Gatineau: Understanding and evaluating our recreational water

Initial study of the health of the Ottawa River watershed

Primary author: Mary Trudeau, PH D, P. Eng.

Ottawa RIVERKEEPER®
GARDE-RIVIÈRE des Outaouais

FONDS VERT

Ville de Gatineau

Acknowledgements

Many people and organizations contributed to the production of this report. Whether by sharing data, putting us in touch with experts, providing advice on the first drafts, or offering their professional and technical services, all played a role in this first phase of the health assessment of the river Outaouais.

Mary Trudeau, PH D, P.Eng., Led the research, data analysis and draft report. She was the enthusiastic and determined driving force that guided our comprehensive approach, while conducting the rigorous analysis of an enormous amount of often disparate data.

For their continued commitment to creating a conceptual model for assessing the health of the river and for their valuable comments on the first drafts of the long list of indicators, we would like to thank the members of the Watershed Health Committee, a group of volunteer experts.

For their advice and other tips on data sources, particularly in Quebec, we sincerely thank four watershed organizations in the Outaouais region (ABV des 7, COBALI, COBAMIL, OBVRPNS), as well as the Nature Conservancy of Canada. Quebec) and World Wildlife Fund Canada.

For their assistance in accessing and interpreting municipal data, we thank the cities of Gatineau, Ottawa, and Montreal.

For their comments on the objectives and anticipated impacts of the project, as well as for valuable information on their own work with respect to water quality, we would like to thank elected officials Audrey Bureau (Councilor, City of Gatineau), Guillaume Lamoureux (Mayor, municipality of La Pêche), and Jeff Leiper (Councilor, City of Ottawa).

For their invaluable contributions in the form of technical advice, review, translation, graphic design and mapping, we would like to thank the professionals who contributed to the technical production of this report: Meredith Brown, Clark Lawlor, Brett Painter, Charles Savard, and Marc St-Onge.

Finally, we wish to express our deepest gratitude to our volunteers whose diverse contributions make us a better organization.

Patrick Nadeau
Executive Director
Ottawa Riverkeeper

City of Gatineau: Preliminary Assessment of Ecosystem Health for the Gatineau and Lièvre Rivers

Table of Contents

City of Gatineau: Preliminary Assessment of Ecosystem Health

1.0 Purpose of this Report

This report provides a preliminary assessment of the ecological health of the Ottawa watershed in the vicinity of the City of Gatineau, and two main tributaries to the Ottawa River that flow through the City of Gatineau, the Lievre River and the Gatineau River. This report was completed in tandem with a study to identify indicators and data sources to assess the health of the Ottawa River watershed, provided to Environment and Climate Change Canada (ECCC) and the City of Gatineau.

This report is written assuming the reader is informed on the importance of a watershed health assessment and already somewhat familiar with the Ottawa Watershed.

The scope of the watershed assessments focuses on ecological health. The assessment focuses on river systems and surface water. Some of the indicators also apply to wetlands, lakes and groundwater but additional indicators are needed to fully include these additional components of water systems. Socio-economic factors are also important and can be included in future phases of work.

Section 2 provides an overview of the three watersheds: the Ottawa watershed and two of its tributaries, the Lievre and Gatineau subwatersheds. Section 3 outlines the framework for organizing ecological indicators and identifies the indicators included in this report. Section 4 identifies the data sources used in the analysis. Section 5 reports a preliminary analysis for the select indicators where data were available. Section 6 summarizes the initial analysis and the health of the three river systems. Section 7 presents potential next steps.

2.0 Watersheds

The assessments take a watershed approach, knowing that rivers reflect the health of the lands they drain, as well as the effects of other stressors acting directly on the rivers themselves. Watersheds are nested systems, with small rivers draining into subsequently larger systems, until they reach an ocean. In this report, the word ‘watershed’ is applied to the Ottawa system and ‘subwatershed’ to the Lievre and Gatineau systems.

2.1 The Ottawa River

The Ottawa River is the largest tributary to the St. Lawrence River and defines the boundary between Quebec and Ontario for much of its length. Of the 146 334 square kilometer[1] area, 65% is in Quebec and 35% is in Ontario. The length of the river from its headwaters to Lac des Deux Montagnes is about 1271 km. Unlike many tributaries, there is no organismes de bassins versants (OBV) du Québec or Ontario Conservation Authority with responsibility for the mainstem Ottawa River.

2.2 The Gatineau River

The Gatineau River is the largest tributary to the Ottawa River. It is 386 km long and drains an area of 23,724 km^2, emptying into the Ottawa River at the Pointe-Gatineau sector of the City of Gatineau[2]. The Gatineau River has about 50 tributary rivers and over 19,000 lakes of all sizes. Of the thousands of lakes in the subwatershed, 307 have areas larger than 100 hectares. In addition, there are wetlands throughout the subwatershed. There are two large reservoirs created by hydropower dam complexes, the Baskatong north of the Mercier dam and the Cabonga reservoir at the Cabonga dam, both in the northwestern portion of the subwatershed. The Gatineau River has two other dams: Chelsea and Farmer's (at the Alonzo-Wright bridge) in the southern portion of the subwatershed. The Agence de bassin versant des 7 (ABV des 7) is responsible for planning and reporting on subwatershed scale activities of the Gatineau subwatershed.

2.3 The Lievre River

The Lievre River is a tributary to the Ottawa River and drains a land area of 9,544 km^2, including 7% of the area of the City of Gatineau[3]. It is 330 km long and empties into the Ottawa River at the Masson-Angers sector of the City of Gatineau. The subwatershed has 3,768 lakes (COBALI website). There are over 70 dams and reservoirs in the Lievre subwatershed, some of which are used for power generation but most serve other purposes and are privately owned. Of the lakes and reservoirs in the system, only 10 are larger than 10 km^2. Reservoir lac du Poisson Blanc, Reservoir Mitchinamecus and Reservoir Kiamika are the largest, each exceeding 40 km^2; these reservoirs are located in the mid to northern portion of the subwatershed. The stretch of river just before the confluence with the Ottawa River is highly modified, including an underground tunnel of 1.6 km that begins downstream of the Rhéaume dam (in the Masson-Angers sector of Gatineau) and carries the water to the Masson hydroelectric power station. The tunnel outlets downstream of the Papier Masson paper mill (White Birch Paper Company) near the confluence

[1] Province of Quebec, *Summary Profile of the Rivière des Outaouais Watershed* (2015)

[2] Source for statistics in this paragraph: OBV des 7, *Plan Directeur de l'eau du basin versant de la riviere Gatineau* (2010)

[3] Source for statistics in this paragraph: COBALI, Plan directeur de l'eau, 2e edition (2013)

with the Ottawa River. The OBV responsible for the Lievre River is the Comité du bassin versant de la rivière du Lièvre (COBALI).

3.0 Indicators for the Watershed Characterization

The indicators for this ecological health assessment are organized into three indicator groups (ecological status; threats; and, socio-economic indicators). Each indicator group has a series of elements that represent categories of end-points of relevance to watershed health (Table 1).

Table 1 Summary Table of Indicator Groups

Indicator Group	Element	Comments
Ecological Status	Biological elements	- specific indicators may vary for rivers versus lakes or wetlands
	Hydro-morphological quality elements	
	Chemical and physico-chemical elements	
Threats	To water quantity	- indicators for many threats overlap, e.g. land use can alter quantity, quality and habitat
	To water quality	
	To habitat and biota	
	Climate change	
Socio-economic	Human health & Well-being	- for future development
	Adaptation & Climate Resilience	

There are three elements for ecological status (biological; hydro-morphological; and, chemical and physico-chemical). Biological elements include plants and animals living in the watershed. Hydro-morphological elements include water flows and the interaction of flows with the land (e.g. riverbed substrates). Hydromorphologic elements are inherently dynamic in nature but form predictable patterns over time unless they perturbed. Chemical and physico-chemical elements include the chemistry of the water as well as other physical properties, such as temperature. The threats indicator group has four elements: threats to water quantity; threats to quality; threats to habitat; and, climate change. Climate change presents threats to the ecological status as well as socio-economic elements. Other threats have the potential to impair two or more of water quantity, quality or habitat. Threat elements can be combined to reflect the nature of a particular threat that has cross-cutting effects. The socio-economic indicator group in Table 1 has not been developed in this phase of work; two elements are suggested (see Table 1).

The development of the short-listed indicators has been documented in the tandem Ottawa Riverkeeper report, *Ottawa River Health Assessment: Phase One* (2019). For this analysis of the Lievre and Gatineau subwatersheds, the specific indicators for which sufficient data were available are summarized in Table 2. For the Ottawa mainstem, there are data available for additional indicators outside the vicinity of the City of Gatineau (see the report *Ottawa River Health Assessment: Phase One* (2019)).

Table 2 Indicators Analyzed in this Report

Indicator Group	Element	Short list Indicators
Ecological Status	Chemical and physico-chemical elements	Total Phosphorus (mg/L)
		Water temperature (°C) (maximum)
		Chlorophyll-a (ppb)
Threats	To water quality	Sewage release incidents: Number of dry weather sewage releases
		Blue green algae occurrences
	To quantity, quality, habitat and biota	Change in land use: Agriculture Urban Road network Forest Harvested forest Wetland

A summary of the rationale for the indicators in Table 2 is provided following, with more complete information available in the *Ottawa River Health Assessment: Phase One* (2019):

- *Total phosphorus* is an indicator for the limiting nutrient for plant and algae growth in freshwaters. Total phosphorus includes both particulate and dissolved forms of the element. Phosphorus can be present from natural sources, such as river substrates, or from human activities, such as crop and lawn fertilizers, excessive erosion and wastewater effluents. Due to the importance of phosphorus in freshwater environments, this element is commonly monitored within the Ottawa watershed, and elsewhere globally.
- *Water temperature* is an important indicator for essential habitat features of the aquatic environment. Water temperature is strongly correlated with oxygen concentration in the water; warmer waters hold less oxygen than cooler waters. Various fish species have preferences and tolerance limitations with respect to water temperature, specifically cold and cool water fish cannot survive in waters that exceed threshold levels. Water temperature is also important to track as climate change progresses. As air temperatures increase, water temperatures can be expected to also change. These changes will likely be more evident initially in smaller tributaries to the Ottawa River than in the mainstem river. The specific temperature records of interest for Phase 1 are the maximum recorded temperature in a year.
- *Chlorophyll-a* is an indicator of the potential for plants and algae to photosynthesize in the water. It allows plants and photosynthesizing animals to release chemical energy during the photosynthesis process. Levels of chlorophyll-a are used to characterize how

much biological activity there is in the water (called the trophic state), from very low (or oligotrophic), to overly active (eutrophic or hyper-eutrophic). Chlorophyll-a therefore indicates the levels of algae in a waterbody. When in balance, photosynthesis supplies oxygen to the water column; when over-active, poor water quality (including decreased oxygen concentrations) result.

- *Sewage release incidents - Number of dry weather sewage releases* is an indicator of an acute water quality threat in the form of releases of sewage to the river during dry weather. Dry weather flows should be preventable when sewer systems are well-maintained, except in cases of catastrophic equipment failure or similar unforeseeable events.
- *Blue green algae (Cyanobacteria) blooms* indicate stress in the aquatic environment. Cyanobacteria are naturally occurring and some carry toxic substances called cyanotoxins. Typically lakes are more affected than riverine systems because lower flow rates and water stagnation contribute to conditions that are more prone to supporting blooms. Another key contributing factor is nutrient inputs, in particular, phosphorus. Water temperature and sunlight also contribute to making conditions more prone to cyanobacteria blooms. Although these key contributing factors are known, prediction of bloom occurrence is not yet possible. Quebec's environment ministry has defined a bloom to be 20,000 cells per millilitre in at least one location of a water body.
- *Change in land use* is an integral part of understanding changes to the interaction of water with the landscape of a watershed or subwatershed. Changes over time to the extent of natural areas, including forests and wetlands, have profound cumulative effects on runoff quantity, both the volume and the momentum of the water as it runs off the land. Increased runoff quantities have greater power to erode streams and to carry pollutants. Further, with transportation networks, industrialization and urbanization, pollutant sources are introduced that affect water quality. These changes in turn alter the quality of aquatic habitat and the biota supported within the altered areas. Urban stream conditions include increased flow flashiness (i.e. frequent, rapid flow increases in response to rain events), increased pollutant loads, altered biotic communities and altered ecosystem function. Agricultural land uses and operations also alter runoff quantity and affect the quality of water. For the short-listed indicator, categories of land use of interest include: agriculture; urban; road networks; forest (natural); harvested forest; wetlands.

4.0 Data Sources

Data were collected from numerous agencies in possession of monitoring results. Table 3 summarizes the spatial and temporal coverage of the data sources. Reports by the OBVs were important sources for subwatershed information, such as the number of lakes, tributaries and other attributes of the Lievre and Gatineau subwatersheds.

Table 3 Summary of Temporal and Spatial Coverage of Data Sources for the Mainstem Ottawa River

Indicator	Spatial Coverage within Ottawa Watershed	Temporal coverage
Ecological Status Indicators		
Total Phosphorus	• Province of Quebec monitoring • Province of Ontario monitoring • City of Ottawa monitoring in the Ottawa River	• 2014 to 2016[4]
Water temperature (maximum annual)	• Quebec provincial monitoring sites	• 2014 to 2016[4]
Chlorophyll-a	• Province of Quebec monitoring	• 2014 to 2016[4]
Threats Indicators		
Dry weather sewage releases	• ECCC • Province of Quebec website • City of Gatineau	• Quebec sewage release reports are available online 2001 to 2013; a searchable database is also available in Quebec
Blue green algae (Cyanobacteria) blooms	• Quebec monitoring	• For lakes in Quebec, since 2004
Change in land use	• Agriculture and Agri-Foods Canada (AAFC) Land Use data	• AAFC land use 1990, 2000, 2010

5.0 Indicator Analysis

5.1 Methodology for Analysis

The methodology for each indicator varies with the information available. For some indicators, this section reports summaries from other sources (e.g. sewage releases). In other cases, analyses of datasets were conducted using GIS tool and statistical analysis as described in the following subsections.

5.1.1 GIS analysis

Land use analysis was done using GIS software and AAFC spatial information for 1990, 2000, and 2010.

[4] These years were the only ones for which data were available on the Province of Quebec website.

5.1.2 Statistical analysis

Data from various organizations were combined into one dataset where it was feasible to do so within the time available. This dataset was examined using the statistical software package R.

5.2 Results by Indicator

5.2.1 Total Phosphorus

The average total phosphorus by year at each station in the Lievre and Gatineau Rivers was below the provincial objective of 0.03 mg/L (Table 4). However, there were exceedances of this target level at all stations except the Gatineau LaVerendrye site (Table 5). All exceedances occurred in the spring months of April or May, indicating high spring flows may have increased erosion, which in turn increases phosphorus in the water. Figure 1 plots the total phosphorus results by year (except the highest value, as indicated in the figure caption). In the database for these two rivers there were a total of 129 total phosphorus measurements over three years (2014, 2015, 2016).

Table 4 Average Total Phosphorus (mg/L) by Year and Station for the Lievre and Gatineau River Monitoring Sites

			Average Total Phosphorus (mg/L)		
River	**Location**	**Station**	**2014**	**2015**	**2016**
Lievre	Mont Laurier Dam	4060001	0.013	0.012	0.012
Lievre	Buckingham	4060004	0.025	0.017	0.012
Gatineau	Chelsea	4080003	0.012	0.012	0.010
Gatineau	LaVerendrye	4080254	0.008	0.007	0.005

Table 5 Occurrences when Total Phosphorus (mg/L) exceeded the Provincial Objective of 0.03 mg/L for the Lievre and Gatineau River Monitoring Sites

River	Location	Station	DATE	Total Phosphorus (mg/L)	Year	Month
Lievre	Mont Laurier Dam	4060001	13/04/2014	0.035	2014	4
Lievre	Mont Laurier Dam	4060001	08/05/2016	0.033	2016	5
Lievre	Buckingham	4060004	15/04/2014	0.200	2014	4
Lievre	Buckingham	4060004	14/04/2015	0.068	2015	4
Gatineau	Chelsea	4080003	15/04/2014	0.054	2014	4
Gatineau	Chelsea	4080003	14/04/2015	0.043	2015	4

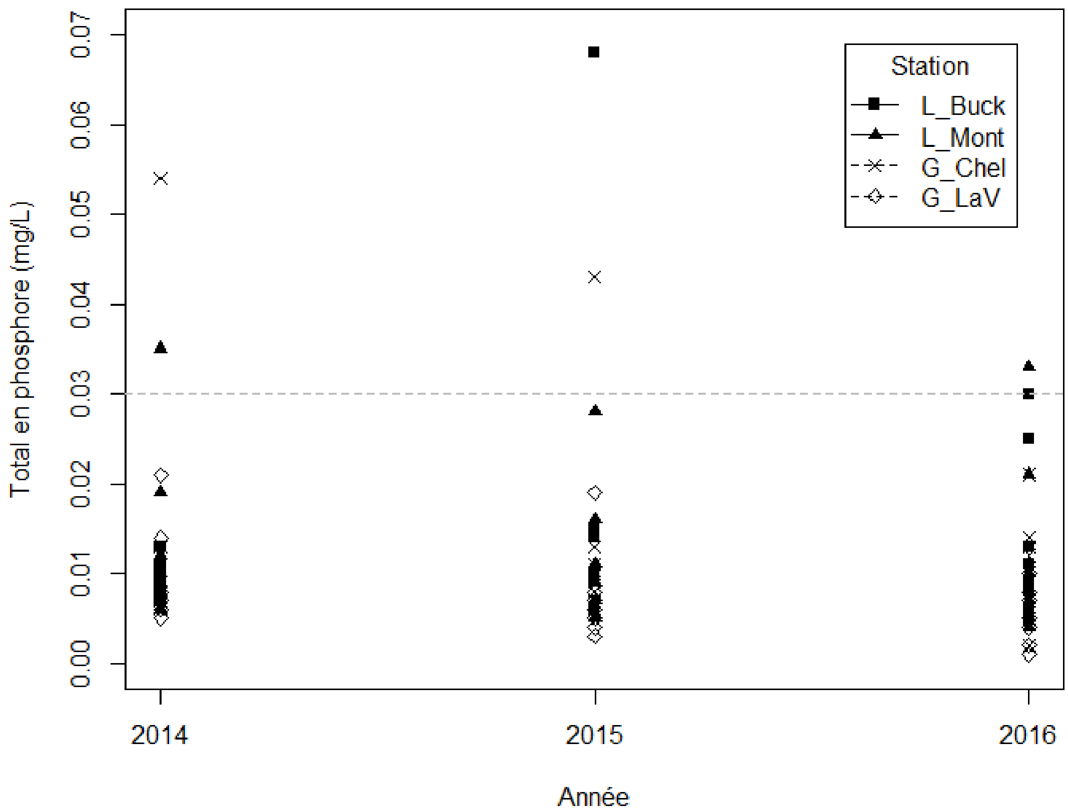

Figure 1 Total Phosphorus (mg/L) in the Lievre and Gatineau Rivers
The straight dotted line at 0.03 mg/L indicates the provincial objective for total phosphorus to maintain good ecological health. Note one point is not plotted due to its extreme value: 0.20 (Lievre at Buckingham in 2014). L_Buck is the Lievre River at Buckingham (site number 04060004); L_Mont is the Lievre River at Mont Laurier Dam (site 04060001); G_Chel is the Gatineau River at Chelsea (site 04080003); and, G_LaV is the Gatineau River at LaVerendrye (site 04080254).

In the Ottawa River, the headwaters region has elevated total phosphorus values, exceeding the objective of 0.03 mg/L on average in Lac Temiskaming (Table 6). Other locations are below the guideline on average according to the Ontario Ministry of Natural Resources and Forestry (OMNRF) 2016 report, *Background Information to the Fisheries Management Plan, Fisheries Management Zone 12 in Ontario, Fisheries Management Zone 25 in Quebec*. All information in Table 6 is extracted from the OMNRF 2016 report.

Table 6 Ottawa River Average Total Phosphorus[5]

Reach	Total Phosphorus (mg/L) 2008-2010
Temiskaming	0.0308
Lac la Cave	0.0166
Holden Lake	0.0109
Allumette Lake	0.0126
Lower Allumette Lake	0.0134
Lac Coulonge	0.0148
Lac du Rocher Fendu	0.0130
Lac des Chats	0.0164
Lac Deschênes	0.0153
Lac Dollard des Ormeaux	0.0213

The OMNRF 2016 report provides these total phosphorus values, summarized by reach as follows:

- Lake Temiskaming: Hydro Québec Generating Station at inflow to Public Works and Government Services Canada dam at outflow
- Lac la Cave: Public Works and Government Services Canada dam at the outflow of Lake Temiskaming to the Otto Holden Generating Station
- Holden Lake: OttoHolden Generating Station toDesJoachims Generating Station
- Allumette Lake: Des Joachims Generating Station to Allumette Rapids at Hwy 148 bridge
- Lower Allumette Lake: Allumette Rapids at Hwy 148 bridge to Paquette Rapids
- Lac Coulonge: Paquette Rapids to the top of Rocher Fendu Rapids near La Passe
- Lac du Rocher Fendu: La Passe to Cheneaux Generating Station
- Lac des Chats: Cheneaux Generating Station to Chats Falls/Fitzroy Generating Station
- Lac Deschênes: Chats Falls/Fitzroy Generating Station to Chaudière Falls Generating Station
- Lac Dollard des Ormeaux: Chaudière Falls Generating Station to Carillon Generating Station

5.2.2 Water Temperature (Maximum)

Water temperature is an important indicator of fish habitat quality. Coldwater fish have an upper lethal limit of around 25°C[6], with slightly higher or lower limits for specific fish species. For example, the upper lethal temperature for lake trout is 23.5°C, whereas the lethal limit for brown

[5] Published in the OMNRF Background Report (2016)

[6] Lethal temperature information can be found at the URL: http://thescientificfisherman.com/temperature-classifications-of-fish/

trout is 26.4°C. Warmwater fish have an upper lethal limit around 36°C. The upper limit for channel catfish and largemouth bass is 36.4°C whereas black crappie is less than 36°C. Coolwater fish require cooler temperatures than warmwater fish but can survive in conditions that are lethal to coldwater fish. For example, the upper lethal limit for walleye is 31.6°C, white bass is 26.7°C and muskellunge is 32.2°C; these three fish species are cool water fish.

The maximum water temperature at four monitoring locations in the Lievre and Gatineau Rivers over three years of available data indicate the Lievre River at Buckingham has had water temperatures that exceed the lethal limits for some coldwater fish species (in 2015) (Figure 2). The depth of water at which the temperature measurements were taken is not reported. Three of the sites had lower or stable maximum temperatures in 2016 relative to 2015, indicating water temperatures (and likely air temperatures) were somewhat lower in 2016. However, the maximum temperature at the upper Gatineau River site, at LaVerendrye, increased year over year.

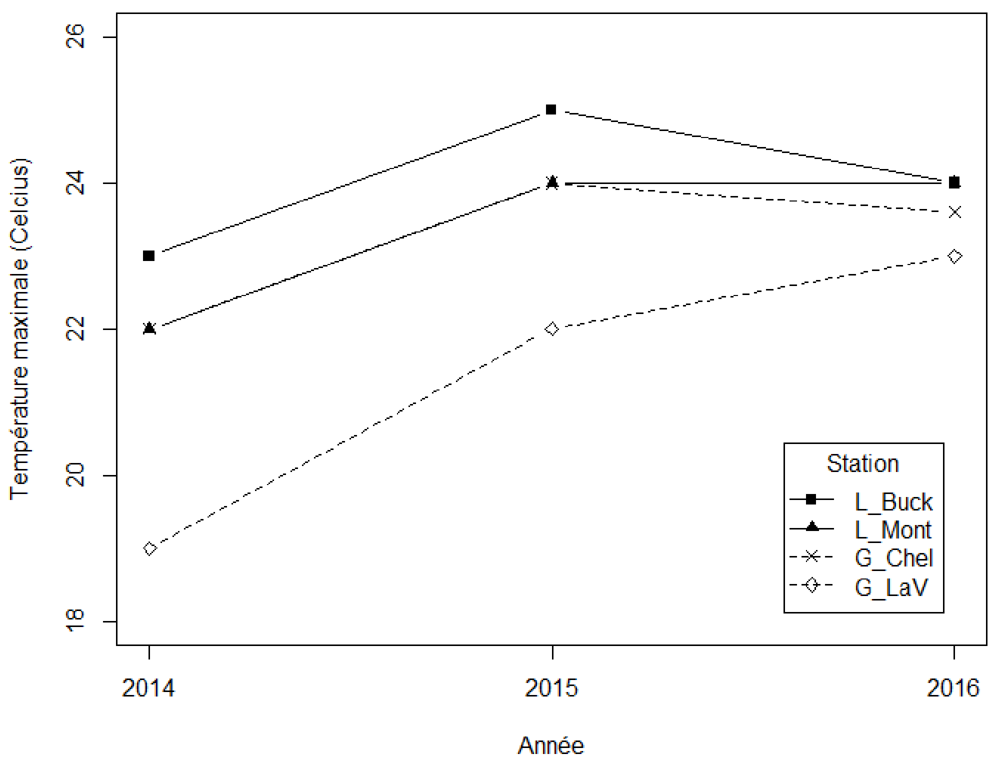

Figure 2 Maximum water temperature (degrees Celsius) in the Lievre and Gatineau Rivers

L_Buck is the Lievre River at Buckingham (site number 4060004); L_Mont is the Lievre River at Mont Laurier Dam (site 4060001); G_Chel is the Gatineau River at Chelsea (site 4080003); and, G_LaV is the Gatineau River at LaVerendrye (site 4080254).

All maximum summer temperatures in the three years of record for the LaVerendrye site were recorded in August. A flow gauge on the Gatineau River (Coordinates: NAD83 47°4'60" -75°45'13") at the Ceizur Rapids (north of the Baskatong Reservoir)[7] can be used to infer trends in flows at the LaVerendrye site. In 2014, annual average flows in the Gatineau River at Ceizur were not unusual, although there were high monthly flows in the Fall which offset the lower than average Spring flows. For August, when the maximum summer temperature was recorded, flows were 26% lower than average. In 2015, the annual average flow was lower than most years on record, with particularly low flows between February and June and in October; August flows were 47% higher than average monthly August flows. Flow records are missing for December 2016, so the annual average cannot be calculated for that year. July and August flows in 2016 were more than 40% lower than the monthly averages for those months. For these three years of recorded data, August flows did not consistently decline, whereas the maximum temperature increased year over year in August at the LaVerendrye site.

It is worth investigating this trend further to ascertain if changes in the vicinity of this site are leading to warmer water temperatures. Changes that increase water temperatures include reduced shade from riparian vegetation, increased road networks, increased urbanization, increased stormsewer discharge, reduced natural cover on the landscape (e.g. from deforestation, agriculture, other), reduced groundwater discharge to the river baseflow, among other reasons.

For the Ottawa River, there is no trend in maximum water temperature by year as indicated in records taken at Ottawa's water purification plants between 1960 and 2015 (Figure 3). The average maximum temperature over the 56 year record is 25.7 C° (standard deviation 1.9 C°).

[7] Flow data are available for this monitoring station from the Government of Quebec website at URL: https://www.cehq.gouv.qc.ca/depot/historique_donnees_som_mensuels/040830_Q_MOY.txt

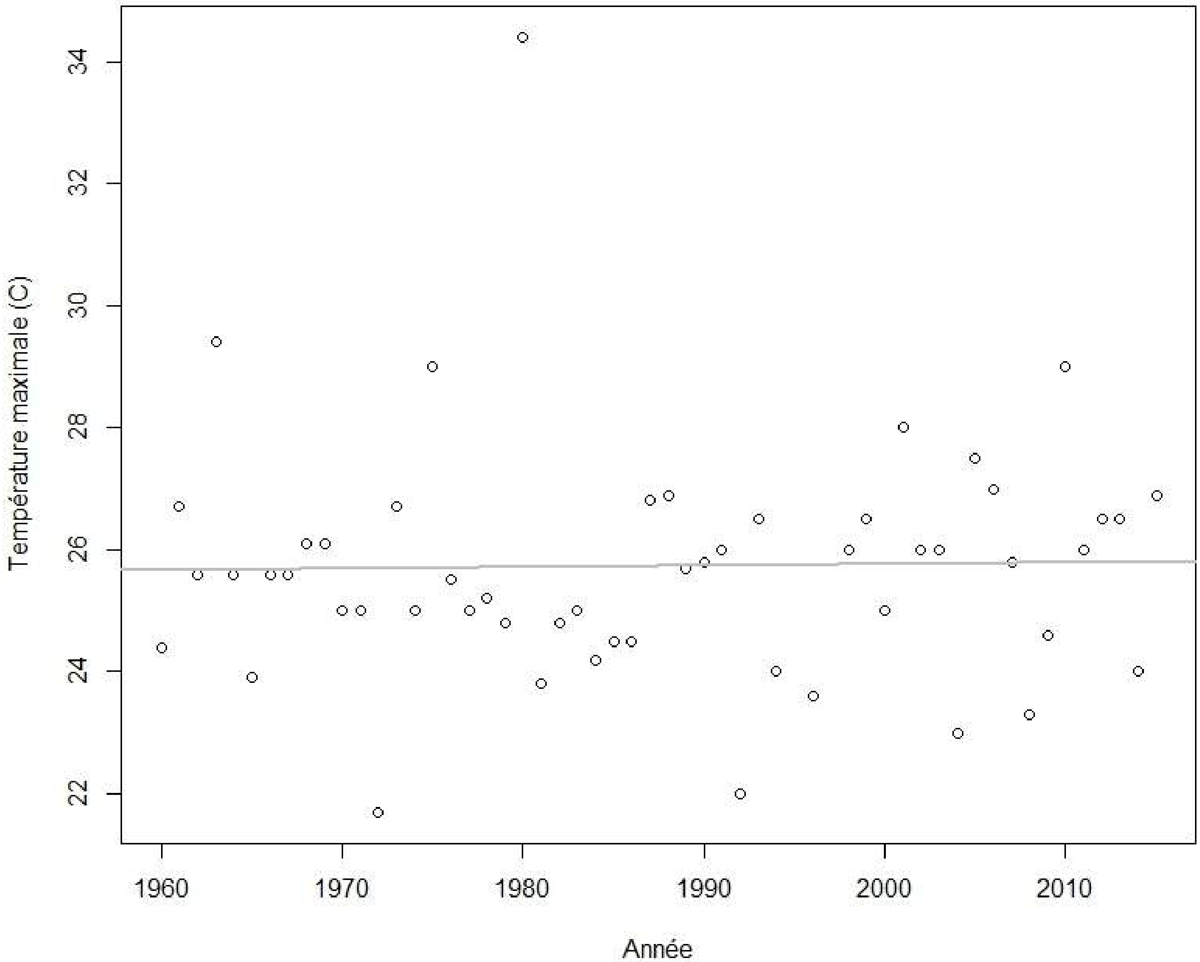

Figure 3 Maximum Temperature by Year for the Ottawa River at Lac Deschênes
The grey line through the points is a simple regression, indicating no trend.
Data source: City of Ottawa Water Purification Plants

5.2.3 Chlorophyll-a

Chlorophyll-a indicates how much algae is present in the water. Higher levels indicate the trophic state of the water or, in other words, the amount of biological activity in a lake. Too much biological activity can result in oxygen depletion and degraded ecological health. The lowest range for tropic state is oligotrophy which has chlorophyll-a no higher than 2.6 µg/L, mesotrophy chlorophyll-a ranges from 2.6 to 7.3 µg/L, eutrophy is 7.3 to 56 µg/L, hypereutrophy is over 56 µg/L[8]. Chlorophyll-a was calculated as the total of chlorophyll-a and phaeopigments measured by Quebec.

[8] For more information, see URL: http://www.secchidipin.org/index.php/monitoring-methods/trophic-state-equations/

Lievre and Gatineau Rivers

There are two monitoring stations on each of the Lievre and Gatineau Rivers. The highest values of chlorophyll-a at three of the sites occurred in 2015 (Figure 4), corresponding to the warmest water temperatures, as indicated by the higher maximum temperatures experienced in 2015 (see section above). Overall, the mean chlorophyll-a records indicate oligotrophic conditions at all sites (Figure 5).

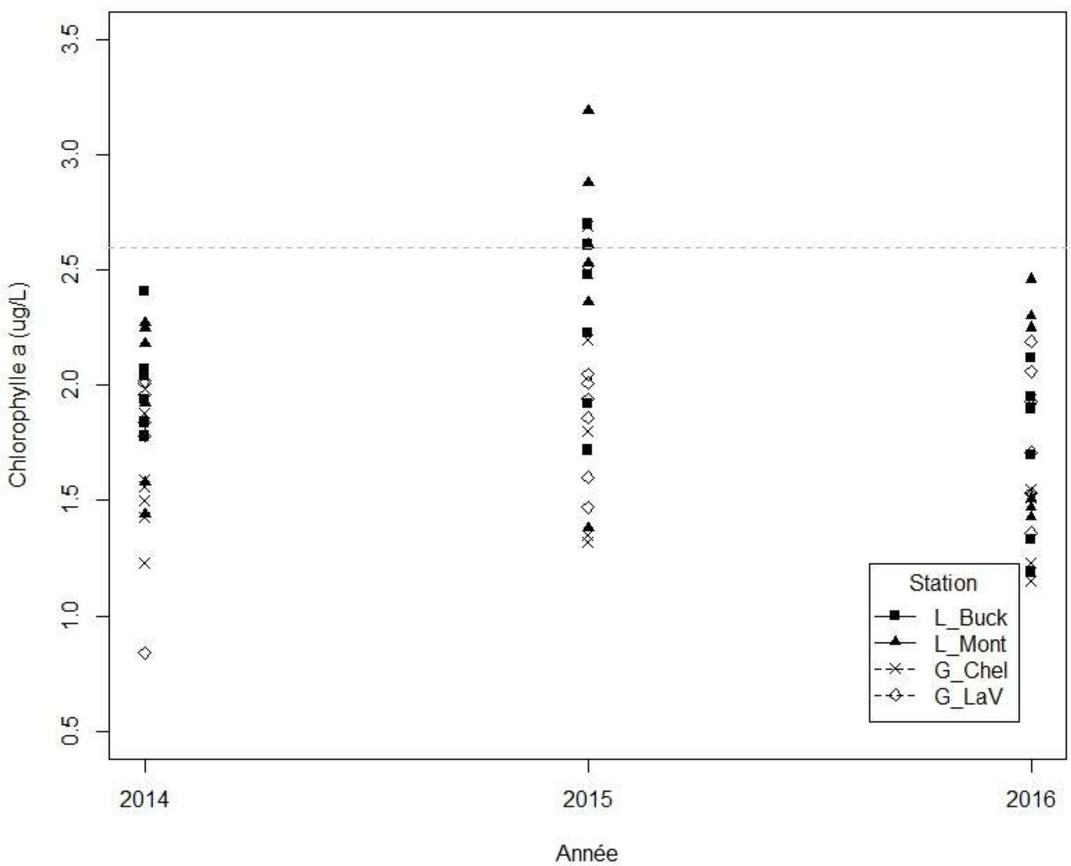

Figure 4 Chlorophyll-a levels (µg/L) by year in the Lievre and Gatineau Rivers
A grey dotted line indicates the threshold between oligotrophic and mesotrophic levels. L_Buck is the Lievre River at Buckingham (site number 4060004); L_Mont is the Lievre River at Mont Laurier Dam (site 4060001); G_Chel is the Gatineau River at Chelsea (site 4080003); and, G_LaV is the Gatineau River at LaVerendrye (site 4080254).

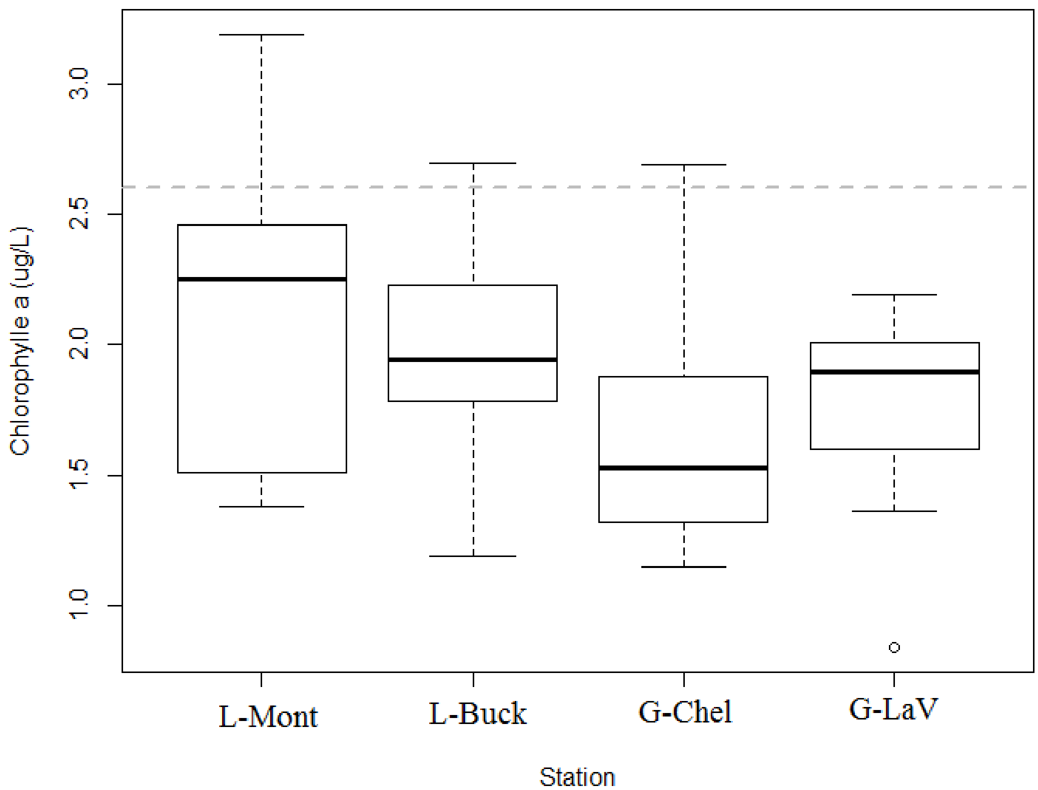

Figure 5 Chlorophyll-a levels (µg/L) by station in the Lievre and Gatineau Rivers (2014 to 2016)

A grey dotted line indicates the threshold between oligotrophic and mesotrophic levels. Lievre River at Mont Laurier Dam (site 4060001); Lievre River at Buckingham (site number 4060004); Gatineau River at Chelsea (site 4080003); and, Gatineau River at LaVerendrye (site 4080254).

The Lievre at Mont Laurier Dam (site 04060001) had the highest recorded level in the three years of record, at 3.19 µg/L, which is mesotrophic. At their highest level, the Lievre at Buckingham (site number 04060004) and the Gatineau at Chelsea (site 04080003) were just over the threshold for mesotrophic conditions at 2.70 and 2.69 µg/L respectively. The highest level of chlorophyll-a at the LaVerendrye site in the Gatineau River occurred in 2016 and was 2.19 µg/L. The lowest reading at the LaVerendrye site was 0.84 µg/L in 2014. This tendency towards increasing chlorophyll-a in the Gatineau River at LaVerendrye provides further evidence that changes are occurring at that location, or upstream of that location, possibly contributing to a degradation of aquatic habitat conditions. Note that even the highest reading of chlorophyll-a at LaVerendrye was within the oligotrophic range. However, a possibly increasing trend in chlorophyll-a at the LaVerendrye location warrants further investigation to assess risks to the aquatic environment.

Ottawa River

Chlorophyll-a records at six sites in the Ottawa River are analysed in two groups due to the very high levels at one site; the site 429002 (à la loutre au pont-route 101 au nord de Saint-Bruno-de-Guigues) is analyzed separately because it occasionally has very high levels of chlorophyll-a.

There is no strong trend by year at five sites (4310002 à la loutre au pont-route 101 au nord de Saint-Bruno-de-Guigues; 4310002 Carillon; 4310008 Chenaux; 4310009 au Pont-Route 101 à Témiscamingue; 4310010 au Pont-Route 101 à Notre-Dame-du-Nord; 4310011 à la traverse de Masson-Cumberland entre le milieu de la Riviére et la Rive Droite) (Figure 6). The site at Carillon dam (4310002) on average is in the mesotrophic range (Figure 7); other sites on average are oligotrophic, although the site at Masson-Cumberland (4310011) has higher variability that reaches into the mesotrophic range. Interestingly, the site in Témiscamingue (4310009) has the lowest mean chlorophyll-a, even though there have been repeated experiences of blue-green algae blooms in the headwaters and Lac Témiscamingue (see Section 5.2.5).

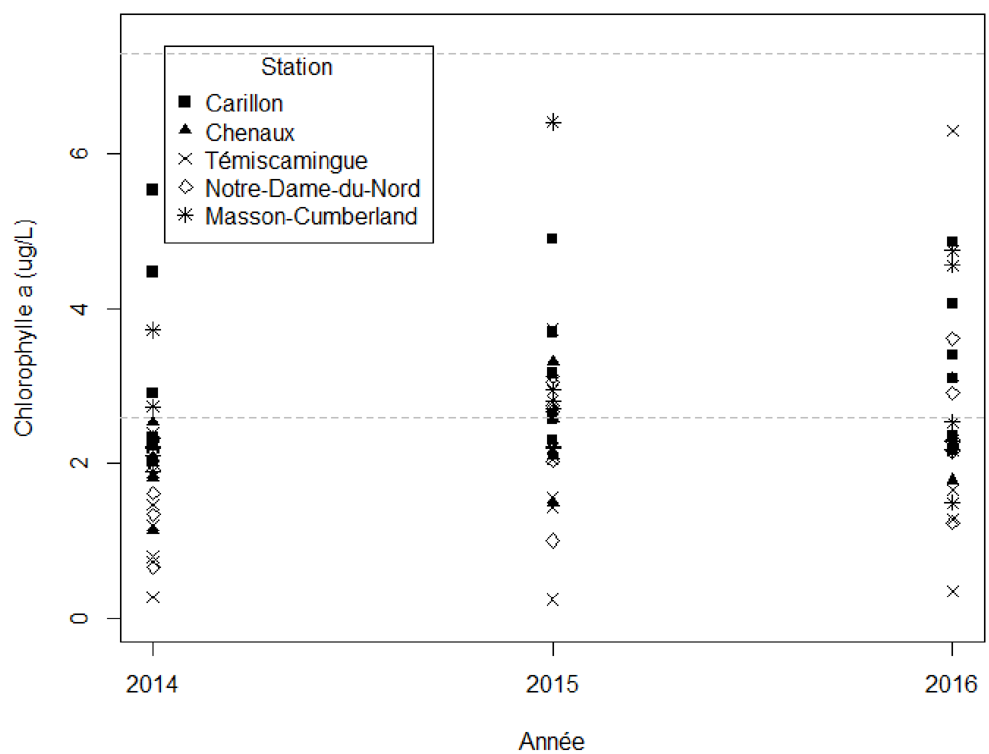

Figure 6 Chlorophyll-a levels (µg/L) by year for 5 Ottawa River sites
A grey dotted line indicates the threshold between oligotrophic and mesotrophic levels, and between mesotrophic and eutrophic levels. The sites are 4310002 Carillon; 4310008 Chenaux; 4310009 at Pont-Route 101 in Témiscamingue; 4310010 at Pont-Route 101 in Notre-Dame-du-Nord; 4310011 at the Masson-Cumberland crossing.

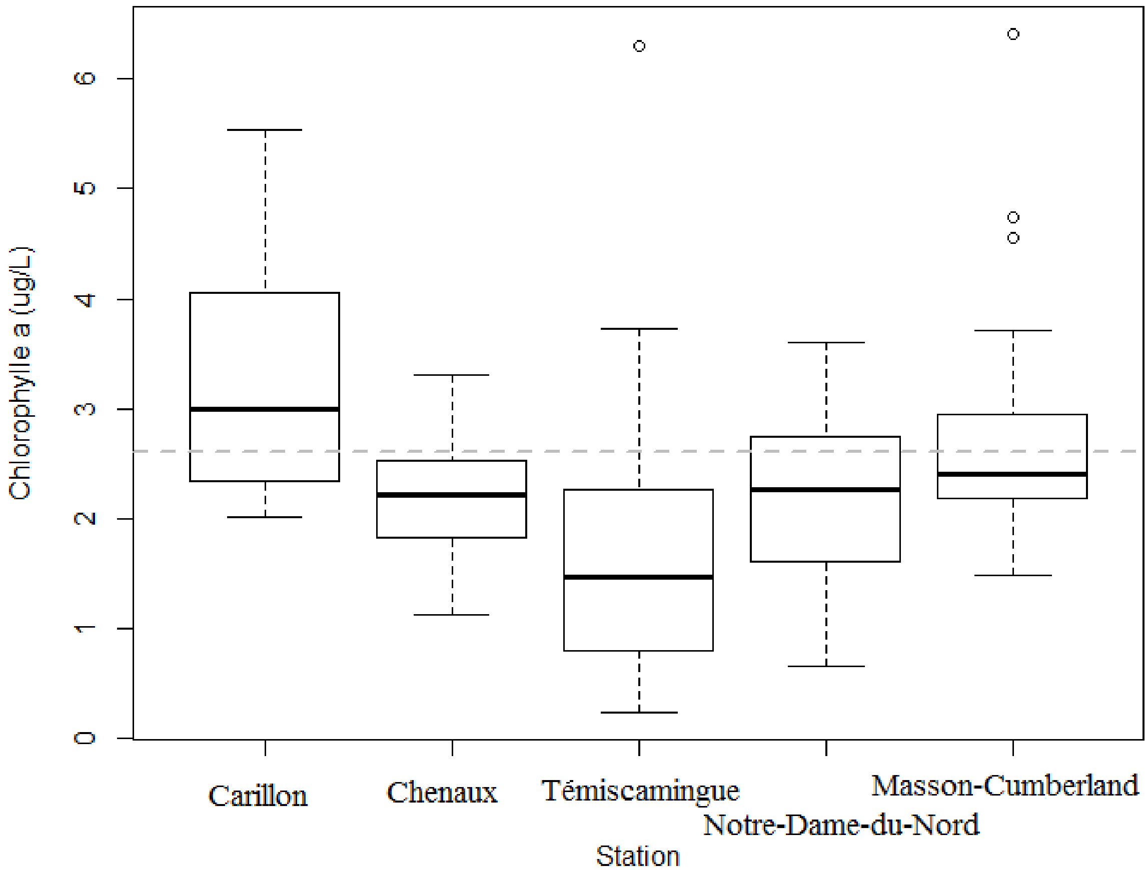

Figure 7 Chlorophyll-a levels (µg/L) by station in the Ottawa River (2014 to 2016)
A grey dotted line indicates the threshold between oligotrophic and mesotrophic levels. The sites are 4310002 Carillon; 4310008 Chenaux; 4310009 at Pont-Route 101 in Témiscamingue; 4310010 at Pont-Route 101 in Notre-Dame-du-Nord; 4310011 at the Masson-Cumberland crossing.

The site 429002 (à la loutre au pont-route 101 au nord de Saint-Bruno-de-Guigues) had very high chlorophyll-a levels recorded, especially in 2015 (Figure 8). On average, this station has chlorophyll-a concentrations that correspond to mesotrophic conditions (Figure 9).

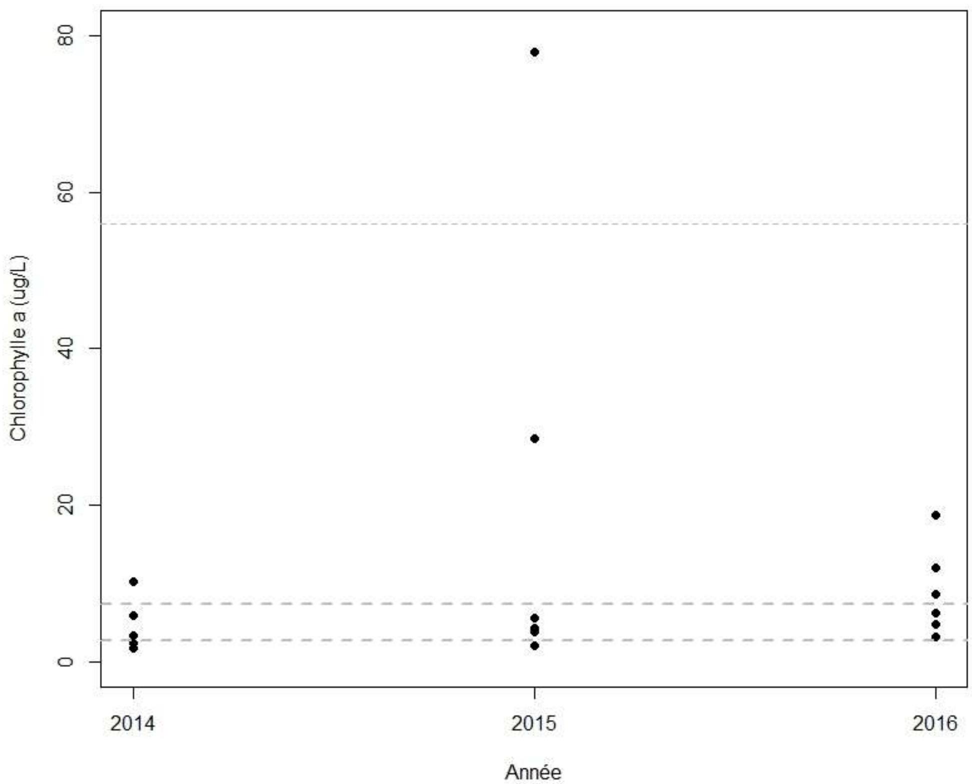

Figure 8 Chlorophyll-a levels (µg/L) by year for station 429002 in the Ottawa River (2014 to 2016)

Station located à la loutre au pont-route 101 au nord de Saint-Bruno-de-Guigues. Grey dotted lines indicate the thresholds between oligotrophic and mesotrophic, between mesotrophic and eutrophic, and hypereutrophic (i.e. over 56 µg/L).

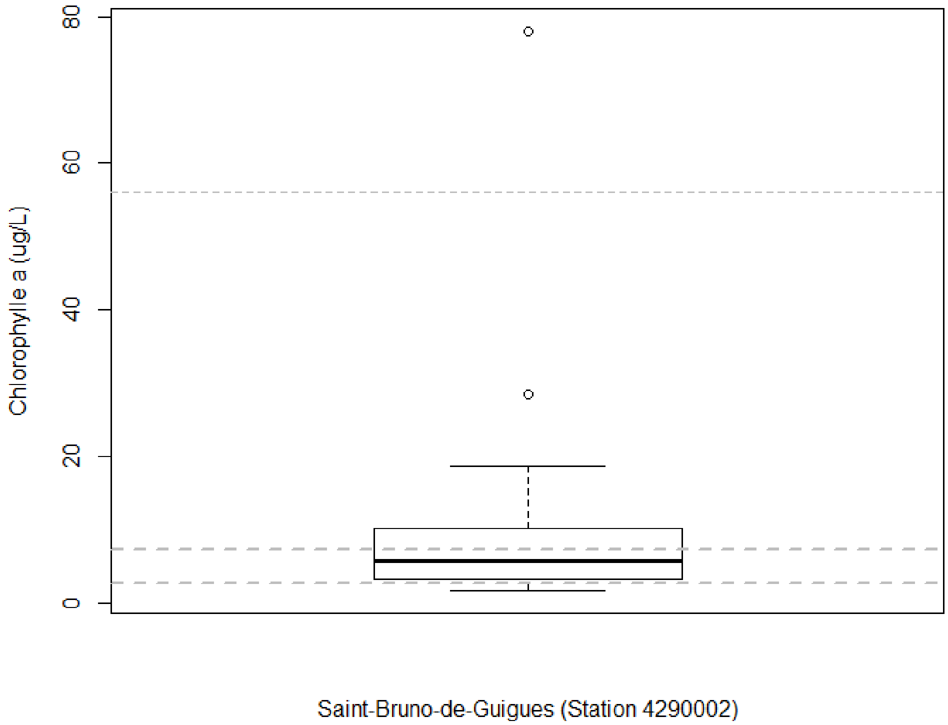

Figure 9 Chlorophyll-a levels (µg/L) at Saint-Bruno-de-Guigues (Station 429002) in the Ottawa River (2014 to 2016)

Station located à la loutre au pont-route 101 au nord de Saint-Bruno-de-Guigues. Grey dotted lines indicate the thresholds between oligotrophic and mesotrophic, between mesotrophic and eutrophic, and hypereutrophic (i.e. over 56 µg/L).

5.2.4 Sewage release incidents: Number of dry weather sewage releases

Combined sewage overflows contain high concentrations of phosphorus and other pollutants that demand oxygen to be assimilated by the river. Combined sewage overflows during wet weather flows, including during rainstorms and spring melt, are not desirable; however, these overflows occur during higher flows in the river. These higher flows help the river to assimilate the wastes. It is highly undesirable to have combined sewage overflows during dry weather because conditions in the river likely to be less prone to waste assimilation. Dry weather overflows can degrade aquatic ecosystem health and even lead to fish kills.

The City of Gatineau operates a wastewater treatment plant that was constructed in 1982 (with upgrades since that time). As of 2019, there are 92 combined sewer overflow sites in Gatineau, Quebec.

The Province of Quebec requires reporting of sewage overflows by municipalities. The City of Gatineau reports the number of overflows during rainfall and spring melt. It also reports overflows during dry weather (Temps Sec), during emergencies (Urgence) and other overflows

(Autres). Table 7 summarizes the number of overflows to the Ottawa, Lievre and Gatineau Rivers reported by the City of Gatineau during the years 2014 to 2016. In 2016, the total number of releases in the three categories was lower for the Ottawa River than the previous two years but higher for the Gatineau River than the previous two years. There were about 30 releases to the Lievre in both 2015 and 2016.

Table 7 Number of Sewer Overflows to the Ottawa, Lievre and Gatineau Rivers from the City of Gatineau

Sewer Overflow Discharge to:	Type of Overflow	Number of overflows by year:		
		2014	2015	2016
Ottawa River	Dry weather	3	2	1
	Urgent	119	25	5
	Other	35	74	1
Lievre	Dry weather	0	0	0
	Urgent	23	19	28
	Other	22	10	2
Gatineau	Dry weather	0	0	0
	Urgent	69	14	19
	Other	4	40	62

5.2.5 Blue green algae occurrences

As indicated in Section 3, Quebec's environment ministry has defined an algae bloom to be 20,000 cells per millilitre in at least one location of a water body. This definition is more strict than the federal government guidelines, which indicates total cyanobacteria should be less than 100 000 cells/mL and total microcystins should be less than 20 µg/L (expressed as microcystin-LR). Ontario does not have a defined limit for recreational water quality standard for cyanobacteria, using the guidelines set out by the federal government.

The Province of Quebec's *Summary Profile of the Rivière des Outaouais Watershed* (2015) reports that from 2004 to 2012, there were blue-green algae blooms in 178 water bodies in 14 subwatersheds of the Ottawa watershed. According to this report, the highest number of incidents occurred in Lac Temiscaming, where every year for seven years, from 2007 to 2013, there were blue-green algae blooms. From 2004 to 2012, 26 waterbodies in the Gatineau subwatershed experienced blue-green algae blooms, including 11 lakes in 2007. Within the Lievre subwatershed, Lac Ouellet and Lac des Îles experienced blue-green algal blooms.

5.2.6 Change in land use

An analysis of land use types was undertaken for 13 land use types: Settlement; Roads; Cropland; Water; Forest; Forest Wetland; Trees; Treed Wetland; Unmanaged Grassland; Wetland; Shrub Wetland; Herbacious Wetland; Other. Nine of these types are natural cover whereas settlement and roads indicate high likelihood of impervious land cover.

The Ottawa River watershed, as well as the Gatineau and Lievre systems, are primarily covered with natural land uses; the Lower Lievre subwatershed experienced the greatest loss of natural cover at 1.8% reduction over 20 years (1990 to 2010) (Table 8). Table 9 summarizes the percent land use allocated to urban uses and road networks. Numerous studies of watersheds in Canada and elsewhere have found that aquatic biodiversity is fundamentally altered at about 10% of a watershed being converted to urban land use. Studies have identified changes in flow regime at just 4% urban land use. The analysis did not include smaller sub-subwatershed scales within the lower Lievre or Lower Gatineau subwatersheds; however, it is worth investigating whether individual catchments exceed 10% urbanization to better understand potential effects on aquatic biota. Agricultural land uses also have stressors to the aquatic environment. The Lower Lievre has the highest percent land cover by crops at 3.2% (Table 10). Analysis at a finer sub-subwatershed scale would be needed to assess any effects of this land use on the aquatic environment.

Table 8 Percent natural land cover by subwatershed
(Source: Analysis based on AgCan maps)

Watershed/ Subwatershed	Percent Natural Cover (2010)	Percent change (1990 to 2010)
Ottawa River	91.4	-0.4
Upper Gatineau	99.6	0
Lower Gatineau	94.7	-0.8
Upper Lievre	96.6	-0.2
Lower Lievre	92.9	-1.2

Table 9 Settlement and road land cover
(Source: Analysis based on AgCan maps)

Watershed/ Subwatershed	Percent Settlement and Roads (2010)	Percent increase (1990 to 2010)
Ottawa River	2.3	0.4
Upper Gatineau	0.3	0
Lower Gatineau	2.8	0.8
Upper Lievre	1.4	0.2
Lower Lievre	3.9	1.2

Table 10 Subwatersheds with the highest percent crop cover
(Source: Analysis based on AgCan maps)

Watershed/ Subwatershed	Percent Crop Land Cover (2010)
Ottawa River	5.4
Upper Gatineau	0
Lower Gatineau	2.5
Upper Lievre	1.9
Lower Lievre	3.2

6.0 Watershed/ Subwatershed Characterization

The total phosphorus concentrations for the three rivers, Ottawa, Lievre and Gatineau are generally below the threshold for concern to maintain aquatic ecosystem health. The highest concentrations occur during spring time in the Gatineau and Lievre Rivers. The maximum recorded water temperatures indicate the Lievre and Gatineau Rivers could support cold water fish, although the temperatures in the Lievre River at Buckingham approached the threshold during the warmest days in 2015. The Gatineau River at LaVerendrye shows an increasing trend in maximum water temperatures, although additional data would be needed to confirm this trend.

The concentrations of chlorophyll-a may also be increasing with year at the LaVerendrye site. However, mean chlorophyll-a concentrations at all four sites on the Lievre and Gatineau Rivers are consistent with oligotrophic conditions. The concentrations of chlorophyll-a in the Ottawa River also generally indicate oligotrophic conditions except at Carillon dam and at Saint-Bruno-de-Guigues, which are mesotrophic. There is high variability of chlorophyll-a concentrations at Saint-Bruno-de-Guigues, indicating possible phosphorus sources in that vicinity.

There are combined sewer overflows during emergency conditions and under other circumstances to the Gatineau, Lievre and Ottawa Rivers. There were also 1 to 3 dry weather overflows recorded over a three year period which impacted only the Ottawa River.

Blue-green algae blooms have recurred in lakes of the Lievre and Gatineau subwatersheds and in Lac Temiscaming in the Ottawa headwaters. As climate change continues to increase air and water temperatures, the incidence of these blooms may increase. This hazard provides incentive to ensure phosphorus concentrations are managed and water temperatures are protected by healthy riparian zones and land use management on a subwatershed scale. The subwatersheds are largely natural cover. However, scientific research has indicated that dramatic changes occur to aquatic biotic health by the time around 10% of a watershed is allocated to urban land use.

Similarly, agricultural land uses create stressors for biota, depending on cropping and animal husbandry practices.

Overall the indicators analyzed point to healthy ecological conditions in the Lievre, Gatineau and Ottawa Rivers. However, planning will be needed with respect to land use change, phosphorus sources and climate change to protect these conditions into the future.

7.0 Recommendations and Potential Next Steps

The focus of the report was to complete a preliminary assessment of ecosystem health for the Gatineau and Lièvre Rivers. However, all recommendations for the City of Gatineau also includes the Ottawa and Blanche Rivers along with smaller streams that encompass these rivers watersheds.

1. **The following indicators should be applied** as a starting point for an assessment and common understanding of the Gatineau and Lièvre Rivers watershed health.

Ecological status indicators	**Threats indicators**
• Benthic invertebrates (HBI) • Fish Diversity (initially, the number of fish species by reach) • Hydro-morphological quality elements (Broad characterization of the average flow in a year relative to a 20-year average; Minimum flow; Maximum flow; Ratio of Maximum to Minimum flows) • Total phosphorus • Dissolved Oxygen • Water temperature (Maximum recorded in a year) • Chlorophyll-a • Mercury	• Sewage release incidents (Number of dry weather releases) • Blue-green algae (cyanobacteria) blooms • Flow connectivity (Number of impassible or partially passible barriers to movement of aquatic biota) • Riparian area connectivity (Percent undeveloped shoreline area) • Fish contaminants (mercury) • Invasive species (number of non-native aquatic species) • Change in land use • Timing of spring freshet • Timing of ice off

2. **Water quality monitoring sites should be established** close to industry, dams and hydro-electric facilities, as well as other sites of interest in order to fully understand the impact of these facilities on the waterways. These sites should monitor, with regular, monthly frequency, ecological status indicators of Total Phosphorous, Dissolved Oxygen, Water temperature, flow, water level, Chlorophyll-a and Mercury which will allow for cumulative

effects assessments within the city of Gatineau and provide information on relative contributions of pollutants at the watershed scale. In addition, reference sites that are more representative of undeveloped, natural conditions should also be included to provide controls.

3. A lead agency or body should **undertake a watershed health assessment every 5 years**. The assessment could begin with the above short-listed indicators, with additional indicators to be added as outlined in Appendix A, as well as additional socio-economic indicators, such recreational water quality through the collection and analysis of E.coli data, finalized through stakeholder engagement.

4. Watershed stakeholders should **prioritize data collection and analysis of short-listed and long-listed indicators** according to existing data gaps (see colour code Table 5; Appendix A) as well as perceived urgency based on preliminary analysis. For example, the available data shows **a worrying trend of decreasing fish diversity** across the Ottawa River watershed. Fish diversity within the Gatineau and Lièvre Rivers should be further investigated and quantified to see if this same trend applies to these subwatersheds.

5. The City of Gatineau adopted the Plan de gestion de l'eau on August 29, 2017. This plan highlights a number of strategies in Orientation 2 (Protéger les écosystèmes aquatiques) including **adopt of green infrastructure (rain gardens, bioswales, stormwater ponds as a technique for minimising stormwater flow and reducing the incidents of combined sewer overflows.** Additionally, **complete shoreline plantings** to help reduce pollution from stormwater runoff and reduce the erosion of stream banks to protect rivers and streams within urban environments. We recommend the City of Gatineau implement the activities in Annexe B and prioritise securing sufficient funding to ensure these are completed within the designated timelines.

6. Agencies should **make their data available in raw form**, not summarized results for indicators, so that individual jurisdictions can manipulate the data per their own conventions (e.g. ECCC's CESI, Québec's IQBR). In addition, any **archived data should be made available** alongside data currently available through online portals such as the MELCC`s site *Atlas interactif de la qualité des eaux et des écosystèmes aquatiques*. Reports such as *État de l'écosystème aquatique — Bassin versant de la rivière Gatineau* which was published by the MELCC in 2004-2006 includes analyticla conclusions regarding the Gatineau River watershed though the ssummarised data. All data collected in these regions, especially those from established stations, should be made available to the public and every effort to **standardize data collection** so that datasets from multiple sources can be used for analyses.

7. Ottawa Riverkeeper is **creating a virtual information hub to consolidate all sources of watershed-based knowledge** (i.e. reports, studies, repository of monitoring activities throughout the watershed). It will include reports on the Ottawa watershed dating back decades, many of which are not widely accessible. This library does not need to contain

datasets - rather, it would centralize information about who is collecting data and how (e.g. monitoring location, indicators being measured, frequency of measurements, owner of data, etc.). This site will be useful for governments, academics, consultants, and non-government organizations. It would increase the efficiency of researchers and promote increased research and collaboration in the watershed. The city of Gatineau should provide relevant data sources to facilitate the inclusion of this data on this site.

Ottawa RIVERKEEPER®
GARDE-RIVIÈRE des Outaouais

275 Bay Street #301, Ottawa, ON K1R 5Z5 | 613-321-1120
www.ottawariverkeeper.ca