduction in species diversity is attributable mainly to lower habitat diversity (few slow-flowing areas, limited aquatic vegetation) combined with habitat deterioration associated with shipping

traffic (dredging, rip-rapping of shorelines to counter erosion). Moreover, the strong tidal currents, as well as the intense shipping traffic in this area forced us to move certain stations and to refrain from sampling others, which may also have influenced the results obtained.

In Lake Saint-François, the construction of dams both upstream and downstream, as well as the subsequent raising and stabilization of the water level undoubtedly contributed to reducing fish diversity. These dams eliminated floodplain habitat, prevented further fish migration and caused the

disappearance of most swift-water spawning grounds. A total of 27 species were caught in this lake, which represents a significantly lower diversity than in the other two fluvial lakes (Saint-Louis and Saint-Pierre), where 40 species were counted in each. In contrast, a total of 43 species were counted as part of an inventory carried out in the summer of 1968 in this area. Species that were relatively rare in 1968 and not found again in 1996 include several species of minnows, which are known to be sensitive to pollution and other disturbances. Although we may never know for sure, it is possible that these species were abundant prior to construction of the Beauharnois generating station (1929) and the St. Lawrence Seaway (late 1950s), after which their populations probably declined progressively up to 1968, before finally disappearing. Other studies have shown that a reduction in the number of species is one of the most obvious signs of a disturbed ecosystem.



Photo: Yves Mailhot, FAPAQ

St. Lawrence River near Montreal

Index of Biotic Integrity

The index of biotic integrity (IBI) generally ranges between fair and poor for the St. Lawrence as a whole, which indicates that the river is in a quite deteriorated state (Figure 3). There are no segments in the excellent category, and only two segments within the good class.

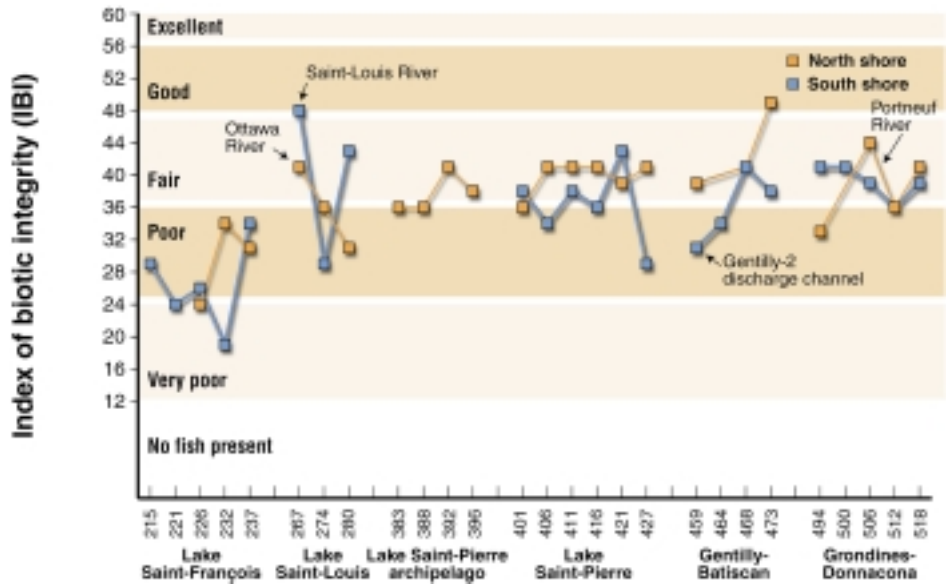
Lake Saint-François, with index values of poor to very poor, is the most disturbed sector of the St. Lawrence. This result indicates that the building of dams at both the inlet and outlet of the lake, the raising and stabilization of the water level, as well as the elimination of the spring floodplain and rapids, may be among the most important stresses inflicted on fish communities. On the north shore, the improvement observed between segments 226 and 232, where the IBI rises from the very poor to the poor class, is consistent with a west to east increasing quality gradient based on the distribution of contaminants and an additional benthic invertebrate index. On the south shore, the IBI reaches the lowest value for the entire St. Lawrence River at segment 232, a sedimentation area which in 1989 had high levels of contaminants, including polychlorinated biphenyls (PCBs).



Fish sampling using seine nets

Photo: Denis Fournier, FAPAO

Figure 3. Index of biotic integrity of the St. Lawrence River: 1995-1997. Each point (■) designates a segment, i.e. a group of stations spread over a distance of 5 km.



The index values for Lake Saint-Louis are generally higher than for Lake Saint-François. On the north shore, downstream from the confluence of the Ottawa River, the fish communities are disturbed, as shown by the gradual decline in the IBI from fair to poor. On the south shore, the index values deteriorate significantly downstream from the confluence of the Saint-Louis River, changing from good to poor, before improving again further downstream to fair. The îles de la Paix sector exhibits the most obvious ecosystem degradation of the entire area studied. The proportion of pollution-tolerant fish increases significantly, as does the percentage of omnivores, a group having a diversified diet and therefore capable of adapting to what the environment has to offer. On the other hand, insectivorous minnows, a group whose diet is highly specialized, disappear almost completely. This deterioration is reflected not only in the characteristics of the fish communities, but also in water, sediment,

benthos and fish contamination. This is attributed to a number of industrial polluters that for many years discharged untreated wastewater directly into Lake Saint-Louis or indirectly via the Saint-Louis River, as well as to leachate water from toxic waste sites. These companies carried out clean-up operations between 1992 and 1998.

On the north shore of the Lake Saint-Pierre archipelago, the improvement in the IBI from poor to fair could reflect, at least in part, the dilution of pollution associated with municipal wastewater discharges from Laval (most of which was untreated at the time of the study in 1995) and from Montreal (treated since 1988). For Lake Saint-Pierre, the index generally falls into the fair class on the north shore, with slightly higher values than on the south shore. However, half of the segments on the south shore are not representative because of the small number of stations and the fact that they were sampled in slow current areas only. Hence, it is difficult to interpret the

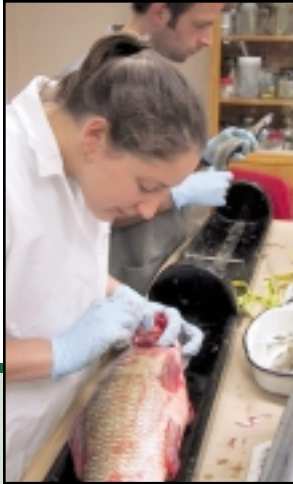


Photo: Yves Maillhot, FAPAQ

Fish examination in the laboratory

KEY VARIABLES

Index of Biotic Integrity

Fish are sensitive to the physical and chemical quality of their habitat. By measuring and compiling a number of characteristics of fish communities such as biomass, diversity, number of pollution-sensitive species and prevalence of abnormalities, we obtain what is called an index of biotic integrity. This type of index, which is used around the world, provides information on the general health of an aquatic ecosystem. Depending on the state of the St. Lawrence, the value of the index will fall into one of the following classes: excellent, good, fair, poor, very poor or no fish present.

differences between opposite shores. The same is true for the Gentilly-Batiscan sector where, this time, the north shore results must be interpreted with caution because of the smaller number of stations and a less systematic sampling than on the opposite shore. On the south shore, the recovery of the fish communities with increasing distance from the Gentilly-2 thermal effluent or as a result of pollution reduction emanating from the Bécancour industrial park cannot be clearly demonstrated, despite the improvement in the index, because of significant discrepancies between the fish community characteristics. Some of the characteristics point to a deterioration, while others indicate an improvement.

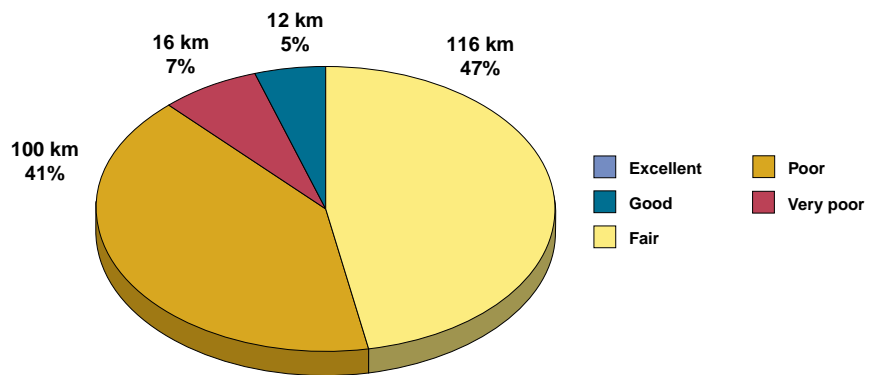
In the Grondines-Donnacona sector, the IBI ranges from fair to poor, with relatively similar values on both shores. On the north shore, the low index value in segment 494 is difficult to explain, but could be the result of the considerable shore erosion around Grondines. The deterioration downstream from the Portneuf wharf and the confluence of the Portneuf River could be attributable to the high proportion of artificial shores in this area, the high levels of

certain metals in the sediments, the change in flow currents caused by the long wharf, as well as the presence of three pulp and paper mills. Although these mills are located further downstream, the pollution they generate may have effects upstream because of the current reversal during flood tide.

Overall, of the 244 km of St. Lawrence River studied (120 km on the north shore and 124 km on the south shore), biotic integrity is classified as good over 12 km (5%), fair over 116 km (47%), poor over 100 km (41%) and very poor over 16 km (7%) (Figure 4). The situation is essentially the same for both shores; that is why the two were combined.

The IBI developed for the St. Lawrence has proven to be a sensitive tool for identifying certain habitat disturbances and pollution sources. However, it appears to less accurately reflect the state of the environment, particularly for Lake Saint-Pierre and the Gentilly-Batiscan sector. Corrective measures proposed for the second phase of sampling, begun in 2001, should help to improve the performance of this index. However, although the IBI is still in need of some refinements, the results of this study, for the most part original,

Figure 4. Assessment of the biotic integrity of the St. Lawrence River (244 km)



still constitute an invaluable source of information for all users of the St. Lawrence River (scientists, managers, riverside communities, ZIP committees, etc.). This data constitutes the first and only information currently available on the state of fish communities in the freshwater portion of the St. Lawrence as a whole.



Photo: Normand Courtemanche, FAPAO

South shore of the Grondines-Saint-Nicolas sector

Outlook

At the Earth Summit in Rio de Janeiro in 1992, the Quebec government made a formal commitment to preserve biodiversity. It was subsequently recommended that activities aimed at providing more accurate assessments of the biological diversity of inland waters be continued. Adopting tools such as the FMN is one way in which Quebec is acting on this commitment, which it reiterated in Johannesburg in 2002.

Furthermore, this monitoring program will provide us with better knowledge and understanding of the Great Lakes-St. Lawrence ecosystem as well as the capability for evaluating its state and evolution over time. This knowledge will be of crucial importance given the various environmental disturbances anticipated in the future and will enable managers to make informed decisions. It will also be vitally important in providing

To Know More

LA VIOLETTE, N., FOURNIER, D., DUMONT, P., and Y. MAILHOT. In preparation. *Caractérisation des communautés de poissons et développement d'un indice d'intégrité biotique pour le fleuve Saint-Laurent, 1995-1997*. Société de la faune et des parcs du Québec, Direction de la recherche sur la faune.

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a reference point for determining the success of planned restoration measures, such as the proposed reintroduction of the striped bass in 2004, a species that disappeared from the St. Lawrence in the late 1960s.

State of the St. Lawrence Monitoring Program

Four government partners — Environment Canada, the ministère de l'Environnement du Québec, the Société de la faune et des parcs du Québec, and Fisheries and Oceans Canada — are pooling their expertise and efforts to provide Canadians with information on the state of the St. Lawrence and long-term trends affecting it. To this end, environmental indicators have been developed on the basis of data collected

as part of each organization's ongoing environmental monitoring activities. These activities cover the main components of the environment, namely water (quality and quantity), sediments, biological resources (species diversity and condition), uses and, eventually, shorelines.

For additional copies or the complete collection of fact sheets, contact the

St. Lawrence Vision 2000 Coordination Office:

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The fact sheets and additional information about the program are also available on the Web site: www.slv2000.qc.ca.

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