

# Monitoring the State of the ST. LAWRENCE RIVER



## The land cover monitoring along the St. Lawrence in 2015

Indicator name: Land cover monitoring

Status: Moderate in 2015

Trend: Unchanged for the last 40 years

### Highlights

Land cover in the sub-watersheds of the St. Lawrence is characterized by increases in intensive agriculture and urban sprawl. However, because the North Shore is still heavily forested, the overall status of land cover along the St. Lawrence is considered moderate.

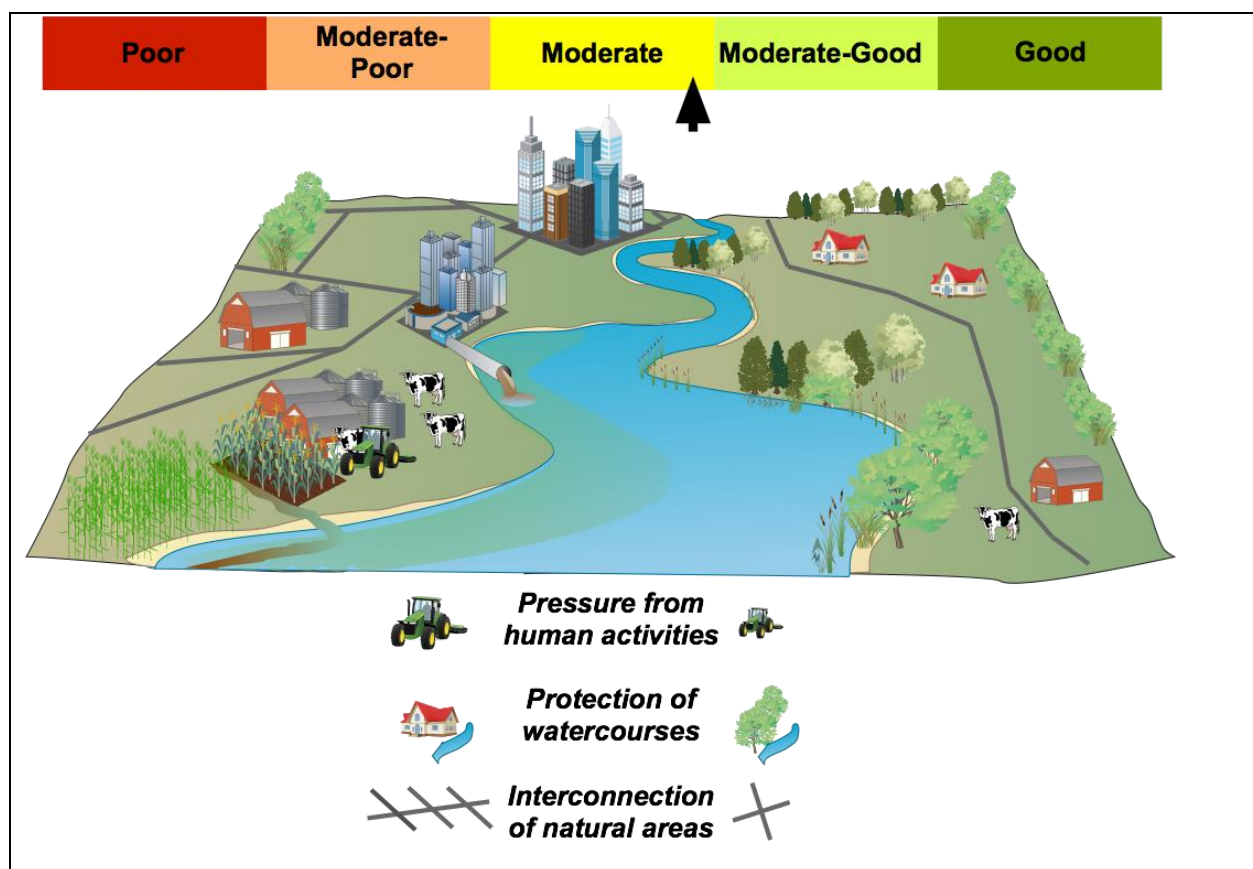


Figure 1. Diagram showing the three indicators used to evaluate the status of land cover

## Problem

Complex relationships exist between the state of the St. Lawrence's shores, land cover in its valley, and the state of the river itself. The methodological approach in this fact sheet is based on the following statements:

- Watersheds that provide good-quality water are those that are subject to little direct pressure from human activities;
- Natural areas around or along waterbodies act as buffer zones that protect ecosystems;
- Each watershed is made up of a mosaic of interconnected natural areas.

## Key measures

### Indicators and criteria for evaluating land cover

**Pressure from human activities** is quantified as the percentage of the sub-watershed that is used for agricultural and urban activity (SOLEC, 2016).

#### Agriculture

- Less than 20%: state is not of concern
- 20% to 50%: state requires monitoring
- More than 50%: state is of concern

#### Urban development

- Less than 6%: state is not of concern
- 6% to 27%: state requires monitoring
- More than 27%: state is of concern

**Protection of watercourses** is defined as the percentage of land covered by natural areas within a 100-metre riparian strip. These natural areas include wetlands, prairies and forests.

- If natural areas cover is more than 75%: state is not of concern
- If natural areas cover from 50% to 75%: state requires monitoring
- If natural areas cover less than 50%: state is of concern

**Interconnection of natural areas** is estimated based on road density: the total length of all roads in the sub-watershed divided by the total area of the sub-watershed (km/km<sup>2</sup>).

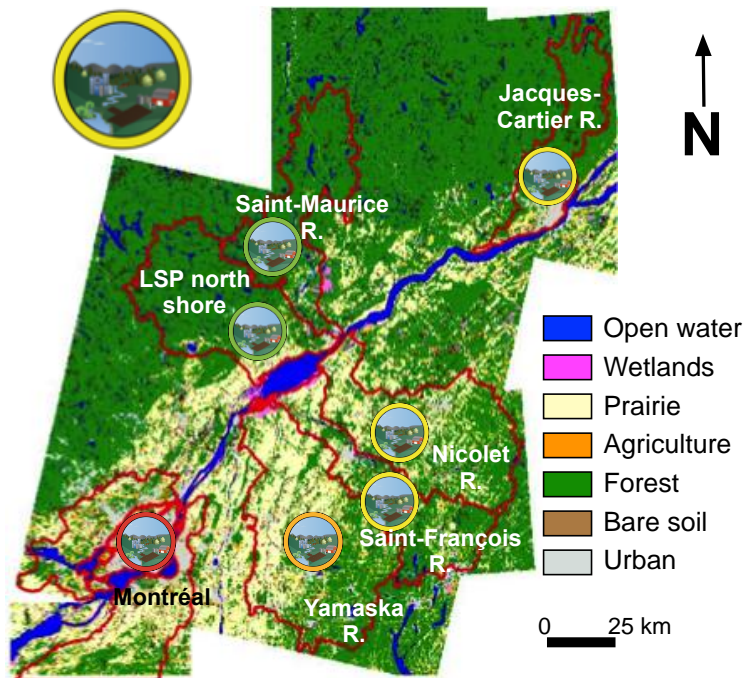
- If the road density is less than 0.9 km/km<sup>2</sup>: state is not of concern
- If the road density is from 0.9% to 1.6 km/km<sup>2</sup>: state requires monitoring
- If the road density is more than 1.6 km/km<sup>2</sup>: state is of concern

**Analysis of changes** is a quantitative indicator, without assessment criteria, that represents the changes in the landscape from 1975 to 2015 for the following types of changes:

- From agriculture to built-up urban area;
- From forest to built-up urban area;
- From forest to agriculture;
- From forest to bare soil.

Seven classes of land cover – open water, wetland, prairie, agricultural land, forest, bare soil, and built-up urban areas – were mapped for the seven sub-watersheds analyzed: Montreal, Yamaska River, Saint-François River, Nicolet River, the north shore of Lake Saint-Pierre, Saint-Maurice River, and Jacques-Cartier River. For Montreal, only the Canadian portion of the sub-watershed was considered. Images acquired in September 2015 by the Landsat 8 OLI<sup>1</sup> satellite were used for this mapping. Images circa 2000 acquired by the Landsat-5 TM and Landsat-7 ETM satellites were used for the 2000 mapping and images circa 1975 acquired by Landsat-2 MSS were used for the 1975 mapping.

<sup>1</sup> Courtesy of USGS : <https://earthexplorer.usgs.gov/>



**Figure 2. Status of the seven sub-watersheds analyzed, in 2015**

## Status and trends

The overall status of the three indicators, by sub-watershed, is considered good for the north shore of Lake Saint-Pierre and the Saint-Maurice River; moderate for the Jacques-Cartier, Nicolet and Saint-François rivers; moderate-poor for the Yamaska River; and poor for the Montreal area. The overall status of the seven sub-watersheds is considered moderate (Figure 2).

### Pressure from human activities

The state of two sub-watersheds on the North Shore (north shore of Lake Saint-Pierre, Saint-Maurice River) was considered not of concern (in green) in 2015, with combined values ranging from 5.4% to 14.5%, based on the assessment criteria selected for this indicator. The status of the sub-watersheds on the South Shore (the Yamaska, Saint-François and Nicolet rivers), plus Montreal and the Jacques-Cartier River, was considered to require monitoring (in yellow), with values ranging from 16.9% to 58.0%.

The trend in the seven sub-watersheds is stable compared to the 2000 results, since changes in the status of these sub-watersheds are not shown for each individual year (Table 1). Data for 1975 has been included for information purposes only. For that year, all herbaceous vegetation was classified as agriculture, but in 2000 and 2015, when better-quality remote sensing images were available, natural prairie could be distinguished. That means agriculture was overestimated for 1975. This indicator does not take into account the significant degradation of water quality, due to the accumulated effect of contaminants, in the rivers along the South Shore in the final kilometres before

they reach the St. Lawrence. Only the overall pressure on the sub-watersheds is evaluated.

**Table 1. Pressure from human activities: Results**

Watershed	1975		2000			2015		
	Agri	Urb	Agri	Urb	Status	Agri	Urb	Status
Saint-Maurice River	5.7	1.7	1.6	1.4	Not of concern	1.4	4.0	Not of concern
North shore of Lake Saint-Pierre	18.1	0.7	11.9	1.2	Not of concern	11.8	2.7	Not of concern
Jacques-Cartier River	10.2	6.7	3.2	7.4	Require monitoring	3.1	13.8	Require monitoring
Saint-François River	42.2	1.3	21.4	2.8	Require monitoring	22.7	6.4	Require monitoring
Nicolet River	52.7	0.4	31.4	1.2	Require monitoring	33.7	3.4	Require monitoring
Yamaska River	58.1	1.1	38.0	3.0	Require monitoring	42.2	5.1	Require monitoring
Montreal	55.2	14.4	29.9	18.0	Require monitoring	32.2	24.5	Require monitoring

Agri = % of land used for agriculture in the sub-watershed.

Urb = % of urbanized land.

Status = Combined status.

Note: The year 1975 was not qualified because of the overestimation of the agricultural class. Ratings are for illustrative purposes only.

## Protection of watercourses

The three sub-watersheds on the North Shore (north of Lake Saint-Pierre and the Saint-Maurice and Jacques-Cartier rivers) are not of concern, with values ranging from 79.7% to 90.3% based on the assessment criteria selected for this indicator. The sub-watersheds of the Saint-François and Nicolet rivers require monitoring, with values of 64.8% and 56.4% respectively. Lastly, the Montreal and Yamaska River sub-watersheds are of concern, with values of 40.9% and 47.2%.

Five sub-watersheds are stable in relation to the 2000 results. Only the Montreal and Yamaska River sub-watersheds show degradation due to loss of natural areas to expanded agricultural activity (Table 2). Here again, the 1975 data are included for information only, as agriculture was overestimated and natural prairie underestimated that year.

**Table 2. Protection of watercourses: Results**

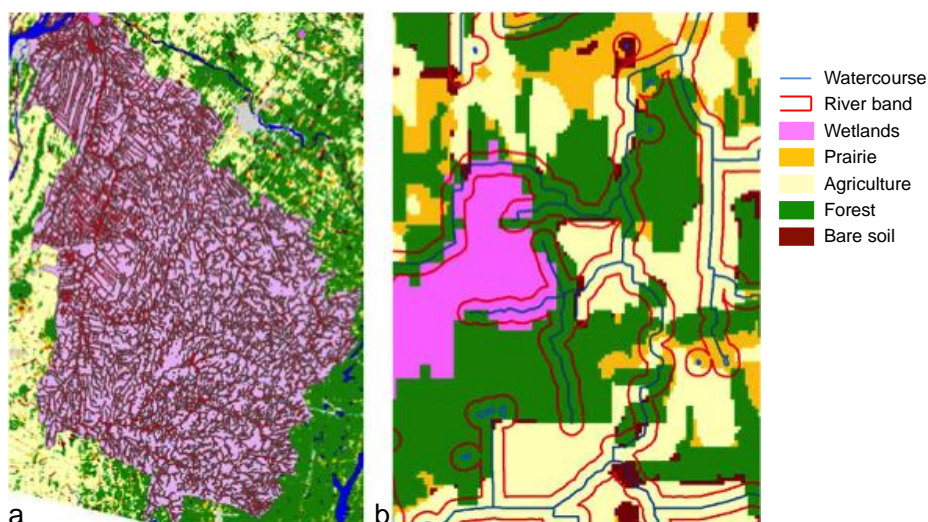
Sub-watershed	Percentage of natural areas, 1975	Percentage of natural areas, 2000	Percentage of natural areas, 2015
Saint-Maurice River	87.9	92.7	90.3
Jacques-Cartier River	81.6	86.9	80.4
North shore of Lake Saint-Pierre	74.0	82.2	79.7
Saint-François River	52.5	71.0	64.8
Nicolet River	40.3	65.9	56.4
Yamaska River	39.3	57.2	47.2
Montreal	24.7	51.8	40.9

Note: The year 1975 was not qualified because of the overestimation of the agricultural class. Ratings are for illustrative purposes only.

The high density of hydrographic networks that can exist in a sub-watershed is illustrated in Figure 3a, using the Yamaska River as an example. The enlargement on the right in



Figure 3b shows the 100 m riparian buffer zone and land cover classes for some small watercourses.



**Figure 3. An example of the density of the hydrographic network in the Yamaska River sub-watershed, showing the 100-m riparian buffer zones**

### Interconnection of natural areas

Road density plays a significant role in fragmentation of the environment, and it is also somewhat independent of, and complementary to, urban land cover. Alberti et al. (2007) and Tiner (2004) propose using road density as a measurement for assessing the degradation of water quality and of aquatic and terrestrial ecosystems.

Two sub-watersheds on the North Shore (north shore of Lake Saint-Pierre; Saint-Maurice River) are not of concern, based on the assessment criteria for this indicator. The sub-watersheds on the South Shore (Yamaska, Saint-François and Nicolet rivers) require monitoring. Lastly, two sub-watersheds (Montreal; Jacques-Cartier River) are of concern (Table 3).

**Table 3. Road density, 2015**

Sub-watershed	Road density (km/km <sup>2</sup> )
Saint-Maurice River	0.62
North shore of Lake Saint-Pierre	0.72
Nicolet River	1.00
Yamaska River	1.20
Saint-François River	1.33
Jacques-Cartier River	1.95
Montreal	3.87

No trend has been calculated, due to the difficulty of finding information quickly about the road network in previous decades. In addition, a change in state between two periods would require a significant modification of road density over a short interval, which did not occur between 2000 and 2015.

In general, we can see that the forest class has a positive influence on the north shore of the St. Lawrence River. However, agriculture has a negative influence on the south shore

and the density of the road network has a negative influence on the region of the two large municipalities – Montreal and Quebec City – as shown in Figure 4.

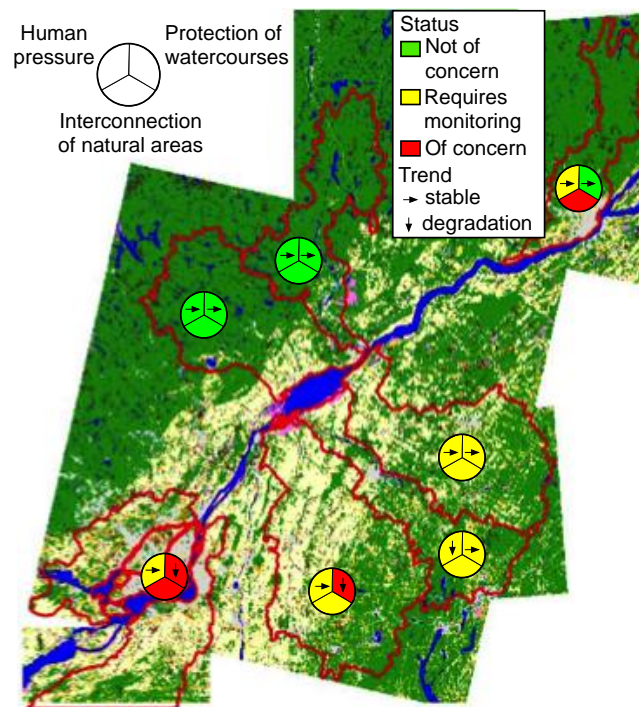


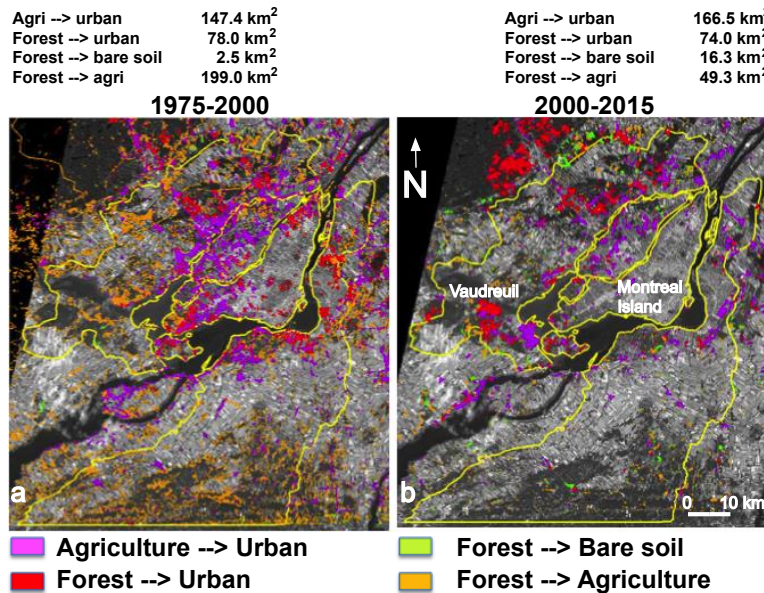
Figure 4. Status and trends for the three land cover indicators

### Changes between 1975, 2000, 2015

The analysis of changes between two periods highlights the expansion (gain) and reduction (loss) for the various land cover classes, showing how land cover has changed over time. For this analysis, the two major urban areas, Montreal and Quebec, are considered.

#### **Montreal region**

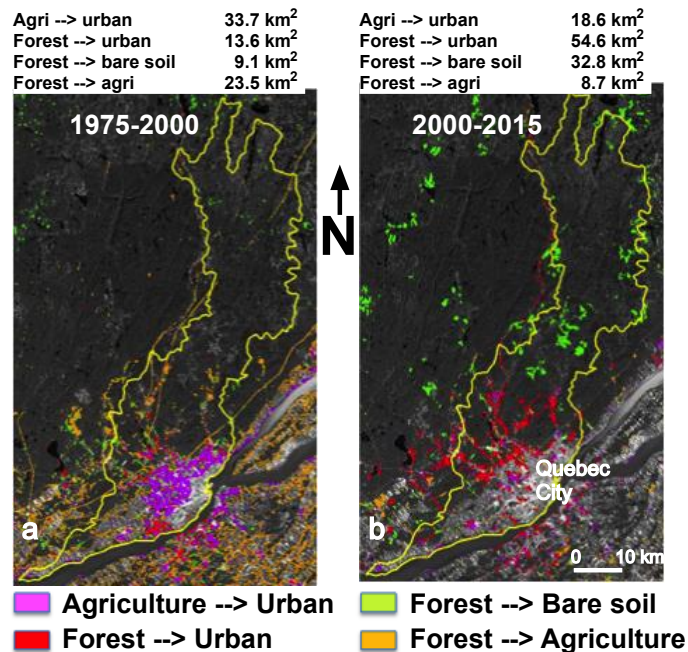
Between 1975 and 2000 on Montreal Island and in communities to the north and south, forest cover and agricultural land was lost to urban development; the total increase in urban land cover was 225 km<sup>2</sup> (Figure 5a). Urban expansion continued between 2000 and 2015, but in areas farther from the St. Lawrence. That expansion is almost complete on Montreal Island, and it has slowed considerably on Île Jésus (Laval) and on the South Shore of the St. Lawrence. However, there was significant urban development in the Vaudreuil area. The overall increase in urban land cover was 240 km<sup>2</sup> (Figure 5b). What these statistics do not show is the densification of the urban fabric on Montreal Island, where some low-density urban spaces such as parking lots were replaced by high-rise apartment buildings.



**Figure 5. Analysis of changes in land cover between 1975 and 2000 and between 2000 and 2015 in the Montreal area**

### **Quebec region**

The analysis of changes in land cover class for the Quebec City area shows that urban land cover increased at the expense of agriculture in the St. Lawrence Valley, by 33.7 km<sup>2</sup>, between 1975 and 2000 (Figure 6a), and by 18.6 km<sup>2</sup>, between 2000 and 2010 (Figure 6b). Loss of forest cover caused by urban expansion, especially on the Canadian Shield, increased from 13.6 km<sup>2</sup>, between 1975 and 2000, to 54.6 km<sup>2</sup>, between 2000 and 2015. Urban sprawl occurred roughly along an axis extending north and south of the Montreal area, moving farther away from the St. Lawrence.



**Figure 6: Analysis of changes in land cover between 1975 and 2000 and between 2000 and 2015 in the Quebec City area.**

## Conclusion

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The overall status – moderate – can be largely explained by the following factors:

- heavy forest cover in the upper watersheds on the north and south shores of the St. Lawrence;
- the presence of buffer zones along watercourses;
- low road density, except in the Montreal and Quebec City areas.

The purpose of this exercise was to evaluate the effect of each of the seven watersheds studied on water quality in the St. Lawrence River. Although the overall status was moderate, the analysis identified some sub-watersheds as being more likely to negatively impact water quality: not surprisingly, the Montreal and Yamaska River sub-watersheds were contributing the most to water quality degradation. However, this analysis did not take into account the spatial distribution of land cover classes within the sub-watersheds.

## For more information

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SOLEC (2016). Great Lakes (SOLEC) Indicators: Descriptions for Reporting in 2016. By the Ecosystem Indicators and Reporting Task Team of the GLWQA, Document in preparation, 114–120.

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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; the Ministère du Développement durable, 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—and 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 the long-term trends affecting it.

For more information about the State of the St. Lawrence Monitoring Program, please consult our website: [http://planstlaurent.gc.ca/en/state\\_monitoring.html](http://planstlaurent.gc.ca/en/state_monitoring.html).

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Several pictograms in this document are courtesy of the Integration and Application Network site, University of Maryland Center for Environmental Science ([ian.umces.edu/symbols/](http://ian.umces.edu/symbols/)).

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