2021-02-24

THINKING WATER

COMMUNITY ENVIRONMENTAL MONITORING IN GREATER SAINT JOHN

ACAP SAINT JOHN
TEL: (506)652-2227, EMAIL: OFFICE@ACAPSJ.ORG
WEB: WWW.ACAPSJ.ORG

Thinking Water: Community Environmental Monitoring in Greater Saint John

Reinhart, Bethany
MacKinnon, Roxanne

2021

Published by:

Atlantic Coastal Action Program [ACAP] Saint John Inc.
139 Prince Edward Street, Suite 323
Saint John, New Brunswick
Canada E2L 3S3
Tel: (506) 652-2227
Fax: (506) 801-3810
E-mail: office@acapsj.org
Web: www.acapsj.org

Acknowledgements

Funding for the Open Waters project was provided by the New Brunswick Environmental Trust Fund and the Department of Fisheries and Oceans Canada. Technical and laboratory support was [once again] generously provided by the Chemical Technology program of the New Brunswick Community College Saint John. Additional support was provided by Saint Mary's University, the Atlantic Water Network and Atlantic DataStream. This report builds directly upon previous project reports from 2012 – 2020 and could not have been completed without the support ACAP Saint John receives each year from the community.

New Nouveau Brunswick

Your Environmental Trust Fund at Work

NBCC COLLEGEWORKS

Table of Contents

Executive Summary

This report will summarize the findings of ACAP Saint John's 2020 Open Waters project. Open Waters aims to assess the general water quality across streams in the Greater Saint John Area, including tributaries of the Wolastoq [St. John River (SJR)] and of the Saint John Harbour. This project is incredibly significant in a city with a long history of human and industrial uses and impacts on waterways. ACAP Saint John has collected over 28 years of water quality data across many sites in the Saint John region and this historic data has been incorporated into this report.

In 2020, 27 sites were analyzed and across the Greater Saint John area's freshwater streams and estuaries. Based on the parameters measured, ten sites were in "Good" or "Excellent" condition as determined by the Canadian Council for the Ministers of Environment (CCME) water quality index calculations, seven sites were in "Fair" condition, nine sites were in "Marginal" condition, and one site was in "Poor" condition. Based on this Water Quality Index calculator we can infer that most sites across Saint John show a degree of impairment, whether it be occasionally (Fair) or always (Poor). The sites showing the most impairment are located in Marsh Creek, Newman's Brook Downstream, Spruce Lake Stream, and Manawagonish Creek. E.Coli was the parameter that exceeded guidelines most often (higher average concentrations at 59 % of sites) with occasional exceedances of nutrients, dissolved oxygen, and temperature at some sites, as well. Though, generally speaking, the water of the Greater Saint John area is in good conditions or is only threatened some of the time, there is evidence of excessive nutrients and E.Coli present at many sites. This suggests that there is an influence of stormwater or sewer inputs in the system and these parameters should continue to be monitored across the Wolastoq, its tributaries, and the Saint John Harbour.

Fish community data is also reported herein and will indicate that there is a wide variety of species and abundant numbers sampled across the Saint John Harbour. This work is part of a larger monitoring program that will help identify baseline ecosystem status through various endpoints, including fish community richness and diversity. This is a preliminary reporting of this data and more analysis is to be completed in 2022.

Introduction

The Wolastoq [St. John River (SJR)] and its tributaries provide habitat for countless aquatic species, as well as a water source for yet more terrestrial ones. Three cities and numerous towns in New Brunswick lie along the banks of the SJR before it flushes into the Saint John Harbour on the Bay of Fundy. This expansive river is culturally, industrially, recreationally, and ecologically significant for many reasons and to many different species beyond humans. Cutting more than 600 km inland, the river impacts more than just wildlife. Modern uses of the River invariably have deleterious effects, including many human influences along the entire length, various freshwater inputs, along with other changing natural conditions. The Saint John Harbour at the mouth of the River hosts frequent shipping and dredging activities, as well as industrial (e.g., pulp and paper effluent, ballast water, and oil refinery effluent), and municipal discharges, all having the potential to influence overall water quality.

Since the mid-1800's, the City of Saint John, like many other port cities, dumped raw sewage into Marsh Creek and the Saint John Harbour. This practice has left rivers and watersheds polluted, creating an unsuitable habitat for aquatic species. In 2014, the Harbour Cleanup project brought the end of the routine discharging of raw sewage and saw the return of migrating fish species and improved water quality. Continuous monitoring projects like this one help identify specific problem areas or recent changes in water quality that need to be addressed. This report provides analysis of the state of water quality in the Greater Saint John Areas and provides recommendations for further action in the city's watersheds.

The purpose of this project is to continue the water quality and fish assemblage monitoring within the Marsh Creek watershed and its neighbouring waterways to document the recovery from centuries of raw sewage disposal. *Thinking Water* is a continuation of the *Rebirth of Water* monitoring program which was originally meant to track improvement after the sewage ban. The project encompasses monitoring of the tributaries of the Wolastoq and other waterways found throughout the City of Saint John.

Methods

Water Quality Monitoring Sites

Water quality monitoring sites are located across 10 different sub watersheds of the Wolastoq to represent the state of freshwater streams in the Greater Saint John Area and to continue historic monitoring in the Marsh Creek watershed. In total, 27 sites were monitored in 2020 (Table 1, Figure 1). GPS coordinates for each of the sites monitored can be found in Appendix 1. Below is a brief overview of selected watersheds that were monitored in 2020.

Marsh Creek: An internationally recognized environmental concern due in large part to its receipt of untreated municipal wastewater and heavy creosote contamination in the sediments downstream.
Hazen Creek: Flows through forested, residential, commercial, and industrial areas. As such, the watershed has suffered over the years from indirect and direct impacts of development.
Taylor Brook: The main threat to this watershed is potential encroachment from development as East Saint John and the Town of Rothesay expand further into the watershed.
Newman's Brook: The headwaters of Newman's Brook lie in an area that was once a landfill which has only been partially capped, resulting in the potential for leachate to move through the brook.

Caledonia Brook: Development and encroachment have put pressure on sections of the watershed potentially affecting the water quality.
Salmon Creek: Many residential homes are located within this watershed and the watercourse may suffer from the indirect and direct effects of development, riparian area degradation, nutrient runoff, and natural flow regime changes.
Mill Creek: The watershed itself is mostly forested with some development (mostly housing) as it approaches the Saint John River and the Saint John Marina which is located at the outflow of the creek and flushes into the Saint John River.
Spruce Lake Stream: A quarry is located within the watershed that may impact the stream with sediment runoff.
Manawagonish Creek: The watercourse flows through a stormwater pond and crosses Highway 1 twice before by-passing a wastewater treatment plant.
Crescent Lake: This lake is in Rockwood Park and is a site for the aquatic driving range. It is adjacent to both Rockwood Park Golf course and the high traffic Sandy Point road.

Table 1: Locations and site codes of sites sampled in ACAP Saint John's 2020 Thinking Waters.

Site	Site ID	Latitude	Longitude
Fairweather Brook	FB	45.374320	-65.982060
Taylor Brook US	TB-US	45.378540	-65.978870
Taylor Brook DS	TB-DS	45.382140	-65.996340
Salmon Creek US	SC-US	45.422590	-65.959140
Salmon Creek DS	SC-DS	45.400330	-65.992310
Newmans Brook US	NB-US	45.296900	-66.071290
Newmans Brook DS	NB-DS	45.277260	-66.089320
Caledonia US	CB-US	45.290250	-66.094490
Caledonia DS	CB-DS	45.296870	-66.118670
Crescent Lake	CL	45.305960	-66.076810
Spruce Lake Stream US	SLS-US	45.243470	-66.157650
Spruce Lake Stream Mouth	SLS-M	45.253560	-66.143960
Manawagonish Creek US	Man-US	45.243600	-66.102600
Manawagonish Creek DS	Man-DS	45.244450	-66.107370
Dominion Park	DP	45.268890	-66.125290
Mill Creek	MC	45.279310	-66.155487
Kennebacasis Drive	KD	45.305689	-66.095746
Inner Harbour	IH	45.272068	-66.073478
Marsh Creek WS 2	MC2	45.281834	-66.049478
Marsh Creek WS DS	MC-DS	45.282676	-66.049784
Marsh Creek WS 3	MC3	45.284826	-66.052373
Marsh Creek WS 4	MC4	45.289029	-66.047363
Marsh Creek WS 5	MC5	45.291050	-66.043541
Marsh Creek 11	MC11	45.309737	-66.033974
Marsh Creek Watershed Upstream	MC-US	45.321672	-66.015109
Hazen Creek Mouth	HC-M	45.260928	-66.015080
Hazen Creek 2/Expansion	HC2	45.275821	-65.999035

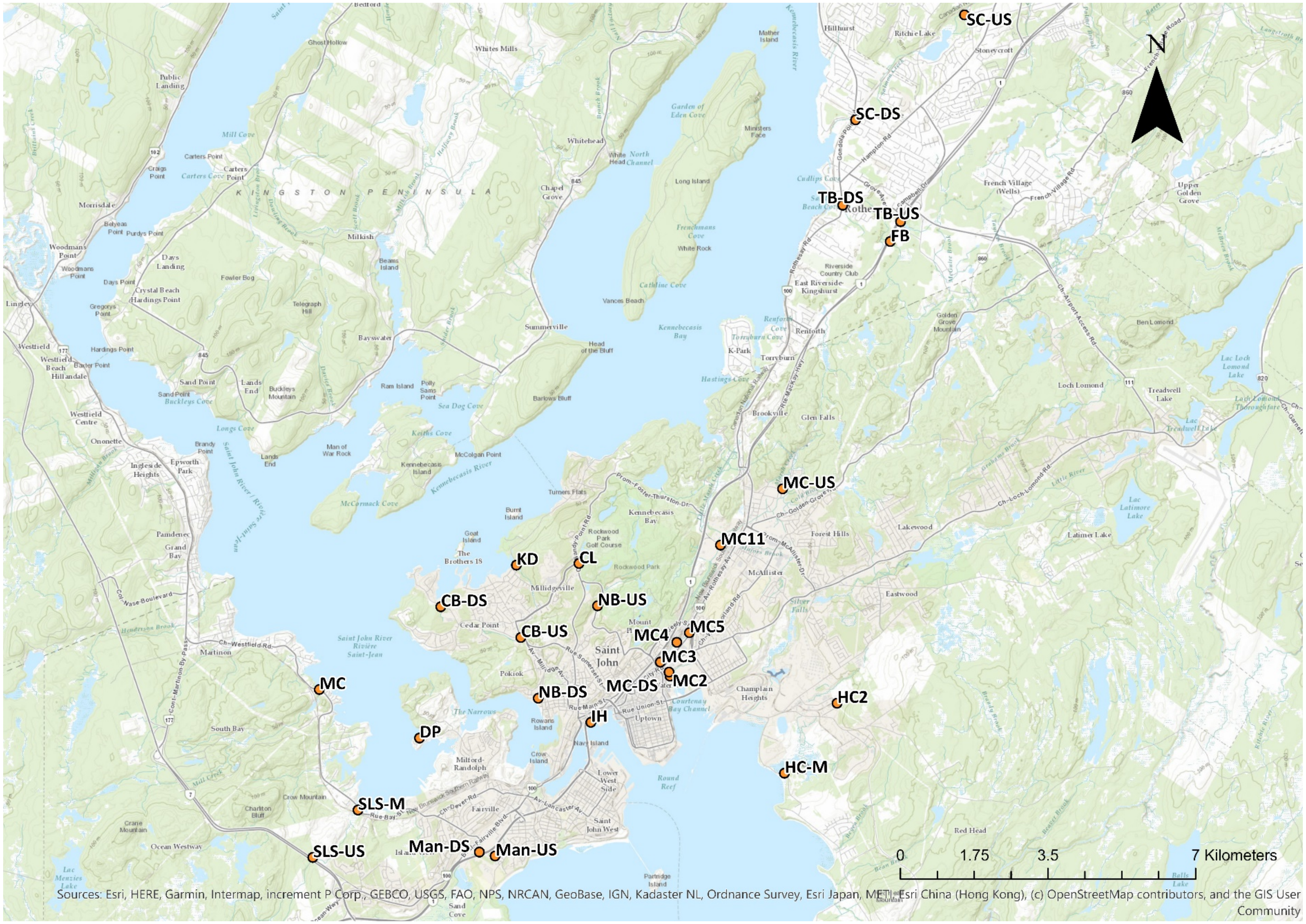

Figure 1: Locations of water quality sampling sites during the 2020 field season. Coordinates and site names can also be seen in Table 1.

Water Quality Analyses

Water quality data collected includes dissolved oxygen (DO), salinity, and pH, measured with a handheld YSI Professional Plus probe in the field. Dissolved oxygen and pH probes are calibrated following the manufacturer's recommendations. Turbidity is also measured in the field using a handheld turbidity meter. Escherichia coli (E. coli), orthophosphate, and ammonia were quantified at ACAP Saint John using an IDEXX-Colilert-18 system and DR900 colorimeter.

E.Coli

This field season was the first that E.Coli was measured in this water quality monitoring program. Historically our data included total coliform instead. Since not all total coliform species present a threat of illness or indication of contamination, replacing this measure with E.Coli will give a better indication of the water quality status at each site. E.Coli was measured using an IDEXX-Colilert-18 system. The Colilert-18 reagent was added to 100 mL of sample and incubated in standardized trays at 35 degrees Celsius for 18 hours. After 18 hours the number of yellow and fluorescing trays corresponded to the Total Coliform and E.Coli concentrations, respectively, measured as most probably number/100 mL (MPN/100 mL). If site water exceeded 4 ppt salinity it was analyzed in a 1:10 dilution so that the salinity would not interfere with the bacterial growth, and results were multiplied by ten to achieve MPN/100 mL. Before 2020 Fecal Coliforms were incubated and measured in the NBCC laboratory in coliform forming units/100 mL (CFU/100 mL).

Orthophosphate

In 2020 because of Covid-19 and lack of access to the NBCC laboratory the orthophosphate was measured at ACAP Saint John using the DR900 Phosphorus, Reactive (Orthophosphate) method 8048. Results are in mg/L as concentration of both Phosphorus and Phosphate. Before 2020 to measure orthophosphate in water, samples were mixed with concentrated sulfuric acid to convert polyphosphates to orthophosphates; orthophosphates elicit a colour change when exposed to ascorbic acid while polyphosphates do not. The solution was then reacted with potassium antimonyl tartrate and ammonium molybdate to create an antimony-phosphomolybdate complex which turned blue after ascorbic acid was added. Orthophosphate concentration was measured by depth of sample colour using a spectrophotometer (Thermo Scientific Genesys 200) set at 840 nm and recording transmittance and absorbance. The orthophosphate concentration was determined using a calibration curve created from analyzing known standard concentrations and is expressed as mg/L of P.

Ammonia

In 2020 because of Covid-19 and lack of access to the NBCC laboratory ammonia was measured at ACAP Saint John using the DR900 Nitrogen, Ammonia method 8155. Results are in mg/L. Before 2020, to measure ammonia water, samples were mixed with phenol, sodium nitroprusside, and an oxidizing agent (trisodium citrate, sodium hydroxide, and sodium hypochlorite). This produced a colour change which was measured by a spectrophotometer set at 640 nm and compared against a standardized calibration curve which was used to determine ammonia concentration expressed as mg/L.

Guidelines

Water quality guidelines and thresholds taken from literature were used for various parameters in this report to interpret the environmental state at each site. The threshold used for temperature was an upper limit of 23°C, which is considered optimal for juvenile salmonids (Breau, Cunjak, Bremset, 2007). The guideline used for dissolved oxygen was a lower limit of 6.5 mg/L (Canadian Council of Ministers of the Environment, 1999c). For pH, the guidelines used were a lower limit of 6.5 and an upper limit of 9 (Canadian Council of Ministers of the Environment, 1999b). The guideline used for E.Coli in 2020 was 200 MPN/100 mL (Canadian Council of Ministers of the Environment, 1999a). For ammonia, the upper limit used herein was 0.1 mg/L total ammonia because concentrations are generally less than this value in “natural waters” (Canadian Council of Ministers of the Environment, 2010). Orthophosphate has no guideline from the Canadian Council of Ministers of the Environment (CCME), but triggers should be based on historic values. Herein the trigger used for Orthophosphate (PO_4-P) was 0.035 mg/L. For turbidity, triggers should also be based on deviations from background levels and there is no set guideline from CCME, herein 50 ntu was used as an upper limit.

Fish Community Monitoring

Fishing occurred monthly at 8 sites (June – Oct) across the Saint John Harbour in coordination with ACAP Saint John’s Harbour Baseline Monitoring. Fishing was conducted using seine nets (one 3-min tow each month) and fyke nets (24 hour deployment each month). Fish were identified and measured (total length) and returned to the water. This is part of a larger monitoring program that will develop a baseline of fish communities within the Harbour near some of Saint John’s most industrially or residentially impacted sites. Fish counts across the Harbour are presented below.

Marsh Creek Water Quality

The Marsh Creek watershed has the longest running water quality monitoring data due to its historical contamination. This section combines two different data sets. The older *Rebirth of Water* dataset dates as far back as 1993 and monitors two sites (labelled MCUS and MCDS) while the newer *Open Waters* dataset goes back to 2012 and monitors six sites (labelled MC2, MC3, MC4, MC5, and MC11).

The CCME has created a Water Quality Index (WQI) that rates water quality based on a ratio of parameters that exceed guidelines (see methods for guidelines used herein) to the total number of parameters measured (minimum number of four parameters measured over four timepoints). This index has five rankings: poor (0-44), marginal (45-64), fair (65-79), good (80-94), and excellent (95-100) (Canadian Council of Ministers of the Environment, 2001). Water quality in Marsh Creek is categorized as “Fair” at one of the seven of the sites, “Marginal” at five sites, and “Poor” at MC2 near the stream mouth (Figure 2). These WQI calculations were based on temperature, DO, pH, salinity, ammonia, phosphate (measured as P), and E.Coli (n=5 samples per site in 2020). The primary parameter causing the low WQI scores is the E.Coli concentration. There were occasional exceedances of nutrient concentrations or DO across sites, but E.Coli was higher than the guidelines at each site, sometimes drastically so. This excessive bacterial presence could be from combined sewage and stormwater overflows. However, since these concentrations occur even outside of heavy precipitation events, there may be other unidentified ways that E.Coli is entering the system. Fecal coliform and E.Coli contamination has been a historical problem for Marsh Creek for decades and continues to be a prevalent issue in the watershed in 2020.

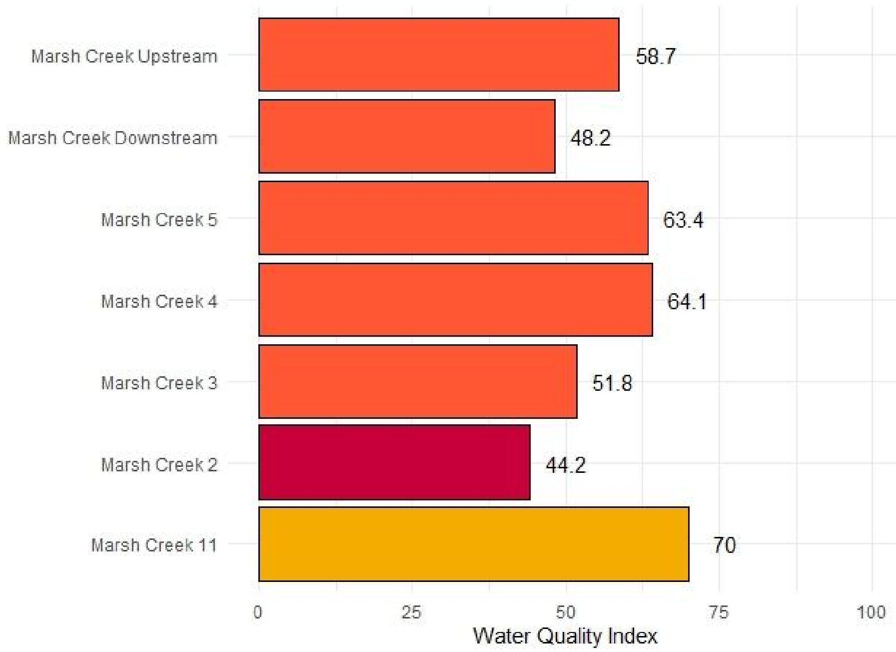

Figure 2: Calculated water quality index for all seven Marsh Creek Sites in 2020.

In Figures 3 - 5 the data are presented in Xbar-R (mean-range) control charts. Control charts plot the data over a specified time interval. Comparing the data to the mean (blue line) and control limits (red lines, which are based on the standard deviations) shows how far individual parameter measurements deviate from the typical values. Hollow points show individual sample measurements and black points show mean per year. The sites are arranged by relative position (Figures 3 – 5) with the most upstream Marsh Creek site on the left and the most downstream on the right. Data from Marsh Creek 1 is visually displayed in these charts, however, there is no data for 2020 as it was no longer considered safe to access this site.

For most Marsh Creek sites, average ammonia and orthophosphate (as P) concentrations have decreased since the 2019 analysis (Figure 3) and, though there are individual data points exceeding guidelines across sites, average site concentrations generally remain within the recommended CCME range across all sites. The exception is at Marsh Creek Upstream where ammonia exceeded and Marsh Creek Downstream where orthophosphate exceeded. For this report the acceptable ranges for these parameters were 0 - 0.035 mg/L for orthophosphate and 0 - 0.1 mg/L for ammonia (see methods for further explanation). Though average concentrations of these parameters look better than they have in many years, there were still individual data points that exceeded guidelines at each site. Since stopping the dumping of raw sewage into Marsh Creek in late 2014, ammonia and orthophosphate levels still spike regularly, likely as lift stations overflow during heavy rains (these nutrients are highly tied to sewage inputs). Additionally, Marsh Creek has many stormwater influences and poor riparian areas to buffer runoff washing more nutrients into the system. The concentrations of ammonia and orthophosphate observed in 2020 shine a hopeful light on the story of recovery in the Creek.

Figure 4 shows the control charts with fecal coliform data up until 2019 and in 2020 the data displayed is E.Coli due to our in-house shift in analysis. E.Coli data will give a more accurate indication of the presence of coliforms that are confirmed to be a threat to human health. E.Coli data then, appear to be lower at all sites than the fecal coliforms measured in previous years. This is expected as E.Coli make up a portion of fecal coliform counts. There are massive spikes in fecal coliforms starting in 2000 and ending in 2015, which corresponds to the ceasing of raw sewage inputs. Due to the skewing effect these spikes have on the overall mean, it is not a good measure of central tendency of the data. The trend in mean-by-years more accurately describes true fecal coliform levels over time. The average E.Coli MPN/100 mL ranged from 448-8545 across sites (Table 2). The guideline for E.Coli in waters for recreational use is an average of 200 MPN/100 mL. While some of these values look much better than they did in previous decades, each of the Marsh Creek sites remains at a level of concern for E.Coli contamination in 2020. Fecal contamination in Marsh Creek is likely from lift station overflows that persist during heavy rainfall events when the system receives too much stormwater. This means that after heavy rainfalls, contact with Marsh Creek should be limited.

Mean pH in Marsh Creek exceeds upper and lower control limits for some sites but still stays within the CCME guidelines for all years including 2020 (Figure 4, Table 2) (6.5 – 9; Canadian Council of Ministers of the Environment, 1999b).

Water temperatures were within the range considered optimal for this report (< 23 °C; Breau, Cunjak, Bremset, 2007) and remained similar or lower than most previous values (Figure 5, Table 2). Similarly, DO concentrations all were within the acceptable range across Marsh Creek sites (> 6.5 mg/L) indicating that aquatic life, in particular fish species, can inhabit this section of the creek (Figure 5, Table 2) (Canadian Council of Ministers of the Environment, 1999c). Mean temperature decreases slightly moving more downstream from influences of cool tidal water.

Though not pictured in charts, average turbidity of all Marsh Creek sites were observed to be in the acceptable range, as well (<50 ntu, Table 2).

With the above summary of Marsh Creek data, it can be concluded that the main offender in reducing the water quality in Marsh Creek remains to be E.Coli and fecal related bacteria. The concerning levels of E.Coli and the occasional exceedance of ammonia and phosphate across sites, even in the upstream reaches, is an indication that sewage overflow contamination was likely still occurring in 2020.

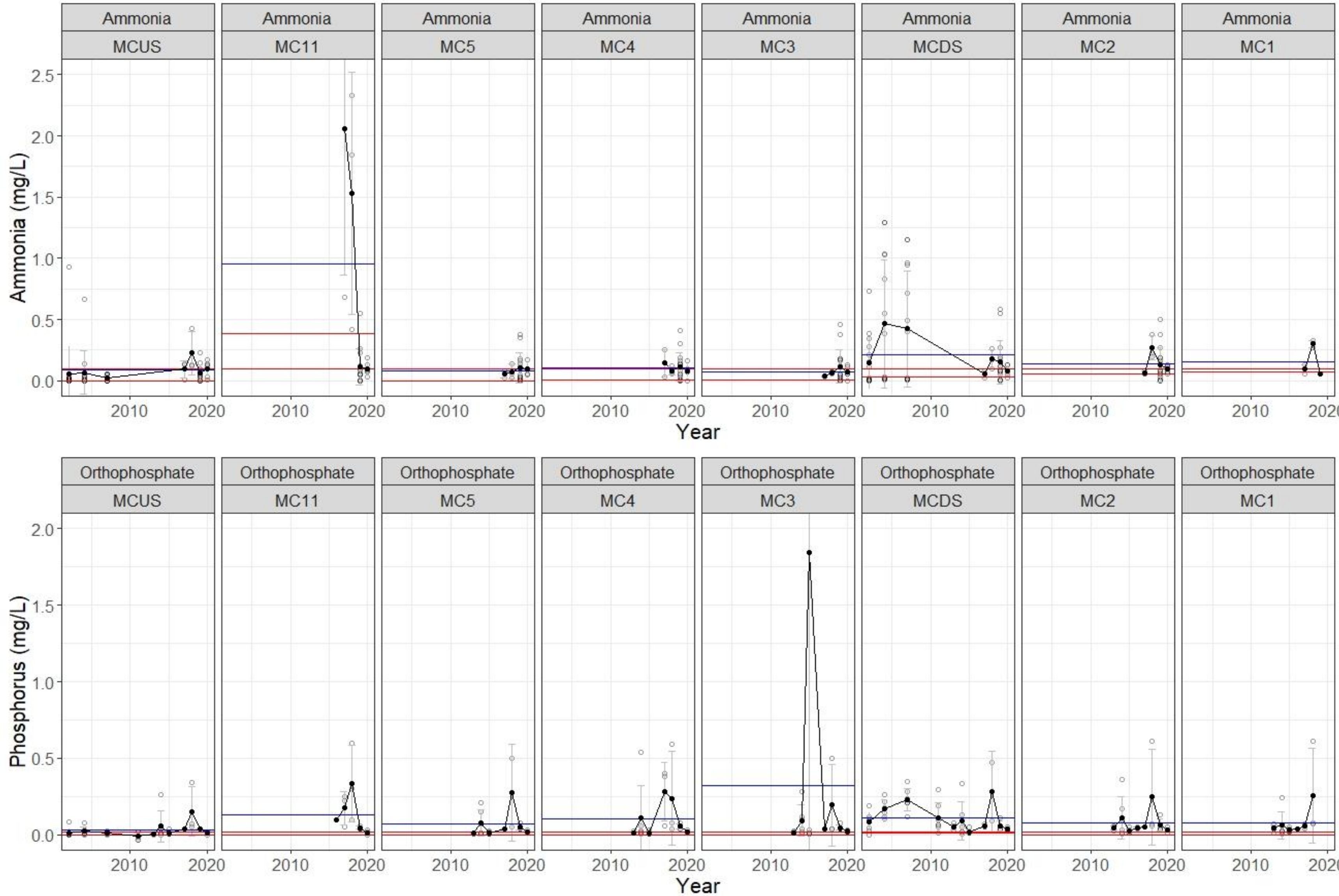

Figure 3: Xbar-R control chart of ammonia (mg/L) and orthophosphate (mg/L P) levels per year in Marsh Creek from 1999-2020. Plots have been zoomed in and outliers cropped out to better visualize the data.

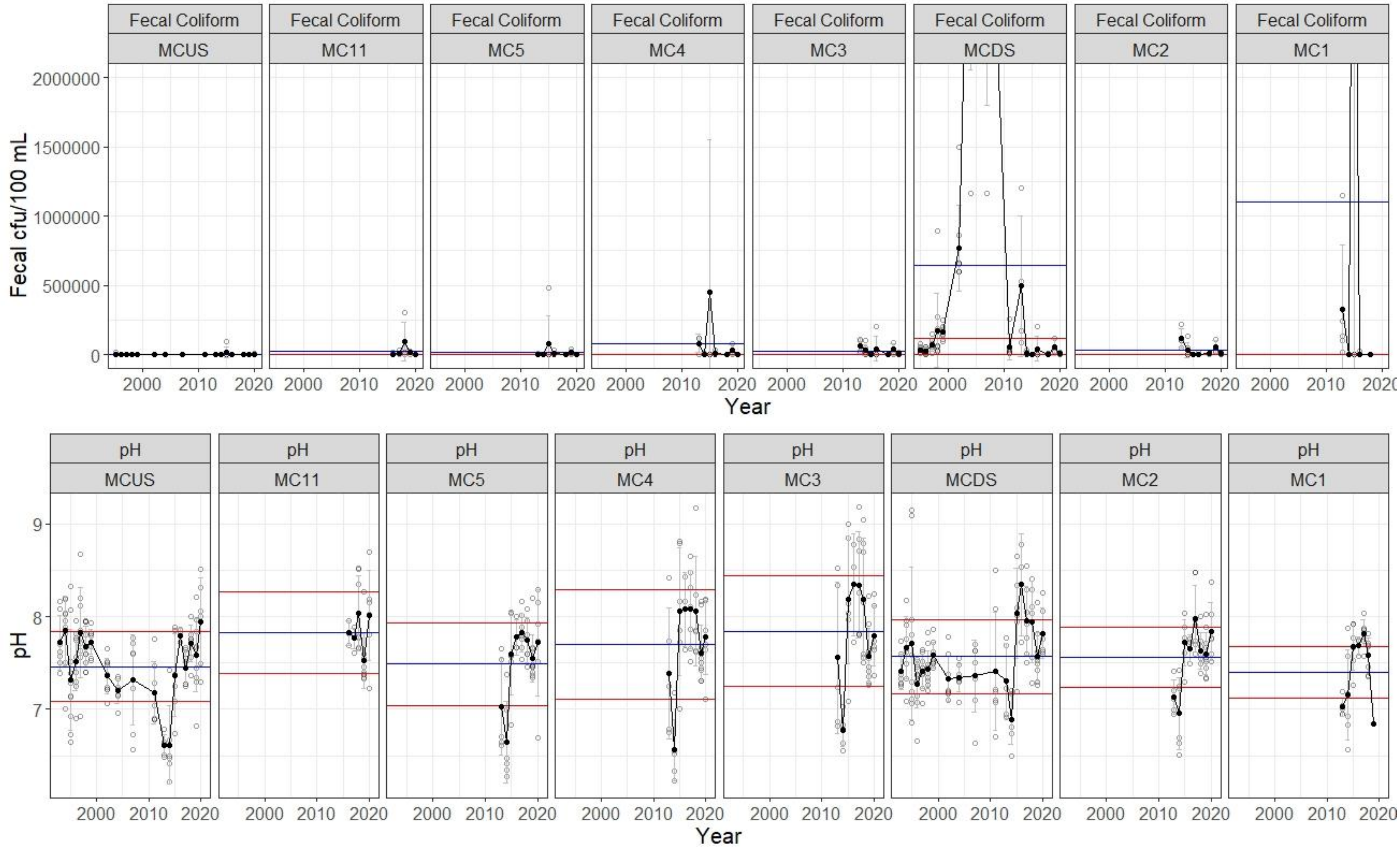

Figure 4: Xbar-R control chart of fecal coliform (cfu/100mL) and pH levels in Marsh Creek (1993-2020). Plots have been zoomed in and outliers cropped out to better visualize the data.

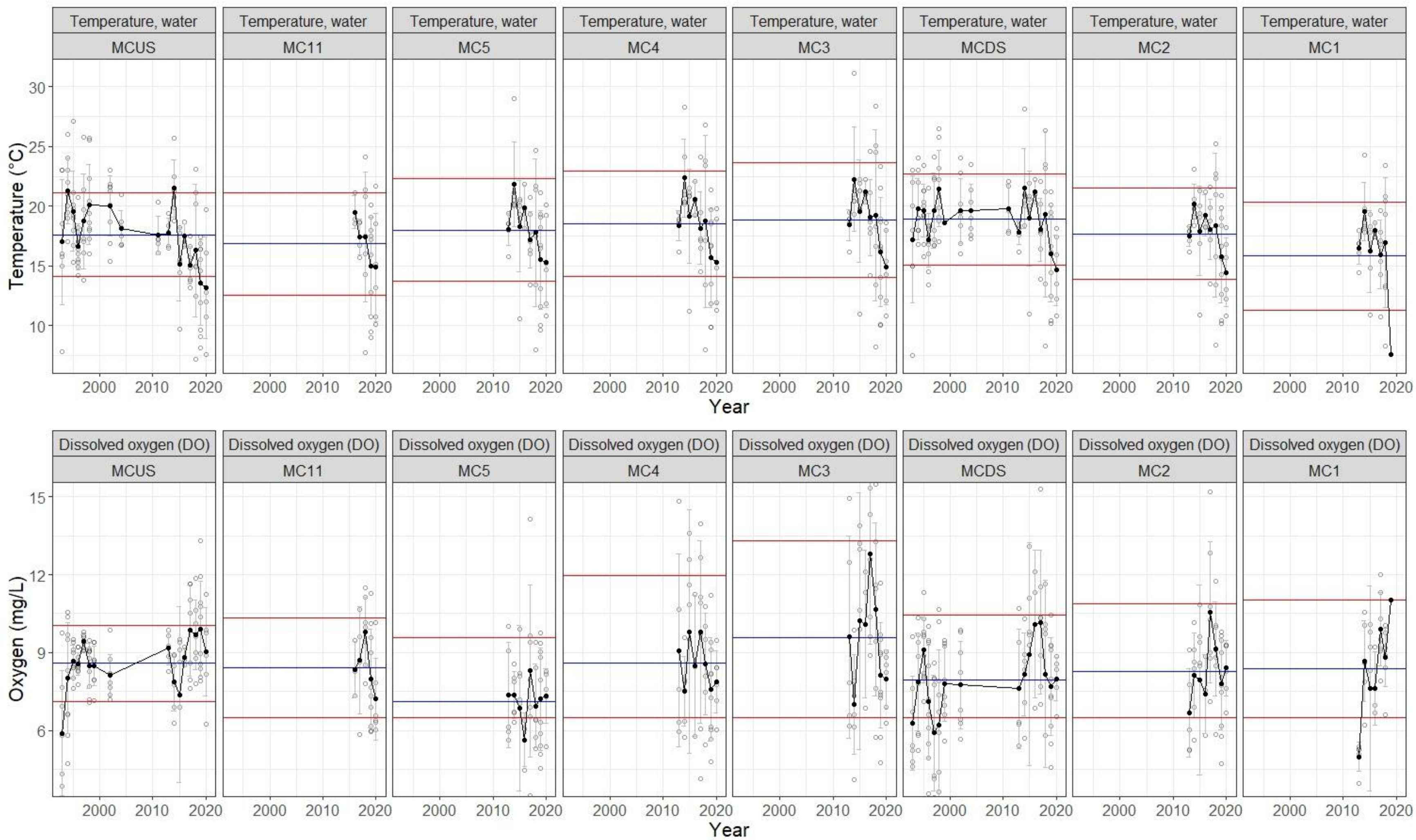

Figure 5: Xbar-R control chart of water temperature (°C) and dissolved oxygen (mg/L) levels in Marsh Creek (1993-2020). Plots have been zoomed in and outliers cropped out to better visualize the data.

Water Quality in the Greater Saint John Area

In this section, the water quality monitoring completed in the Greater Saint John area outside of Marsh Creek is presented. Due to the large volume of data collected in the Marsh Creek watershed since 1993 it was reported in an isolated chapter above. Again, this Water Quality Index (WQI) has five rankings: poor (0-44), marginal (45-64), fair (65-79), good (80-94), and excellent (95-100) (Canadian Council of Ministers of the Environment, 2001). These WQI calculations were based on temperature, DO, pH, salinity, ammonia, phosphate (measured as P), and E.Coli (n=5 samples per site in 2020).

In total, 3 sites, Inner Harbour, Fairweather Brook, and Dominion Park, had “Excellent” water quality based on the index score of 100 (Figure 6). “Good” water quality scores were calculated for seven sites, six sites had “Fair” water quality, and four sites had “Marginal” water quality. There were no sites with “Poor” water quality outside of Marsh Creek. These calculations suggest that 50 % of sites sampled in this monitoring program show little to no impairment (Good or Excellent ratings), while the other half of sites show indications of occasional impairment (Fair) or even frequent impairment (Marginal).

We can summarize that threats to water quality are often not present at 80 % of the sites we tested located outside of Marsh Creek, except the four with a “Marginal” rating. These sites include those in Manawagonish Creek, Newman’s Brook Downstream, and Spruce Lake Stream Mouth. These sites in Manawagonish Creek and Newman’s Brook receive runoff from streets and neighbourhoods within the city, as well as stormwater and combined sewer overflows. These factors are likely causing the frequent departures from the optimal ranges of of E.Coli and nutrient concentrations at these sites. Spruce Lake Stream mouth is also next to a roadway but we are unsure at this point on the source of the E.Coli.

Similar to the Marsh Creek WQI score, exceedances of the E.Coli guideline appear to be the main cause for the lower scores in the sites rated Fair and Marginal. The average concentrations for each parameter can be seen in Figure 7, Figure 8, and Table 2. At Newman’s Brook Downstream high nutrients are also contributing to the low score. Some individual measures of low DO had an influence on the Crescent Lake, Mill Creek, and Manawagonish Upstream scores. Also, temperature was occasionally higher than the protective 23°C threshold at Crescent Lake, Spruce Lake Stream Mouth, Kennebecasis Drive, and Taylor’s Brook Upstream. Nutrients, E.Coli, low DO, and higher temperatures can all be linked with sewage inputs entering the system and causing excessive bacterial activity. High temperatures could also be linked with the extremely low water levels that were observed in the summer of 2020.

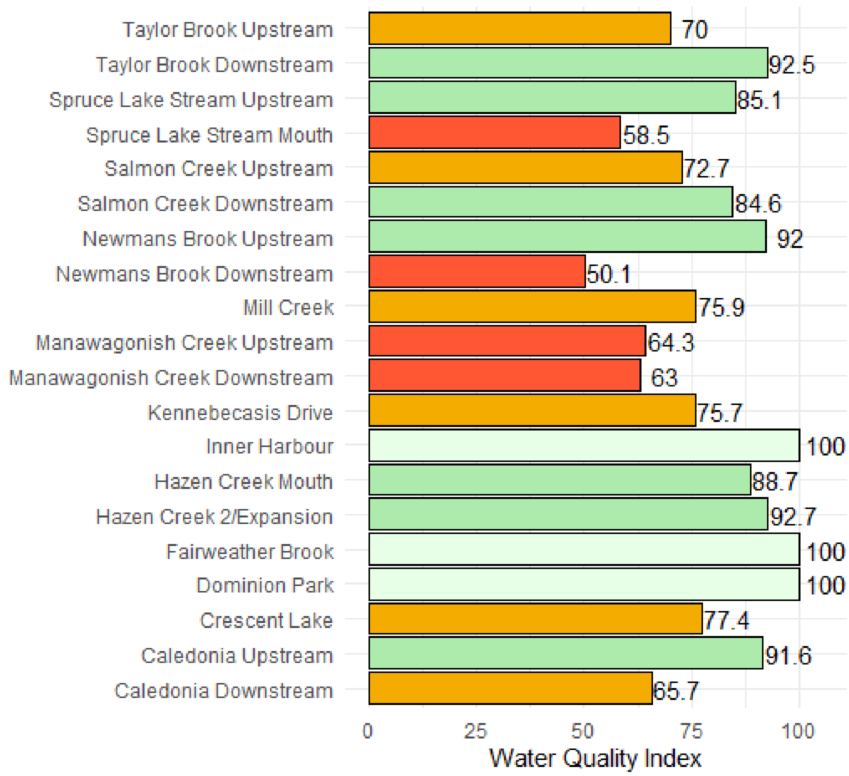

Figure 6: Water quality index of monitored sites around the Greater Saint John area for 2020.

When looking at average ammonia concentrations across sites, only Newman's Brook Downstream exceeded the guideline (Figure 7, Table 2). The other 19 sites outside of Marsh Creek had acceptable levels of ammonia on average. Newman's Brook Downstream, again, had phosphate levels exceeding the guideline, as well as Salmon Creek Upstream. Salmon Creek Upstream is a small creek in a residential neighbourhood in Quispamsis, and Newman's Brook is a stream receiving plenty of municipal inputs and road runoff with a documented nutrient issue. The other 18 sites outside of Marsh Creek had acceptable average concentrations of phosphate.

E.Coli concentrations were exceeded more often than the other parameters. Overall, nine out of 20 sites outside of Marsh Creek had average concentrations above the 200 MPN/100 mL threshold. When including Marsh Creek that is 16 out of 27 sites or 59 % of sites that show the presence of E.Coli contamination. There appears then, to be a strong presence of E.Coli across the Greater Saint John area, which is consistent with previous ACAP Saint John reports. With the changing climate, as water levels get lower and summer temperatures warmer, the heavy E.Coli presence will become even more of an issue both as a biological hazard, but also from the associated low DO that will threaten aquatic life. We recommend monitoring the sites that exceed E.Coli guidelines closely and trying to find and stop the sources in the coming years.

Though individual data points were sometimes lower than the lowest DO threshold for the protection of aquatic life, Newman's Brook Downstream was the only site that had an average concentration lower than this point (Figure 8, Table 2). This suggests that on average, almost all sites outside of Marsh Creek have DO concentrations that can support adult fish populations.

Though individual temperature data points sometimes exceeded the upper threshold considered optimal for salmonids (Crescent Lake, Taylor's Brook Upstream, Kennebecasis Drive, and Spruce Lake Stream Mouth), this was rare and on average all sites had acceptable temperatures (Figure 8, Table 2).

Average pH and turbidity were also acceptable across all sites outside of Marsh Creek (Figure 8, Table 2).

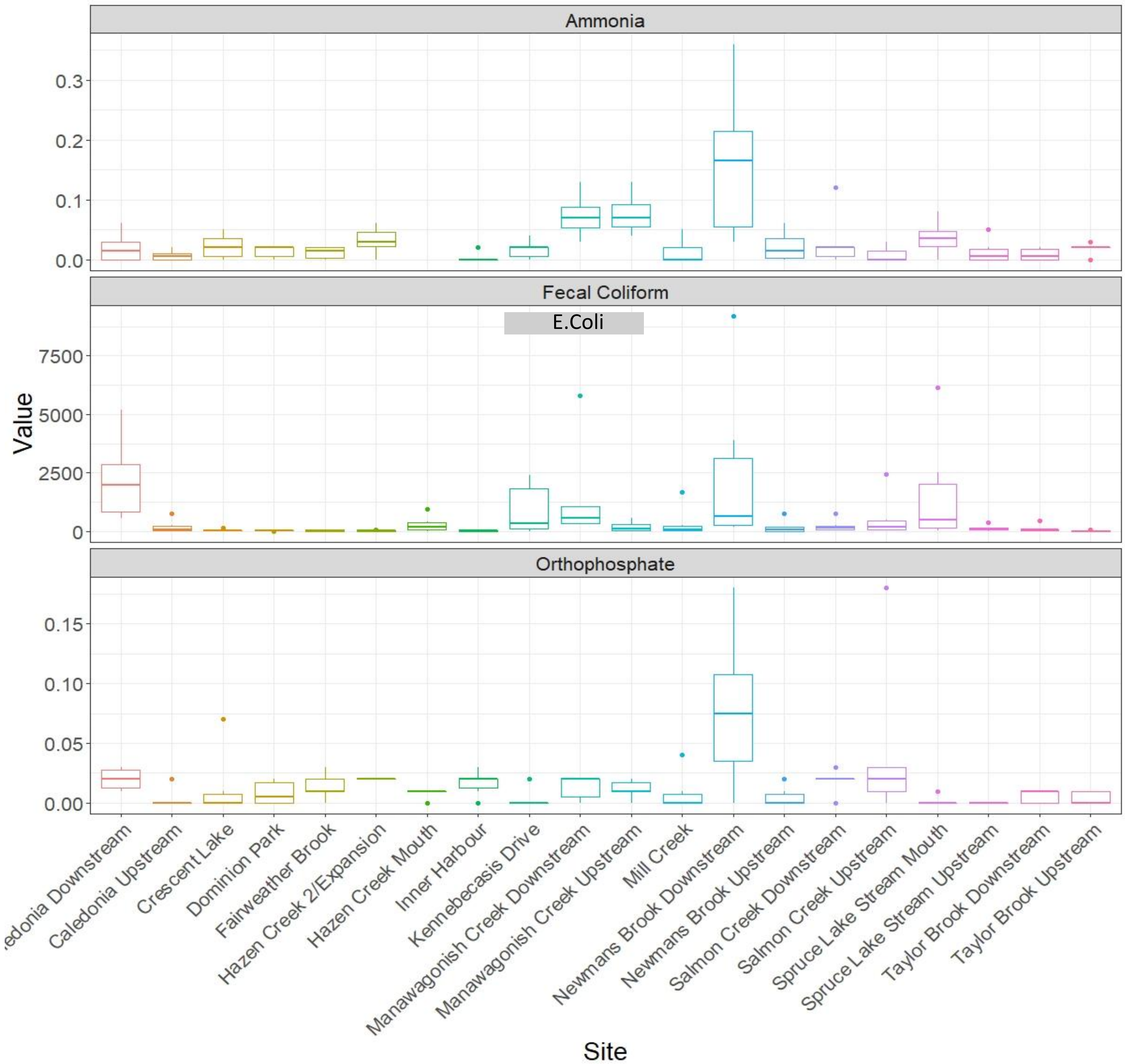

Figure 7. Concentrations of ammonia, E.Coli, and Orthophosphate (as P) displayed in boxplots for each site outside of Marsh Creek on the Y axis, with the value displayed on the x axis in mg/L, MPN/100 mL, and mg/L, respectively.

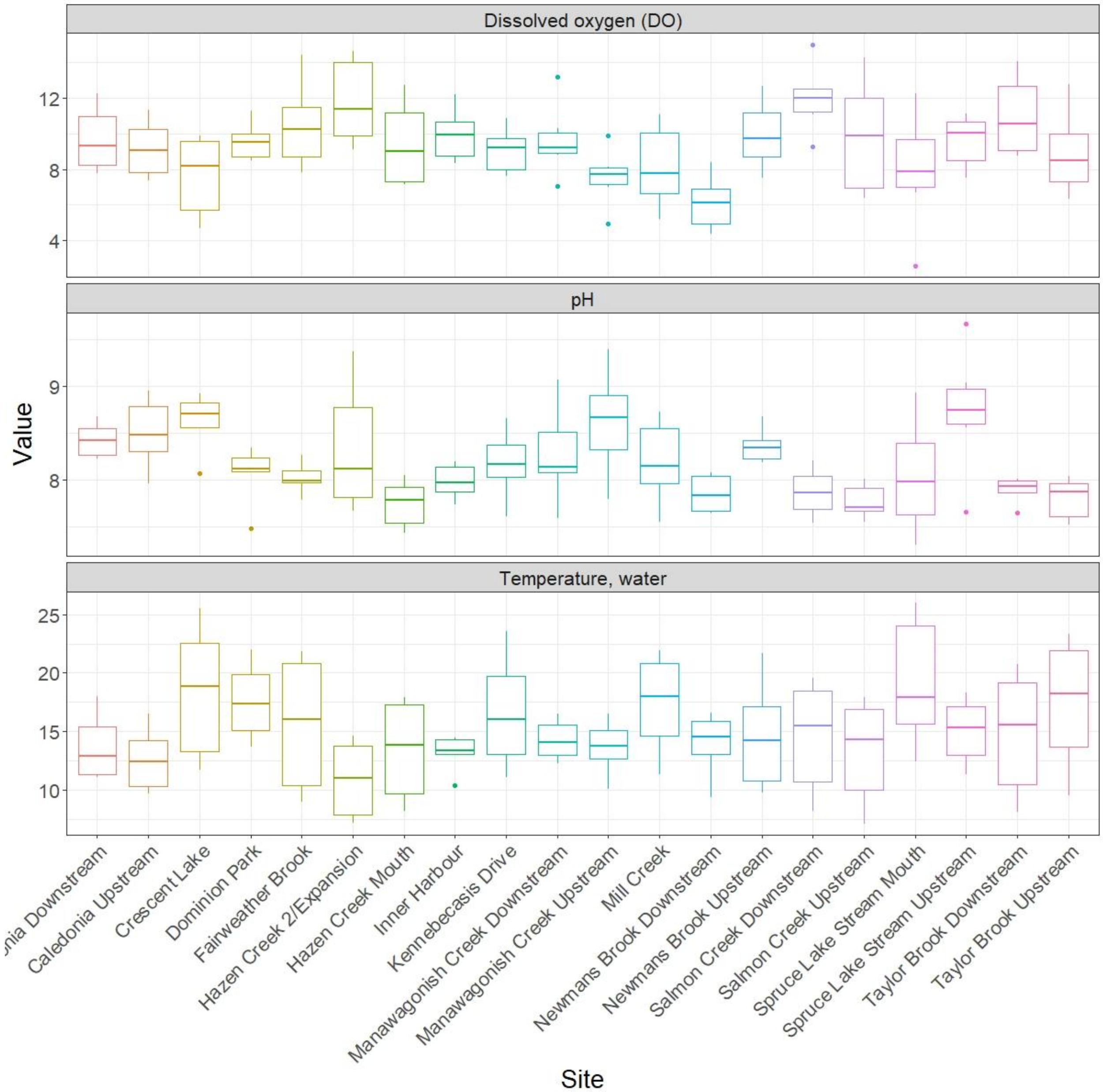

Figure 8. Dissolved oxygen, pH, and temperature displayed in boxplots for each site outside of Marsh Creek on the Y axis, with the value displayed on the x axis in mg/L, no units, and degrees Celsius, respectively.

Table 2: Summary table for water quality data across 27 Greater Saint John sites in 2020. Average (x) and standard error (SE) are displayed with measures that depart from optimal ranges ***highlighted in red*** *(see methods for thresholds used).*

Site ID	Ammonia mg/L		Phosphate as P mg/L		E.Coli MPN/100 mL		pH		Dissolved Oxygen mg/L		Temperature °C		Specific Conductance µS/cm		Turbidity ntu	
	x	SE	x	SE	x	SE	x	SE	x	SE	x	SE	x	SE	x	SE
CB-DS	0.020	0.010	0.020	0.004	**2281**	**831**	8.4	0.1	9.7	0.7	13.7	1.2	745	63	10	5
CB-US	0.007	0.003	0.003	0.003	194	121	8.5	0.2	9.1	0.6	12.6	1.1	453	18	7	4
CL	0.022	0.008	0.013	0.011	43	26	8.6	0.1	7.6	0.9	18.4	2.3	403	17	13	6
DP	0.013	0.004	0.008	0.004	19	5	8.1	0.1	9.6	0.4	17.6	1.4	18330	4272	11	6
FB	0.012	0.004	0.014	0.005	41	14	8.0	0.1	10.5	1.0	15.6	2.4	173	12	5	3
HC2	0.032	0.009	0.020	0.000	23	9	8.3	0.3	11.8	1.0	10.9	1.4	360	88	4	4
HC-M	0.068	0.009	0.008	0.002	**301**	**140**	7.7	0.1	9.4	1.0	13.4	1.8	22653	4240	12	2
IH	0.003	0.003	0.017	0.004	18	3	8.0	0.1	9.9	0.6	13.2	0.6	33502	4215	16	5
KD	0.017	0.006	0.003	0.003	**904**	**459**	8.2	0.1	9.1	0.5	16.6	2.0	13838	3555	16	6
Man-DS	0.073	0.014	0.013	0.004	**1610**	**1054**	8.3	0.2	9.6	0.8	14.3	0.7	735	104	16	4
Man-US	0.077	0.014	0.012	0.003	197	133	8.6	0.2	7.6	0.7	13.7	0.9	900	131	8	3
MC11	0.098	0.023	0.014	0.005	**448**	**106**	8.0	0.2	7.2	0.6	14.9	1.9	488	50	13	7
MC2	0.093	0.012	0.030	0.006	**8545**	**3959**	7.8	0.1	8.4	0.4	14.5	1.2	22888	6658	10	3
MC3	0.070	0.019	0.022	0.002	**4608**	**3819**	7.8	0.1	8.0	0.5	14.9	1.3	20491	7168	10	3
MC4	0.082	0.021	0.020	0.003	**1549**	**379**	7.8	0.2	7.9	0.5	15.3	1.4	16228	6281	10	3
MC5	0.095	0.017	0.020	0.003	**1631**	**447**	7.7	0.2	7.3	0.4	15.3	1.5	13333	5450	9	3
MC-DS	0.080	0.018	**0.036**	**0.004**	**6648**	**1900**	7.8	0.1	8.0	0.3	14.7	1.2	22212	6950	11	3
MC-US	**0.100**	**0.026**	0.014	0.004	**2208**	**948**	7.9	0.2	9.0	0.7	13.2	1.7	193	18	18	6
MC	0.014	0.010	0.008	0.007	**351**	**267**	8.2	0.2	8.2	0.9	17.4	1.7	6367	3687	2	1
NB-DS	**0.162**	**0.052**	**0.078**	**0.027**	**2463**	**1465**	7.9	0.1	**6.1**	**0.6**	14.0	1.1	24020	4889	4	3
NB-US	0.022	0.010	0.005	0.003	189	120	8.4	0.1	10.0	0.8	14.6	1.9	345	20	8	4
SC-DS	0.030	0.018	0.018	0.005	**230**	**114**	7.9	0.1	12.0	0.8	14.6	2.0	631	49	4	2
SC-US	0.008	0.005	**0.048**	**0.033**	**571**	**376**	7.8	0.1	9.9	1.3	13.3	1.8	642	45	2	2
SLS-M	0.037	0.011	0.002	0.002	**1619**	**977**	8.0	0.2	7.9	1.3	19.2	2.3	12143	4146	17	10
SLS-US	0.013	0.008	0.000	0.000	123	56	8.7	0.3	9.6	0.6	15.0	1.1	440	133	11	8
TB-DS	0.008	0.004	0.006	0.002	124	67	7.9	0.1	11.0	0.9	14.8	2.2	244	22	1	1
TB-US	0.018	0.005	0.004	0.002	20	8	7.8	0.1	8.9	1.0	17.4	2.3	264	16	26	14

Fish Communities

In total, 7,891 individuals across 16 species were collected in the seine net in 2020 across our 8 Harbour fishing sites (monthly fishing; Table 2). This is much lower than 2019's 15,312 individuals from 21 different species. In 2019 however, we fished in May and that did not occur in 2020 due to COVID-19 (fishing monthly from June to October in 2020). Like 2019 though, the most abundant species caught in 2020 was Atlantic silverside (*Menidia menidia*) with 4,354 individuals (55 % of overall catch) recorded across all sites. Sand shrimp (Crangon septemspinosa) were also quite numerous across sites and made up 38 % of the overall catch. Like 2019 again, the most abundant site sampled in 2020 was Spar Cove (SC) with a total of 3,328 individuals recorded across all species (Figure 9). This is the site where large schools of Atlantic Silverside are often caught.

Table 2. Total number of individuals collected using seine nets in the Harbour Monitoring program from June – October in 2020.

Total Seine Catch 2020	
Common Name	**Count**
Atlantic Silverside	4354
Atlantic Tomcod	22
Banded Killifish	4
Black-spotted Stickleback	41
Fourspine Stickleback	3
Hake	10
Mummichog	69
Mysid	90
Northern Pipefish	1
Rainbow Smelt	29
Rock gunnel	1
Sand Shrimp	3059
Smooth Flounder	1
Threespine Stickleback	148
White Sucker	1
Winter Flounder	58
Total	7891

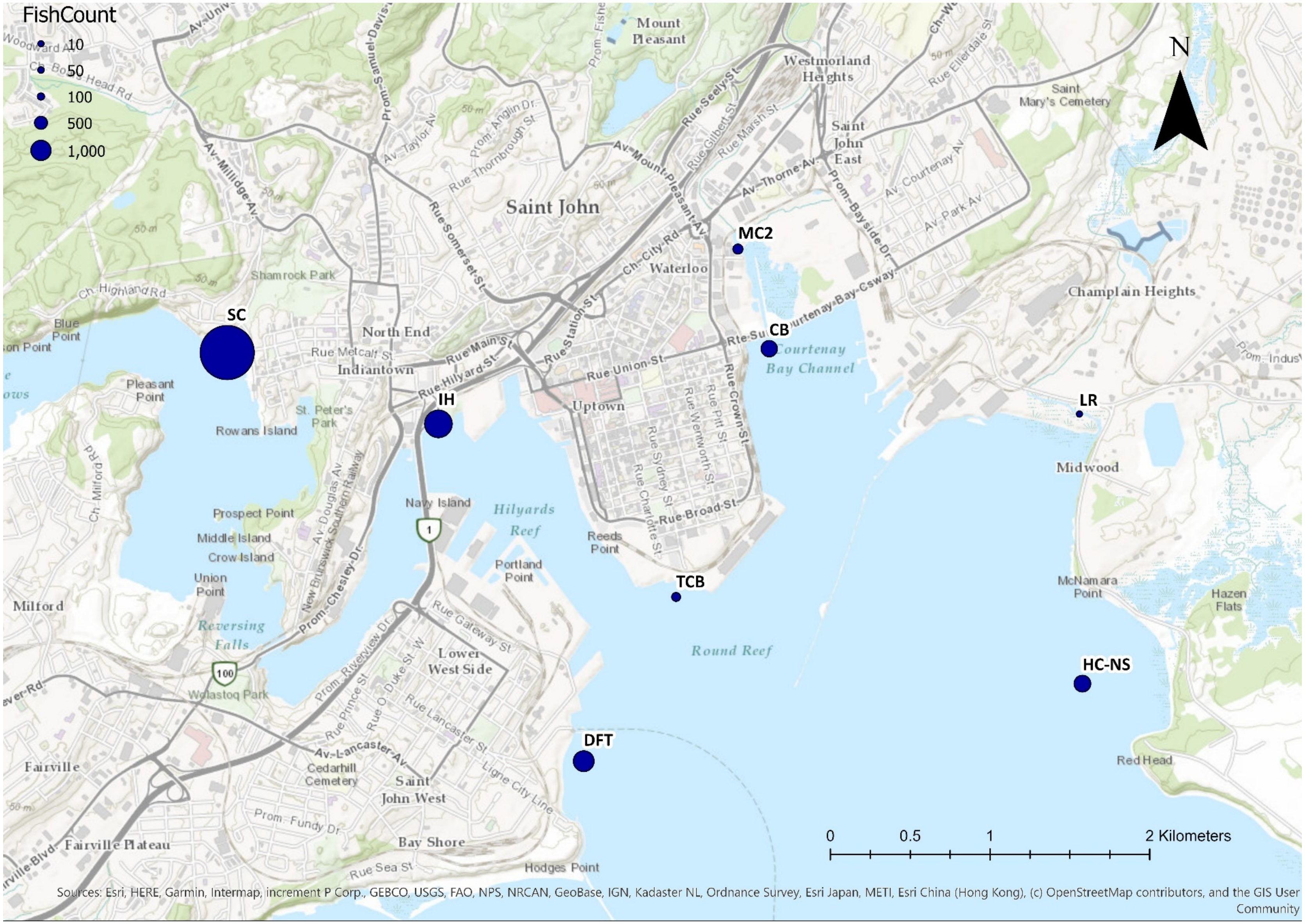

Figure 9: Total abundance of all species caught using a beach seine at the eight fishing sites in 2020 (June - October).

Using the fyke nets, 360 individuals were collected across fifteen species (Table 3). This is lower than 2019's 530 fish, likely due to us not fishing in May from COVID-19, but two additional species were represented in 2020 compared to 2019. Like 2019, the most abundant species was Atlantic tomcod (*Microgadus tomcod*) with 175 (49 % of overall catch) caught and counted. Surprisingly, in 2020 the most abundant site was Little River (LR) with a total of 114 individuals being recorded across all species (Figure 10). Little River regularly has very poor water quality, but as an estuarine environment, can be home to plenty of freshwater or estuarine fishes. Almost all of these individual fish were caught on one day in Little River with over 100 individuals of White Sucker and Golden Shiner (two freshwater species) in the fyke net.

Table 3. Total number of individuals collected using seine nets in the Harbour Monitoring program from June – October in 2020.

Total Fyke Catch 2020	
Common Name	**Count**
Alosa sp.	5
American Eel	6
Atlantic Rock Crab	2
Atlantic Tomcod	175
Common Shiner	1
Golden Shiner	18
Lake Chub	1
Longhorn Sculpin	1
Mummichog	1
Pollock	3
Rainbow Smelt	20
Sand Shrimp	25
Threespine Stickleback	9
White Sucker	86
Winter Flounder	7
Total	360

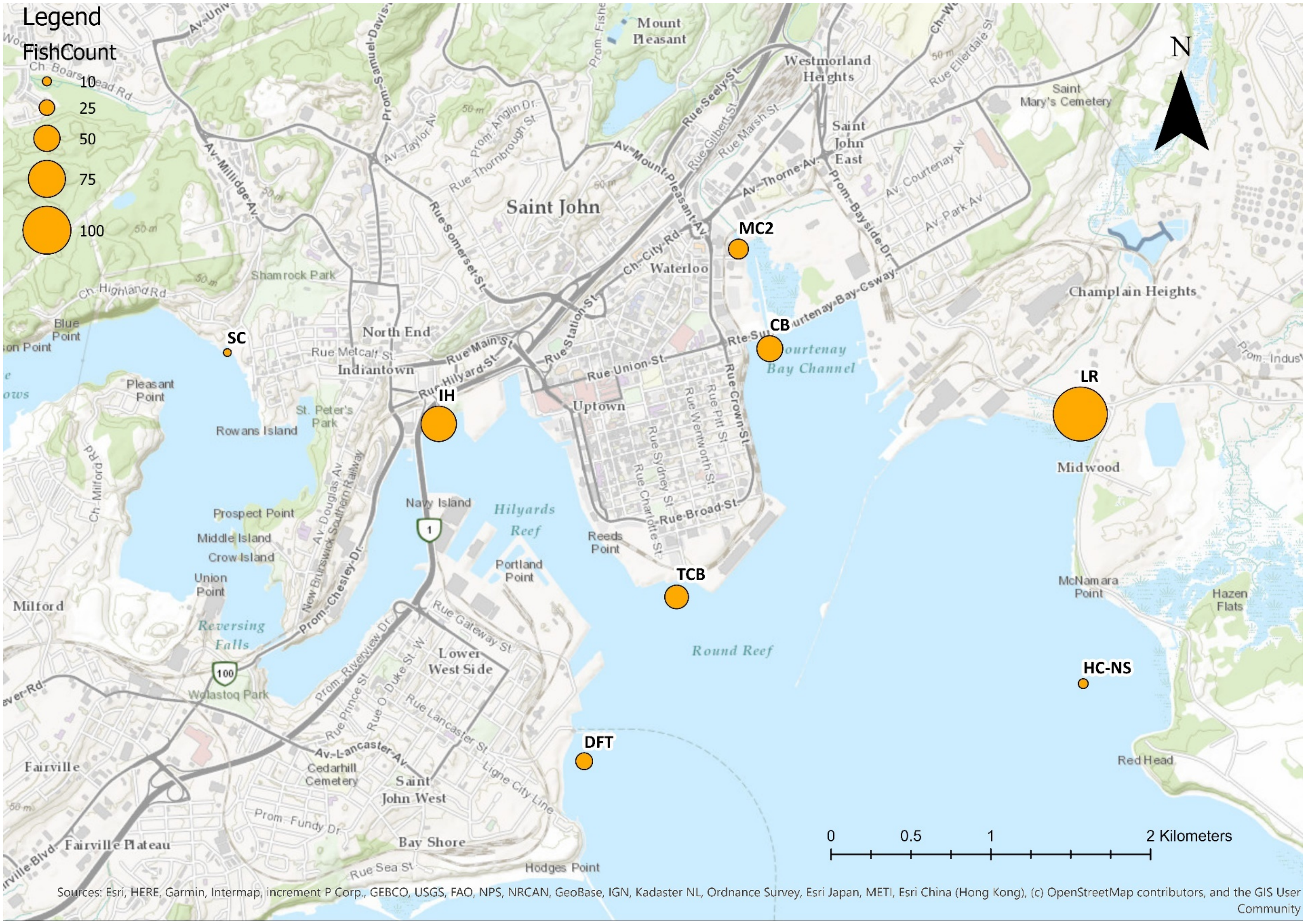

Figure 10: Total abundance of all fish species caught using the Fyke nets across the eight fishing sites from June – October in 2020.

Conclusion

Water quality monitoring was successfully conducted at 27 sites over ten watersheds within the Greater Saint John Area in 2020. Given their location in urban settings many of these watercourses are subject to riparian degradation, stormwater inputs, and modifications to natural flow that can impact water quality. In 2020 it appears that more than half of the sites examined have water quality that is occasionally, frequently, or always threatened. This was the first year of testing E.Coli at all of these sites (instead of fecal coliforms), and that was the parameter that was exceeded the most. This issue of sewer and municipal inputs across the Greater Saint John area has been documented consistently in the past by ACAP Saint John. Generally, these sites are likely able to support healthy aquatic life given the low average temperatures, generally high DO, and acceptable pH and turbidity observed across almost all sites. Further work to reduce nutrients and fecal contamination is recommended including riparian restoration/enhancement and stormwater storage and filtration structures to help further improve water quality.

References

Breau, C., Cunjak, R.A., Breset, G. (2007). Age-specific aggregation of wild juvenile Atlantic salmon *Salmo salar* at cool water sources during high temperature events. Journal of Fish Biology. 71, 1179–1191.

Canadian Council of Ministers of the Environment. (1999a). *Recreational Water Quality Guidelines and Aesthetics.* Retrieved from Canadian environmental quality guidelines: http://ceqg-rcqe.ccme.ca/download/en/316

Canadian Council of Ministers of the Environment. (1999b). *pH*. Retrieved from Canadian Council of Ministers of the Environment: http://st-ts.ccme.ca/en/index.html?lang=en&factsheet=162

Canadian Council of Ministers of the Environment. (1999c). *Dissolved Oxygen (Freshwater).* Retrieved from Canadian Water Quality Guidelines for the Protection of Aquatic Life: http://ceqg-rcqe.ccme.ca/download/en/177/

Canadian Council of Ministers of the Environment. (2001). *CCME Water Quality Index Technical Report.* Retrieved from Canadian Water Quality Guidelines for the Protection of Aquatic Life: http://ceqg-rcqe.ccme.ca/download/en/137

Canadian Council of Ministers of the Environment. (2010). *Canadian Water Qaulity Guidelines for the Protection of Aquatic Life.* Retrieved from Ammonia: http://ceqg-rcqe.ccme.ca/download/en/141?redir=1582827542

Appendix 1: Sampling Sites

Table 4: Characteristics of all water quality sampling sites of the project area sampled in 2020.

Site Name	Latitude	Longitude	Site Description
Marsh Creek Upstream	45.321517	-66.015117	Located on the downstream side of the small bridge on Glen Road near MacKay Street.
Marsh Creek Downstream	45.282400	-66.04946	Located immediately downstream of the access road/rail crossing containing three metal culverts just beyond the Universal Truck and Trailer parking lot.
Marsh Creek 2	45.281560	-66.048694	Located approximately 500 m upstream from Site 1, just upstream of where Dutchman's Creek enters Marsh Creek.
Marsh Creek 3	45.284844	-66.052393	Located 500 m upstream from Site 2 immediately (2 m) upstream of the former raw sewage outfall adjacent to the Universal Truck and Trailer parking lot.
Marsh Creek 4	45.288143	-66.048764	Located 500 m upstream from Site 3, immediately upstream of the former raw sewage outfall.
Marsh Creek 5	45.290998	-66.043606	Located upstream of the raw sewage outfalls, approximately 2 km from the outlet of Marsh Creek at the tide gates (Site 1). This sampling station can be found beneath the train bridge adjacent to Rothesay Avenue.
Marsh Creek 11	45.30963	-66.03402	Located approximately 2.2 km upstream of Site 5, on Ashburn Lake road, directly across from Strescon.
Hazen Creek Mouth	45.220990	-66.015505	Located upstream of the bridge crossing along Red Head Road at the outflow of Hazen Creek into the Saint John Harbour.
Hazen Creek 2	45.275878	-65.998910	Located upstream of the culvert on Dedication Street within the industrial park.
Fairweather Brook	45.378423	-65.978840	Located upstream of the McKay Highway (Highway 1) crossing next to the Dolan Road Irving gas station.

Taylor Brook Upstream	45.374322	-65.982063	Located at the outflow of Carpenter's Lake, upstream of the McKay Highway culvert crossing on the other side of the Dolan Road Irving gas station.
Taylor Brook Downstream	45.382143	-65.996388	Located under the bridge crossing on Rothesay Road by Rothesay Netherwood School.
Newman's Brook Upstream	45.296902	-66.071298	Located along Sandy Point Road, roughly 300 m above Hazen White-St. Francis School, in the above ground section of Newman's Brook.
Newman's Brook Downstream	45.277345	-66.089187	Located at the furthest inland point in Spar Cove, just downstream of the stormwater/Newman's Brook outflow.
Inner Harbour	45.27182	-66.07439	Located underneath the Harbour Bridge just off the Harbour Passage boardwalk.
Caledonia Brook Upstream	45.29025	-66.09449	Located just downstream of the culvert crossing Millidge Avenue, next to the Saint John Energy substation.
Caledonia Brook Downstream	45.29687	-66.11867	Located just upstream of the culvert crossing at 159 Ragged Point Road.
Salmon Creek Upstream	45.42371	-65.95859	Located upstream of the culvert crossing at 7 Rafferty Court.
Salmon Creek Downstream	45.40077	-65.9918	Located within Salmon Creek off of Salmon Crescent where it meets Clark Road.
Spruce Lake Stream Mouth	45.25356	-66.14397	Located on the left-hand side of the street (Westfield Road) heading West; head down the embankment and sampling occurred near the culvert.
Spruce Lake Stream Upstream	45.24347	-66.15765	Located on the right-hand side of Highway 7 heading West; head down the embankment and sampling occurred near the culvert.
Crescent Lake	45.30596	-66.07681	Located near the outflow of Crescent Lake found in Rockwood Park.
Manawagonish Creek (Downstream)	45.24445	-66.10737	Located off of Fairville Boulevard near the Comfort Inn parking, turn into the MelMart parking lot and park towards the end. Head

			down the embankment until the creek is reached.
Manawagonish Creek (Upstream)	45.24355	-66.10259	Located off of Honeysuckle Drive, a weir is located on the outside of the street. Water was sampled 100 m upstream of the weir.
Dominion Park	45.26889	-66.1253	Located at the Dominion Beach park.
Kennebecasis Drive	45.305689	-66.095746	Located on the main stem of the Wolastoq off Kennebecasis drive. Tidal area near the outflow of Alder Brook.
Mill Creek	45.27860	-66.15567	Located off the Westfield Road across the street from the Saint John Marina.

Appendix 2: Raw Water Quality Data Collected over the 2020 field season.

Table 5: Raw water quality data collected at all of the Thinking Waters sites in 2020.

Site	Latitude	Longitude	Date yyyy-mm-dd	Temp (C)	DO (%)	DO (mg/L)	Cond (µS/cm)	Salinity	pH	NH3-N mg/L	PO4 mg/L	PO4-P mg/L	Turb-idity (ntu)	Total coliforms MPN/ 100ml	E.coli MPN/ 100 ml
Caledonia DS	45.29687	-66.11867	2020-05-27	11.5	113.1	12.2	889	0.4	8.5	<0.01	0.03	0.01	0	1986.3	579.4
Caledonia DS	45.29687	-66.11867	2020-06-24	14.3	85.1	8.7	844	0.4	8.3	0.06	0.08	0.03	0	>2419.6	816.4
Caledonia DS	45.29687	-66.11867	2020-07-29	18.0	85.5	7.8	880	0.4	8.3	0.03	0.08	0.03	21	>2419.6	1986.3
Caledonia DS	45.29687	-66.11867	2020-08-26	15.8	82.1	8.1	682	0.3	8.7	<0.01	0.06	0.02	15	>2419.6	>2419.6
Caledonia DS	45.29687	-66.11867	2020-09-23	11.1	91.7	10.0	497	0.2	8.2	0.03	0.04	0.01	24	>24196	5172.0
Caledonia DS	45.29687	-66.11867	2020-10-21	11.3	103.4	11.3	679	0.3	8.6	<0.01	0.08	0.02	0	12033.0	2851.0
Caledonia US	45.29025	-66.09449	2020-05-27	10.6	102.2	11.3	441	0.2	8.3	<0.01	0.05	0.02	0	547.5	6.3
Caledonia US	45.29025	-66.09449	2020-06-24	14.2	86.2	8.5	477	0.2	8.6	0.02	0.02	0.00	0	1732.9	63.1
Caledonia US	45.29025	-66.09449	2020-07-29	16.5	76.3	7.6	510	0.3	8.0	<0.01	<0.02	0.00	6	1413.6	70.3
Caledonia US	45.29025	-66.09449	2020-08-26	14.2	72.2	7.4	458	0.2	9.0	0.01	0.02	0.00	13	>2419.6	249.5
Caledonia US	45.29025	-66.09449	2020-09-23	9.7	84.2	9.6	377	0.2	8.4	0.01	0.03	0.00	25	>2419.6	770.1
Caledonia US	45.29025	-66.09449	2020-10-21	10.2	93.6	10.5	457	0.2	8.9	<0.01	0.03	0.00	0	248.9	5.2
Crescent Lake	45.30596	-66.07681	2020-05-27	16.7	93.3	9.0	373	0.2	8.6	<0.01	0.03	0.01	0	195.6	4.1
Crescent Lake	45.30596	-66.07681	2020-06-24	23.1	86.1	7.3	360	0.2	8.8	0.02	0.02	0.00	0	>2419.6	32.3
Crescent Lake	45.30596	-66.07681	2020-07-29	25.5	63.2	5.2	375	0.2	8.1	0.05	0.21	0.07	30	>2419.6	15.6
Crescent Lake	45.30596	-66.07681	2020-08-26	21.0	52.4	4.7	456	0.2	8.8	<0.01	<0.02	0.00	32	>2419.6	17.1
Crescent Lake	45.30596	-66.07681	2020-09-23	12.2	91.9	9.8	406	0.2	8.6	0.02	<0.02	0.00	17	>2419.6	143.9
Crescent Lake	45.30596	-66.07681	2020-10-21	11.7	91.3	9.9	449	0.2	8.9	0.04	0.02	0.00	0	387.3	<1
Dominion Park	45.26889	-66.12529	2020-05-28	15.1	113.2	11.3	926	0.5	8.4	0.02	0.06	0.02	0		<1
Dominion Park	45.26889	-66.12529	2020-06-25	20.0	108.0	9.2	10477	5.9	8.3	<0.01	0.04	0.01	0		4.1
Dominion Park	45.26889	-66.12529	2020-07-30	22.0	104.0	8.5	21593	13.0	8.1	<0.01	<0.02	0.00	41		20.0
Dominion Park	45.26889	-66.12529	2020-08-25	19.5	104.0	8.6	27911	17.2	8.1	0.02	0.02	0.00	10		<10

Dominion Park	45.26889	-66.12529	2020-09-24	15.2	108.8	9.8	25835	15.8	7.5	0.02	0.05	0.02	9		30.0
Dominion Park	45.26889	-66.12529	2020-10-22	13.7	105.2	10.0	23238	14.1	8.1	0.02	0.02	0.00	7		20.0
Fairweather Brook	45.37432	-65.98206	2020-05-25	13.1	101.9	10.7	177	0.1	8.0	0.02	0.03		0	116.4	76.4
Fairweather Brook	45.37432	-65.98206	2020-06-23	21.5	88.7	7.8	184	0.1	8.0	0.02	0.08	0.03	0	2419.6	79.4
Fairweather Brook	45.37432	-65.98206	2020-07-27	21.8	95.3	8.3	125	0.1	7.8	<0.01	0.05	0.02	3	920.8	14.6
Fairweather Brook	45.37432	-65.98206	2020-08-24	18.9	105.3	9.8	203	0.0	8.0	0.02	0.01	0.00	19	1046.2	5.2
Fairweather Brook	45.37432	-65.98206	2020-09-21	9.5	102.7	11.7	196	0.1	8.1	0.01	0.04	0.01	3	435.2	8.5
Fairweather Brook	45.37432	-65.98206	2020-10-19	9.0	125.1	14.4	152	0.1	8.3	<0.01	0.04	0.01	5	770.1	60.5
Hazen Creek 2/ Expansion	45.260928	-66.01508	2020-05-25	7.6	122.0	14.5	255	0.1	8.0	0.06	0.05		0	261.3	6.3
Hazen Creek 2/ Expansion	45.260928	-66.01508	2020-06-23	13.2	97.0	10.2	285	0.1	7.8	0.03	0.05	0.02	0	1299.7	12.2
Hazen Creek 2/ Expansion	45.260928	-66.01508	2020-07-27	14.6	91.0	9.1	284	0.1	7.7	<0.01	0.06	0.02	2	>2419.6	65.7
Hazen Creek 2/ Expansion	45.260928	-66.01508	2020-08-24	13.9	97.2	9.8	777	0.4	8.3	0.03	0.06	0.02	0	>2419.6	33.6
Hazen Creek 2/ Expansion	45.260928	-66.01508	2020-09-21	7.2	107.6	12.6	386	0.2	9.0	0.05	0.08	0.02	0	816.4	14.6
Hazen Creek 2/ Expansion	45.260928	-66.01508	2020-10-19	8.8	126.5	14.6	172	0.1	9.4	0.02	0.05	0.02	24	125.0	6.3
Hazen Creek Mouth	45.275821	-65.999035	2020-05-25	10.6	117.4	12.7	7084	3.9	8.0	0.09	0.05		5		75.4
Hazen Creek Mouth	45.275821	-65.999035	2020-06-23	17.1	81.7	7.3	20804	12.5	7.8	0.04	0.04	0.01	5		933.0
Hazen Creek Mouth	45.275821	-65.999035	2020-07-27	17.9	84.6	7.4	15899	14.9	7.5	0.04	0.04	0.01	19		288.0
Hazen Creek Mouth	45.275821	-65.999035	2020-08-24	17.3	85.2	7.1	34149	21.5	7.4	0.08	0.03	0.01	15		404.0

Hazen Creek Mouth	45.275821	-65.999035	2020-09-21	8.2	104.0	10.7	33193	20.6	7.8	0.09	0.02	0.00	14		10.0
Hazen Creek Mouth	45.275821	-65.999035	2020-10-19	9.4	108.6	11.4	24786	15.0	8.1	0.07	0.04	0.01	16		98.0
Inner Harbour	45.272068	-66.073478	2020-05-27	10.4	114.5	12.2	14987	8.7	8.2	<0.01	0.04	0.01	9		20.0
Inner Harbour	45.272068	-66.073478	2020-06-24	13.6	115.7	10.8	29088	18.0	7.9	<0.01	0.06	0.02	9		20.0
Inner Harbour	45.272068	-66.073478	2020-07-29	14.5	110.8	9.6	40052	25.6	7.9	0.02	0.07	0.02	39		20.0
Inner Harbour	45.272068	-66.073478	2020-08-26	14.5	97.0	8.4	42481	27.3	8.2	<0.01	<0.02	0.00	16		10.0
Inner Harbour	45.272068	-66.073478	2020-09-23	13.0	95.0	8.5	40340	25.8	7.7	<0.01	0.08	0.03	21		30.0
Inner Harbour	45.272068	-66.073478	2020-10-21	13.1	111.5	10.3	34065	21.4	8.0	<0.01	0.06	0.02	0		10.0
Kennebecasis Drive	45.305689	-66.095746	2020-05-27	13.2	103.7	10.8	923	0.5	8.7	<0.01	0.03	0.00	0		3.1
Kennebecasis Drive	45.305689	-66.095746	2020-06-24	20.0	100.3	8.9	6952	3.8	8.4	0.02	0.03	0.00	8		53.0
Kennebecasis Drive	45.305689	-66.095746	2020-07-29	23.6	97.0	7.6	19803	11.8	8.2	0.02	0.02	0.00	35		457.0
Kennebecasis Drive	45.305689	-66.095746	2020-08-26	18.8	86.8	7.7	14333	8.4	8.1	0.02	<0.02	0.00	26		2282.0
Kennebecasis Drive	45.305689	-66.095746	2020-09-23	11.1	93.0	9.6	16034	9.4	7.6	0.04	<0.02	0.00	26		2400.0
Kennebecasis Drive	45.305689	-66.095746	2020-10-21	13.0	101.9	9.8	24984	15.2	8.0	<0.01	0.06	0.02	0		226.0
Manawagonish Creek DS	45.24445	-66.10737	2020-05-28	12.3	123.8	13.2	703	0.4	8.2	0.06	<0.02	0.00	0	1299.7	325.5
Manawagonish Creek DS	45.24445	-66.10737	2020-06-25	16.5	105.5	10.3	602	0.3	8.1	0.13	0.05	0.02	18	>2419.6	>2419.6
Manawagonish Creek DS	45.24445	-66.10737	2020-07-30	14.7	92.1	9.3	683	0.3	7.6	0.05	0.02	0.00	32	>2419.6	579.4
Manawagonish Creek DS	45.24445	-66.10737	2020-08-25	15.8	71.4	7.0	422	0.2	9.1	0.09	0.05	0.02	15	>24196	5794.0
Manawagonish Creek DS	45.24445	-66.10737	2020-09-24	13.5	88.7	9.2	817	0.4	8.6	0.03	0.06	0.02	20	>24196	1046.0
Manawagonish Creek DS	45.24445	-66.10737	2020-10-22	12.8	84.1	8.8	1182	0.6	8.1	0.08	0.06	0.02	10	4360.0	305.0

Manawagonish Creek US	45.2436	-66.1026	2020-05-28	10.1	88.5	9.9	703	0.3	9.0	0.07	0.05	0.02	0	344.8	7.5
Manawagonish Creek US	45.2436	-66.1026	2020-06-25	14.3	74.2	7.5	1098	0.6	8.6	0.1	0.03	0.00	13	>2419.6	>2419.6
Manawagonish Creek US	45.2436	-66.1026	2020-07-30	15.4	82.3	8.2	565	0.3	7.8	0.04	0.04	0.01	10	>2419.6	17.3
Manawagonish Creek US	45.2436	-66.1026	2020-08-25	16.5	50.8	5.0	826	0.4	9.4	0.13	0.06	0.02	19	>2419.6	>2419.6
Manawagonish Creek US	45.2436	-66.1026	2020-09-24	13.3	68.0	7.0	763	0.4	8.7	0.07	0.04	0.01	4	11199.0	576.0
Manawagonish Creek US	45.2436	-66.1026	2020-10-22	12.4	75.0	7.9	1445	0.7	8.2	0.05	0.04	0.01	3	3255.0	189.0
Marsh Creek 11	45.309737	-66.033974	2020-05-26	13.2	75.2	7.9	399	0.2	8.2	0.13	0.18		1	>2419.6	488.4
Marsh Creek 11	45.309737	-66.033974	2020-06-22	18.5	68.1	6.4	478	0.2	8.0	0.19	0.03	0.01	0	>2419.6	>2419.6
Marsh Creek 11	45.309737	-66.033974	2020-07-28	21.7	70.0	6.0	433	0.2	7.8	0.09	0.09	0.03	19	15531.0	624.0
Marsh Creek 11	45.309737	-66.033974	2020-08-27	15.1	63.0	6.3	574	0.3	7.2	0.08	0.05	0.02	10	14136.0	691.0
Marsh Creek 11	45.309737	-66.033974	2020-09-22	10.1	58.4	6.6	684	0.3	8.7	0.07	0.03	0.01	7	2481.0	97.0
Marsh Creek 11	45.309737	-66.033974	2020-10-20	10.7	90.9	10.2	357	0.2	8.2	0.03	0.03	0.00	43	1785.0	341.0
Marsh Creek Watershed Upstream	45.321672	-66.015109	2020-05-26	12.0	91.0	9.8	146	0.1	8.3	0.03	0.04		0	>2419.6	313.0
Marsh Creek Watershed Upstream	45.321672	-66.015109	2020-06-22	16.1	84.4	8.2	241	0.1	8.1	0.13	0.05	0.02	0	>2419.6	1553.1
Marsh Creek Watershed Upstream	45.321672	-66.015109	2020-07-28	19.7	68.6	6.3	213	0.1	7.5	0.14	0.05	0.02	27	>2419.6	2419.6
Marsh Creek Watershed Upstream	45.321672	-66.015109	2020-08-27	12.8	84.1	8.9	177	0.1	7.3	0.12	0.04	0.01	28	19863.0	6488.0
Marsh Creek Watershed Upstream	45.321672	-66.015109	2020-09-22	7.6	83.0	9.9	239	0.1	8.5	0.17	0.06	0.02	26	>2419.6	2400.0

Marsh Creek Watershed Upstream	45.321672	-66.015109	2020-10-20	10.7	101.3	11.3	141	0.1	8.0	0.01	<0.02	0.00	26	2359.0	74.0
Marsh Creek WS 2	45.281834	-66.049478	2020-05-26	13.0	774.0	7.6	5334	2.9	8.0	0.12	0.03		0		>2419.6
Marsh Creek WS 2	45.281834	-66.049478	2020-06-22	16.8	73.8	6.7	18696	11.1	7.8	0.11	0.09	0.03	0		>24196
Marsh Creek WS 2	45.281834	-66.049478	2020-07-28	18.2	100.5	8.3	35131	22.2	7.8	0.13	0.16	0.05	20		8164.0
Marsh Creek WS 2	45.281834	-66.049478	2020-08-27	15.7	108.9	9.3	37120	23.6	7.5	0.07	0.1	0.03	16		19863.0
Marsh Creek WS 2	45.281834	-66.049478	2020-09-22	12.2	101.4	9.3	38422	24.4	7.6	0.07	0.08	0.03	11		3076.0
Marsh Creek WS 2	45.281834	-66.049478	2020-10-20	10.8	85.0	9.3	2625	1.4	8.4	0.06	0.04	0.01	13		3076.0
Marsh Creek WS 3	45.284826	-66.052373	2020-05-26	14.3	67.6	6.9	1775	0.9	8.2	0.11	<0.02		0		>2419.6
Marsh Creek WS 3	45.284826	-66.052373	2020-06-22	18.6	69.7	6.3	10600	6.0	7.7	0.13	0.05	0.02	17		19863.0
Marsh Creek WS 3	45.284826	-66.052373	2020-07-28	18.0	103.0	8.5	34738	21.9	7.7	0.06	0.08	0.03	13		958.0
Marsh Creek WS 3	45.284826	-66.052373	2020-08-27	15.4	104.8	9.0	37025	23.5	7.4	<0.01	0.05	0.02	3		1467.0
Marsh Creek WS 3	45.284826	-66.052373	2020-09-22	12.1	89.2	8.2	36932	23.4	7.6	0.06	0.07	0.02	8		373.0
Marsh Creek WS 3	45.284826	-66.052373	2020-10-20	10.8	80.3	8.8	1873	1.0	8.1	0.06	0.05	0.02	17		379.0
Marsh Creek WS 4	45.289029	-66.047363	2020-05-26	14.8	72.6	7.2	870	0.4	8.2	0.1	0.14		10		1986.3
Marsh Creek WS 4	45.289029	-66.047363	2020-06-22	19.8	66.6	6.0	4764	2.6	7.9	0.16	0.07	0.02	2		2419.6
Marsh Creek WS 4	45.289029	-66.047363	2020-07-28	18.9	91.6	7.8	28576	17.7	7.6	0.07	0.09	0.03	12		1529.0
Marsh Creek WS 4	45.289029	-66.047363	2020-08-27	15.3	94.6	8.4	31131	19.4	7.1	<0.01	0.07	0.02	6		2481.0
Marsh Creek WS 4	45.289029	-66.047363	2020-09-22	11.9	88.5	8.4	30870	19.2	7.7	0.09	0.06	0.02	12		546.0

Marsh Creek WS 4	45.289029	-66.047363	2020-10-20	11.3	86.4	9.5	1156	0.6	8.2	0.07	0.03	0.01	20		332.0
Marsh Creek WS 5	45.29105	-66.043541	2020-05-26	14.7	75.1	7.6	590	0.3	8.2	0.09	<0.02		0		1986.3
Marsh Creek WS 5	45.29105	-66.043541	2020-06-22	20.1	59.5	5.4	2583	1.3	7.9	0.17	0.04	0.01	16		1203.3
Marsh Creek WS 5	45.29105	-66.043541	2020-07-28	19.2	86.4	7.3	23925	14.5	7.5	0.1	0.08	0.03	9		2282.0
Marsh Creek WS 5	45.29105	-66.043541	2020-08-27	15.2	81.6	7.3	28102	17.3	6.7	0.1	0.06	0.02	6		3255.0
Marsh Creek WS 5	45.29105	-66.043541	2020-09-22	11.8	83.1	8.2	24251	14.7	7.7	0.05	0.06	0.02	4		845.0
Marsh Creek WS 5	45.29105	-66.043541	2020-10-20	10.8	73.7	8.3	548	0.3	8.3	0.06	0.07	0.02	19		213.0
Marsh Creek WS DS	45.282676	-66.049784	2020-05-26	13.5	74.6	7.7	3691	2.0	8.1	0.13	0.09		3		>2419.6
Marsh Creek WS DS	45.282676	-66.049784	2020-06-22	17.4	72.2	6.5	16408	9.7	7.6	0.13	0.09	0.03	14		5475.0
Marsh Creek WS DS	45.282676	-66.049784	2020-07-28	18.1	96.8	8.0	35488	22.4	7.8	0.07	0.13	0.04	19		12997.0
Marsh Creek WS DS	45.282676	-66.049784	2020-08-27	15.9	101.1	8.6	37140	23.6	7.6	0.05	0.1	0.03	18		8664.0
Marsh Creek WS DS	45.282676	-66.049784	2020-09-22	12.2	90.5	8.3	38518	24.5	7.6	0.02	0.15	0.05	9		2495.0
Marsh Creek WS DS	45.282676	-66.049784	2020-10-20	10.8	81.4	8.8	2028	1.0	8.3	0.08	0.08	0.03	0		3609.0
Mill Creek	45.27931	-66.155487	2020-05-28	17.4	87.5	8.3	405	0.2	8.7		0.04	0.01	0		23.1
Mill Creek	45.27931	-66.155487	2020-06-25	21.6	82.3	7.2	348	0.2	8.2	<0.01	0.03	0.00	0		279.0
Mill Creek	45.27931	-66.155487	2020-07-30	21.9	76.1	6.5	10146	5.7	7.6	0.05	<0.02	0.00	8		7.5
Mill Creek	45.27931	-66.155487	2020-08-25	18.6	61.0	5.2	23074	14.0	7.9	0.02	0.03	0.00	0		1670.0
Mill Creek	45.27931	-66.155487	2020-09-24	13.7	106.9	11.1	303	0.2	8.2	<0.01	0.03	0.00	2		108.6
Mill Creek	45.27931	-66.155487	2020-10-22	11.3	98.5	10.6	3927	2.1	8.7	<0.01	0.12	0.04	4		18.9
Newmans Brook DS	45.27726	-66.08932	2020-05-27	9.4	41.1	4.8	1656	0.8	8.0	0.03	0.56	0.18	0		189.0

Newmans Brook DS	45.27726	-66.08932	2020-06-24	15.5	60.4	5.5	20230	12.1	7.7	0.36	0.34	0.11	0		495.0
Newmans Brook DS	45.27726	-66.08932	2020-07-29	16.6	98.4	8.4	31734	19.8	7.7	0.2	<0.02	0.00	17		195.0
Newmans Brook DS	45.27726	-66.08932	2020-08-26	16.0	50.5	4.4	32919	20.7	8.1	0.22	0.31	0.10	3		9208.0
Newmans Brook DS	45.27726	-66.08932	2020-09-23	13.6	74.7	6.8	31817	19.9	7.7	0.13	0.17	0.05	4		3873.0
Newmans Brook DS	45.27726	-66.08932	2020-10-21	12.9	73.1	7.0	25765	15.8	8.1	0.03	0.09	0.03	0		816.0
Newmans Brook US	45.2969	-66.07129	2020-05-27	12.1	106.6	11.4	390	0.2	8.4	0.06	0.04	0.02	0	920.8	3.1
Newmans Brook US	45.2969	-66.07129	2020-06-24	16.3	92.2	9.0	355	0.2	8.3	0.01	0.04	0.01	0	1986.3	29.5
Newmans Brook US	45.2969	-66.07129	2020-07-29	21.7	86.1	7.5	390	0.2	8.2	<0.01	0.03	0.00	18	1986.3	139.6
Newmans Brook US	45.2969	-66.07129	2020-08-26	17.4	90.1	8.6	370	0.2	8.4	<0.01	0.02	0.00	21	>2419.6	770.1
Newmans Brook US	45.2969	-66.07129	2020-09-23	10.3	94.0	10.5	276	0.1	8.2	0.04	0.03	0.00	10	2419.6	186.0
Newmans Brook US	45.2969	-66.07129	2020-10-21	9.8	112.1	12.7	291	0.1	8.7	0.02	0.02	0.00	0	770.1	6.2
Salmon Creek DS	45.40033	-65.99231	2020-05-25	12.5	116.5	12.5	582	0.3	7.9	0.02	0.02		0	1046.2	17.5
Salmon Creek DS	45.40033	-65.99231	2020-06-23	18.4	99.2	9.3	627	0.3	7.6	0.12	0.1	0.03	0	>2419.6	185.0
Salmon Creek DS	45.40033	-65.99231	2020-07-27	19.6	121.3	11.1	455	0.3	8.2	<0.01	0.07	0.02	10	>2419.6	260.3
Salmon Creek DS	45.40033	-65.99231	2020-08-24	18.5	123.0	11.6	802	0.4	8.1	0.02	0.01	0.00	5	2419.6	770.1
Salmon Creek DS	45.40033	-65.99231	2020-09-21	8.2	106.3	12.5	721	0.4	7.5	0.02	0.06	0.02	0	>2419.6	74.9
Salmon Creek DS	45.40033	-65.99231	2020-10-19	10.1	134.3	15.0	600	0.3	7.8	<0.01	0.07	0.02	8	1732.9	73.3
Salmon Creek US	45.42259	-65.95914	2020-05-25	12.7	114.7	12.1	659	0.3	8.0	0.02	0.02		0	547.5	74.3
Salmon Creek US	45.42259	-65.95914	2020-06-23	17.2	85.5	8.2	667	0.3	7.7	<0.01	0.04	0.01	0	>2419.6	2419.6
Salmon Creek US	45.42259	-65.95914	2020-07-27	17.9	70.0	6.6	611	0.5	7.6	<0.01	0.09	0.03	5	>2419.6	71.7
Salmon Creek US	45.42259	-65.95914	2020-08-24	15.9	64.9	6.4	579	0.3	7.7	0.03	0.03	0.00	10	1732.9	488.4
Salmon Creek US	45.42259	-65.95914	2020-09-21	7.1	97.2	11.6	832	0.4	7.7	<0.01	0.56	0.18	0	>2419.6	275.5
Salmon Creek US	45.42259	-65.95914	2020-10-19	9.1	125.1	14.3	507	0.3	8.0	<0.01	0.07	0.02	0	1986.3	95.9

Spruce Lake Stream Mouth	45.25356	-66.14396	2020-05-28	15.5	80.2	7.9	507	0.4	8.4	0.02	0.02	0.00	0	980.4	28.8
Spruce Lake Stream Mouth	45.25356	-66.14396	2020-06-25	26.0	154.5	12.3	3601	1.9	8.9	0.04	0.04	0.01	0	>2419.6	344.8
Spruce Lake Stream Mouth	45.25356	-66.14396	2020-07-30	25.4	133.7	10.3	17887	10.6	8.3	<0.01	<0.02	0.00	46	>2419.6	6131.0
Spruce Lake Stream Mouth	45.25356	-66.14396	2020-08-25	19.8	31.0	2.6	24265	14.7	7.7	0.08	0.01	0.00	4	>24196	613.0
Spruce Lake Stream Mouth	45.25356	-66.14396	2020-09-24	16.0	81.3	7.9	5406	3.0	7.6	0.05	0.02	0.00	51	>24196	2500.0
Spruce Lake Stream Mouth	45.25356	-66.14396	2020-10-22	12.4	68.3	6.7	21194	12.7	7.3	0.03	0.02	0.00	4	>24196	98.0
Spruce Lake Stream US	45.24347	-66.15765	2020-05-28	13.9	104.1	10.8	201	0.1	8.6	0.01	0.03	0.00	14	1732.9	62.2
Spruce Lake Stream US	45.24347	-66.15765	2020-06-25	17.3	109.3	10.4	205	0.1	8.7	<0.01	0.03	0.00	0	686.7	67.7
Spruce Lake Stream US	45.24347	-66.15765	2020-07-30	18.3	80.4	7.5	342	0.2	7.7	<0.01	<0.02	0.00	48	1986.3	52.1
Spruce Lake Stream US	45.24347	-66.15765	2020-08-25	16.7	84.2	8.1	591	0.3	9.7	0.05	0.02	0.00	0	>2419.6	387.3
Spruce Lake Stream US	45.24347	-66.15765	2020-09-24	12.7	92.4	9.7	267	0.1	8.8	0.02	0.03	0.00	0	>2419.6	155.3
Spruce Lake Stream US	45.24347	-66.15765	2020-10-22	11.3	102.6	11.1	1034	0.5	9.0	<0.01	0.02	0.00	1	144.5	10.9
Taylor Brook DS	45.38214	-65.99634	2020-05-25	13.6	110.5	11.3	224	0.1	7.9	0.02	0.03		0	613.1	43.9
Taylor Brook DS	45.38214	-65.99634	2020-06-23	19.7	95.4	8.8	246	0.1	7.7	<0.01	0.02	0.00	0	>2419.6	60.9
Taylor Brook DS	45.38214	-65.99634	2020-07-27	20.7	99.4	8.8	165	0.1	8.0	<0.01	0.04	0.01	5	>2419.6	456.9
Taylor Brook DS	45.38214	-65.99634	2020-08-24	17.5	102.3	9.8	311	0.2		0.01	0.01	0.00	0	1299.7	18.5
Taylor Brook DS	45.38214	-65.99634	2020-09-21	8.1	112.4	13.1	301	0.1	7.9	0.02	0.03	0.01	0	648.8	71.2
Taylor Brook DS	45.38214	-65.99634	2020-10-19	9.4	123.3	14.1	217	0.1	8.0	<0.01	0.03	0.01	0	1553.1	90.8
Taylor Brook US	45.37854	-65.97887	2020-05-25	15.6	105.4	10.4	260	0.1	8.0	0.02	0.04		0	275.5	16.1
Taylor Brook US	45.37854	-65.97887	2020-06-23	23.3	83.7	7.0	274	0.1	7.9	0.02	0.04	0.01	0	>2419.6	2.0
Taylor Brook US	45.37854	-65.97887	2020-07-27	22.3	92.9	8.1	200	0.1	7.5	>0.5	0.04	0.01	23	>2419.6	23.3
Taylor Brook US	45.37854	-65.97887	2020-08-24	20.9	71.0	6.3	312	0.2	7.5	0.03	<0.02	0.00	61	>2419.6	9.7

Taylor Brook US	45.37854	-65.97887	2020-09-21	13.0	86.2	8.9	294	0.1	7.8	0.02	0.01	0.00	0	2419.6	9.8
Taylor Brook US	45.37854	-65.97887	2020-10-19	9.5	112.2	12.8	242	0.1	8.0	<0.01	0.03	0.00	73	>2419.6	56.3