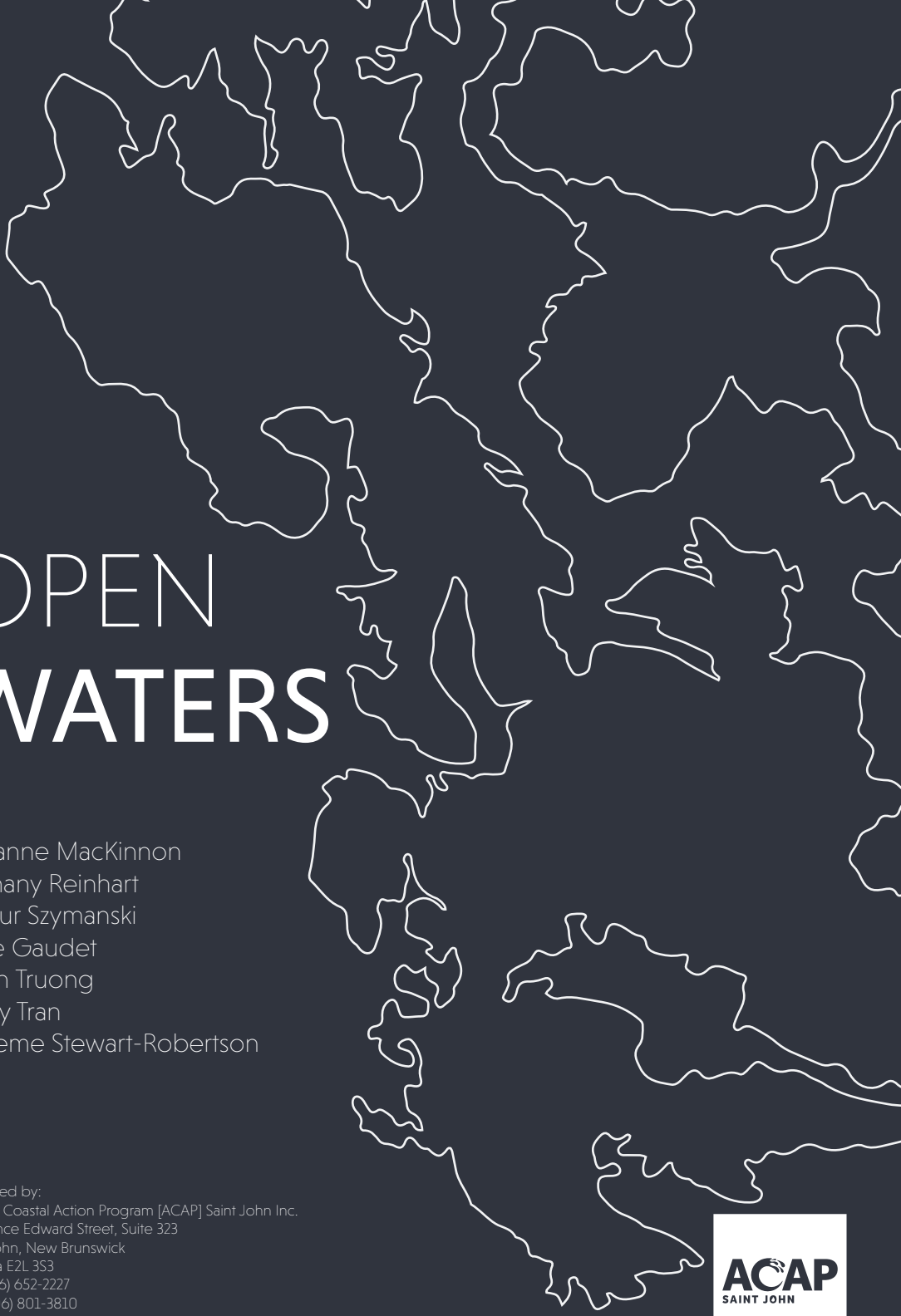

OPEN WATERS

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2020

Published by:
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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 – 2018 and could not have been completed without the support ACAP Saint John receives each year from the community.

Table of Contents

Executive Summary

This report will summarize the findings of ACAP Saint John's 2019 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 27 years of water quality data across many sites in the Saint John region and this historic data has been incorporated into this report.

In 2019, 26 sites were analyzed and across these sites, when excluding fecal coliform counts, general water quality was observed to be in good or excellent condition at 19 of these sites, as determined by the Canadian Council for the Ministers of Environment (CCME) water quality index calculations. This suggests that most sites across Saint John show minimal to no impairment in water quality parameters measured, an excellent feat for an industrial Harbour region. The exception to this is in Marsh Creek and Newman's Brook Downstream where sites are in fair condition, suggesting water quality is occasionally impaired or threatened. When considering fecal coliform counts the data suggest further impairment across sites (15 of 26 sites). This is especially evident in Marsh Creek where historical sewage contamination is known to be present, although concentrations are low compared to pre-Harbour Cleanup (2014) values. Though generally speaking the water of the Greater Saint John area is in good conditions, the excess nutrients and fecal coliform present across a range of sites suggests that there is an influence of stormwater or sewer inputs in the system and this monitoring should continue 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.

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 and 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 (i.e. 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. *Open Waters* is a continuation of the *Rebirth of Water* monitoring program which originally was meant to track improvement after the sewage ban. It monitors tributaries of the Wolastoq and other waterways found throughout the City of Saint John.

Methods

Water Quality Monitoring Sites

Water quality monitoring sites are in nine different watersheds 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, 26 sites were monitored in 2019 (Figure 1). GPS coordinates for each of the sites monitored can be found in Appendix 1.

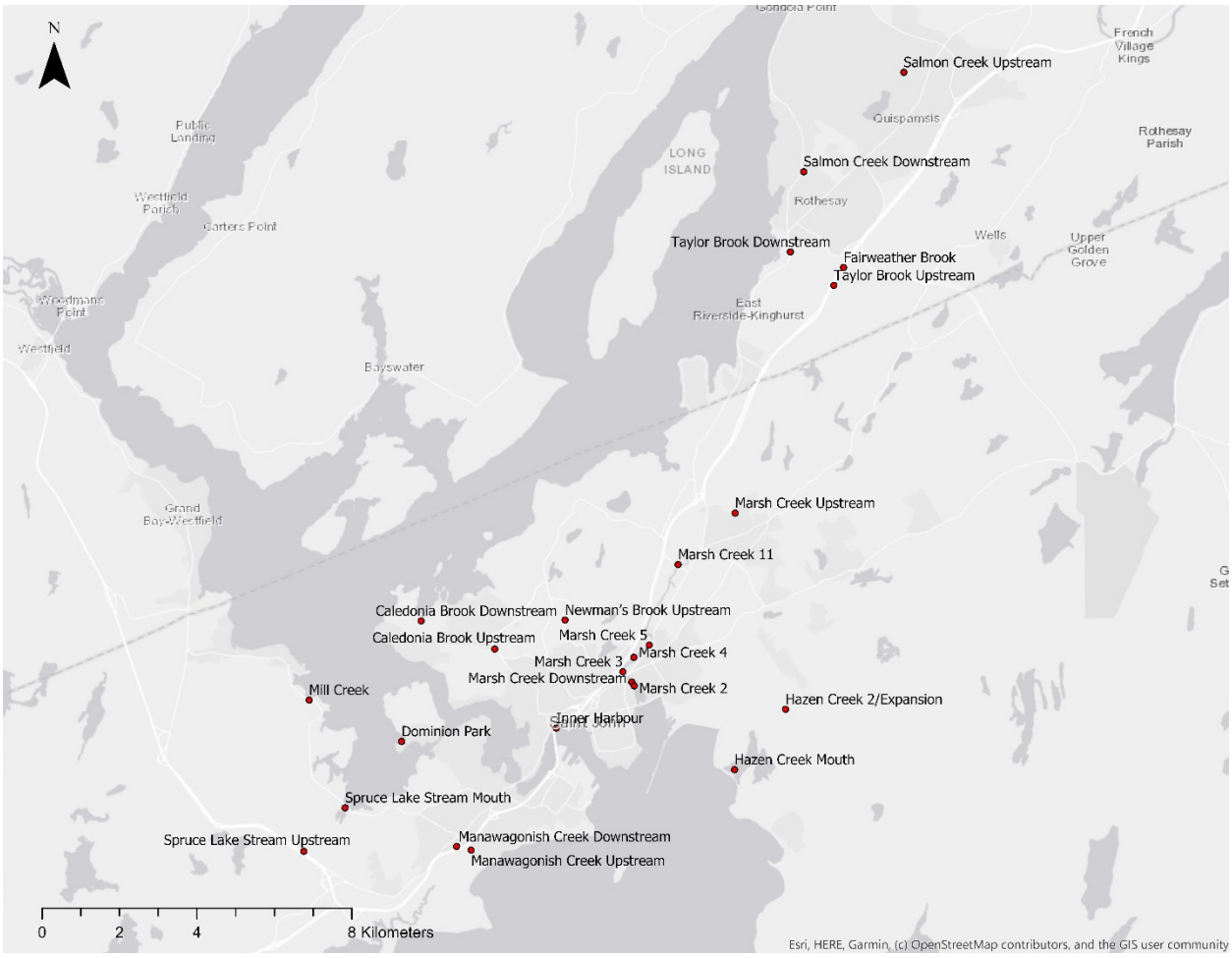

Figure 1: Locations of water quality sampling sites during the 2019 field season.

Below is a brief overview of why these nine watersheds were monitored in 2019.

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 not been 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.

Water Quality Analyses

Water quality data collected includes dissolved oxygen, 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. Total suspended solids, fecal coliform, orthophosphates, and ammonia were quantified in the lab.

Total Suspended Solids

Total suspended solids (TSS) were measured by vacuum filtration. The sample (100 mL) was filtered through a pre-weighed glass fibre filter (Whatman Grade 934-AH Circles 55 mm) and rinsed with deionized water. The filter was then dried in an oven at 105°C and allowed to cool to room temperature in a desiccator. TSS was calculated based on the filter weight difference of the sample before and after, and is expressed as mg/L.

Fecal Coliform

Fecal coliforms were measured via membrane filtration. Water samples were diluted (dilutions were 1:10 mL, 1:100 mL, 1:1000 mL, 1:10000 mL water) and vacuum filtered through a Millipore filter disk. The disk was then transferred to a Petri dish with m-FC agar and 1% rosolic acid, incubated for 24 hours, and the resulting bacterial colonies were counted. If the colonies could not be counted as they were too numerous and grew together, the plate was reported as too numerous to count (TNTC). Using the dilution ratio for each plate, the number of coliforming units (CFU) were standardized and expressed as number of CFU per 100 mL of water.

Orthophosphate

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

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.

Fish Community Monitoring

Fishing occurred monthly at 8 sites (May – 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 (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 Upstream and Downstream) while the newer *Open Waters* dataset goes back to 2012 and monitors six sites (labelled 1,2,3,4,5, and 11). Marsh Creek 1 was removed from the program in 2019 for safety reasons (n = 1 sample in 2019).

The CCME has created a Water Quality Index (WQI) that rates water quality based on a ratio of parameters that exceed guidelines 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). This calculation does not account for fecal coliform data as there was a problem quantifying bacterial growth plates in 2019 and there were too few successful measurements at each site. Fecal contamination is a well documented issue in Marsh Creek and it is expected that it would reduce the overall water quality score if it were included in the WQI. Water quality in Marsh Creek is categorized as fair at 6 out of 7 of the sites and good at the Upstream site in 2019 (Figure 2). The worst offenders are ammonia and orthophosphate, whose levels exceeded acceptable CCME ranges at all sites and are responsible for most of the violations (more on this below).

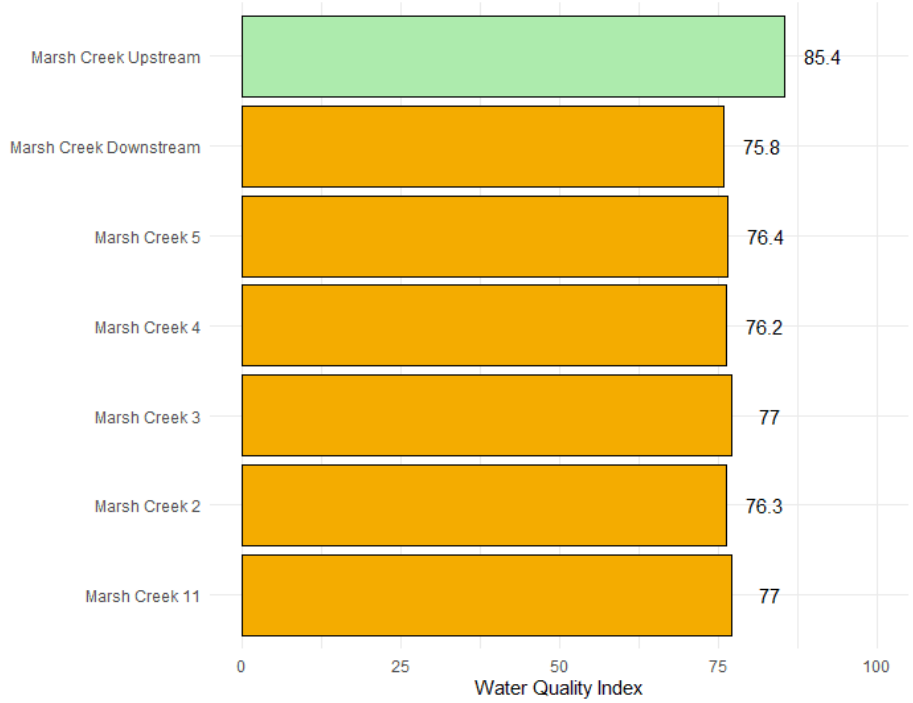

Figure 2: Calculated water quality index for all seven Marsh Creek Sites in 2019.

In Figures 3 - 5 the data are presented in Xbar-R (mean-range) control charts. Control charts plot the mean (blue line) over a specified time interval, showing how far individual parameter measurements deviate from this. These charts also show acceptable guidelines of the measured water quality parameters (red lines) as specified by the CCME. The guidelines are related to the measured ranges of each parameter for each year at each site to demonstrate how water quality compares to these targets. 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.

Average ammonia and orthophosphate levels remain higher than the recommended CCME range across all sites except at Marsh Creek Upstream (0 - 0.02 mg/L for orthophosphate and 0 - 0.1 mg/L for ammonia; Figure 3) (Canadian Council of Ministers of the Environment, 2010). This suggests most anthropogenic influences begin regularly impacting Marsh Creek somewhere between Marsh Creek Upstream and Marsh Creek 11 within East Saint John. Considering minimal impacts at Marsh Creek Upstream, this site could be used as a control for future analyses. Since stopping the dumping of raw sewage into Marsh Creek in late 2014, ammonia and orthophosphate levels still spike, 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. However, in recent years, levels seem to be approaching acceptable ranges compared to historical data.

Fecal coliform levels also exceed guidelines at all sites except Marsh Creek Upstream site (0 - 200 cfu/100 ml), further establishing it as a good control site (Figure 4) (Canadian Council of Ministers of the Environment, 1999a). 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. Recently, levels dropped significantly, nearing CCME guidelines, representing a major improvement in this watercourse. But, an increase again in 2019 suggests fecal coliforms should still be monitored closely. 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 per year exceeds upper and lower control limits but still stays within the CCME guidelines (6.5 – 9; Canadian Council of Ministers of the Environment, 1999b).

Water temperature fluctuates within the CCME guidelines (4 - 24 °C), as does DO (> 6.5 mg/L) indicating that aquatic life, in particular fish species, can inhabit this section of the creek (Figure 5) (Canadian Council of Ministers of the Environment, 1999c). Mean temperature decreases slightly moving more downstream likely due to influences of tidal water and no trend is seen in dissolved oxygen relative to ocean proximity.

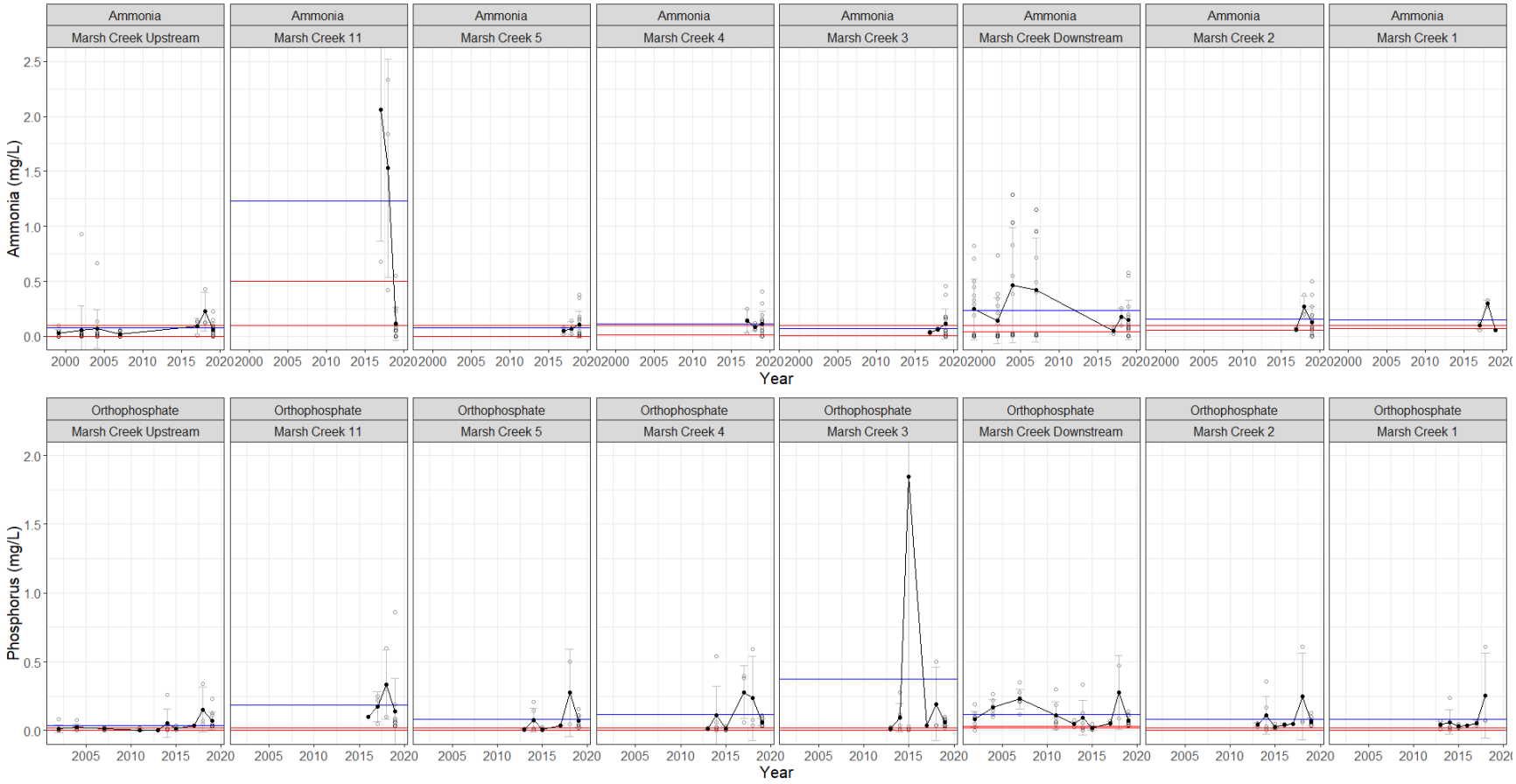

Figure 3: Xbar-R control chart of ammonia (mg/L) and orthophosphate (mg/L) levels per year in Marsh Creek from 1999-2019. Plots have been zoomed in and outliers cropped out to better visualize the data.

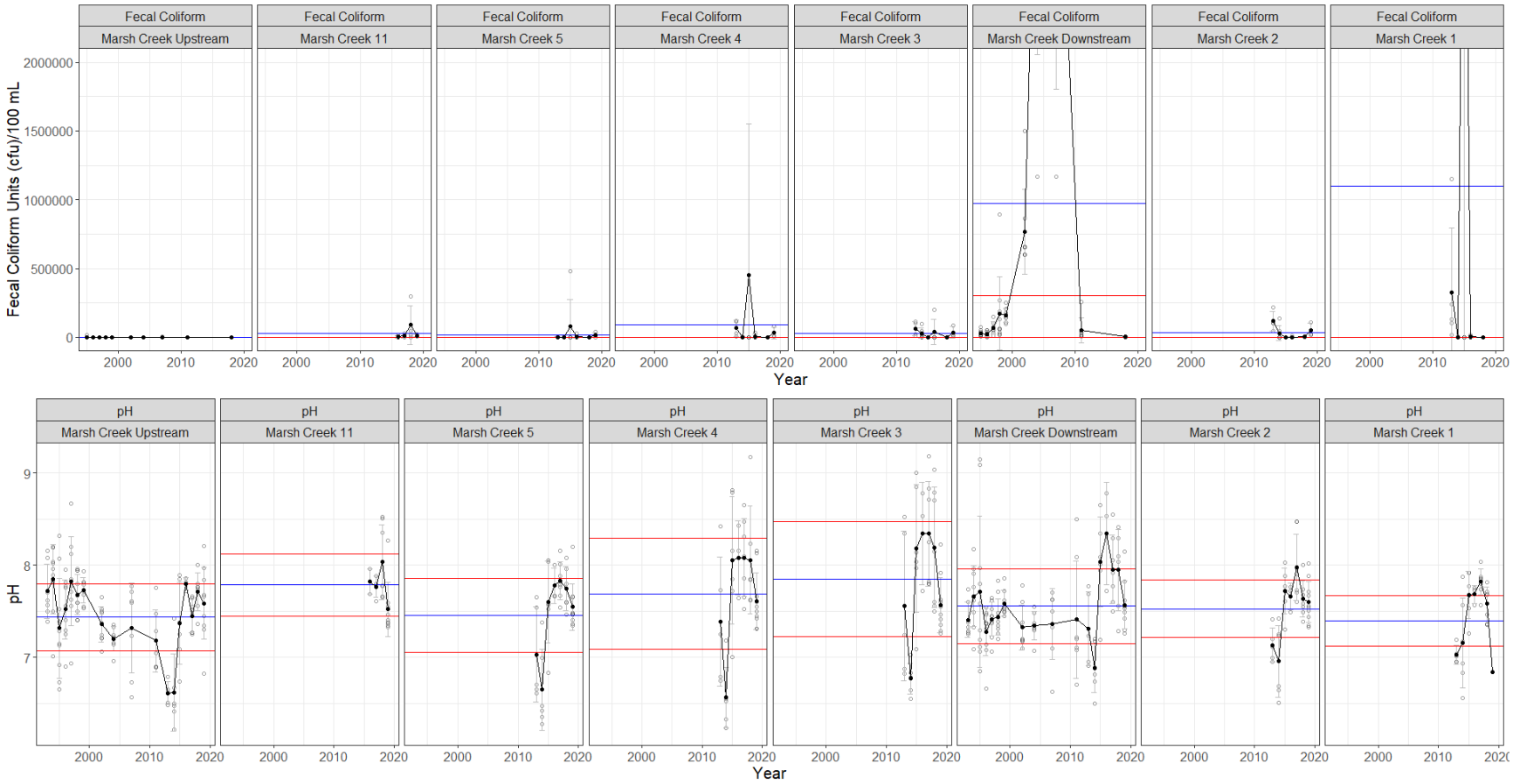

Figure 4: Xbar-R control chart of fecal coliform (cfu/100mL) and pH levels in Marsh Creek (1993-2019). Plots have been zoomed in and outliers cropped out to better visualize the data.

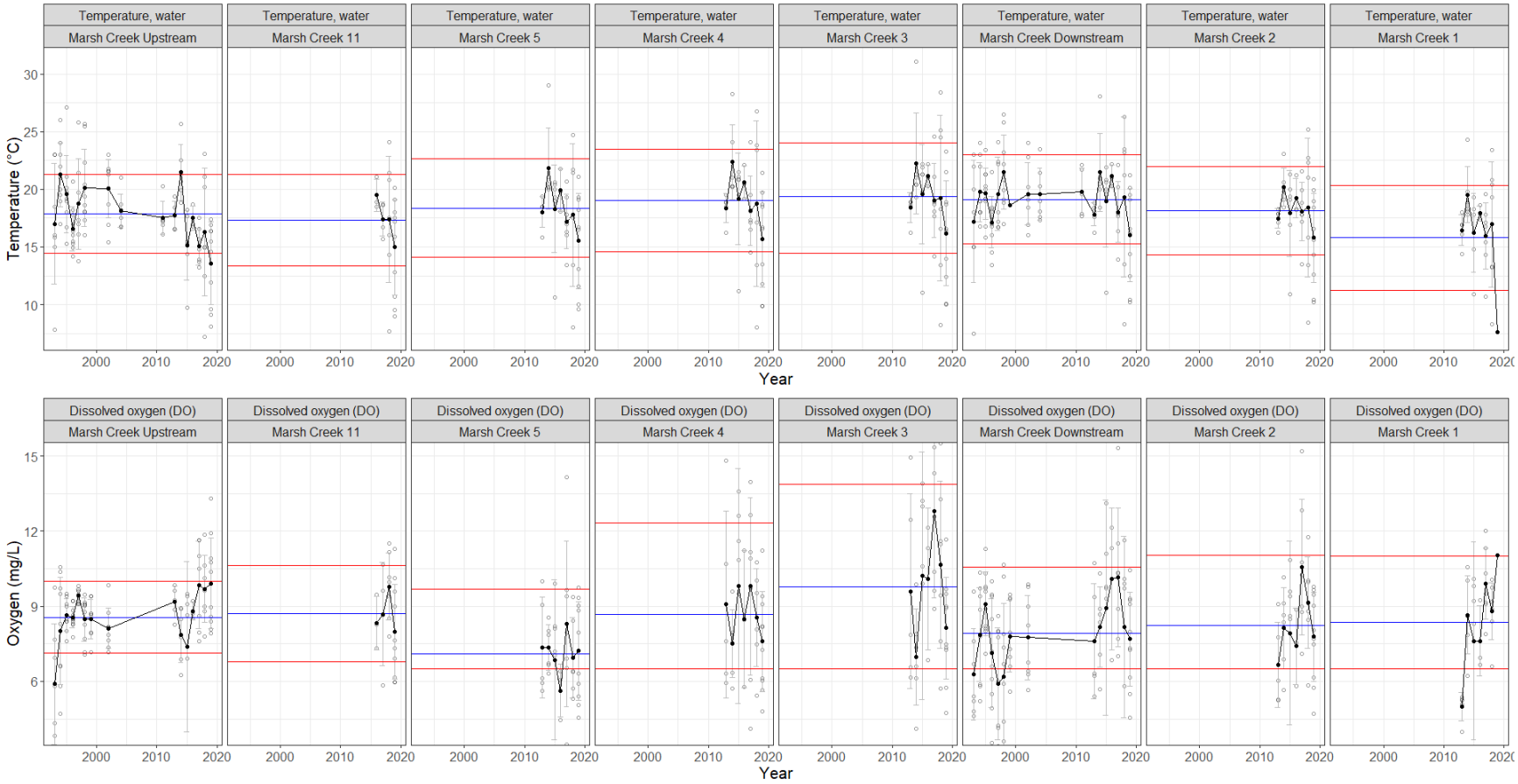

Figure 5: Xbar-R control chart of water temperature (°C) and dissolved oxygen (mg/L) levels in Marsh Creek (1993-2020). Plots have been zoomed in and outliers cropped out to better visualize the data.

Water Quality in the Greater Saint John Area

In this section, the water quality monitoring completed in the Greater Saint John Area is presented. Due to large volume of data collected in the Marsh Creek watershed since 1993 it was reported in an isolated chapter above.

The Water Quality Index was calculated for these sites based on fewer datapoints than Marsh Creek sites (Table 1) as sites in this program are not monitored at the same frequency and lab samples are not collected at every monitoring time point due to laboratory availability. Again, these calculations did not incorporate fecal coliform as there were too few successful measurements across sites. Except for Hazen Creek sites, Mill Creek, and Inner Harbour, this calculation also did not consider ammonia as it was only sampled a total of three times per site.

In total, seven sites were calculated to have excellent water quality based on the index score of 100 (Figure 6). These sites were Taylor Brook Downstream, Spruce Lake Upstream, Salmon Creek, Mill Creek, Dominion Park, and Caledonia Brook Downstream.

More than 50% of the sites sampled in 2019 were found to have a good Water Quality Index reading, indicating that water quality is protected with only minor threats or impairment (Figure 6). These sites include Taylor Brook Upstream, Spruce Lake Stream Mouth, Newman's Brook Upstream, Manawagonish Creek, Inner Harbour, Hazen Creek Mouth, Hazen Creek 2, Fairweather Brook, Crescent Lake, and Caledonia Brook Upstream. This calculated index is an indication of good health despite the location of some of these sites, particularly Manawagonish Creek and Hazen Creek Mouth which are adjacent to sewage treatment facilities where impairment would be expected. The most common offenders for guideline deviations were ammonia (when used), orthophosphate, temperature, and dissolved oxygen.

Newman's Brook Downstream received the worst score (70) which categorizes this site as fair (Figure 6). Newman's Brook Downstream is located at a stormwater outflow and thus has unnatural inputs from Saint John's North End. The offenders for this site were orthophosphate and dissolved oxygen. When looking at the other parameters collected but not included in the calculation, fecal coliform and ammonia levels were also elevated, indicating that the stormwater is negatively impacting water quality at this site (Table 1).

Keeping in mind that these indices did not consider fecal coliform counts and ammonia concentrations (for most sites), these results suggest a wide range of water quality among tributaries to the Wolastoq and Saint John Harbour.

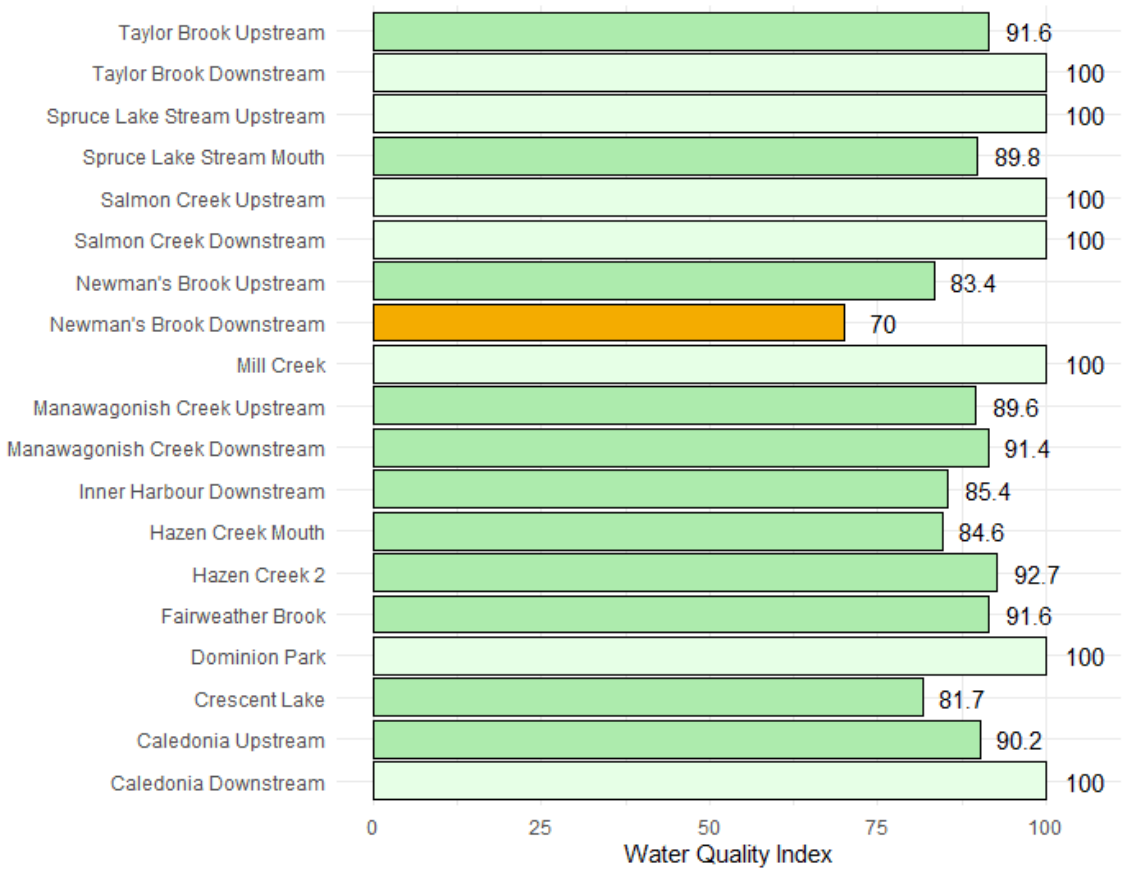

Figure 6: Water quality index of monitored sites around the Greater Saint John area for 2019.

Many of the sites monitored (15 sites) had average fecal coliforms exceeding CCME guidelines indicating that fecal contamination is still an issue across watersheds in the Greater Saint John area (Table 1). Average fecal coliforms across all sites (including Marsh Creek) was 6676 cfu/100 mL. Additionally, average ammonia concentrations were elevated at 9 sites, 7 of which are in Marsh Creek (average 0.18 mg/L across all sites), and orthophosphate was elevated at 13 sites (average 0.06 mg/L across all sites). Together, these indicate stormwater influences and the need for better riparian and nutrient management. It is recommended that monitoring continues at these sites to track any changes. Though individual data points occasionally exceeded guidelines throughout the course of this monitoring program, average temperature and dissolved oxygen were acceptable across sites (Table 1). Not shown in Table 1 is conductivity, salinity, pH, turbidity, and total suspended solids whose exceedances were very minimal compared to nutrients and fecal coliform values. All raw water quality data collected in 2019 can be found in Appendix 2.

*Table 1: Summary table for water quality data across 26 Greater Saint John sites. Average (x), standard deviation (SD), and sample numbers (n) are displayed with measures that exceeded guidelines in **bold**. Conductivity, salinity, pH, turbidity, and total suspended solids are not shown here.*

Site	Temperature (℃)			DO (mg/L)			Ammonia (mg/L)			Orthophosphate (mg/L)			Fecal Coliform (cfu/100 mL)		
	x	SD	n	x	SD	n	x	SD	n	x	SD	n	x	SD	n
Caledonia Downstream	14.9	2.9	6	10.0	1.4	6	0.05	0.02	2	0.04		1	**4501**	**6935**	**3**
Caledonia Upstream	16.4	5.1	6	10.0	1.1	6	0.08	0.02	2				**546**	**429**	**4**
Crescent Lake	21.1	3.4	6	7.6	2.0	6	**0.11**	**0.11**	**2**				33	53	4
Dominion Park	18.5	3.8	6	8.9	1.0	6				0.04		1	38	39	2
Fairweather Brook	18.8	4.5	6	8.4	0.8	6				0.04	0.00	2	96	98	4
Hazen Creek 2	12.1	3.0	10	10.2	1.5	10	0.06	0.02	4	**0.06**	**0.03**	**2**	174	103	5
Hazen Creek Mouth	16.3	4.6	10	9.5	1.8	10	0.09	0.03	4	**0.08**	**0.04**	**5**	100	120	4
Inner Harbour Downstream	13.3	2.7	10	9.5	1.5	10	0.08	0.06	2	**0.06**		**1**	147	109	5
Manawagonish Creek Downstream	14.9	2.2	7	9.7	2.3	7	0.09	0.10	3	**0.05**	**0.01**	**3**	**476**	**854**	**5**
Manawagonish Creek Upstream	14.5	2.1	5	8.7	1.0	5	0.09	0.06	3	**0.05**	**0.01**	**3**	**345**	**349**	**2**
Marsh Creek 1	7.6		1	11.0		1									
Marsh Creek 11	15.0	4.1	10	8.0	1.9	10	**0.29**	**0.25**	**3**	**0.05**	**0.01**	**4**	**14100**	**10379**	**3**
Marsh Creek 2	15.8	3.9	10	7.8	1.8	10	**0.25**	**0.23**	**4**	**0.06**	**0.04**	**5**	**51100**	**52342**	**3**
Marsh Creek 3	16.2	4.6	10	8.1	2.0	10	**0.29**	**0.23**	**3**	**0.05**	**0.02**	**5**	**36733**	**44931**	**3**
Marsh Creek 4	15.7	4.1	10	7.6	2.0	10	**0.25**	**0.20**	**3**	**0.06**	**0.02**	**5**	**32333**	**41645**	**3**
Marsh Creek 5	15.5	4.1	10	7.6	2.0	8	**0.25**	**0.19**	**3**	**0.05**	**0.02**	**4**	**16967**	**19791**	**3**
Marsh Creek Downstream	16.0	4.0	10	7.7	1.9	10	**0.40**	**0.28**	**3**	**0.06**	**0.03**	**5**	**65250**	**72478**	**2**
Marsh Creek Upstream	13.6	3.6	10	9.9	1.8	10	**0.12**	**0.09**	**3**	0.04	0.00	2	**1833**	**2149**	**3**
Mill Creek	16.9	4.8	10	8.8	1.8	10	0.06		1				36	30	4
Newman's Brook Downstream	17.8	4.0	6	8.3	2.5	6	**0.58**	**0.17**	**2**	**0.11**	**0.10**	**2**	**1683**	**2491**	**3**
Newman's Brook Upstream	17.4	3.8	12	8.7	1.9	12	0.03		1				**983**	**1760**	**6**
Salmon Creek Downstream	16.5	3.0	6	9.4	1.2	6	0.06		1	0.04		1	**226**	**72**	**4**
Salmon Creek Upstream	15.9	2.3	6	8.9	0.9	6							189	93	4
Spruce Lake Stream Mouth	18.5	5.3	6	9.1	1.2	6	0.06		1	**0.06**		**1**	**770**	**330**	**3**
Spruce Lake Stream Upstream	15.3	3.3	6	9.0	0.9	6				0.04	0.00	2	112	90	4
Taylor Brook Downstream	18.1	3.4	6	9.1	1.1	6	0.03		1	0.04		1	172	165	4
Taylor Brook Upstream	19.2	4.2	6	8.2	1.0	6				0.04		1	81	133	4
Grand Total	16.1	4.1	207	8.8	1.8	205	**0.18**	**0.18**	**51**	**0.06**	**0.03**	**56**	**6676**	**20809**	**94**

Fish Communities

In total, 15,312 fish from 21 different species were caught using the beach seine across the eight sample sites over the 2019 field season. The most abundant species caught was Atlantic silverside (*Menidia menidia*) with 7,366 individuals (48%) recorded across all sites. The most abundant site sampled was Spar Cove with a total of 6,330 fish recorded across all species (Figure 7).

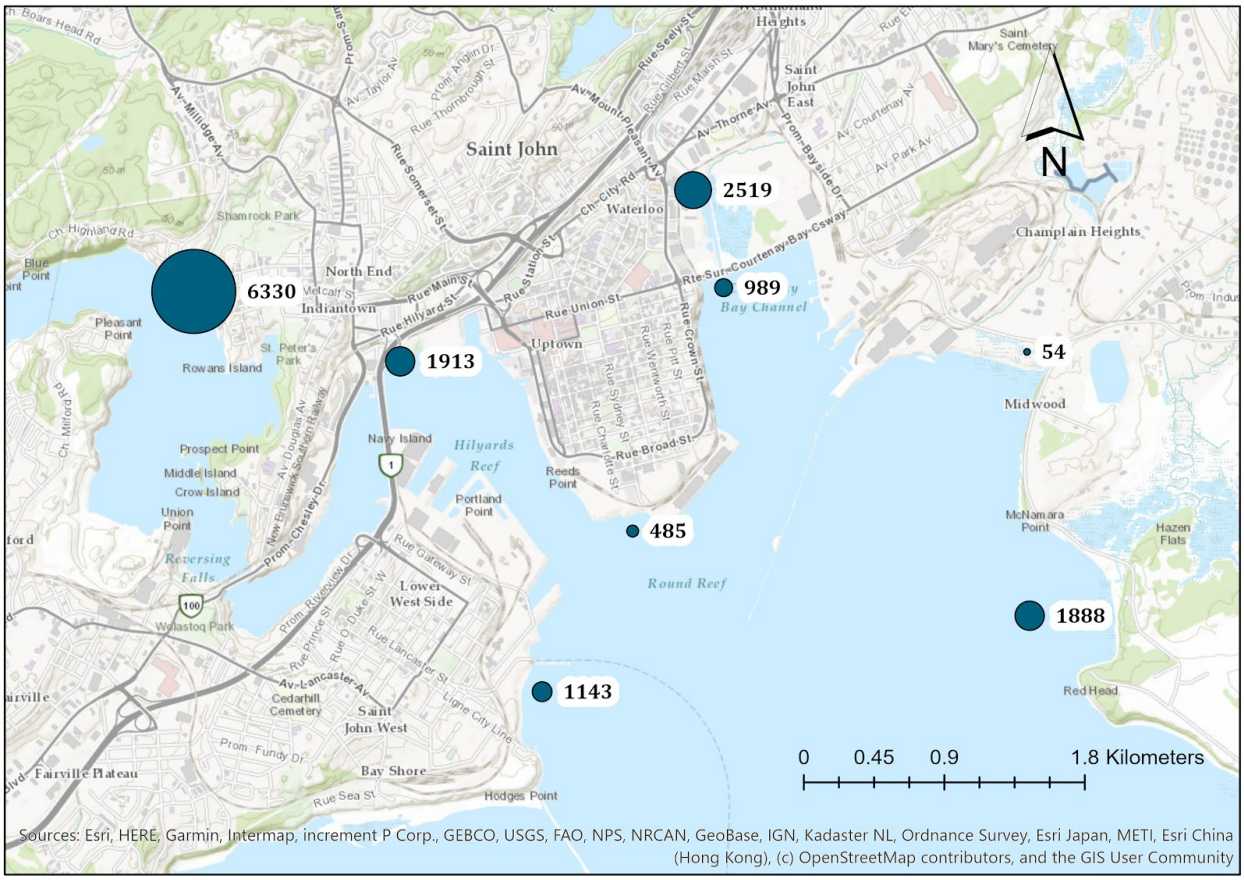

Figure 7: Total abundance of all fish species caught using a beach seine at the eight fishing sites in 2019 (May - October).

Using the Fyke nets, 530 fish representing 13 different species were caught over the field season. The most abundant species was Atlantic tomcod (*Microgadus tomcod*) with 387 (73%) caught and counted. The most abundant site was Inner Harbour with a total of 137 fish being recorded across all species (Figure 8).

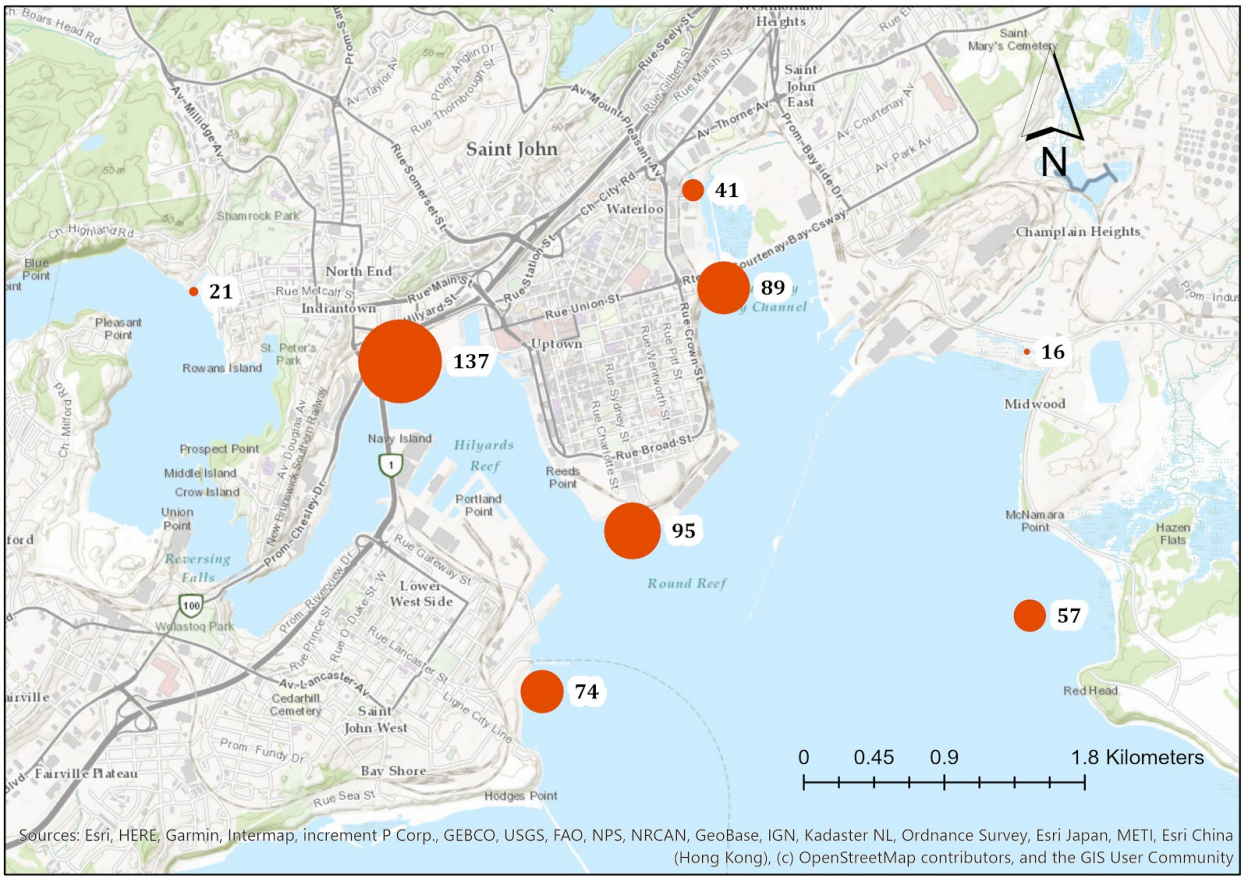

Figure 8: Total abundance of all fish species caught using the Fyke nets across the eight fishing sites.

Conclusion

Water quality monitoring was successfully conducted at 26 sites over nine watersheds within the Greater Saint John Area in 2019. 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. Although some watersheds have impairments to water quality (primarily Marsh Creek and Newman's Brook), overall, most of the freshwater analyzed throughout Saint John in 2019 showed little to no impairment, is considered in good standing, and supports a diversity of aquatic species. The main parameters that exceeded guidelines across sites were concentrations of ammonia, orthophosphate, and fecal coliform suggesting influences of sewer and municipal inputs across the region. 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.

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Appendix 1: Sampling Sites

Table 2: Characteristics of all water quality sampling sites of the project area sampled in 2019.

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.

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 2019 field season

Table 3: Raw water quality data collected at all of the Marsh Creek watershed sites in 2019.

Site	Date	Temp (C)	DO (%)	DO (mg/L)	Cond (µs/cm)	Sal (ppt)	pH	Total Ammonia (NH3-N mg/L)	Free Ammonia (NH3-N mg/L)	Orthohosphate (P mg/L)	Turbidity (NTU)	TSS (mg/L)	Fecal coliform
Marsh Creek 1	08-05-2019	7.6	96.8	11.03	11202	6.35	6.84				3.03		
Marsh Creek 2	08-05-2019	10.4	86.4	9.65	1186	0.59	7.34				3.28		
Marsh Creek Downstream	08-05-2019	10.4	83.9	9.3	1072	0.53	7.26				4.23		
Marsh Creek 3	08-05-2019	10.1	86.1	9.69	790	0.40	7.26				9.18		
Marsh Creek 4	08-05-2019	9.9	80.7	9.09	630.7	0.31	7.31				7.53		
Marsh Creek 5	08-05-2019	9.6	86.6	9.74	366.2	0.18	7.34				3.96		
Marsh Creek 11	08-05-2019	9.0	98.5	11.29	334	0.16	7.34				0.00		
Marsh Creek Upstream	08-05-2019	8.1	113.3	13.31	111.7	0.05	7.34				0.00		
Marsh Creek 2	24-05-2019	10.2	84.0	9.46	404.5	0.21	7.71				31.34		
Marsh Creek Downstream	24-05-2019	10.2	82.2	9.09	403.5	0.19	7.56				20.21		
Marsh Creek 3	24-05-2019	10.0	84.4	9.49	340.3	0.16	7.60				23.69		
Marsh Creek 4	24-05-2019	9.9	83.6	9.40	223.4	0.11	7.60				28.00		
Marsh Creek 5	24-05-2019	10.0	88.4	9.35	277.0	0.13	7.47				21.78		
Marsh Creek 11	24-05-2019	9.5	88.4	10.12	189.4	0.09	7.46				29.09		
Marsh Creek Upstream	24-05-2019	9.1	94.8	10.90	95.2	0.04	7.58				56.00		
Marsh Creek 2	07-06-2019	14.3	88.2	9.01	810.0	0.40	7.54				0.5		
Marsh Creek Downstream	07-06-2019	14.4	91.1	9.25	702.0	0.35	7.56				0.04		
Marsh Creek 3	07-06-2019	14.0	67.2	8.98	485.2	0.25	7.55				2.34		
Marsh Creek 4	07-06-2019	13.5	78.6	8.19	232.05	0.17	7.5				0.00		
Marsh Creek 5	07-06-2019	13.1	75.6	7.96	316.7	0.15	7.46				0.00		
Marsh Creek 11	07-06-2019	12.8	91.4	9.58	274.1	0.13	7.55				0.00		

Marsh Creek Upstream	07-06-2019	11.9	111.0	11.93	104.6	0.05	7.66				0.00		
Marsh Creek 2	21-06-2019	16.6	59.5	5.76	572.00	0.42	7.33			0.04	23.05	0.5	TNTC
Marsh Creek Downstream	21-06-2019	16.6	56.3	5.48	727.00	0.35	7.42			0.04	20.44	0.0	TNTC
Marsh Creek 3	21-06-2019	16.6	59.4	5.75	630.50	0.55	7.35			0.04	23.74	0.2	TNTC
Marsh Creek 4	21-06-2019	16.6	58.8	5.66	494.30	0.24	7.42			0.06	24.13	0.0	TNTC
Marsh Creek 5	21-06-2019	16.5	60.8	5.89	309.50	0.15	7.40			0.04	29.65	0.0	TNTC
Marsh Creek 11	21-06-2019	15.9	71.4	6.9	311.40	0.15	7.38			0.02	6.47	0.0	TNTC
Marsh Creek Upstream	21-06-2019	14.6	88.2	8.96	112.20	0.05	7.45			0.02	0.00	0.3	TNTC
Marsh Creek 2	08-07-2019	18.4	82.4	7.49	4224	2.25	7.56	0.03	0.00	0.04	8.9		TNTC
Marsh Creek Downstream	08-07-2019	19.5	80.1	7.25	3488	1.87	7.62	0	0.00	0.04	11.64		TNTC
Marsh Creek 3	08-07-2019	18.7	82.7	7.48	1846	0.94	7.63	0	0.00	0.04	7.73		TNTC
Marsh Creek 4	08-07-2019	19.7	66.2	6.02	997	0.44	7.55	0	0.00	0.04	8.98		TNTC
Marsh Creek 5	08-07-2019	19.1	59.7	5.40	370.5	2.28	7.48	0	0.00	0.04	8.85		TNTC
Marsh Creek 11	08-07-2019	17.5	79.8	7.64	289.8	0.14	7.59	0.00	0.00	0.04	0.00		TNTC
Marsh Creek Upstream	08-07-2019	16.4	88.0	8.57	118.6	0.06	7.97	0	0.00	0.02	0.00		TNTC
Courtenay Bay	22-07-2019	18.1	81.5	7.37	16255.00	9.57	7.26	0.38	0.01	0.11	32.91	2.5	111500
Marsh Creek 2	22-07-2019	19.0	51.1	4.72	1117.00	0.56	7.67	0.17	0.00	0.13	31.52	2.0	111500
Marsh Creek Downstream	22-07-2019	19.1	49.9	4.56	916.00	0.45	7.29	0.55	0.01	0.11	32.69	1.8	116500
Marsh Creek 3	22-07-2019	18.9	51.2	4.75	751.00	0.37	7.28	0.46	0.01	0.08	27.79	1.7	88000
Marsh Creek 4	22-07-2019	18.5	51.5	4.80	396.40	0.19	7.31	0.41	0.01	0.08	28.62	1.5	80000
Marsh Creek 5	22-07-2019	18.2	48.5	4.55	339.10	0.15	7.36	0.35	0.01	0.08	27.77	1.5	39500
Marsh Creek 11	22-07-2019	18.0	55.4	6.16	254.30	0.14	7.33	0.26	0.00	0.04	26.56	0.6	24000
Marsh Creek Upstream	22-07-2019	16.4	85.7	8.39	129.10	0.06	7.68	0.23	0.01	0.04	0.00	0.4	4250
Courtenay Bay	06-08-2019	19.2	101.7	8.3	33316	20.91	7.91	0.03	0.00	0.02	0.00	0.3	500
Marsh Creek 2	06-08-2019	20.9	117.1	9.79	18654	11.08	8.02	0.08	0.00	0.04	2.05	0.1	19000
Marsh Creek Downstream	06-08-2019	21.2	123.6	10.45	16733	5.81	8.15	0.08	0.01	0.06	1.45	0.8	24000
Marsh Creek 3	06-08-2019	21.5	137.4	11.66	12876	7.40	8.22	0.03	0.00	0.04	2.99	1.3	18000
Marsh Creek 4	06-08-2019	21.4	127.5	11.22	7113	3.92	8.16	0.03	0.00	0.06	4.50	1.0	14000
Marsh Creek 5	06-08-2019	21.1	103.2	8.83	5107	2.76	7.66	0.03	0.00	0.04	6.63	0.7	9000

Marsh Creek 11	06-08-2019	20.1	64.5	5.96	426.4	0.20	7.37	0.55	0.01	0.04	0.18	0.1	15000
Marsh Creek Upstream	06-08-2019	15.5	81.3	7.92	234.5	0.11	6.82	0.08	0.00	0.04	1.70	0.2	135
Marsh Creek 2	20-08-2019	19.9	69.2	6.17	7082	3.9	7.44	0.5	0.01	0.04	0.00	0.6	22800
Marsh Creek Downstream	20-08-2019	20.1	69.2	6.16	6035	3.24	7.49	0.58	0.01	0.04	3.32	0.3	14000
Marsh Creek 3	20-08-2019	23.3	82.7	7.27	6462	3.23	7.41	0.38	0.01	0.04	3.59	0.3	4200
Marsh Creek 4	20-08-2019	18.7	68.1	6.13	1666	0.84	7.45	0.3	0.01	0.04	1.59	0.1	3000
Marsh Creek 5	20-08-2019	19.3	66.0	5.07	9421	0.71	7.46	0.38	0.01	0.02	1.51	0.3	2400
Marsh Creek 11	20-08-2019	19.1	65.8	5.98	455.7	0.22	7.4	0.06	0.00	0.02	0.00	0.1	3300
Marsh Creek Upstream	20-08-2019	17.4	84.2	8.07	211.0	0.1	7.3	0.06	0.00	0.02	0.00	0.0	1115
Marsh Creek 2	03-09-2019	15.6	87.2	7.71	31009	19.27	7.51				0		
Marsh Creek Downstream	03-09-2019	16.2	78.6	7.32	13743	3.06	7.53				0.42		
Marsh Creek 3	03-09-2019	16.4	77	7.35	6874	3.3	7.46				0.13		
Marsh Creek 4	03-09-2019	16.7	75.9	7.25	2746	1.43	7.66				8.23		
Marsh Creek 5	03-09-2019	16.7	65.9	6.3	1582	0.8	7.65				0		
Marsh Creek 11	03-09-2019	17.2	76.4	7.32	369.9	0.18					11.96		
Marsh Creek Upstream	03-09-2019	16.9	107.4	10.37	152.6	0.07	7.84				0		
Marsh Creek 2	04-10-2019	12.6	81.4	8.05	22615	13.59	7.88				3.92		
Marsh Creek Downstream	04-10-2019	12.5	80.5	7.98	19376	11.55	7.82				2.47		
Marsh Creek 3	04-10-2019	12.4	88.5	8.92	12802	7.38	7.92				10.69		
Marsh Creek 4	04-10-2019	11.8	76.8	8.16	4373	2.34	8.13				13.83		
Marsh Creek 5	04-10-2019	11.6	83.8	9.03	2538	1.32	8.2				4.44		
Marsh Creek 11	04-10-2019	10.7	82.1	9	433	0.21	8.27				3.55		
Marsh Creek Upstream	04-10-2019	9.6	94.5	10.76	184.3	0.09	8.21				0		

Table 4: Water quality data collected over the 2019 field season at all Open Waters sites except Marsh Creek.

Site	Date	Temp (C)	DO (%)	DO (mg/L)	Cond (µs/cm)	Sal (ppt)	pH	Total Ammonia (NH3-N mg/L)	Free Ammonia (NH3-N mg/L)	Phosphate (P mg/L)	Turbidity (NTU)	TSS (mg/L)	Fecal coliform
Hazen Creek Upstream	08-05-2019	6.1	94.8	11.64	2406	1.23	7.43				7.76		
Hazen Creek 2/Expansion	08-05-2019	4.9	107.5	13.74	159	0.08	8.2				25.45		
Inner Harbour	09-05-2019	7.4	104.5	12.65	28660	0.14	7.46				20.67		
Mill Creek	09-05-2019	9.2	107.3	12.3	142.4	0.07	8.73				18.23		
Hazen Creek Upstream	27-05-2019	12.1	103.1	11.05	585.5	0.29	7.70				15.26		
Hazen Creek 2/Expansion	27-05-2019	9.5	97.2	10.92	92.4	0.04	7.63				0.00		
Inner Harbour	28-05-2019	10.2	97.3	10.75	2255.50	1.85	7.61				0.05		
Mill Creek	29-05-2019	11.4	99.3	10.66	87.10	0.06	8.00				0.00		
Spruce Lake Stream	30-05-2019	14.1	79.5	8.17	105.5	0.05	7.61				2.64		
Spruce Lake Stream US	30-05-2019	11.8	88.0	9.50	198.9	0.09	7.19				0.00		
Manawagonish Creek DS	30-05-2019	12.3	136.2	14.55	40003.65	0.30	7.99				5.27		
Manawagonish Creek US	30-05-2019	11.8	94.4	10.14	804	0.40	7.80				5.49		
Dominion Park	30-05-2019	12.3	99.2	10.60	252.3	0.12	7.84				2.15		
Fairweather Brook	31-05-2019	13.4	93.1	9.71	122.0	0.06	7.70				0.00		
Taylor Brook US	31-05-2019	13.5	93.1	9.65	163.4	0.08	7.55				0.00		
Taylor Brook DS	31-05-2019	14.3	95.2	9.72	156.0	0.07	7.88				0.00		
Salmon Creek US	31-05-2019	13.6	98.8	10.28	350.9	0.17	7.88				0.00		
Salmon Creek DS	31-05-2019	13.5	107.1	11.02	422.2	0.20	8.44				0.00		
Newsman Brook US	03-06-2019	11.0	97.1	10.70	284.6	0.14	7.81						
Newsman Brook DS	03-06-2019	11.8	92.8	9.95	2524.0	1.32	7.64						
Caledonia US	03-06-2019	9.7	96.7	10.95	350.9	0.17	7.91						
Caledonia DS	03-06-2019	10.3	108.0	12.03	600.1	0.29	7.91						
Crescent Lake	03-06-2019	15.8	108.6	10.89	318.2	0.15	7.99						
Mispec River DS	05-06-2019	15.3	103.1	10.33	51.1	0.02	7.88						
Hazen Creek Upstream	10-06-2019	18.2	97.6	9.04	5777	3.15	7.83				10.74		
Hazen Creek 2/Expansion	10-06-2019	12.1	91.2	9.75	247.7	0.12	7.78				0.00		

Inner Harbour	11-06-2019	12.5	106.2	10.57	18385	10.89	7.79				8.68		
Mill Creek	11-06-2019	16.4	96.0	9.40	3022	1.95	7.68				0.00		
Spruce Lake Stream	14-06-2019	14.4	79.8	8.10	293.55	0.22	7.40				17.00		
Spruce Lake Stream US	14-06-2019	12.6	89.1	9.45	70.20	0.05	7.73				2.62		
Manawagonish Creek DS	14-06-2019	13.3	81.5	8.51	330.20	0.25	7.38				20.40		
Manawagonish Creek US	14-06-2019	13.7	87.0	8.85	429.00	0.32	7.65				9.97		
Dominion Park	17-06-2019	16.7	92.1	8.77	5132	2.77	7.74				2.56		
Fairweather Brook	14-06-2019	14.9	82.0	8.34	79.95	0.06	7.58				0.00		
Taylor Brook US	14-06-2019	16.8	82.8	7.97	126.10	0.09	7.63				0.31		
Taylor Brook DS	14-06-2019	15.0	88.1	8.86	107.25	0.08	7.93				0.00		
Salmon Creek US	14-06-2019	13.4	77.7	8.15	232.70	0.17	7.63				0.08		
Salmon Creek DS	14-06-2019	13.2	89.5	9.37	279.50	0.21	7.94				0.00		
Newsman Brook US	17-06-2019	14.0	97.1	10.00	193.05	0.14	8.04				0.00		
Newsman Brook DS	17-06-2019	16.3	90.6	8.71	5751	3.12	7.23				64.00		
Caledonia US	17-06-2019	12.8	95.7	10.12	242.45	0.18	8.08				0.00		
Caledonia DS	17-06-2019	12.6	102.8	10.89	650.9	0.32	8.33				0.00		
Crescent Lake	14-06-2019	18.4	81.0	7.60	202.15	0.16	8.10				0.00		
Hazen Creek Upstream	24-06-2019	18.1	123.6	11.58	3984	2.12	8.04			0.04	8.60	0.4	78
Hazen Creek 2/Expansion	24-06-2019	12.6	101.4	10.83	197.4	0.09	7.63			0	0.03	0.2	64
Inner Harbour	26-06-2019	14.3	87.0	8.13	21699	13.13	7.87			0.02	10.49	1.2	180
Mill Creek	27-06-2019	16.3	92	8.97	115.05	0.08	7.79			0.02	0.00	0.2	TNTC
Spruce Lake Stream	27-06-2019	13.3	93.1	9.74	78.65	0.06	7.51			0.06	26.32	1.1	TNTC
Spruce Lake Stream US	27-06-2019	13.2	99.0	10.31	52.65	0.04	7.65			0.04	4.95	0.3	240
Manawagonish Creek DS	27-06-2019	13.8	78.7	8.13	334.8	0.16	7.54			0.04	18.31	0.4	40
Manawagonish Creek US	27-06-2019	13.9	84.9	8.75	269.1	0.20	7.50			0.04	10.66	0.6	TNTC
Dominion Park	27-06-2019	17.6	96.4	8.86	60.73	3.32	7.48			0.02	0.00	0.1	TNTC
Fairweather Brook	02-07-2019	16.5	90.4	8.80	92.35	0.07	7.96			0.04	0.00	0.1	240
Taylor Brook US	02-07-2019	16.9	94.4	9.12	187.5	0.09	7.57			0.00	2.93	0.1	280
Taylor Brook DS	02-07-2019	16.2	96.0	9.39	182.3	0.09	7.83			0.02	0.00	0.2	250
Salmon Creek US	02-07-2019	15.2	90.8	9.11	339.3	0.16	7.60			0.06	0.00	0.0	320

Salmon Creek DS	02-07-2019	15.4	96.7	9.61	474.3	0.23	7.96			0.00	0.00	0.1	220
Newsman Brook US	04-07-2019	18.2	98.7	9.30	307.6	0.15	8.00			0.00	0.00	0.1	300
Newsman Brook DS	04-07-2019	20.5	109.5	9.56	9315.0	5.22	7.25			0.00	23.66	2.2	TNTC
Caledonia US	04-07-2019	15.7	96.7	9.59	385.2	0.19	8.01			0.00	0.00	1.1	240
Caledonia DS	04-07-2019	16.4	105.5	10.16	630.0	0.31	8.27			0.00	0.00	0.3	TNTC
Crescent Lake	04-07-2019	21.5	105.2	9.16	316.9	0.15	8.11			0.00	0.00	0.2	20
Hazen Creek Upstream	09-07-2019	19.1	109.0	9.41	19806	11.84	7.96	0.12	0.01	0.04	0.26	0.2	TNTC
Hazen Creek 2/Expansion	09-07-2019	14.3	95.7	9.55	161.85	0.12	7.86	0.08	0.00	0.0	0.00	1.1	260
Inner Harbour	11-07-2019	14.8	106.0	9.45	29711	18.39	7.87	0.12	0.00	0.02	0.00	0.8	295
Mill Creek	19-07-2019	20.5	76.6	6.95	212.55	0.16	7.78		0.00	0.00	0.00	0.0	46
Spruce Lake Stream	19-07-2019	19.5	98.3	9.00	819.00	0.58	7.98	0.06	0.00	0.02	0.00	0.3	600
Spruce Lake Stream US	19-07-2019	15.7	91.2	8.81	147.00	0.07	8.02	0.00	0.00	0.00	0.00	0.1	56
Manawagonish Creek DS	18-07-2019	15.0	92.6	9.27	639.00	0.31	7.52	0.20	0.00	0.05	2.81	0.2	39
Manawagonish Creek US	18-07-2019	14.3	88.0	8.98	491.00	0.24	7.65	0.15	0.00	0.07	0.00	0.1	123
Dominion Park	19-07-2019	20.9	103.1	8.96	8697.00	4.87	8.27	0.00	0.00	0.00	0.00	0.2	TNTC
Fairweather Brook	17-07-2019	24.4	85.2	7.74	111.15	0.08	7.52	0.00	0.00	0.02	0.00	0.1	75
Taylor Brook US	17-07-2019	20.8	91.0	8.17	144.95	0.11	7.5	0.00	0.00	0.00	0.00	0.0	14
Taylor Brook DS	17-07-2019	19.5	118.0	10.82	211.90	0.10	7.67	0.00	0.00	0.00	0.00	0.1	30
Salmon Creek US	17-07-2019	17.9	103.1	9.74	452.40	0.22	7.43	0.00	0.00	0.00	0.00	0.0	190
Salmon Creek DS	17-07-2019	17.5	105.0	10.17	593.00	0.29	7.61	0.06	0.00	0.02	0.00	0.1	255
Newsman Brook US	19-07-2019	16.6	92.2	8.96	340.50	0.16	8.03	0.00	0.00	0.00	0.00	0.1	TNTC
Newsman Brook DS	19-07-2019	15.7	36.6	3.39	12032.00	7.72	6.97	0.70	0.01	0.18	20.00	0.7	4550
Caledonia US	18-07-2019	17.4	91.3	8.30	437.50	0.21	8.09	0.09	0.00	0.02	0.00	0.1	975
Caledonia DS	18-07-2019	15.0	88.8	8.75	774.00	0.38	8.26	0.06	0.00	0.05	0.00	0.1	12500
Crescent Lake	18-07-2019	22.2	70.0	5.91	332.90	0.16	7.87	0.18	0.01	0.02	0.00	0.1	110
Hazen Creek Upstream	23-07-2019	17.1	78.0	7.42	2060.50	1.66	7.92	0.06	0.00	0.11	4.99	0.5	21
Hazen Creek 2/Expansion	23-07-2019	14.1	86.5	8.88	107.25	0.08	7.61	0.08	0.00	0.08	0.00	0.1	94
Inner Harbour	24-07-2019	16.50	95.00	8.39	29554.00	18.56	7.86	0.03	0.00	0.04	4.91	0.6	175
Mill Creek	29-07-2019	23.90	79.10	6.55	276.25	0.20	7.67		0.00	0.02	0.00	0.2	10
Spruce Lake Stream	29-07-2019	24.6	127.9	11.25	455.00	0.39	8.94	0	0.00	0.02	0.03	0.0	560

Spruce Lake Stream US	29-07-2019	19.4	88.2	8.1	170.1	0.08	7.60	0.00	0.00	0.00	0.00	0.2	41
Manawagonish Creek DS	29-07-2019	16.9	111.0	10.72	682.00	0.23	7.56	0.03	0.00	0.02	2.66	0.1	177
Manawagonish Creek US	29-07-2019	16.4	99.0	8.19	509.00	0.25	7.45	0.09	0.00	0.02	0.00	0.3	98
Dominion Park	29-07-2019	21.3	101.7	8.54	15753	9.23	8.20	0.00	0.00	0.02	0.00	0.1	10
Fairweather Brook	31-07-2019	23.0	89.8	7.70	185.8	0.09	7.91	0.00	0.00	0.00	0.00	0.0	44
Taylor Brook US	31-07-2019	24.6	90.3	7.48	247.0	0.12	7.92	0.00	0.00	0.00	0.00	0.2	2
Taylor Brook DS	31-07-2019	22.8	92.8	7.97	253.0	0.12	7.70	0.03	0.00	0.00	0.00	0.1	40
Salmon Creek US	31-07-2019	19.0	90.1	8.33	453.7	0.24	7.43	0.00	0.00	0.23	0.00	0.0	125
Salmon Creek DS	31-07-2019	20.4	93.4	8.42	728.0	0.36	7.85	0.00	0.00	0.23	0.00	0.2	300
Newsman Brook US	30-07-2019	20.3	89.1	8.06	334.00	0.12	8.04	0.03	0.00	0.02	0.00	0.4	525
Newsman Brook DS	30-07-2019	19.6	97.8	8.72	10000	5.64	7.18	0.46	0.01	0.02	14.15	0.6	460
Caledonia US	30-07-2019	18.4	103.6	9.71	489.3	0.24	7.88	0.06	0.00	0.00	0.00	0.1	850
Caledonia DS	30-07-2019	17.6	99.6	9.47	797.00	0.39	7.97	0.03	0.00	0.02	0.00	0.1	820
Crescent Lake	30-07-2019	24.3	71.0	5.82	241.8	0.18	7.81	0.03	0.00	0.02	0.00	0.1	0
Mispec River DS	02-08-2019	15.7	98.8	9.55	48.6	0.02	7.9	0.03	0.00	0.02	0.00	0.6	20
Hazen Creek Upstream	07-08-2019	21.7	81.6	6.75	20026	19.17	7.57	0.12	0.00	0.08	8.00	0.8	25
Hazen Creek 2/Expansion	07-08-2019	14.7	81.7	8.29	301.6	0.22	7.6	0.06	0.00	0.04	0.00	0.0	300
Inner Harbour	08-08-2019	15.1	116.8	9.99	130226	25.78	7.88	0	0.00	0.02	22.02	4.1	70
Mill Creek	08-08-2019	20.7	96.4	8.25	6097	5.27	7.94	0.06	0.00	0.00	0.00	0.2	14
Spruce Lake Stream	13-08-2019	24.80	104.80	8.50	4244.00	3.63	7.88	0.00	0.00	0.04	0.00	0.1	1150
Spruce Lake Stream US	13-08-2019	19.00	85.90	7.85	198.20	0.09	7.56	0.00	0.00	0.04	0.00	0.1	110
Manawagonish Creek DS	13-08-2019	18.50	85.70	8.01	475.20	0.23	7.52	0.03	0.00	0.06	0.56	0.0	2000
Manawagonish Creek US	13-08-2019	16.90	77.00	7.51	369.20	0.28	7.46	0.03	0.00	0.06	0.00	0.2	592
Dominion Park	13-08-2019	22.40	93.50	7.55	20154.00	12.04	8.17	0.00	0.00	0.04	0.00	0.1	65
Fairweather Brook	14-08-2019	20.50	87.50	7.90	196.00	0.09	7.69	0.00	0.00	0.04	0.00	0.1	26
Taylor Brook US	14-08-2019	22.60	81.00	7.01	259.50	0.12	7.67	0.00	0.00	0.04	0.00	0.2	28
Taylor Brook DS	14-08-2019	20.60	90.40	8.11	267.50	0.13	7.64	0.00	0.00	0.04	0.00	0.4	368
Salmon Creek US	14-08-2019	16.40	82.80	8.06	589.40	0.29	7.34	0.00	0.00	0.04	0.00	0.3	120
Salmon Creek DS	14-08-2019	19.00	81.00	7.53	639.00	0.31	7.83	0.00	0.00	0.04	0.00	8.9	130
Newsman Brook US	15-08-2019	21.30	82.00	7.22	427.10	0.21	7.92	0.00	0.00	0.02	0.00	0.1	20

Newsman Brook DS	15-08-2019	23.10	118.60	9.53	19761.00	11.66	7.03	0.00	0.00	0.04	0.40	0.0	40
Caledonia US	15-08-2019	24.50	939.10	11.32	547.00	0.26	8.27	0.00	0.00	0.02	0.00	0.0	120
Caledonia DS	15-08-2019	17.40	88.00	8.41	838.00	0.41	7.96	0.00	0.00	0.02	0.00	0.3	182
Crescent Lake	15-08-2019	24.60	75.80	6.33	383.20	0.18	8.04	0.00	0.00	0.00	0.00	0.1	0
Hazen Creek Upstream	21-08-2019	19.5	110.3	9.64	13702	8.00	7.85	0.06	0.00	0.02	0.00	7.2	276
Hazen Creek 2/Expansion	21-08-2019	14.5	94.6	9.62	346.7	0.17	7.41	0.03	0.00	0.02	0.00	0.2	150
Inner Harbour	22-08-2019	15.2	95.1	8.23	24823	4.29	7.65	0.00	0.00	0.02	0.00	0.1	15
Mill Creek	22-08-2019	21.0	79.3	7.13	455	0.34	7.36	0.00	0.00	0.02	0.00	0.5	74
Hazen Creek Upstream	06-09-2019	18.4	122	11.03	10657	6.07	7.94				4.17		
Hazen Creek 2/Expansion	05-09-2019	13.1	99	10.41	282.5	0.14	8.12				0		
Inner Harbour	05-09-2019	13.9	103.2	8.85	42517	27.27	7.88				2.36		
Mill Creek	05-09-2019	17.8	94.7	8.38	20775	12.51	7.97				0		
Hazen Creek Upstream	02-10-2019	12.9	80.6	7.52	29778	18.48	7.28				8.88		
Hazen Creek 2/Expansion	02-10-2019	10.9	89.6	9.79	352	0.17	7.93				0		
Inner Harbour	03-10-2019	13.5	87.3	8.02	32571	20.37	8.12				4.95		
Mill Creek	03-10-2019	11.8	87.5	9.27	5216	2.82	8.41				0		

Appendix 3: Number of fish species caught durning fish community monitoring in 2019.

Table 5: Total number of fish recorded per species caught using the beach seine from May to October, 2019.

Common Name	Total
Atlantic silverside	7,366
Sand shrimp	5,010
Threespine stickleback	1,928
Banded killifish	586
Blackspotted stickleback	110
Rainbow smelt	106
Winter flounder	81
Atlantic tomcod	34
Pinaeid *sp.*	32
Mummichog	24
Alosa sp.	14
Fourspine stickleback	7
Pollock	6
Killifish	5
Ninespine stickleback	3
Lake chub	2
Northern pipefish	2
White hake	2
Grubby	1
Haddock	1
Shorthorn sculpin	1

Table 6: Total number of fish recorded per species caught in the Fyke net from May to October, 2019.

Common Name	Total
Atlantic tomcod	387
Sand shrimp	33
Rainbow smelt	31
Winter flounder	17
American eel	12
Threespine stickleback	8
White hake	8
White sucker	8
Pollock	7
Mummichog	6
Alosa *sp.*	5
Golden shiner	2
White perch	2
Atlantic Rock crab	1
Cancer *sp.*	1
Jonah crab	1
Northern crayfish	1

ACAP SAINT JOHN

Founded in 1992, ACAP Saint John is a community-based, non-profit organization that encourages communication, partnership and active involvement from all sectors of the community in managing the environment.

At its heart, ACAP has always been an environmental incubator, one that transforms and evolves our region's landscapes with the help of governments, companies and community collaborators. Our work is designed to be seen, felt and experienced throughout the environment – from our wetlands and coastlines to our streets and public spaces.

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