Monitoring the State of the
ST.LAURENCE RIVER

BIOLOGICAL RESOURCES

WATER | SEDIMENTS | SHORELINES | USES

What is the status of benthic communities in Lake Saint-Pierre?

3rd edition

Status: Moderate-Good

Observed change: Deterioration from 2004 to 2006, followedby an improving trend until 2014.

Highlight

Benthic macroinvertebrates—insects, worms and molluscs that live on the bottom of lakes and rivers—can be used to determine whether environmental conditions are good or show signs of disturbance. Based on biomonitoring studies conducted by Environment and Climate Change Canada scientists, the status of the benthic communities in Lake Saint-Pierre between 2012 and 2014 was classified as moderate-good; these communities have shown signs of improvement since 2006.

Issue

In natural aquatic ecosystems, benthic organisms are distributed according to their biological needs. Some benthic organisms require oxygen-rich water, while others live in or on soft or rocky substrates. The set of environmental conditions that a species needs in order to complete its life cycle and maintain a stable population is referred to as its "ecological niche."

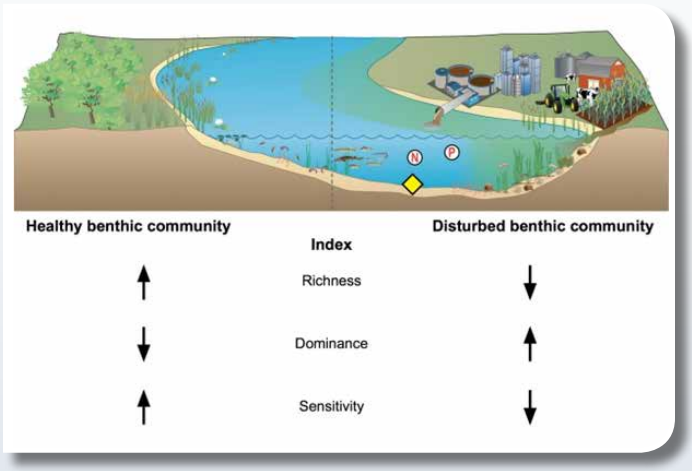

Figure 1: Change in indices related to the status of benthic macroinvertebrate communities

Over time, changes in environmental conditions lead to changes within the benthic community. Natural factors—including climatic variations (precipitation, temperature), type of wetland sampled (aquatic grass beds vs. low marsh), site elevation or the presence of a competing species—may be involved. Anthropogenic factors may also affect benthic communities. For example, the impacts of urban and agricultural runoff on benthic communities have been observed downstream from the Island of Montreal. Monitoring results for the period prior to 2013 showed a worrisome situation for benthic communities in downstream areas, particularly around the Contrecoeur Islands and the Berthier-Sorel Islands in Lake Saint-Pierre, but this was not the case for communities located upstream (Savage et al., 2013).

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Since benthic organisms respond to changes in their environmental conditions, they are useful indicators for aquatic biomonitoring aimed at assessing water quality (presence of nutrients). Certain species are more sensitive than others to various stressors, and may exhibit a decrease in their growth or reproduction (chronic effect) or even mortality (acute effect). Exposure to stressors may result in changes in abundance and benthic community composition.

Key measures

Three indices are used to assess benthic community status, or condition: community (taxa) richness, community composition and number of pollution-sensitive families.

The quality criteria for these three indices were calculated using more than 100 reference sites along the St. Lawrence from Lake Saint-François to Lake Saint-Pierre. Benthic communities can be classified in five categories based on their condition: *excellent*, *enriched*, *satisfactory*, *impoverished* and *degraded*.

Community (taxa) richness

The greater the richness of a community, the better its state of health (Gernes and Helgen 1999; U.S. EPA 2002). In benthic communities, the number of genus declines as the level of disturbance increases.

Degrated	Impoverished	Satisfactory	Enriched	Excellent
<14	14 to 20	>20 to 30	>31 to 38	>38

Dominance in macroinvertebrate community composition

The relative abundance of crustaceans and molluscs increases in response to disturbance. Where a community is dominated by a group of species or a given species, this indicates that the biophysical conditions are unfavourable (or too degraded) for other species. The higher the index value, the more a community is considered to be degraded (Gernes and Helgen 1999; US EPA 2002).

Degrated	Impoverished	Satisfactory	Enriched	Excellent
>57%	>27 to 57%	>18 to 27%	3 to 18%	<3%

Number of organic pollution-sensitive families

As organic pollution increases, the abundance of pollution-sensitive macroinvertebrates decreases. This metric uses the number of families of Ephemeroptera, Trichoptera, Pisidiidae and Anisoptera (ETPA).[1] The greater the number of ETPA families, the healthier the benthic community (Gernes and Helgen 1999; U.S. EPA 2002).

Degrated	Impoverished	Satisfactory	Enriched	Excellent
0 to 1	>1 to 2	>2 to 5	>5 to 6	>6

1 Formerly called the ETSD index (Ephemeroptera, Trichoptera, Sphaeriidae and Dragonflies [Anisoptera])

Community (taxa) richness is better than satisfactory

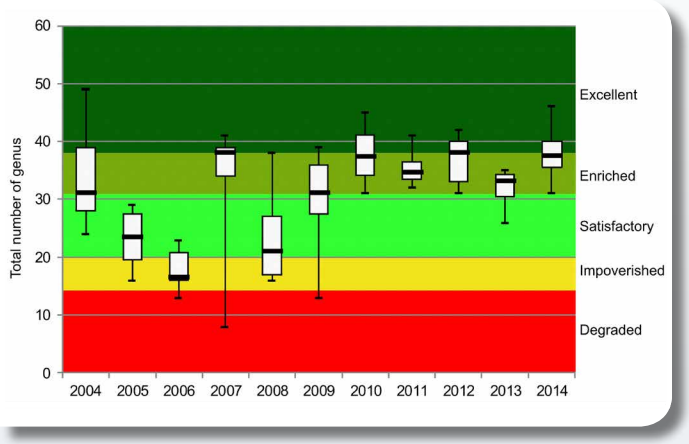

Figure 2: Total number of genus in Lake Saint-Pierre

The total number of invertebrate genus varies over the years. The number of genus decreased so much from 2004 to 2006 that benthic community richness in Lake Saint-Pierre was degraded in 2006. Beginning in 2007, the number of genus counted steadily increased, reaching 33 to 38 genus in Lake Saint-Pierre from 2012 to 2014, which is indicative of enriched benthic communities (Figure 2).

This index must be interpreted with caution, because a minor disturbance can allow new species to appear in a community, thereby increasing richness. The index value will decrease only in response to a protracted, high intensity disturbance. Therefore, the actual effects of a disturbance can only be assessed in light of the other two indices, that is, dominance and sensitivity to pollution.

A benthic community dominated by crustaceans and molluscs is impoverished

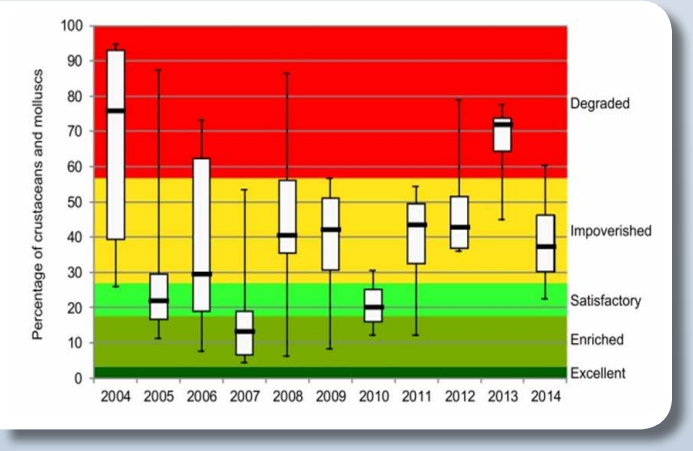

Figure 3: Relative abundance (%) of crustaceans and molluscs in Lake Saint-Pierre

The index of the relative abundance of crustaceans and molluscs exhibits large inter-annual variations, making it difficult to identify a clear trend. These inter-annual variations can be explained by such factors as suitable habitat availability, water level fluctuations or food abundance (Brown 2001). From 2012 to 2014, the relative abundance of crustaceans and molluscs in Lake Saint-Pierre ranged from 37% to 71%, which points to an impoverishment of the benthic communities. In 2013, as in 2004, the relative abundance of crustaceans and molluscs was high, which is indicative of degradation. In contrast, the low relative abundance of crustaceans and molluscs in 2005, 2007 and 2010 points to enrichment (Figure 3). The pulmonate gastropods *Ferrissia*, *Physa*, *Gyraulus* and *Planorbidae*, known for their tolerance to organic pollution, are the most commonly observed and most abundant molluscs in Lake Saint-Pierre.

The number of organic pollution-sensitive families (ETPA) is considered satisfactory or excellent

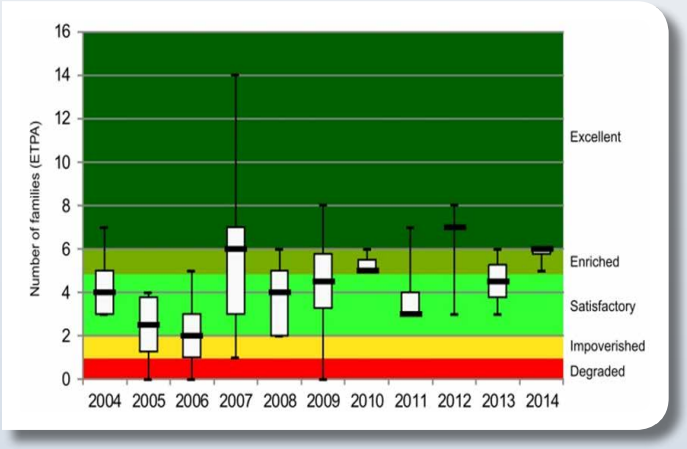

Figure 4: Number of organic pollution-sensitive families in Lake Saint-Pierre

The families considered when calculating this index are known to be sensitive to organic enrichment, particularly phosphorus enrichment. When present at high concentrations in an aquatic ecosystem, this essential nutrient can cause eutrophication. Since 2004, the median values for this index have ranged from two to seven families, which corresponds to a satisfactory or even excellent status. The trend in this index since 2004 is considered stable.

A simultaneous comparison of the three metrics can provide a better assessment of the changes in the benthic community in Lake Saint-Pierre since 2012. Over this time period, two of the three indices maintained a status of at least satisfactory.

COMPARISON OF INDICES	2012	2013	2014
Richness of communities	Enriched	Enriched	Enriched
Dominance in community composition	Impoverished	Poor	Impoverished
Number of organic pollution-sensitive families	Excellent	Satisfactory	Enriched

Influence of environmental conditions

Overall, the status of the benthic communities in Lake Saint-Pierre can be classified as moderate-good. The high relative abundance of crustaceans and molluscs in 2013 is nonetheless indicative of both natural and anthropogenic disturbances. Since the period 2004 to 2006, when the number of genus and the abundance of pollution-sensitive families declined, the benthic communities in Lake Saint-Pierre have remained stable in spite of inter-annual fluctuations. In addition, recent work indicates that the status of benthic communities in the St. Lawrence is linked to various factors, particularly the hydrologic cycle (e.g. the amplitude of water level fluctuations) and habitat characteristics, such as wind exposure and sediment and vegetation type (Tall et al., 2015). A number of earlier studies also identified the important influence of the hydrologic cycle and water quality on benthic community structure and composition in wetlands (Hentges and Stewart 2010; Cooper et al., 2006; McCormick et al., 2004).

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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 Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques and the Ministère des Forêts, de la Faune et des Parcs—in collaboration with Stratégies Saint-Laurent, a non-governmental organization that works actively with riverside communities, are pooling their expertise and efforts to provide Canadians with information on the state of the St. Lawrence and its long-term changes.

To this end, environmental indicators have been developed on the basis of data collected as part of each organization's ongoing environmental monitoring activities over the years. These activities cover the main components of the environment, namely water, sediments, biological resources, uses and shorelines.

For more information on the State of the St. Lawrence Monitoring Program, please visit our website at www.planstlaurent.qc.ca/en.

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