H_2O Chelsea program – Surface water

Summary of full H2O report

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Mountains Lake (Beamish) and Hayworth Creek

Executive Summary

Mountains Lake (Beamish) is classified as meso-eutrophic according to its total phosphorus and chlorophyll a concentration and its transparency. Its nutrient concentrations, particularly phosphorus and nitrogen, are higher than the other two lakes being studied. There was a slight decrease in total phosphorus concentrations from 2004 to 2010, followed by an increase from 2010 to 2012; a steadiness between 2014 and 2017 balancing between the mesotrophic and eutrophic classes; and a slight decrease in 2018. Since phosphorus concentrations are higher in the hypolimnion than in the epilimnion during part of the summer season, there appears to be a release of phosphorus from the sediment. In addition, the total Kjeldahl nitrogen also slightly decreased in 2018, and now corresponds more to the mesotrophic category. Conductivity was particularly high in Mountains Lake (Beamish) compared to Kingsmere and Meech lakes, probably because it receives more deicing salt because of the greater number of roads near its shores and in its watershed. It is also important to note that it is highly likely that Mountains lake (Beamish) receives more nutrients and suspended solids from its watershed than the other two lakes studied, as the latter is largely composed of urban and peri-urban areas (Fig 2), while the Kingsmere and Meech lakes watersheds are mainly in Gatineau Park, with fewer human disruptions. The Mountains lake (Beamish) and most of its watershed located in the St. Lawrence Lowlands (Table 2) probably contribute to the increased nutrient and sediment inputs. Also, given its relatively small-scale surface area and shallow depth (Table 2), Mountains lake (Beamish) has a lower dilution capacity. Mountains lake (Beamish) follows the typical pattern of lakes in temperate regions where two seasonal mixings occur, one in the spring and one in the fall. In May 2018, thermal stratification was already installed during the first sampling, contrary to May 2016 (the lake had not been sampled in May 2017) due to the possibility of an earlier spring in the last year. The thermocline seems to be around 3 m deep. After experiencing similar temperatures in 2018 compared to previous years, September and October were colder than normal, indicating a colder early fall. While pH values were high in 2016, they decreased in 2017 and were more in the range of pH 7, similar to what they were in 2018. In May 2018 only, at a depth of 2 m, the upper threshold for recreational activities and aesthetics was met. During the summer of 2018, the

thresholds for the protection of aquatic life were not met. Dissolved oxygen concentrations in Mountains lake (Beamish) increased in 2018compared to 2017, a year marked by relatively low DO concentrations. the water from the hypolimnion reached anoxia once in August. Also, the amount of DO was higher in September and October 2018 than during the same period in the previous year. As early as September, the DO stratification weakened, bringing oxygen to the deeper water layers earlier in the season. Compared to 2017, the summer average of fecal coliforms decreased, and is similar to the 2016 average. Finally, Hayworth Creek appears to be making little contribution to phosphorus

and suspended solids inputs to Mountains lake (Beamish), except for a few very punctual episodes. The highest levels of fecal coliforms were measured in July, August and September in Hayworth Creek. Although this does not appear to have influenced levels in Mountains lake (Beamish), this situation is of concern and deserves more attention to avoid future episodes with so many bacteria in the creek.

Kingsmere Lake

Executive Summary

According to the MELCC classification system, Kingsmere lake is classified as an oligo-mesotrophic lake. The latter is also dimictic, i.e. it undergoes two mixing operations per

year, like the vast majority of lakes in temperate regions, and its thermocline is around 4 m. In 2018, the temperature profiles were similar to previous years, except for one month in September when water temperatures and stratification were slightly higher than in previous years. However, this may simply be due to the lake being sampled at the very beginning of the month and

the temperatures decreasing in subsequent weeks. In summer 2018, the pH of the epilimnion was around 8, so it was slightly alkaline. However, the waters of metalimnion and hypolimnion were more acidic than in the past. The values measured in 2018 were amongst the lowest recorded since 2014 and exceeded the protection threshold for recreational activities and aesthetics in July and September. Dissolved oxygen values were slightly lower in 2018 than in previous years, with several measurements below the threshold for the protection of aquatic life, which had only been

measured once in 2017. Summer averages of both total phosphorus and Kjeldahl nitrogen in surface waters decreased in 2018, after a gradual increase from 2014 to 2017, reaching levels that were among the lowest since the beginning of the H_2O Chelsea program.

However, particularly high concentrations of total phosphorus in hypolimnion suggest sediment release episodes associated with periods of hypoxia in hypolimnion, which is similar to profiles of chlorophyll a. Indeed, when the total hypolimnetic phosphorus concentration was high, the chlorophyll a concentration was also high. Moreover, the transparency of the water was satisfactory for living photosynthetic organisms at the bottom of the lake. Despite high concentrations of chlorophyll a in metalimnion and hypolimnion, concentrations of this pigment in epilimnion were rather low in 2018. The average fecal coliform count remained low during the summer. It therefore seems that the increase observed in 2016 was only temporary.

Meech Lake

Executive Summary

Meech lake has two sampling sites; ML3 and ML5. This lake is the largest and deepest among the three lakes in this study (Table 2). Its watershed is also the largest, covering mainly the northernmost areas of Gatineau Park, and lakes Mousseau, Philippe, Lusk, Taylor, Renaud, Kiddler and Clair (Fig 2). According to the MELCC classification system, Meech lake is classified as oligotrophic. In 2018 compared to 2017, Chlorophyll a and phosphorus values were slightly higher, although they remain relatively low compared to other lakes surveyed and historical values. Meech lake still corresponds to the oligotrophic class, although it was close to the oligomesotrophic class in 2018. However, phosphorus concentrations in the hypolimnion were high, suggesting that the lake sediments were releasing phosphorus into the water column in 2018 as in previous years. Nitrogen concentrations were also high in the hypolimnion. Following the recommendations of the H_2O Chelsea 2016 report, ammonia nitrogen concentrations were measured in the Meech lake water column in 2017 and at one meter above sediments in 2018. These were quite low in 2017 and 2018, although a value approximated the threshold that compromised the effectiveness of disinfection and treatment at ML5 in August. Fecal coliforms

were at very low concentrations in 2018 as in previous years; indicating excellent water quality for swimming and recreational activities. Temperature profiles were similar to previous years, although epilimnion waters were in the higher range compared to previous years in July and August. During sampling in October, the water column was isothermal around 10oC, suggesting imminent fall mixing. The pH values were more alkaline compared to 2017 and the upper threshold for the protection of aquatic life was reached only once in June in the epilimnion. As for dissolved oxygen, the Meech lake hypolimnion was anoxic in August, similar to previous years. Although this is common in lakes of this depth, avoiding the addition of organic matter and nutrients would help prevent the phenomenon from escalating.

Gatineau River

Executive summary

The Gatineau river originates from the Baskatong Reservoir, north of the Ottawa River, and flows 386 km long to its outflow into the Ottawa river. The water quality in this river, at the sites studied as part of the H_2O project, appears to be very good and quite suitable for recreational activities. Phosphorus and nitrogen concentrations are very low and correspond to an oligotrophic class for watercourses. Historic fecal coliform concentrations fluctuated between excellent and good water quality conditions and corresponded to excellent water quality in 2018. Since concentrations of phosphorus, nitrogen and fecal coliforms do not have an obvious pattern from upstream to downstream, there does not appear to be a specific or significant source of these nutrients between Wakefield and Chelsea. Water temperature in 2018 led to a similar start to summer compared to previous years, followed by rather hot measurements in August and September. Dissolved oxygen concentrations were among the highest since the beginning of the H_2O Chelsea program and similar for the entire water column in 2018; providing a suitable habitat for aquatic organisms that require oxygen. In 2018 and in previous years, water transparency in the Gatineau river was rather low. This is probably related to the presence of the inorganic rather than organic particles. Following relatively acidic summer seasons in 2016 and 2017, it appears that pH values rose to normal levels in 2018. Moreover, pH measurements did not exceed the thresholds for the

protection of aquatic life in 2018. Finally, the Gatineau river's conductivity was low, indicating that it obtained little salt input relative to its water volume.

Chelsea Creek

Executive Summary

In 2018, water quality in Chelsea Creek was quite good and showed several signs of improvement over the past two years. More specifically, the summer average total phosphorus content was the lowest recorded since 2004. Nitrogen concentrations have also decreased and the summer average has been among the lowest recorded since 2004. According to these two nutrients, Chelsea Creek corresponds to the oligotrophic class. Suspended solids also decreased in 2018. Fecal coliforms have remained fairly constant since 2016 with concentrations corresponding to good water quality after a particularly high year in 2015. For ions, chloride and sodium concentrations slightly increased from 2017 to 2018, after a significant increase in 2016. Potassium had similar concentrations from 2016 to 2018. For the three ions studied, concentrations increase systematically from upstream to downstream, suggesting the presence of ion sources along Chelsea Creek, such as de-icing salts, abrasives and fertilizers. Chelsea Creek has five sampling stations (Fig 1). In 2018, the stream was sampled five times, compared to four times in 2017, three times in 2016, four times in 2015 and five times in 2014. The highest station is located at the entrance of the NCC on Scott Road (C2), followed by a station downstream of Old Chelsea (C4), a station downstream of a tributary stream (C7), a station near Highway 5 (C8) and a station next to Fleury Road (C9). Intensive sampling at 12 sites along Chelsea Creek from 2005 to 2008 revealed areas of severe erosion such as localized landslides and bank undermining in the lower part of the creek. These erosion zones have certainly contributed to the degradation of water quality in Chelsea Creek. In 2008, several sampling sites were deserted for a multitude of reasons, including the consistency between inter-annual results and budget cuts. However, a new site near Highway 5 (C8) has been added to note possible changes in residential development in the area.

Meech Creek

Executive Summary

Meech Creek originates from a bay on Meech lake north of O'Brien Beach, then flows north to discharge into the Gatineau river about 9 km away. Six sampling stations are located along the creek: M_{out} (Meech lake outlet), M10 (Cowden bridge), M12 (Covered bridge), M11 (Parking 16), M13A (Route 105) and M14 (Saint-Clément road) (Fig 1). In 2018, the stream was sampled five times, from May to September. In previous years, Meech Creek was sampled four to three times, often from June to September. Following some deterioration in Meech Creek's water quality between 2014 and 2016, the stream showed several signs of improvement in 2017. Precisely, the increase in nitrogen, fecal coliforms, anions and cations concentrations from 2014 to 2016 was followed by a decrease in these variables in 2017. In 2018, nitrogen concentrations continued to slightly decrease. However, all other measured variables increased. Total phosphorus increased in 2018, as sites M13A and M14 corresponded to a mesotrophic level, while in the previous year all sites corresponded to an oligotrophic level. In 2018, fecal coliforms increased significantly and reached concerning levels. The four most downstream sites indicated poor water quality according to this parameter. The results obtained ranged from 2 CFU/100 ml to 2200 CFU/100 ml. This indicates that there were significant sources of contamination along Meech Creek. Concentrations of chlorides, sodium, potassium and suspended solids also increased in 2018 compared to previous years, although they remain well below the protection thresholds for aquatic life. The spatial pattern of upstream-downstream increase also persisted in 2018, hinting at the presence of sources of nutrients, fecal coliforms, sediments, anions and cations along Meech Creek. Indeed, the concentrations of all these variables increase from upstream to downstream and this has mostly been the case since the beginning of the H_2O Chelsea program.

At the beginning of the H_2O Chelsea program in 2004 and 2005, several water quality variables, including fecal coliforms, phosphorus and suspended solids, cations and anions, were quite high (Fig 31 A to I). Concentrations of the latter also increased from upstream to downstream, especially downstream of the National Capital Commission (NCC) parking lot 16.

This strongly suggested that the livestock in the bed and riparian zone of Meech Creek contributed to the degradation of water quality. As a result, H_2O Chelsea submitted a recommendation to the

NCC, Environnement Québec and Environment Canada to remove the livestock from the creek valley. This was done in the fall of 2005and several water quality variables have improved since. In any case, this improvement was relatively short-lived and since 2014, we have seen a deterioration in water quality in Meech Creek that meets or even exceeds the condition of the creek before livestock removal in 2005. While 2017 was marked by a decrease in most variables and thus showed signs of improvement in water quality; the summer 2018 saw an increase in most variables, including fecal coliforms, to a level similar to that of 2005.

Conclusion and Recommendations

Based on the results obtained in 2018, combined with historical data, it is suggested that surface water quality in the municipality of Chelsea appears to be good to fairly good. In recent years, some signs of water quality degradation have been noted in most water bodies, although some signs of improvement have also been noted. Total phosphorus has remained relatively stable in Mountains lake (Beamish) and since 2012 has declined slightly in Kingsmere and Meech lakes. Signs of phosphorus release from sediment in Mountains (Beamish) and Meech lakes are evident. From 2016 to 2018, Kjeldahl nitrogen decreased somewhat in the surface waters of the three lakes. From 2013 to 2017, fecal coliforms gradually increased in Mountains lake (Beamish) and was followed by a decrease in 2018. Fecal coliform concentrations remained low in the other two lakes, indicating excellent water quality. Mountains lake (Beamish) showed an improvement in dissolved oxygen concentrations, while Kingsmere lake experienced some decrease in 2018. Since 2011, the Gatineau river appears to have very good water quality, with a decrease in fecal coliforms compared to historical data. Chelsea Creek contains more ions than Meech Creek, with ion sources located between the NCC entrance and Fleury Road. Meech Creek appears to have sources of nutrients, fecal coliforms and sediment between the Carbide Willson ruins and the creek outlet in the Gatineau river.