Improving Water Quality in the Shediac and Scoudouc Rivers

Final Report

By:

The Shediac Bay Watershed Association Inc.

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Contributors:

Jolyne Hébert

Rémi Donelle

Ryan Leblanc

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1. INTRODUCTION

The primary mandate of the Shediac Bay Watershed Association is the protection and enhancement of water quality as well as increase public awareness of environmental issues. Since the implementation of the water classification program in 1999, the SBWA has conducted a water quality monitoring program for surface water in the Shediac and Scoudouc rivers. The program has evolved and improved during the last 20 years. To better understand the suitability for fish habitat, water temperature loggers have been installed in different areas of the watershed since 2016.

A long-term water monitoring program allows the association and government agencies to detect changes or trends in water quality data. This information is used to prioritize areas that require restoration work or more in-depth investigations. Stream surveys are undertaken to determine specific restoration projects when needed.

Each year, actions are done to help improve riparian habitat based on the information gathered from monitoring and stream surveys. Stream banks are stabilized and reforested to help improve water quality. In 2019, we worked to reduce stream bank erosion in two areas of the watershed. Stream clean-ups are also regularly undertaken with the help of the summer students.

Education is an important part of the mandate of the Association and we will continue to work with local schools and residents to educate on the importance of a healthy watershed.

This report will highlight the monitoring results and actions that have been undertaken in 2019.

1.1 Overview of the Shediac Bay Watershed

The Shediac Bay watershed covers 420 km^2 of land area and stretches along 36 km of coastline, from Cap Bimet to Cap de Cocagne (Fig. 1). The Shediac Bay watershed is composed of two major river systems emptying into Shediac Bay: the Shediac River and the Scoudouc River. The Shediac and the Scoudouc Rivers are characterized by dendritic patterns of small tributaries covering a watershed of 201.8 and 143.3 km^2, respectively. The Shediac River is composed of two major water arms. The northern water arm is created by the convergence of the McQuade Brook, the Weisner and the Calhoun Brook. The southern large water arm of the Shediac River is the continuation of the Batemans Brook. Water velocity in both rivers is generally weak due to the gentle regional elevation. The watershed boundaries stretch into both Kent and Westmorland County and cross into both Shediac and Moncton.

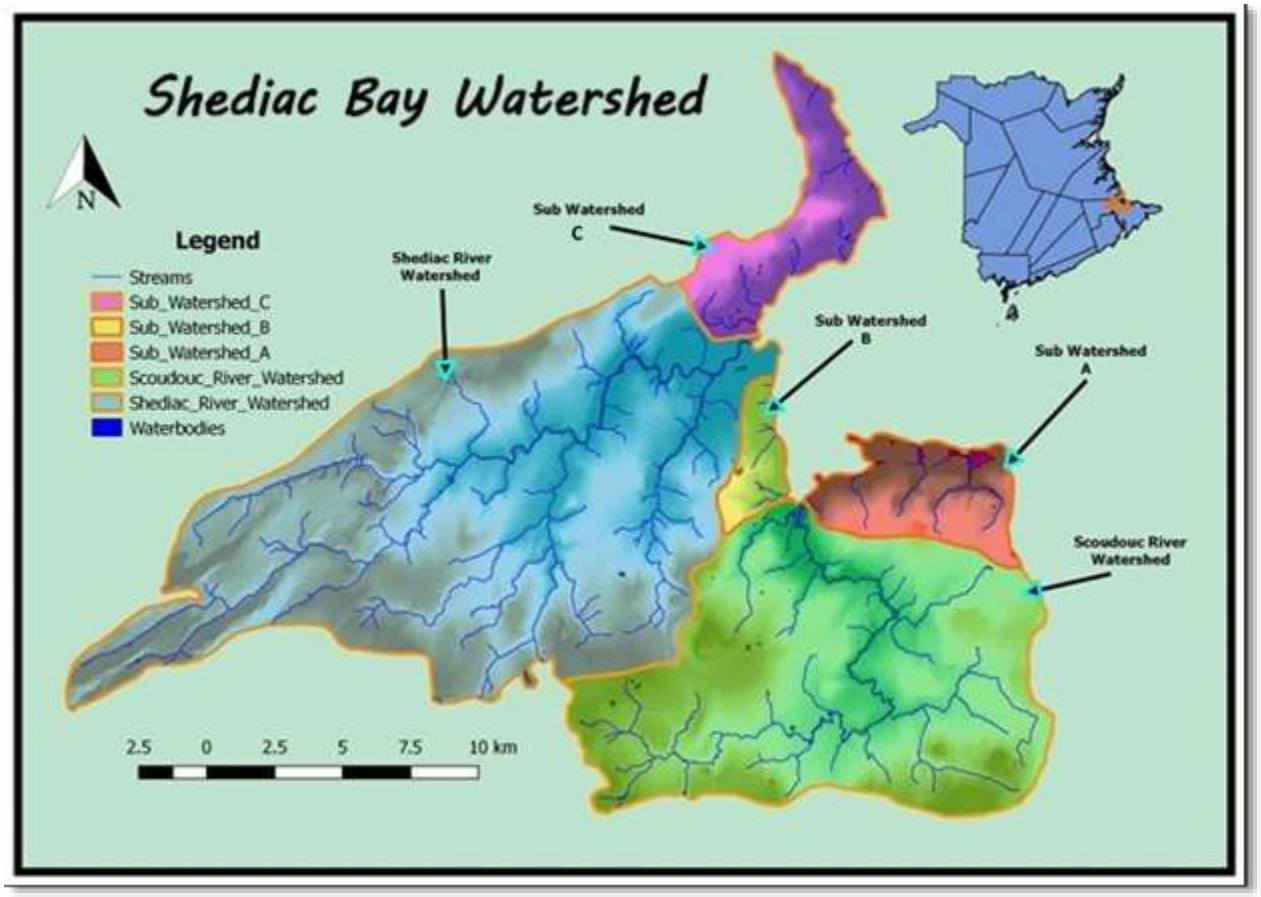


Figure 1: Map of Shediac Bay watershed boundaries and sub-watersheds

2. METHODOLOGY

2.1 Water Quality Sampling

Water quality monitoring was conducted once a month from June to September 2019, at 10 sampling stations in the major rivers and tributaries of the Shediac Bay watershed. Water quality sampling was performed using the protocol developed by the New Brunswick Department of Environment. Water samples were not collected after heavy rainfall events.

Basic water quality parameters (DO, temperature, pH, conductivity and salinity) were measured using a new YSI- *Professional Plus* multi-parameter metre. Water samples were sent to *RPC Laboratory* for analysis of *E.coli* and inorganic elements.

The equipment needed to conduct the sampling and collect the habitat data includes; laboratory issued sample bottles, labels, latex or nitrile gloves, clipboard, waterproof paper for field sheets, pencils, waders or rubber boots, GPS, digital camera, YSI (water conditioning metre), metre stick and survey measuring tape.

2.2 Site Information – Water Classification Stations

The following describes the sample site information for the 10 water classification monitoring stations established in 1999.

Table 1: Water Quality Monitoring Site Information

Site ID	Latitude	Longitude	Elevation (m) Google Earth	Location Description
Shd A	N46°12'13.42"	W64°47'53.01"	83	On route 115, Irishtown Rd, in between junction with Ammon Rd and Scotch Settlement Rd, just upstream of culvert
Shd B	N46°13'55.17"	W64°44'35.81"	27	On Scotch Settlement Rd, North of junction with MacLean Crossroad Rd, just upstream of culvert
Shd C	N46°12'33.10"	W64°44'33.24"	27	On Cape Breton Rd, at junction with McLean Crossroad Rd, just upstream from bridge and downstream from tributary
Shd E	N46°14'43.24"	W64°39'52.21"	7	At the covered bridge of the Shediac River, upstream from covered bridge
Shd G	N46°12'53.56"	W64°40'29.74"	13	Weisner Brook, at bridge on St-Philippe Rd, upstream from bridge
Shd H	N46°13'50.95"	W64°37'15.89"	11	Bateman Brook, on Bateman's Mill Road, approx. 10 m upstream from bridge
Scd B	N46° 8'42.74"	W64°33'51.55"	24	Scoudouc River, downstream from bridge on Route 132, next to *Waggin' Tail Inn* and Dionne road
***Scd E-2**	N46° 9'57.12"	W64°31'58.13"	11	Scoudouc River, at 156 Scoudouc River Rd, take trail between garage and field, access is marked down the field
Scd F	N46°10'50.52"	W64°30'17.78"	13	Unnamed tributaries of the Scoudouc River, on Pellerin Rd
****Scd H**	N46°12'12.32"	W64°34'55.49"	17	Cornwall Brook, take Harbour view drive, after Chevy Dealership to end of road then first left through field

*ScdE-2 formerly known as ScdE

**ScdH formerly known as ScdG

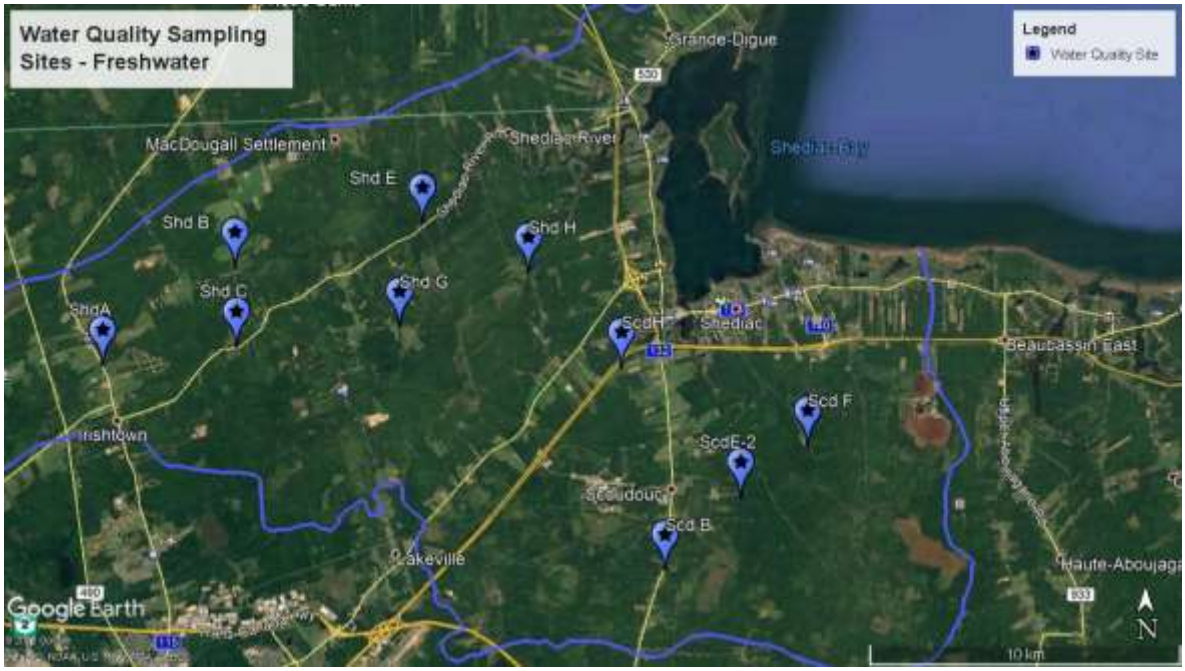


Figure 2: Water Quality Sampling Sites – Water Classification Stations

2.3 Water Quality Parameters

The water quality monitoring program analyses many chemical and physical parameters to assess the overall water quality for the protection of aquatic life. Although all results are presented in the report, only a few key parameters will be discussed in the report, as some of these were above the recommended guidelines or they are of greater significance to the assessment of the overall water quality.

2.3.1 Water Temperature

Water temperature can fluctuate depending on the period of the day and during seasonal changes. Values are influenced by numerous factors such as the tree canopy providing shade, water velocity and depths, presence of cold springs, etc. It is considered that water above 25 or 29 degrees Celsius ($^{\circ}$C) tends to be of poor quality because less oxygen can be dissolved. Therefore, water temperature directly influences the dissolved oxygen levels. Water temperatures above 22 $^{\circ}$C is said to cause thermal stress to salmonid populations, causing them to stop feeding and search for thermal refugia.

2.3.2 Potential Hydrogen (pH)

The potential hydrogen (pH) level indicates if the water is acidity or basic. It affects how much other substances, such as metals, dissolve in the water. In facts, the pH affects the solubility and toxicity of chemicals and heavy metals in water. Many aquatic organisms are sensitive to changes in pH and may be adversely affected by the pH that is either too high or too low. The pH varies naturally depending on bedrock, climate and vegetation cover, but may also be affected by industrial or other effluents, the exposure of some type of rock (for example during road construction) or drainage from mining operations. According to the CCME's Canadian water quality guidelines, pH should be between 6.5 and 9, as pH levels move away from this range it can stress animal systems and reduce hatching and survival rates in the stream.

2.3.3 Dissolved Oxygen

Dissolved oxygen (DO) represents the concentration of oxygen in gaseous form in the dissolved in the water column. Most of the oxygen in the water comes from the surface atmosphere and is mixed in the water by turbulence and current. The measurement of the concentration of dissolved oxygen in surface waters is essential for measuring changes in water condition and evaluating water quality. It has a direct effect on aquatic life and can be influenced by stream habitat alteration. DO is essential for the survival of fish and many other forms of aquatic life. The temperature limits the amount of oxygen that can dissolve in water, dissolved oxygen varies with temperature and tends to be lower when the water temperature is high. However, temperature is not the only cause of low-oxygen, too many bacteria and an excess amount of biological oxygen demand from the oxygen consumption used by the microorganisms (aerobic bacteria) in the oxidation of organic matter also affects the dissolved oxygen concentrations. According to the Canadian Council of Ministers of the Environment (CCME) Canadian water quality guidelines,

the lowest acceptable DO concentration for aquatic life in cold water is 9.5 mg/l for early life stages and 6.5 mg/l for other life stages.

2.3.4 Conductivity

Conductivity is the measurement of the ability of water to pass an electrical current. It is affected by the amount of inorganic dissolved solids (nitrate, chloride, sulfate, sodium, etc.) found in the water. The conductivity level may be influenced by rainwater, agricultural or urban runoff and the geology of the area. There are no set criteria for conductivity levels for water quality, but the US Environmental Protection Agency states that stream conductivity levels ranging between 0.15 and 0.5 mS/cm usually seem to support a good mixed fisheries. Consequently, a higher conductivity level may indicate a higher amount of dissolved material in the water and the presence of contaminants.

2.3.5 Nitrate-Nitrogen

Nitrogen is essential for plant growth, but the presence of excessive amounts in water presents a major pollution problem. Nitrogen compounds may enter water as nitrates or be converted to nitrates from agricultural fertilizers, sewage, industrial and packing house wastes, drainage from livestock feeding areas, farm manures and legumes. The acceptable amount of Nitrate-nitrogen for the protection of aquatic life in freshwater is set at 2.9 mg/l (NO3).

2.3.6 Phosphates

Phosphates exist in different forms: orthophosphate, metaphosphate and organically compound contains phosphorus. These forms of phosphate occur in living and decomposing plants and animals, as free ions, chemically bonded in aqueous system or mineralized compounds in sediments, soils and rocks. Large amount of phosphate coming from cleaning products (detergents), run off from agricultural and residential fertilizer components can lead to eutrophication. Soil erosion is a major contributor of phosphorus to stream. It is recommended by Environment Canada to apply the Canadian Framework for phosphorus. Trigger ranges are based on the range of phosphorus concentrations in water that define the reference trophic status for a site. Measured phosphorus concentrations should not exceed predefined trigger ranges and should not increase more than 50% over baseline (reference) levels. Total phosphorus levels should be under 0.025 mg/L to maintain its unaffected trophic state.

2.3.7 Escherichia Coli

Escherichia coli (*E. coli*) is one of many species of bacteria living in the lower intestines of mammals. The presence of *E. coli* in water is a common indicator of fecal contamination. The acceptable count of E.coli in water is set at 400 MPN/100 ml.

2.3.8 Aluminum

A high concentration of aluminum, due to non-point sources such as rain and snowmelt leaching from watershed soils, can pose a risk to fish in freshwater habitats. For example, ionoregulatory and osmoregulatory complications can develop in fish where aluminum concentrations exceed the CCME recommended guideline of 5 $\mu g \bullet L^{-1}$ when the pH is less than 6.5, and 100 $\mu g \bullet L^{-1}$ when the pH is greater than or equal to 6.5. Furthermore, respiratory problems can occur due to the precipitation of aluminum on the gills, as the positively charged aluminum ion (Al^{3+}) binds with the negatively charged epithelium of the gill.

Many of Atlantic Canada's freshwater habitats naturally contain aluminum concentrations that often exceed CCME guidelines for the protection of aquatic wildlife; however, various fish species are abundant in New Brunswick's rivers. This increased amount of aluminum and other metals is often accompanied by runoff organic carbon due to Atlantic Canada's relatively flat topography and impermeability (Dennis & Clair, 2012). The organic carbon possesses a negatively charged carboxylic functional group, which attracts and binds with the positively charged dissolved aluminum ion. This neutralizes the aluminum ion, rendering it inert and therefore unable to bind with the negatively charged epithelium of the fish gill. Despite this, aluminum ion levels in Atlantic Canada can still reach levels dangerous to fish (Dennis & Clair, 2012).

2.3.9 Iron

Iron enters freshwater habitats in a similar manner to aluminum. Rain and snowmelt leach iron from rocks and watershed soils, and the runoff enters rivers and streams. Anthropogenic sources, such as wastewater and storm water discharges, are also non-point sources of iron in freshwater habitats. A high concentration of iron may cause physiological and/or morphological changes in aquatic plant species (Xing & Liu, 2011).

2.3.10 Copper

Because copper is an essential metal, aquatic organisms have developed methods of copper regulation in the body. Despite this, however, copper toxicity is still possible at high concentrations.

2.3.11 Lead

In many cases, the factors that influence the toxicity of xenobiotic substances have been identified. For example, relationships between water hardness and acute toxicity to fish have been established for several metals (e.g., cadmium, copper, lead, nickel, and zinc; CCREM 1987; Nagpal 1997).

In the case of Lead, the guidelines for the protection of aquatic life is as follows: when the hardness ($CaCO_3$) ranges from 0-60 mg/L, the limit is set at 1 μg/L, from 60-120 mg/L the limit is 2 μg/L, from 120-180 mg/L the limit is 4 μg/L, and when the hardness is higher than 180 mg/L the limit is 7 μg/L.

The combination of low dissolved oxygen and toxic chemicals may lead to stress responses in aquatic organisms. The toxicities of zinc, lead, copper, pentachlorophenol, cyanide, hydrogen sulphide and ammonia are enhanced by low dissolved oxygen. Dissolved metals may be removed from the water column by adsorption, precipitation, and co-precipitation processes. Lead, for example, is strongly adsorbed to particles and can be removed from the water column and concentrated in sediments (Canadian Council of Ministers of the Environment, 2008)

2.4 CCME - Canadian Environmental Quality Guidelines (CEQGs)

Table 2: Summary of the CCME Canadian Environmental Quality Guidelines

CCME RECOMMENDED GUIDELINES FOR THE PROTECTION OF AQUATIC LIFE (FRESHWATER) SUMMARY						
Parameter	Condition	Value (mg/L)	Condition	Value (mg/L)	Equation Between Conditions	Notes
Ag	—	—	Long-Term	**0.00025**	—	The following parameters did not have CCME recommended guidelines for the protection of aquatic life and were therefore omitted from the table:
Al	pH<6.5	**0.005**	pH≥6.5	**0.1**	—	
As	—	—	Upper	**0.005**	—	
B	Short-Term	**29**	Long-Term	**1.5**	—	
Cd (Short-Term)	HARD<5.3	**0.00011**	HARD>360	**0.0077**	10^(1.016*LOG(HARD)-1.71)	
Cd (Long-Term)	HARD<17	**0.00004**	HARD>280	**0.00037**	10^(0.83*LOG(HARD)-2.46)	
Cl	Short-Term	**640**	Long-Term	**120**	—	
CLRA	Narrative; refer to CCME website for more information.				—	
Cu	HARD<82	**0.002**	HARD>180	**0.004**	0.2*EXP(0.8545*LN(HARD)-1.465)	
DO (warm) †	Early	**6**	Other	**5.5**	—	
DO (cold)	Early	9.5	Other	**6.5**	—	
E-coli ‡	—	—	Upper	**400** MPN/100mL	—	
Fe	—	—	Upper	**0.3**	—	
Mo	—	—	Upper	**0.073**	—	
NH3_T	Table; refer to CCME website for more information.				—	
NH3_Un	—	—	Long-Term	**0.019**	—	
Ni	HARD≤60	**0.025**	HARD>180	**0.15**	EXP(0.76*LN(HARD)+1.06)	
NO2	—	—	Upper	**0.197**	—	
NO3	Short-Term	**124**	Long-Term	**2.9**	—	
Pb	HARD≤60	**0.001**	HARD>180	**0.007**	EXP(1.273*LN(HARD)-4.705)	
pH	Lower L-T	**6.5**	Upper L-T	**9**	—	
Se	—	—	Upper	**0.001**	—	
Tl	—	—	Upper	**0.008**	—	
U	Short-Term	**0.033**	Long-Term	**0.015**	—	
Zn	—	—	Upper	**0.03**	—	

ALK_T	Ba	Be	HCO3	
Bi	Br	Ca	CO3	
Co	COND	Cr	F	
HARD	K	Lang_Ind (20°C)		
Li	Mg	Mn	Na	
NOX	Rb	pH (Sat)	Sb	
Sn	SO4	Sr	TDS	
Te	TKN	TOC	TP-L	
TURB	V			

† The guideline for dissolved oxygen is separated into warm water biota, early life stages; warm water biota, other life stages; cold water biota, early life stages; and cold water biota, other life stages.

‡ There is no limit for the protection of aquatic wildlife. The limit of 400 MPN/100mL for the protection of environmental and human health is used instead.

2.5 Health Canada - Guidelines for Canadian Recreational Water Quality

Table 3: Guidelines for Health Canada Recreational Water Quality: Summary Table

Guidelines for Health Canada Recreational Water Quality		
Parameter	Considerations	Guideline
Escherichia coli (Primary-Contact Recreation)*	Geometric mean concentration (minimum 5 samples)	≤ 200 *E. coli* /100 mL
	Single sample maximum concentration	≤ 400 *E. coli* /100 mL
Enterococci (Primary-Contact Recreation)*	Geometric mean concentration (minimum 5 samples)	≤ 35 Enterococci /100 mL
	Single sample maximum concentration	≤ 70 Enterococci /100 mL
*Advice regarding waters intended for secondary-contact recreational activities is provided in Section 4.2. of the *Guidelines for Canadian Recreational Water Quality: Third Edition*		
https://www.canada.ca/content/dam/canada/health-canada/migration/healthy-canadians/publications/healthy-living-vie-saine/water-recreational-recreative-eau/alt/pdf/water-recreational-recreative-eau-eng.pdf		

2.6 CCME Recommendation Guidelines for the Protection of Aquatic Life (Freshwater)

Table 4: CCME Recommendation Guidelines for the Protection of Aquatic Life (Freshwater)

CCME RECOMMENDED GUIDELINES FOR THE PROTECTION OF AQUATIC LIFE (FRESHWATER) SUMMARY OF OTHER PARAMETERS					
Parameter	Description	Value	Units	Notes	
Dissolved O_{2} †	Early life stages, cold water biota†	9.5	mg/L	†	The guidelines for the lowest acceptable dissolved oxygen concentrations are divided into four different categories to accommodate the wide range of tolerances exhibited by freshwater species at various life stages, and with warmer or colder temperature preferences.
	Other life stages, cold water biota	6.5	mg/L		
	Early life stages, warm water biota	6	mg/L		
	Other life stages, warm water biota	5.5	mg/L		
pH	Lower long-term limit	6.5	—	‡	There is no limit for the protection of aquatic wildlife for E. coli. The limit of 400 MPN/100 mL for the protection of environmental and human health is used instead.
	Upper long-term limit	9	—		
E. coli ‡	Upper limit	400	MPN/100 mL		

2.7 CCME Guidance framework for Phosphorus

Table 5: CCME Guidance framework for Phosphorus

CCME Guidance Framework for Total Phosphorus (TP-L)					
Parameter	Description	Value	Units	Notes	
TP-L*	Hyper-eutrophic	>0.100	mg/L	†	The CCME recommended guidelines for the protection of aquatic wildlife (freshwater) indicates the concentrations of total phosphorus at which each condition may occur. This does not suggest that a stream with hyper-eutrophic levels of total phosphorus will necessarily exhibit hyper-eutrophic properties, for example.
	Eutrophic	0.035 - 0.100	mg/L		
	Meso-eutrophic	0.020 - 0.035	mg/L		
	Mesotrophic	0.010 - 0.020	mg/L		
	Oligotrophic	0.004 - 0.010	mg/L		
	Ultra-oligotrophic	> 0.004	mg/L	*	Total phosphorus level

2.8 Terms and Definitions

All data collected during the sampling season has been organized in 3 distinct tables: water chemistry data and *E. coli* results, nutrient results, and inorganics results. The following provides the terms and definitions of the acronyms used in the data tables.

Table 6: Terms and definitions for water chemistry and bacterial data tables

TERMS AND DEFINITIONS FOR FIELD DATA COLLECTED BY YSI AND LABORATORY SAMPLES		
Parameter	Unit	Definition
Temp	°C	Air and water temperature measured in degrees Celsius
SAL	ppt	Salinity measured in parts per thousand
Dissolved O_2	mg/L, %	Dissolved oxygen measured in milligrams per litre and percentage
E. coli	MPN/100mL	Escherichia coli concentration measured in most probable number per 100 millilitres
ALK_T	mg/L	Total alkalinity measured in milligrams per litre
CLRA	TCU	Water colour measured in true colour units
COND	µS/cm	Conductivity measured in microsiemens per centimetre in the field and laboratory
HARD	mg/L	Hardness measured in milligrams per litre
Lang_Ind (20°C)	—	Langlier index at 20 degrees Celsius
pH	—	Potential of hydrogen measured in the field and laboratory, and the saturation pH at 20 degrees Celsius
Sat (20°C)	—	The pH at which water at 20 degrees Celsius is saturated with calcium carbonate
TDS	mg/L	Total dissolved solids measured in milligrams per litre
TURB	NTU	Water turbidity measured in nephelometric turbidity units

Table 7: Terms and definitions for nutrients data tables

TERMS AND DEFINITIONS FOR NUTRIENT DATA					
Parameter	Unit	Definition	Parameter	Unit	Definition
HCO_3	mg/L	Bicarbonate measured in milligrams per litre	NH_3_Un	µg/L	Ammonia unionized at 20°C measured in micrograms per litre
Br	µg/L	Bromine measured in micrograms per litre	NO_2	µg/L	Nitrite measured in micrograms per litre
Ca	mg/L	Calcium measured in milligrams per litre	NO_3	µg/L	Nitrate measured in micrograms per litre
CO_3	µg/L	Carbonate measured in micrograms per litre	NO_X	µg/L	Nitrite + Nitrate measured in micrograms per litre
Cl	mg/L	Chloride measured in milligrams per litre	SO_4	mg/L	Sulphate measured in milligrams per litre
F	µg/L	Fluoride measured in micrograms per litre	TKN	mg/L	Total Kjedhal nitrogen measured in milligrams per litre
K	mg/L	Potassium measured in milligrams per litre	TN	mg/L	Total nitrogen calculated in milligrams per litre
Mg	mg/L	Magnesium measured in milligrams per litre	TOC	mg/L	Total organic carbon measured in milligrams per litre
Na	mg/L	Sodium measured in milligrams per litre	TP-L	µg/L	Total phosphorus measured in micrograms per litre
NH_3I	µg/L	Total ammonia measured in micrograms per litre	—	—	—

Table 8: Terms and definitions for inorganics data tables

TERMS AND DEFINITIONS FOR HEAVY METAL DATA					
Parameter	Unit	Definition	Parameter	Unit	Definition
Al	µg/L	Aluminum measured in micrograms per litre	Mn	µg/L	Manganese measured in micrograms per litre
As	µg/L	Arsenic measured in micrograms per litre	Mo	µg/L	Molybdenum measured in micrograms per litre
B	µg/L	Boron measured in micrograms per litre	Ni	µg/L	Nickel measured in micrograms per litre
Ba	µg/L	Baryium measured in micrograms per litre	Pb	µg/L	Lead measured in micrograms per litre
Cd	µg/L	Cadmium measured in micrograms per litre	Rb	µg/L	Rubidium measured in micrograms per litre
Co	µg/L	Cobalt measured in micrograms per litre	Sb	µg/L	Antimony measured in micrograms per litre
Cr	µg/L	Chromium measured in micrograms per litre	Sr	µg/L	Strontium measured in micrograms per litre
Cu	µg/L	Copper measured in micrograms per litre	U	µg/L	Uranium measured in micrograms per litre
Fe	µg/L	Iron measured in micrograms per litre	V	µg/L	Vanadium measured in micrograms per litre
Li	µg/L	Lithium measured in micrograms per litre	Zn	µg/L	Zinc measured in micrograms per litre

3. SAMPLING RESULTS

The following section contains the results on all the data collected during the water quality monitoring for 2019. All water samples are assigned with a designated field number so that it can be logged into the *Department of Environment and local Government* database.

It was discovered that during the water classification sampling years (1999-2003), the site ScdG was actually located in the higher reaches of the Scoudouc River, just above the Trans-Canada Highway. When the sampling program was restarted in 2005-2006, it is unknown why the station was changed to the Cornwall Brook, but the site code remained the same. Therefore, the station ID was changed to ScdH, and all data taken since 2006 under the site ID ScdG will now be compared to the data under the site name ScdH.

A similar mistake was done in 2005-2006 at the site ScdE; in 1999-2003, the sample was taken approximately 1 km downstream of the current day location. The original ScdE was located under the transmission power lines crossing the Scoudouc River, and was most likely reached using an ATV. In 2005-2006, it is believed that staff found a different way of getting close to the area by contacting landowners and gaining permission of access. Since it is not in the exact location, a decision was taken to rename the site ScdE-2.

3.1 Shediac River – ShdA

This water quality sampling site is located in the main branch of the Shediac River, off Route 115 in Irishtown. The sample is taken upstream of the culvert. The surrounding land uses includes; residential, agricultural fields, farmlands containing cattle, a mineral extraction pit and a golf course. It is important to note that there is intense development of new residential sectors and roads upstream of the sampling site (off NB-490). There has been a lot of changes in the land uses around this site in the last 2-3 years, therefore 2 maps were added to compare the surrounding areas between 2015 and 2017.

The farm fields on both sides of the river are used for the cultivation of hay and as cattle pastures. Intense tree planting was done with the help of the SBWA back in the early 2000s, to increase the buffer zones. There is cattle fencing along the river, but it does allow the cows to cross the river in one area upstream of the sample site. There is a section of the brook, 100 m in length in the cow crossing area, that only has a thin buffer zone (> 10 m) or none at all in some spots.

A new apple orchard field has been established in 2016-2017 less than 200 metres from the sampling site. Approximately 20 hectares was cleared of vegetation for the orchard and possibly for the cultivation of other products. There are no tree buffers that would prevent drainage from these fields from reaching the river when flowing down to NB-115 and following the ditch to the water. Near the top of the parcel of land, trees were cut and land was tilled up to 15 metres from the river. Depending of land elevations and drainage direction, this area may be high risk for the river.

Next to the orchard is another plot of land (20 ha) that was previously used for agriculture and possibly farm animals, but aerial imagery from 2017 demonstrates evidence of the land being sold, possibly for mineral extraction. The fields have been stripped of its vegetation, house and barn, and is now an empty field that contains a road and a gravel/mineral pit at the top of the field. The pit currently takes up 1 hectares of the parcel. The only trees visible are the ones outside of the property lines. These fields are located approximately 700 metres away from the sample site (distance measured along the road), continued monitoring is important to measure whether these activities will have an impact on the Shediac River.

The golf course is located to the right of the river (looking upstream) approximately 500 m away from the sample site (distance measured along the road), and it is unknown if any runoff from this location reaches the site by the ditch along NB-115. One of the cattle fields separate the river and the golf course. The sampling parameters used in this report may not include the detection of certain chemicals present in pesticides that are commonly used in golf courses. It is unknown whether or not the golf courses use pesticides and/or fertilizers on their lawns.

The water sampling results for the site ShdA, for 2019, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen.

Total phosphorus levels for long-term eutrophic conditions, according to the *CCME Guidance framework for Phosphorus*, were in the mesotrophic range (0.010 – 0.020 mg/L) from June to August, and in the eutrophic range (0.035 – 0.100 mg/L) in September.

Concentration results for the nitrate ion (NO3) are below the short term (124 mg/L) and long term (2.9 mg/L) CCME recommendations for direct toxicity to sensitive freshwater life (these guidelines do not consider indirect effects due to eutrophication, nor does this interpret results for assessment of eutrophic conditions).

Aluminum exceeded the guidelines in September (0.177 mg/L), when the recommendation is 100 µg/L when the pH value is ≥ 6.5. Iron also exceeded the guidelines in July (0.37 mg/L) and September (0.32 mg/L), when the recommendation is 0.300 mg/L.

Bacterial levels did not exceed the maximum concentration of *E. coli* from the Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 9: Water chemistry data and *E. coli* results for ShdA, 2019

SITE ShdA: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																	
Date (yy-mm-dd)	Temp (°C)		SAL	DO	E. coli (MPN /100mL)	ALK_T	CLRA	COND (µS/cm)		HARD	Lang_Ind	pH (pH)			TDS (mg/L)		TURB
	Air	Water	(ppt)	(mg/L)		(mg/L)	(TCU)	Field	Lab	(mg/L)	(20°C)	Field	Lab	Sat (20°C)	Field	Lab	(NTU)
19-06-26	17.0	15.1	0.08	10.62	40.2	58	31	0.136	169	62.7	-0.60	7.28	7.7	8.3	109.20	97	2.4
19-07-24	27.0	21.4	0.11	9.45	118.0	85	19	0.220	241	95.2	0.14	7.96	8.1	8	154.05	133	1.5
19-08-21	26.0	20.2	0.11	6.78	39.0	76	16	0.217	240	95.4	-0.11	7.80	7.9	7.9	155.35	129	2.9
19-09-26	15.0	12.7	0.05	12.76	249.0	30	70	0.076	102	34	-1.54	7.13	7.3	8.8	64.35	63	8.1

Table 10: Nutrient results for ShdA, 2019

SITE ShdA: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO3 (mg/L)	Br (mg/L)	Ca (mg/L)	CO3 (mg/L)	Cl (mg/L)	F (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH3T (mg/L)	NH3_Un (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NOX (mg/L)	SO4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (mg/L)
19-06-26	57.7	0.02	19.3	0.272	10.4	0.13	0.65	3.52	6.9	<0.05	<0.001	<0.05	0.570	0.570	12	—	0.8	6.2	0.016
19-07-24	83.9	0.05	30.1	0.993	11.9	0.13	0.75	4.86	7.4	<0.05	<0.001	<0.05	0.680	0.680	19	—	0.8	3.6	0.016
19-08-21	75.4	0.02	30.2	0.563	9.2	0.18	0.86	4.86	7.4	<0.05	<0.001	<0.05	0.760	0.760	23	—	0.8	3.6	0.014
19-09-26	29.9	0.02	10.1	0.056	8.0	0.19	0.80	2.13	5.8	0.300	0.002	<0.25	<0.25	<0.25	6	—	0.5	10.7	0.046

Table 11: Inorganics results for ShdA, 2019

SITE ShdA: HEAVY METALS AND OTHER ELEMENTS																				
Date (yy-mm-dd)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Cd (µm/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Rb (mg/L)	Sb (mg/L)	Sr (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
19-06-26	0.064	<0.001	0.020	0.042	<0.00001	<0.0001	<0.001	<0.001	0.28	0.0014	0.022	0.0014	<0.001	0.0001	0.0007	<0.0001	<0.001	0.0008	<0.001	0.002
19-07-24	0.060	<0.001	0.029	0.055	0.00001	0.0001	<0.001	<0.001	0.32	0.0022	0.062	0.0025	<0.001	0.0002	0.0009	<0.0001	<0.001	0.0016	<0.001	0.003
19-08-21	0.066	<0.001	0.032	0.050	<0.00001	<0.0001	<0.001	<0.001	0.2	0.0022	0.032	0.0026	<0.001	0.0001	0.0011	<0.0001	<0.001	0.0015	<0.001	<0.001
19-09-26	0.177	<0.001	0.013	0.031	<0.00001	0.0001	<0.001	0.001	0.37	0.0008	0.019	0.0006	<0.001	0.0004	0.0007	<0.0001	<0.001	0.0002	<0.001	0.001

Figure 3: ShdA site location and surrounding land uses (imagery view of 2015)

Figure 4: ShdA site location and surrounding land uses (imagery view of 2017)

Figure 5: Site photos for water quality sampling site ShdA, (photos May 2018)

3.2 Shediac River – ShdB

This water quality sampling site is located in the McQuade Brook, off Scotch Settlement Road (175 m after turning right off MacLean Crossroad rd.). The sample is taken upstream of the culvert. The surrounding land uses includes; residences, agricultural fields, cattle farms, and a mineral extraction pit.

Most of the drainage providing from agricultural and cattle fields around the site would flow into other small tributaries of the McQuade Brook, converging at a lower points in the system. The gravel/mineral pit is close to the brook approximately 3 km upstream of the sampling site. There is a buffer zone between the riverbanks and the pit, ranging from 20 m to 100 m or more in density. Further upstream, the watercourse crosses transmission power lines. The McQuade Brook is made up of a lot of small tributaries from around McQuade and Scotch Settlement, which are places with several farms and clear cut lots from past logging activity.

The water sampling results for the site ShdB, for 2019, meet the recommendations for the survival of freshwater aquatic life based on pH. However, levels of dissolved oxygen dropped below the recommendation (6.5 mg/L) for general cold water organisms in August (5.94 mg/L).

Total phosphorus levels for long-term eutrophic conditions, according to the *CCME Guidance framework for Phosphorus*, were: in the oligotrophique range (0.004 – 0.010 mg/L) in June, in the mesotrophic range (0.010 – 0.020 mg/L) in July and August; and in the meso-eutrophic range (0.020 – 0.035 mg/L) in September.

Concentration results for the nitrate ion (NO_3) are below the short term (124 mg/L) and long term (2.9 mg/L) CCME recommendations for direct toxicity to sensitive freshwater life (these guidelines do not consider indirect effects due to eutrophication, nor does this interpret results for assessment of eutrophic conditions).

Concentrations of aluminum exceeded the CCME water quality guideline (0.100 mg/L when the pH is ≥6.5) in the sample taken in September (0.251 mg/L). Iron exceeds the guideline (0.300 mg/L) in each sample except June. The highest iron concentration was in the month of August (0.52 mg/L).

Bacterial levels did exceed the maximum concentration of *E. coli* from Health Canada recreational guideline (≥ 400 MPN/100 mL) for the sample taken in August; 689.5 MPN/100 mL.

Table 12: Water chemistry data and *E. coli* results for ShdB, 2019

SITE ShdB: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL	DO	E. coli (MPN /100mL)	ALK_T	CLRA	COND (µS/cm)		HARD	Lang_Ind	pH (pH)			TDS (mg/L)		TURB
	Air	Water	(ppt)	(mg/L)		(mg/L)	(TCU)	Field	Lab	(mg/L)	(20°C)	Field	Lab	Sat (20°C)	Field	Lab	(NTU)
19-06-26	18.0	14.0	0.05	13.97	52.4	39	51	0.086	111	39.7	-1.06	7.27	7.6	8.7	70.85	64	1.0
19-07-24	27.0	21.3	0.09	9.10	146.0	76	19	0.176	191	67.9	-0.36	7.84	7.8	8.2	122.85	104	0.8
19-08-21	26.0	17.5	0.11	**5.94**	**689.6**	80	17	0.190	223	79.4	-0.28	7.50	7.8	7.8	143.65	115	1.3
19-09-26	14.0	12.4	0.03	11.93	148.0	20	100	0.049	65	21.8	-2.00	6.86	7.2	9.2	41.60	49	4.6

Table 13: Nutrient results for ShdB, 2019

SITE ShdB: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO3 (mg/L)	Br (mg/L)	Ca (mg/L)	CO3 (mg/L)	Cl (mg/L)	F (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH3T (mg/L)	NH3_Un (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NOX (mg/L)	SO4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (mg/L)
19-06-26	38.8	0.03	11.8	0.145	6.3	0.07	0.65	2.48	6.6	<0.05	<0.001	<0.05	<0.05	<0.05	3	—	0.4	8.8	0.009
19-07-24	75.5	0.05	20.5	0.448	11.4	0.13	0.90	4.07	10.7	<0.05	<0.001	<0.05	0.08	0.08	5	—	0.3	4.0	0.012
19-08-21	79.5	0.05	24	0.472	12.9	0.16	1.03	4.72	12.0	<0.05	<0.001	<0.05	0.06	0.06	7	—	0.2	3.5	0.015
19-09-26	20.0	0.02	6.31	0.030	6.0	0.25	0.51	1.47	4.3	<0.25	<0.001	<0.25	<0.25	<0.25	3	—	0.3	14.8	0.034

Table 14: Inorganics results for ShdB, 2019

SITE ShdB: HEAVY METALS AND OTHER ELEMENTS																			
Date (yy-mm-dd)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Cd (µm/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Rb (mg/L)	Sb (mg/L)	Sr (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
19-06-26	0.081	<0.001	0.008	0.049	<0.00001	0.0001	<0.001	<0.001	0.23	0.0007	0.084	0.0005	<0.001	<0.0001	0.0007	<0.0001	<0.001	0.0001	<0.001	0.005
19-07-24	0.044	<0.001	0.010	0.077	<0.00001	0.0002	<0.001	<0.001	0.35	0.0009	0.234	0.0008	<0.001	0.0001	0.0011	<0.0001	<0.001	0.0002	<0.001	0.004
19-08-21	0.037	<0.001	0.014	0.092	<0.00001	0.0002	<0.001	<0.001	0.52	0.0010	0.318	0.0009	<0.001	0.0001	0.0012	<0.0001	<0.001	0.0003	<0.001	<0.001
19-09-26	0.251	<0.001	0.006	0.033	0.00001	0.0001	<0.001	<0.001	0.33	0.0005	0.024	0.0003	<0.001	0.0003	0.0006	<0.0001	<0.001	<0.0001	<0.001	0.001

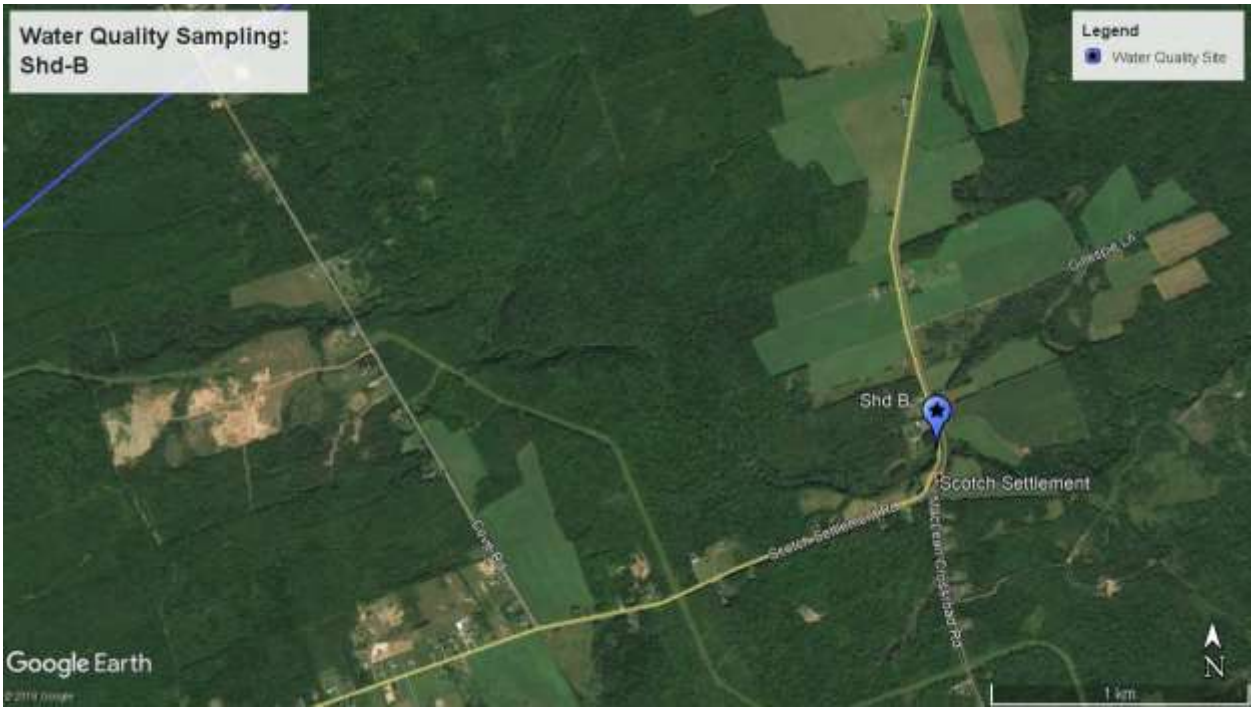


Figure 6: ShdB site location and surrounding land uses

Figure 7: Site photos for water quality sampling site ShdB, (photos May 2018)

3.3 Shediac River - ShdC

This water quality sampling site is located in the main branch of the Shediac River, at the bridge of MacLean Crossroad rd. (at the junction with Shediac River Road/Cape Breton Road). The sample is taken upstream of the bridge. The surrounding land uses is mainly residences and forested land. This site is located over 5.3 km downstream of the site ShdA, and there is little more than houses and cabins in regards to land use in between those two sites. From aerial imagery, there is evidence of an ATV crossing without an appropriate bridge approx. 1.6 km downstream of the site.

The water sampling results for the site ShdC, for 2019, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen.

Total phosphorus levels for long-term eutrophic conditions, according to the CCME Guidance framework for Phosphorus, were in the mesotrophic range (0.010 – 0.020 mg/L) from June to August, and in the eutrophic range (0.035 – 0.100 mg/L) in September.

Concentration results for the nitrate ion (NO3) are below the short term (124 mg/L) and long term (2.9 mg/L) CCME recommendations for direct toxicity to sensitive freshwater life (these

guidelines do not consider indirect effects due to eutrophication, nor does this interpret results for assessment of eutrophic conditions).

Concentrations of aluminum exceeded the CCME water quality guideline (0.100 mg/L when the pH is ≥6.5) in the sample taken in September (0.240 mg/L). Concentrations of iron also exceeded the guidelines in September (0.390 mg/L), when the recommendation is 0.300 mg/L.

Bacterial levels did exceed the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL) for the sample taken in September; 538.0 MPN/100 mL.

Table 15: Water chemistry data and *E. coli* results for ShdC, 2019

SITE ShdC: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	DO (mg/L)	E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water						Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
19-06-26	17.0	14.2	0.07	11.77	52.4	47	41	0.114	156	53.9	-0.86	7.13	7.6	8.5	92.30	86	1.2
19-07-24	26.0	20.4	0.11	10.14	399.0	80	14	0.212	230	86.2	0.06	7.87	8.1	8	150.80	127	0.8
19-08-21	25.0	18.6	0.12	7.80	323.2	81	10	0.221	255	96.2	-0.19	7.54	7.8	7.8	164.45	135	1.0
19-09-26	14.0	12.7	0.04	12.82	**538.0**	30	90	0.067	88	27.1	-1.82	6.87	7.1	8.9	55.90	62	7.8

Table 16: Nutrient results for ShdC, 2019

SITE ShdC: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO3 (mg/L)	Br (mg/L)	Ca (mg/L)	CO3 (mg/L)	Cl (mg/L)	F (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH3T (mg/L)	NH3_Un (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NOX (mg/L)	SO4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (mg/L)
19-06-26	46.8	0.02	16.3	0.175	11.6	0.12	0.90	3.21	8.4	<0.05	<0.001	<0.05	0.160	0.160	9	—	0.4	6.9	**0.012**
19-07-24	79.0	0.03	26.4	0.935	14.0	0.13	1.11	4.93	9.7	<0.05	<0.001	<0.05	0.210	0.210	17	—	0.4	3.6	**0.015**
19-08-21	80.5	0.02	29.6	0.477	14.1	0.15	1.26	5.42	10.5	<0.05	<0.001	<0.05	0.350	0.350	20	—	0.5	2.8	**0.011**
19-09-26	30.0	0.02	8.21	0.036	8.0	0.25	0.86	1.61	6.0	<0.25	<0.001	<0.25	<0.25	<0.25	5	—	0.4	13.5	**0.054**

Table 17: Inorganics results for ShdC, 2019

SITE ShdC: HEAVY METALS AND OTHER ELEMENTS																			
Date (yy-mm-dd)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Cd (µm/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Rb (mg/L)	Sb (mg/L)	Sr (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
19-06-26	0.071	<0.001	0.013	0.046	<0.00001	<0.0001	<0.001	<0.001	0.19	0.0009	0.023	0.0007	<0.001	<0.0001	0.0008	<0.0001	<0.001	0.0003	<0.001	<0.001
19-07-24	0.031	<0.001	0.017	0.068	<0.00001	<0.0001	<0.001	<0.001	0.1	0.0011	0.032	0.0012	<0.001	<0.0001	0.0010	<0.0001	<0.001	0.0008	<0.001	<0.001
19-08-21	0.038	<0.001	0.023	0.078	<0.00001	<0.0001	<0.001	<0.001	0.06	0.0012	0.035	0.0013	<0.001	<0.0001	0.0011	<0.0001	<0.001	0.0007	<0.001	<0.001
19-09-26	**0.240**	<0.001	0.011	0.034	0.00001	0.0002	<0.001	0.001	**0.39**	0.0006	0.021	0.0003	<0.001	0.0004	0.0008	<0.0001	<0.001	0.0002	<0.001	0.001

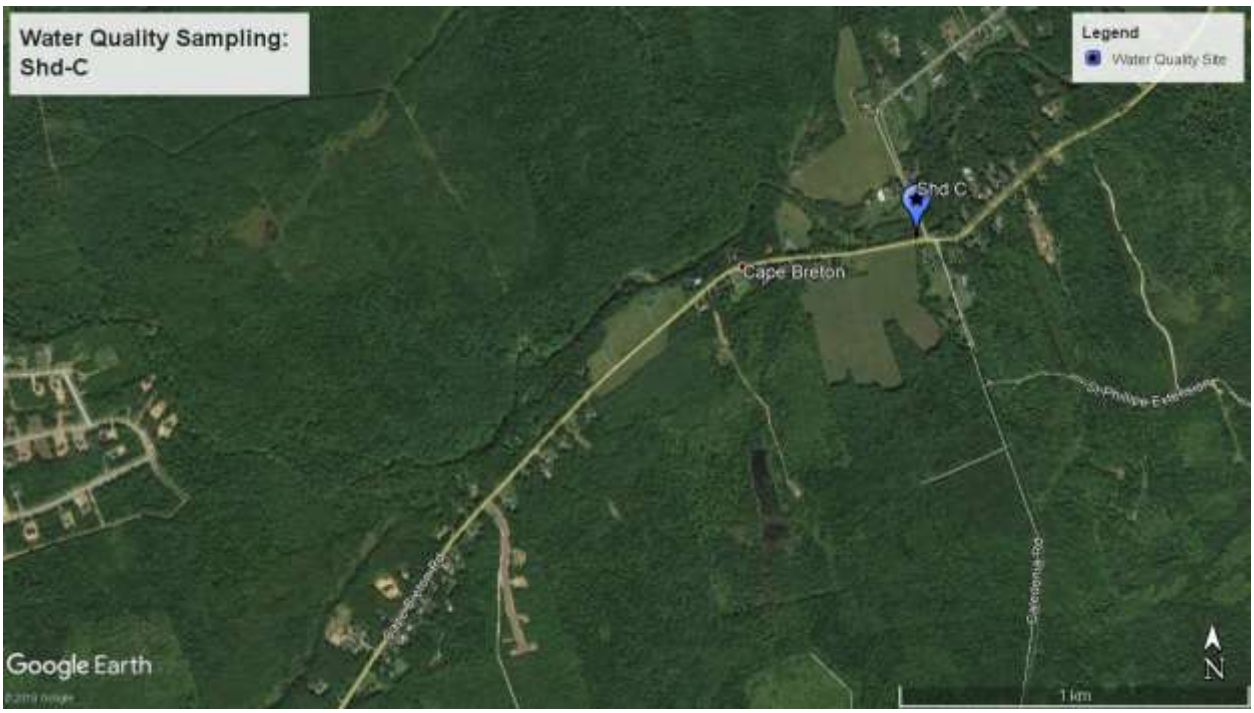


Figure 8: ShdC site location and surrounding land uses

Figure 9: Site photos for water quality sampling site ShdC, (photos May 2018)

3.4 Shediac River – ShdE

This water quality sampling site is located in the main branch of the Shediac River, at the old covered bridge. The sample is taken upstream of the covered bridge. The surrounding land uses is mainly residences, forested land, ATV trails, and transmission power lines crossing overhead of the site. There are some clear-cut lots along the river further upstream, and some buffer zone in these areas may be less than 10-15 m.

The water sampling results for the site ShdE, for 2019, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen However, the DO value for the month of August was slightly below the recommended value (6.5 mg/L) for general cold water organisms in August (6.42 mg/L). The water temperature exceeded the limit for thermal stress in salmonids (22.5˚C) in July (26.0˚C) and in August (25.0˚C).

Total phosphorus levels for long-term eutrophic conditions, according to the *CCME Guidance framework for Phosphorus*, were in the mesotrophic range (0.010 – 0.020 mg/L) from June to August, and in the eutrophic range (0.035 – 0.100 mg/L) in September.

Concentration results for the nitrate ion (NO3) are below the short term (124 mg/L) and long term (2.9 mg/L) CCME recommendations for direct toxicity to sensitive freshwater life (these guidelines do not consider indirect effects due to eutrophication, nor does this interpret results for assessment of eutrophic conditions).

Concentrations of aluminum exceeded the CCME water quality guideline (0.100 mg/L when the pH is ≥6.5) in the sample taken in September (0.268 mg/L). Concentrations of iron also exceeded the guidelines in June (0.33 mg/L) and September (0.46 mg/L), when the recommendation is 0.300 mg/L.

Bacterial levels did exceed the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL) for the samples taken in August (581.8 MPN/100 mL) and September (530.0 MPN/100 mL).

Table 18: Water chemistry data and *E. coli* results for ShdE, 2019

SITE ShdE: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL	DO	E. coli (MPN /100mL)	ALK_T	CLRA	COND (µS/cm)		HARD	Lang_Ind	pH (pH)			TDS (mg/L)		TURB
	Air	Water	(ppt)	(mg/L)		(mg/L)	(TCU)	Field	Lab	(mg/L)	(20°C)	Field	Lab	Sat (20°C)	Field	Lab	(NTU)
19-06-26	18.0	15.5	0.05	11.12	24.2	39	63	0.090	113	38.8	-1.26	6.97	7.4	8.7	71.05	63	1.4
19-07-24	26.0	20.8	0.05	9.87	41.0	65	23	0.161	178	65.6	-0.33	7.59	7.9	8.2	114.40	96	1.2
19-08-21	25.0	19.0	0.10	6.42	581.8	72	11	0.185	211	77.3	-0.42	7.34	7.7	7.7	135.85	110	0.9
19-09-26	13.0	12.8	0.03	12.42	530.0	20	110	0.051	68	21.9	-2.19	6.55	7.0	9.2	42.90	52	6.5

Table 19: Nutrient results for ShdE, 2019

SITE ShdE: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO3 (mg/L)	Br (mg/L)	Ca (mg/L)	CO3 (mg/L)	Cl (mg/L)	F (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH3T (mg/L)	NH3_Un (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NOX (mg/L)	SO4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (mg/L)
19-06-26	38.9	0.02	11.9	0.092	7.6	0.11	0.73	2.21	6.2	<0.05	<0.001	<0.05	<0.05	<0.05	<1	—	0.4	9.6	0.012
19-07-24	64.5	0.03	20.5	0.482	10.7	0.13	0.98	3.50	8.2	<0.05	<0.001	<0.05	0.1	0.1	7	—	0.4	5.0	0.013
19-08-21	71.6	0.03	24.2	0.337	12.7	0.15	1.22	4.09	9.8	<0.05	<0.001	<0.05	0.07	0.07	10	—	0.2	3.5	0.012
19-09-26	20.0	0.02	6.57	0.019	6.0	0.24	0.75	1.33	4.6	<0.25	<0.001	<0.25	<0.25	<0.25	4	—	0.4	15.4	0.044

Table 20: Inorganics results for ShdE, 2019

SITE ShdE: HEAVY METALS AND OTHER ELEMENTS																			
Date (yy-mm-dd)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Cd (µm/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Rb (mg/L)	Sb (mg/L)	Sr (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
19-06-26	0.083	<0.001	0.008	0.048	<0.00001	<0.0001	<0.001	<0.001	0.33	0.0007	0.032	0.0004	<0.001	0.0001	0.0007	<0.0001	<0.001	0.0002	<0.001	0.002
19-07-24	0.040	<0.001	0.010	0.072	<0.00001	<0.0001	<0.001	<0.001	0.25	0.0011	0.048	0.0006	<0.001	<0.0001	0.0010	<0.0001	<0.001	0.0003	<0.001	0.001
19-08-21	0.032	<0.001	0.014	0.090	<0.00001	<0.0001	<0.001	<0.001	0.13	0.0012	0.049	0.0008	<0.001	<0.0001	0.0012	<0.0001	<0.001	0.0004	<0.001	0.001
19-09-26	0.268	<0.001	0.008	0.036	0.00001	0.0002	<0.001	0.001	0.46	0.0006	0.028	0.0002	<0.001	0.0003	0.0007	<0.0001	<0.001	0.0001	<0.001	0.002

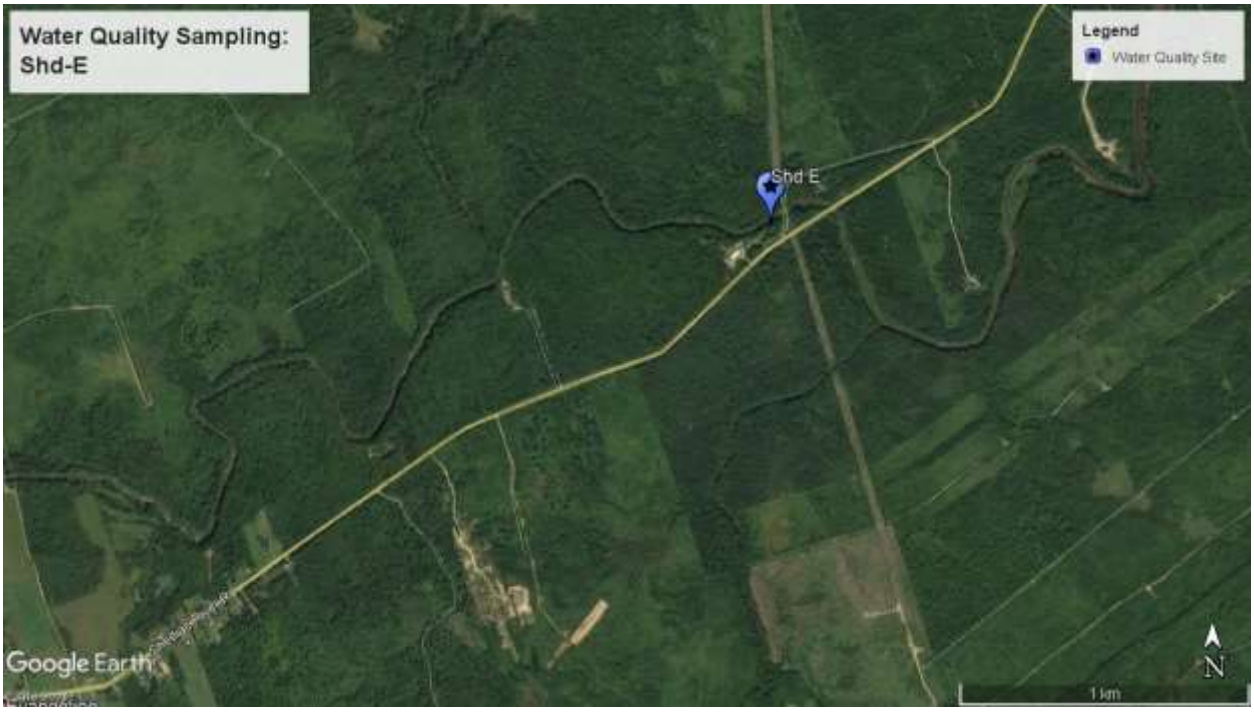


Figure 10: ShdE site location and surrounding land uses

Figure 11: Site photos for water quality sampling site ShdE, (photos May 2018)

3.5 Shediac River – ShdG

This water quality sampling site is located in the Weisner Brook, at the small bridge on St-Philippe Rd. The sample is taken downstream of the bridge, due to a large beaver dam spanning the length of the bridge, creating deep beaver habitat unfit for chest waders. The surrounding land uses includes; residences, large open fields with ATV activity, forested land, transmission power lines, mineral extraction pit and farmland.

The Weisner Brook is a major tributary of the Shediac River, a combination of many small streams and the Calhoun Brook. A defining characteristic of this brook is the colder water temperatures, in comparison to the rest of the Shediac River system. This factor is created by long stretches of forested riparian habitats and cold springs input into its tributaries. The Weisner Brook is recognized by the Department of Natural Resources as a "summer resting refuge for mature trout", due to the cooler temperatures. In addition, the *Department of Fisheries and Oceans Canada* has placed a variation order (GVO-2004-004) on this watercourse that prohibits any retention of brook trout (catch and release only, bag limit 0 at all times) within the "Weisner Brook from its confluence with the Shediac River upstream to its source, including all tributaries."

A few areas along the brook, in the open fields, have thinner buffer zone (> 10 m) mostly made up of young shrubs. To the left of the sampling site (looking upstream) directly upstream of the bridge, is a field recently transformed into a corn crop. In 2018, the field was tilled in preparation for agriculture activities, and the clearing had reached the riverbank, and has left little vegetation in the riparian area spanning approx. 175 m. Some alders on the riverbank were also shredded during the tilling of the adjoining field (see site photos).

A gravel/mineral extraction pit is located in the upper reaches of the Weisner Brook, over 3.3 km upstream. There is a tree buffer between the pit and the brook (> 160 m). Further upstream from the pit are few farm fields and clear cut areas, also with good tree density separating the fields from the brook (> 150 m).

The water sampling results for the site ShdG, for 2019, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen.

Total phosphorus levels for long-term eutrophic conditions, according to the CCME Guidance framework for Phosphorus, were in the meso-eutrophic range (0.020 – 0.035 mg/L) range in June, July and August; and in the eutrophic range (0.035 – 0.100 mg/L) in September.

Concentration results for the nitrate ion (NO3) are below the short term (124 mg/L) and long term (2.9 mg/L) CCME recommendations for direct toxicity to sensitive freshwater life (these guidelines do not consider indirect effects due to eutrophication, nor does this interpret results for assessment of eutrophic conditions).

Concentrations of aluminum exceeded the CCME water quality guideline (0.100 mg/L when the pH is ≥6.5) in the sample taken in June (0.122 mg/L) and September (0.201 mg/L). Concentrations of iron also exceeded the guidelines in June (0.51 mg/L), July (0.51 mg/L) and September (0.56 mg/L), when the recommendation is 0.300 mg/L.

Bacterial levels did not exceed the maximum concentration of E. coli from the Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 21: Water chemistry data and *E. coli* results for ShdG, 2019

SITE ShdG: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL	DO	E. coli (MPN /100mL)	ALK_T	CLRA	COND (µS/cm)		HARD	Lang_Ind	pH (pH)			TDS (mg/L)		TURB
	Air	Water	(ppt)	(mg/L)		(mg/L)	(TCU)	Field	Lab	(mg/L)	(20°C)	Field	Lab	Sat (20°C)	Field	Lab	(NTU)
19-06-26	17.0	14.4	0.03	10.56	29.2	23	130	0.051	64	25	-1.82	7.00	7.3	9.1	41.60	49	1.2
19-07-24	25.0	16.9	0.06	10.41	41.0	48	63	0.102	121	47.1	-0.95	7.79	7.6	8.5	78.00	68	1.0
19-08-21	23.0	16.5	0.07	7.49	107.6	55	22	0.123	146	55.9	-0.73	7.27	7.7	7.7	94.90	76	1.6
19-09-26	13.0	13.0	0.03	10.66	63.0	20	160	0.049	55	19.1	-2.28	6.12	7.0	9.3	40.95	53	2.1

Table 22: Nutrient results for ShdG, 2019

SITE ShdG: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO3 (mg/L)	Br (mg/L)	Ca (mg/L)	CO3 (mg/L)	Cl (mg/L)	F (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH3T (mg/L)	NH3_Un (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NOX (mg/L)	SO4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (mg/L)
19-06-26	22.9	0.02	6.7	0.043	4.2	4.20	0.34	2.03	3.8	<0.05	<0.001	<0.05	0.07	0.07	2	—	0.5	15.0	0.028
19-07-24	47.8	0.03	12.5	0.179	5.8	0.15	0.56	3.86	5.3	<0.05	<0.001	<0.05	0.19	0.19	<1	—	0.5	8.6	0.026
19-08-21	54.7	0.02	14.7	0.258	7.0	0.17	0.79	4.67	6.6	<0.05	<0.001	<0.05	0.12	0.12	3	—	0.3	4.8	0.026
19-09-26	20.0	0.02	5.2	0.019	5.0	0.31	0.76	1.48	3.7	<0.25	<0.001	<0.25	<0.25	<0.25	2	—	0.5	22	0.036

Table 23: Inorganics results for ShdG, 2019

SITE ShdG: HEAVY METALS AND OTHER ELEMENTS																				
Date (yy-mm-dd)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Cd (µm/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Rb (mg/L)	Sb (mg/L)	Sr (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
19-06-26	0.122	<0.001	0.009	0.038	<0.00001	0.0001	<0.001	<0.001	0.51	0.0008	0.049	<0.0001	<0.001	0.0002	0.0004	<0.0001	<0.001	<0.0001	<0.001	0.003
19-07-24	0.050	<0.001	0.012	0.055	<0.00001	0.0002	<0.001	<0.001	0.51	0.0014	0.092	<0.0001	<0.001	0.0002	0.0007	<0.0001	<0.001	<0.0001	<0.001	0.002
19-08-21	0.046	<0.001	0.019	0.069	<0.00001	0.0002	<0.001	<0.001	0.22	0.0017	0.106	0.0001	<0.001	0.0002	0.0008	<0.0001	<0.001	<0.0001	<0.001	<0.001
19-09-26	0.201	<0.001	0.013	0.037	0.00001	0.0002	<0.001	<0.001	0.56	0.0007	0.097	<0.0001	<0.001	0.0002	0.0008	<0.0001	<0.001	<0.0001	<0.001	0.002

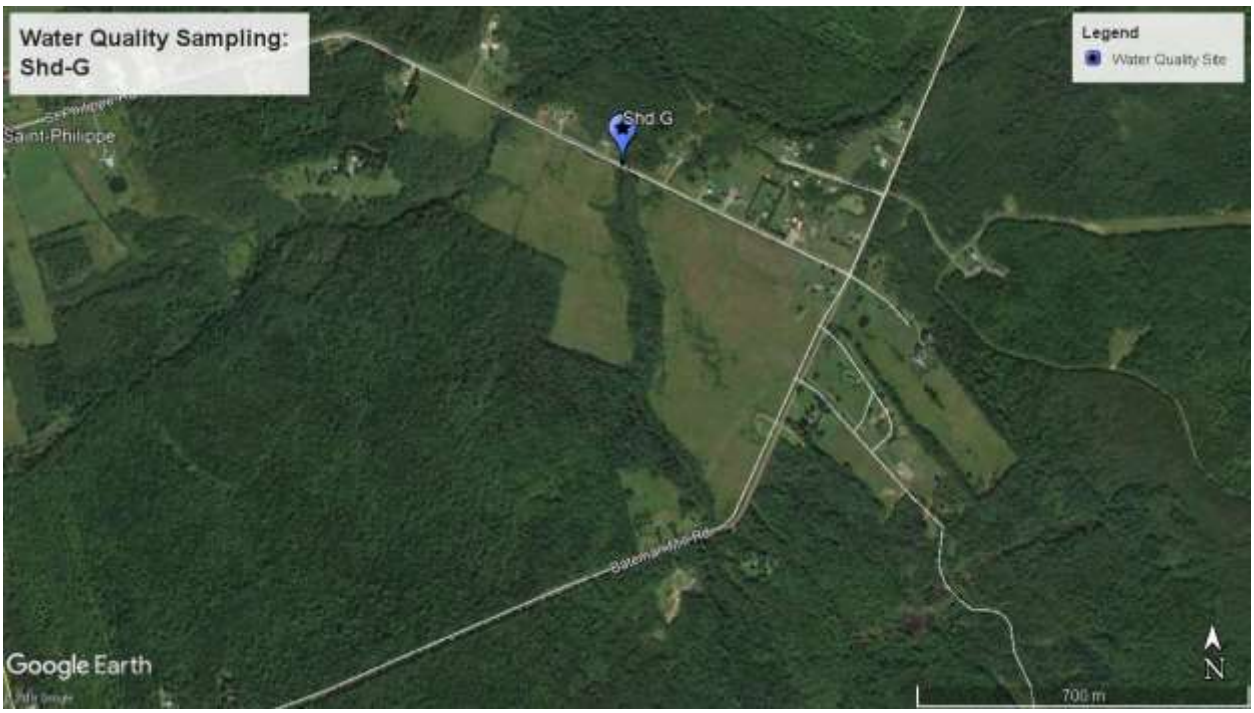


Figure 12: ShdG site location and surrounding land uses

Figure 13: Site photos for water quality sampling site ShdG, (photos May 2018)

3.6 Shediac River – ShdH

This water quality sampling site is located in the Bateman Brook, at the culvert on Bateman Mill Rd. The sample is taken upstream from the culvert. The surrounding land uses includes mainly residences and farm fields for both the cultivation of hay and cattle. The building of a pig farm with an adjoining settling pond is evident on aerial imagery, but it is unknown whether there is still any activity. Further upstream in the Bateman Brook system are several active and/or recently active logging fields.

The tree buffer between the cattle/cultivation fields and the sampling site is on average 15 -20 m in density. Upstream from these fields is logging activity, also with tree lines as little at 10 - 20 m. The forestry activity takes place in various areas of the tributaries and wetlands of the Bateman Brook. Some areas show little in terms of buffer between fields and water or wetlands. Woody debris can be seen in a wetland from aerial imagery.

The water sampling results for the site ShdH, for 2019, meets or exceeds the recommendations for the survival of freshwater aquatic life based on pH. However, levels of dissolved oxygen dropped below the recommendation (6.5 mg/L) for general cold water organisms in August (5.87 mg/L).

Total phosphorus levels for long-term eutrophic conditions, according to the CCME Guidance framework for Phosphorus, were in the meso-eutrophic range (0.020 – 0.035 mg/L) in June, July and August, and in the eutrophic range (0.035 – 0.100 mg/L) in September.

Concentration results for the nitrate ion (NO3) are below the short term (124 mg/L) and long term (2.9 mg/L) CCME recommendations for direct toxicity to sensitive freshwater life (these guidelines do not consider indirect effects due to eutrophication, nor does this interpret results for assessment of eutrophic conditions).

Concentrations of aluminum exceeded the CCME water quality guideline (0.100 mg/L when the pH is ≥6.5) in the sample taken in June (0.117 mg/L) and September (0.211 mg/L). Concentrations of iron also exceeded the guidelines in every sample taken in 2019. The highest level of iron was measured in the month of July; 0.88 mg/L.

Bacterial levels did not exceed the maximum concentration of E. coli from the Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 24: Water chemistry data and *E. coli* results for ShdH, 2019

SITE ShdH: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL	DO	E. coli (MPN /100mL)	ALK_T	CLRA	COND (µS/cm)		HARD	Lang_Ind	pH (pH)			TDS (mg/L)		TURB
	Air	Water	(ppt)	(mg/L)		(mg/L)	(TCU)	Field	Lab	(mg/L)	(20°C)	Field	Lab	Sat (20°C)	Field	Lab	(NTU)
19-06-26	16.0	15.0	0.06	8.11	82.0	37	97	0.096	121	36.2	-1.51	6.53	7.2	8.7	78.00	73	2.2
19-07-24	24.0	18.5	0.08	7.99	228.0	61	48	0.152	172	59.3	-0.89	7.63	7.4	8.3	113.10	93	2.9
19-08-21	23.0	19.0	0.10	5.87	107.8	63	31	0.178	201	64	-0.55	7.35	7.7	7.7	130.75	100	2.1
19-09-26	—	13.0	0.04	11.20	187.0	20	130	0.062	83	22.4	-2.17	6.48	7.0	9.2	52.00	59	4.6

Table 25: Nutrient results for ShdH, 2019

SITE ShdH: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO3 (mg/L)	Br (mg/L)	Ca (mg/L)	CO3 (mg/L)	Cl (mg/L)	F (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH3T (mg/L)	NH3_Un (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NOX (mg/L)	SO4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (mg/L)
19-06-26	36.9	0.03	11.2	0.055	14.2	14.20	0.55	1.99	8.9	<0.05	<0.001	<0.05	0.05	0.05	<1	—	0.6	12.5	0.027
19-07-24	60.8	0.03	18.6	0.144	15.6	0.14	0.70	3.11	10.0	<0.05	<0.001	<0.05	0.05	0.05	<1	—	0.4	6.6	0.022
19-08-21	62.7	0.03	20.1	0.295	18.9	0.16	0.86	3.35	12.1	<0.05	<0.001	<0.05	<0.05	<0.05	<1	—	0.3	5.1	0.022
19-09-26	20.0	0.03	6.81	0.019	11.0	0.22	0.82	1.31	6.9	<0.25	<0.001	<0.25	<0.25	<0.25	2	—	0.4	17.1	0.038

Table 26: Inorganics results for ShdH, 2019

SITE ShdH: HEAVY METALS AND OTHER ELEMENTS																				
Date (yy-mm-dd)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Cd (µm/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Rb (mg/L)	Sb (mg/L)	Sr (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
19-06-26	0.117	<0.001	0.004	0.071	<0.00001	0.0002	<0.001	<0.001	0.77	0.0009	0.208	<0.0001	<0.001	0.0002	0.0006	<0.0001	<0.001	0.0001	<0.001	0.002
19-07-24	0.040	<0.001	0.002	0.103	<0.00001	0.0002	<0.001	<0.001	0.88	0.0013	0.217	<0.0001	<0.001	0.0001	0.0009	<0.0001	<0.001	0.0002	<0.001	0.009
19-08-21	0.030	<0.001	0.007	0.127	<0.00001	0.0002	<0.001	<0.001	0.62	0.0016	0.241	0.0001	<0.001	<0.0001	0.0011	<0.0001	<0.001	0.0002	<0.001	0.001
19-09-26	0.211	<0.001	0.005	0.050	<0.00001	0.0002	<0.001	<0.001	0.61	0.0006	0.049	<0.0001	<0.001	0.0003	0.0008	<0.0001	<0.001	<0.0001	<0.001	0.002

Figure 14: ShdH site location and surrounding land uses

Figure 15: Site photos for water quality sampling site ShdH, (photos May 2018)

3.7 Scoudouc River – ScdB

This water quality sampling site is located in the main branch of the Scoudouc River, at the bridge on Route 132, next to the *Waggin' Tail Inn*. The sample is taken downstream of the bridge. The surrounding land uses includes; residences, the Greater Shediac Sewerage Commission's aeration lagoons, the Scoudouc Industrial Park, the Highway 15 (in the headwaters of the river) and forested land.

The sample site is upstream from the treated wastewater's discharge pipe. The property to the left of the sampling site (looking upstream) mows the lawn up to the riverbank, leaving only a few shrubs and grass on the riparian area. Another property upstream of the bridge, to the right, also has similar lawn mowing trends. Erosion is evident on the left bank. The industrial park has forested land between the edge of the property and the wetlands and drainage system (> 900 m in tree density).

The water sampling results for the site ScdB, for 2019, meet the recommendations for the survival of freshwater aquatic life based on pH. However, levels of dissolved oxygen dropped below the recommendation (6.5 mg/L) for general cold water organisms in July (5.86 mg/L) and August (4.36 mg/L).

Total phosphorus levels for long-term eutrophic conditions, according to the *CCME Guidance framework for Phosphorus*, were in the meso-eutrophic range (0.020 – 0.035 mg/L) in June and September, and in the eutrophic range (0.035 – 0.100 mg/L) in July and August.

Concentration results for the nitrate ion (NO3) are below the short term (124 mg/L) and long term (2.9 mg/L) CCME recommendations for direct toxicity to sensitive freshwater life (these guidelines do not consider indirect effects due to eutrophication, nor does this interpret results for assessment of eutrophic conditions).

Concentrations of aluminum exceeded the CCME water quality guideline (0.100 mg/L when the pH is ≥6.5) in the samples taken in June (0.305 mg/L), July (0.129 mg/L) and September (0.301 mg/L). Concentrations of iron exceeded the CCME water quality guideline (0.300 mg/L) in every sample taken in 2019. The highest level of iron was measured in the month of July; 1.60 mg/L, more than 5X the recommended limit.

Bacterial levels did not exceed the maximum concentration of *E. coli* from Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 27: Water chemistry data and *E. coli* results for ScdB, 2019

SITE ScdB: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL	DO	E. coli (MPN /100mL)	ALK_T	CLRA	COND (µS/cm)		HARD	Lang_Ind	pH (pH)			TDS (mg/L)		TURB
	Air	Water	(ppt)	(mg/L)		(mg/L)	(TCU)	Field	Lab	(mg/L)	(20°C)	Field	Lab	Sat (20°C)	Field	Lab	(NTU)
19-06-26	16.0	15.6	0.03	8.59	59.8	20	250	0.053	63	19.2	-2.01	7.3	7.2	9.2	42.25	66	2.3
19-07-24	20.0	17.8	0.07	**5.86**	51.0	50	160	0.130	149	51.1	-1.01	7.6	7.4	8.4	98.15	101	6.3
19-08-21	19.0	19.5	0.07	**4.36**	167.8	41	128	0.128	142	45.9	-0.94	7.5	7.6	7.6	93.60	90	4.2
19-09-26	—	13.1	0.03	9.24	171.0	10	210	0.047	60	14.1	-2.96	**4.8**	6.7	9.7	39.00	59	2.6

Table 28: Nutrient results for ScdB, 2019

SITE ScdB: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO3 (mg/L)	Br (mg/L)	Ca (mg/L)	CO3 (mg/L)	Cl (mg/L)	F (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH3T (mg/L)	NH3_Un (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NOX (mg/L)	SO4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (mg/L)
19-06-26	20.0	0.03	6.2	0.030	8.0	0.31	0.24	0.93	6.0	<0.25	<0.001	<0.25	<.0.25	<.0.25	2	—	0.7	29.0	0.031
19-07-24	49.9	0.08	16.8	0.118	17.0	0.24	0.50	2.23	9.6	<0.25	<0.001	<0.25	<0.25	<0.25	<5	—	0.7	22.0	0.051
19-08-21	40.8	0.06	15.1	0.153	15.6	0.25	0.63	1.99	9.5	<0.05	<0.001	<0.05	<0.05	<0.05	3	—	0.6	17.3	0.040
19-09-26	10.0	0.03	4.36	0.005	10.0	0.35	0.58	0.79	6.1	<0.25	<0.001	<0.25	<0.25	<0.25	2	—	0.6	28	0.024

Table 29: Inorganics results for ScdB, 2019

SITE ScdB: HEAVY METALS AND OTHER ELEMENTS																				
Date (yy-mm-dd)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Cd (µm/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Rb (mg/L)	Sb (mg/L)	Sr (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
19-06-26	0.305	<0.001	0.006	0.024	0.00001	0.0003	<0.001	<0.001	0.94	0.0005	0.095	<0.0001	<0.001	0.0004	0.0005	<0.0001	<0.001	0.0001	<0.001	0.005
19-07-24	0.129	0.001	0.005	0.033	0.00002	0.0005	<0.001	<0.001	1.6	0.0008	0.334	0.0003	<0.001	0.0005	0.0012	<0.0001	<0.001	0.0004	<0.001	0.008
19-08-21	0.091	0.001	0.015	0.032	0.00001	0.0004	<0.001	<0.001	1.03	0.0008	0.404	0.0002	<0.001	0.0004	0.0013	<0.0001	<0.001	0.0003	<0.001	0.002
19-09-26	0.301	<0.001	0.011	0.025	0.00001	0.0002	<0.001	<0.001	0.81	0.0006	0.062	<0.0001	<0.001	0.0004	0.0009	<0.0001	<0.001	<0.0001	<0.001	0.004

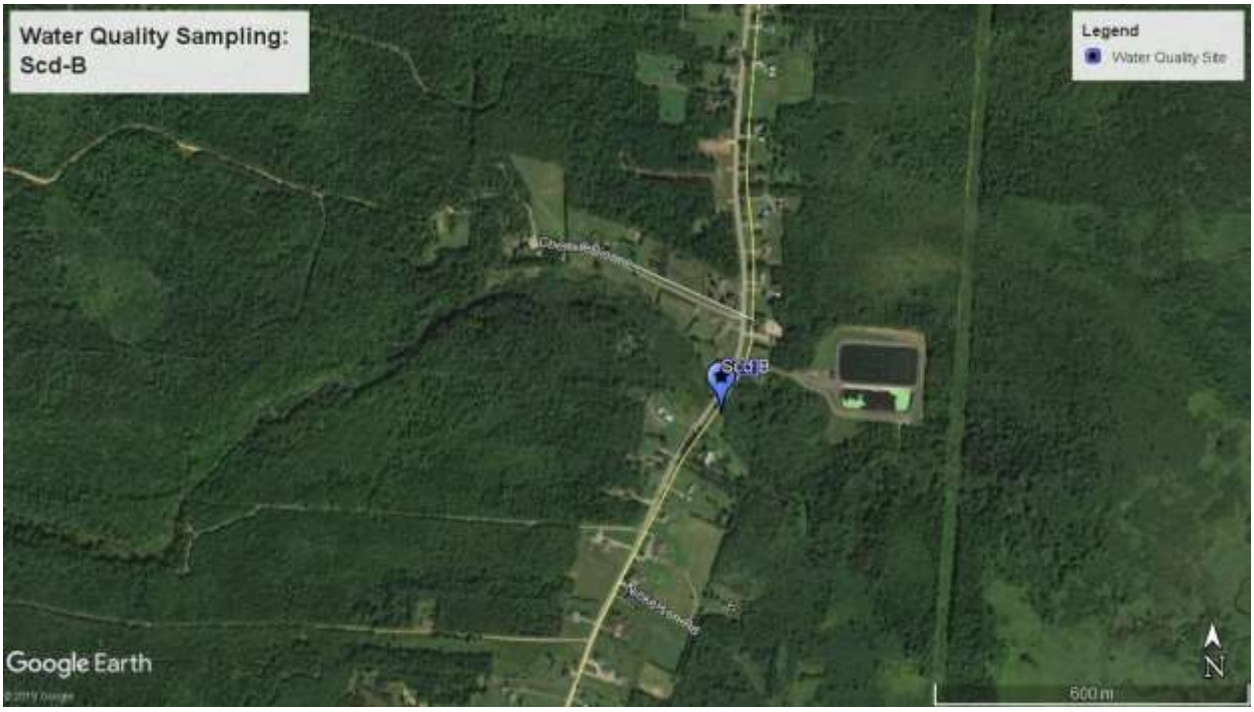


Figure 16: ScdB site location and surrounding land uses

Figure 17: Site photos for water quality sampling site ScdB, (photos May 2018 & Google Maps photo)

3.1 Scoudouc River – ScdE-2

This water quality sampling site is located in the main branch of the Scoudouc River, and is accessed through a private property with landowner permission. Off Scoudouc River Rd, there is a large field that the staff uses to access a trail in the far right corner (1 km from the road). The path is marked with flagging tape and leads to the River. This site is located approx. 11 km downstream from the aeration lagoons. The surrounding land uses is mainly a few residences, forested land, wetlands, ATV trails, and one mineral extraction pit. The pit has a dense tree buffer between the outer limit and the beginning of the wetlands surrounding the river (> 350 m).

The water sampling results for the site ScdE-2, for 2019, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on dissolved oxygen. However, the pH in September (5.0) was below the recommended long term limit of 6.5 using the field probe, but the laboratory test showed readings closer to the normal range (6.4).

Total phosphorus levels for long-term eutrophic conditions, according to the CCME Guidance framework for Phosphorus, were in the meso-eutrophic range (0.020 – 0.035 mg/L) in June, August and September; and in the eutrophic range (0.035 – 0.100 mg/L) in July.

Concentration results for the nitrate ion (NO3) are below the short term (124 mg/L) and long term (2.9 mg/L) CCME recommendations for direct toxicity to sensitive freshwater life (these guidelines do not consider indirect effects due to eutrophication, nor does this interpret results for assessment of eutrophic conditions).

Concentrations of aluminum exceeded the CCME water quality guideline (0.100 mg/L when the pH is ≥6.5) in the samples taken in June (0.282 mg/L), July (0.112 mg/L) and September (0.263 mg/L). Concentrations of iron exceeded the CCME water quality guideline (0.300 mg/L) in every sample taken in 2019. The highest level of iron was measured in the month of July; 1.31 mg/L, more than 4X the recommended limit. Levels of copper was equal to the limit of CCME water quality guidelines for freshwater (0.002 mg/L when hardness HCO3 ≥82) in the month of August (0.002 mg/L).

Bacterial levels did not exceed the maximum concentration of *E. coli* from the Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 30: Water chemistry data and *E. coli* results for ScdE-2, 2019

SITE ScdE-2: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																	
Date (yy-mm-dd)	Temp (°C)		SAL	DO	E. coli (MPN /100mL)	ALK_T	CLRA	COND (µS/cm)		HARD	Lang_Ind	pH (pH)			TDS (mg/L)		TURB
	Air	Water	(ppt)	(mg/L)		(mg/L)	(TCU)	Field	Lab	(mg/L)	(20°C)	Field	Lab	Sat (20°C)	Field	Lab	(NTU)
19-06-26	18.0	16.8	0.02	8.24	146.6	14	260	0.044	52	15.6	-2.45	7.3	7.0	9.5	33.80	57	2.6
19-07-24	21.0	19.0	0.04	8.34	173.0	30	180	0.084	95	31.5	-1.43	7.9	7.4	8.8	61.75	75	2.7
19-08-21	20.0	20.0	0.05	6.76	102.4	32	87	0.104	114	31.3	-1.31	7.6	7.5	7.5	74.75	68	2.3
19-09-26	—	13.2	0.03	7.69	122.0	10	200	0.043	57	13.9	-3.26	5.0	6.4	9.7	36.40	54	2.4

Table 31: Nutrient results for ScdE-2, 2019

SITE ScdE-2: NUTRIENT DATA																				
Date (yy-mm-dd)	HCO3 (mg/L)	Br (mg/L)	Ca (mg/L)	CO3 (mg/L)	Cl (mg/L)	F (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH3T (mg/L)	NH3_Un (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NOX (mg/L)	SO4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (mg/L)
19-06-26	14.0	0.03	5.0	0.013	8.0	0.26	0.20	0.76	5.1	<0.25	<0.001	<0.25	<0.25	<0.25	1	—	0.7	27.0	0.034
19-07-24	29.9	0.05	10.3	0.071	12.0	0.26	0.33	1.40	7.5	<0.25	<0.001	<0.25	<0.25	<0.25	2	—	0.7	22.0	0.035
19-08-21	31.9	0.06	10.2	0.095	13.7	0.21	0.52	1.42	9.3	<0.05	<0.001	<0.05	<0.05	<0.05	<1	—	0.4	12.6	0.027
19-09-26	10.0	0.03	4.29	0.002	9.0	0.28	0.63	0.77	5.2	<0.25	<0.001	<0.25	<0.25	<0.25	2	—	0.6	25	0.031

Table 32: Inorganics results for ScdE-2, 2019

SITE ScdE-2: HEAVY METALS AND OTHER ELEMENTS																				
Date (yy-mm-dd)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Cd (µm/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Rb (mg/L)	Sb (mg/L)	Sr (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
19-06-26	0.282	<0.001	0.005	0.024	0.00001	0.0002	<0.001	<0.001	0.87	0.0005	0.088	<0.0001	<0.001	0.0003	0.0004	<0.0001	<0.001	<0.0001	<0.001	0.005
19-07-24	0.112	<0.001	0.002	0.028	<0.00001	0.0002	<0.001	<0.001	1.31	0.0006	0.072	0.0001	<0.001	0.0004	0.0008	<0.0001	<0.001	<0.0001	<0.001	0.011
19-08-21	0.048	<0.001	0.010	0.032	<0.00001	0.0002	<0.001	0.002	0.46	0.0007	0.112	0.0001	<0.001	0.0002	0.0011	<0.0001	<0.001	<0.0001	<0.001	0.002
19-09-26	0.263	<0.001	0.007	0.026	0.00002	0.0002	<0.001	<0.001	0.82	0.0006	0.085	<0.0001	<0.001	0.0003	0.0010	<0.0001	<0.001	<0.0001	<0.001	0.003

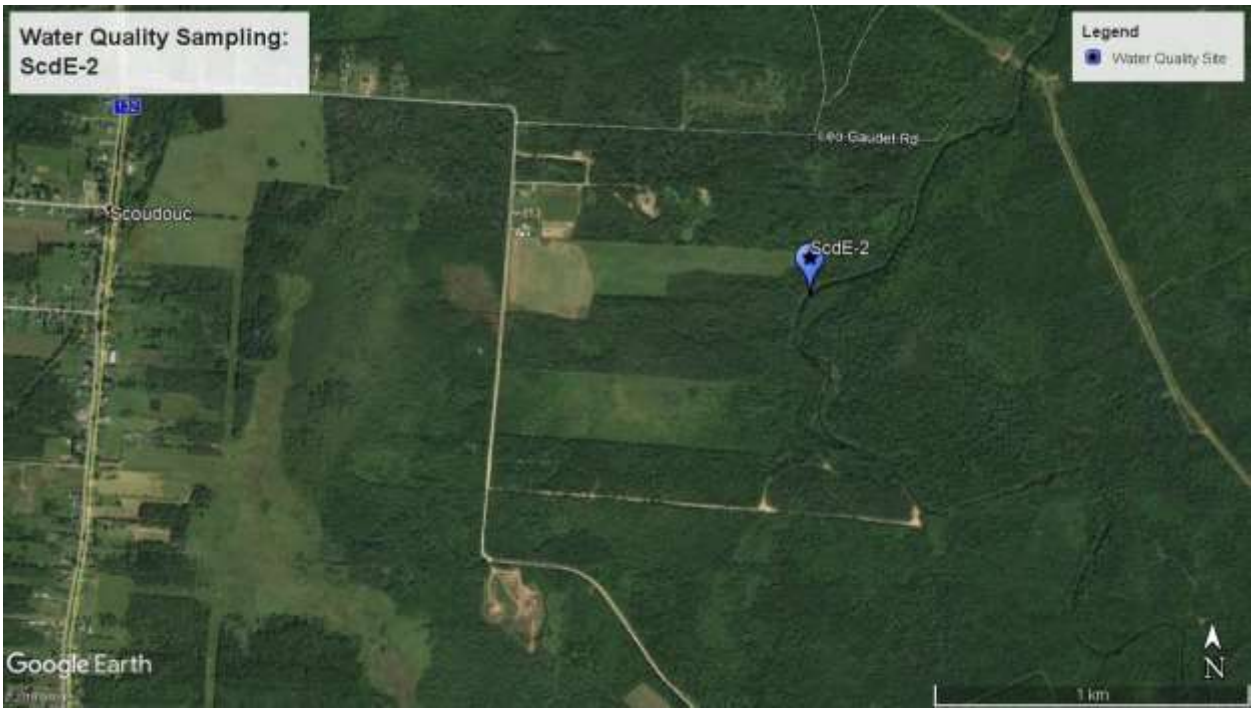


Figure 18: ScdE-2 site location and surrounding land uses

Figure 19: Site photos for water quality sampling site ScdE-2, (photos May 2018)

3.2 Scoudouc River – ScdF

This water quality sampling site is located in an unnamed tributary of the Scoudouc River, accessed by the public dirt road, Pellerin Rd, off Lino Road. On Google maps, the road shows up as Sackville Road. The sample is taken downstream of the road's culvert. The surrounding land uses in mainly cottages, forests, wetlands, ATV trails, and at the headwaters, a bog being exploited for peat moss. The peat moss extraction spans over 200 hectares as seen and measured on aerial imagery of 2017.

The water sampling results for the site ScdF, for 2019, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen. It is to note that the pH in July (9.2) was above the recommended long term limit (9.0) using the field probe, but the laboratory test showed readings in the normal range.

Total phosphorus levels for long-term eutrophic conditions, according to the CCME Guidance framework for Phosphorus, were in the eutrophic range (0.035 – 0.100 µg/L) in all samples collected in 2019.

Concentration results for the nitrate ion (NO3) are below the short term (124 mg/L) and long term (2.9 mg/L) CCME recommendations for direct toxicity to sensitive freshwater life (these guidelines do not consider indirect effects due to eutrophication, nor does this interpret results for assessment of eutrophic conditions).

Concentrations of aluminum exceeded the CCME water quality guideline (0.100 mg/L when the pH is ≥6.5) in all samples taken in 2019. The highest aluminum value was in September (0.387 mg/L). Concentrations of iron also exceeded the CCME water quality guideline (300 µg/L) for every sample taken in 2019. The highest iron value was in September (1.90 mg/L); over 6X the recommended limit.

Levels of copper was equal to the limit of CCME water quality guidelines for freshwater (0.002 mg/L when hardness HCO3 ≥82 mg/L) in the month of August (0.002 mg/L). Concentrations of lead was equal to the limit of CCME water quality guidelines for freshwater (0.0010 mg/L when hardness HCO3 ≤60 mg/L) in the month of August (0.0010 mg/L) and exceeded this limit in the month of August (0.0015 mg/L).

Bacterial levels did not exceed the maximum concentration of *E. coli* from the Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 33: Water chemistry data and *E. coli* results for ScdF, 2019

SITE ScdF: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	DO (mg/L)	E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water						Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
19-06-26	15.0	16.8	0.02	8.74	60.2	15	280	0.032	38	15.2	-2.25	8.7	7.2	9.4	24.70	52	4.6
19-07-24	17.0	18.3	0.03	7.44	30.0	20	270	0.059	61	26.8	-1.78	9.2	7.3	9.1	42.90	63	6.6
19-08-21	14.0	17.0	0.06	7.47	118.2	44	89	0.104	113	44.3	-1.23	8.7	7.3	7.3	79.30	68	11.9
19-09-26	—	13.3	0.02	9.87	110.0	10	210	0.036	50	13.5	-3.21	8.4	6.5	9.7	29.90	118	2.9

Table 34: Nutrient results for ScdF, 2019

SITE ScdF: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO3 (mg/L)	Br (mg/L)	Ca (mg/L)	CO3 (mg/L)	Cl (mg/L)	F (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH3T (mg/L)	NH3_Un (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NOX (mg/L)	SO4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (mg/L)
19-06-26	15.0	0.03	4.66	0.022	4.0	0.27	0.26	0.86	2.6	<0.25	<0.001	<0.25	<0.25	<0.25	<5	—	0.6	29	0.037
19-07-24	20.0	0.04	8.4	0.038	6.0	0.29	0.42	1.43	3.3	<0.25	<0.001	<0.25	<0.25	<0.25	<5	—	0.8	29.0	0.051
19-08-21	43.9	0.03	14	0.082	4.7	0.18	0.75	2.26	4.2	0.070	<0.001	<0.05	0.060	0.06	2	—	0.5	11	0.080
19-09-26	10.0	0.02	3.82	0.003	9.0	0.28	1.32	0.95	3.5	<0.25	<0.001	<0.25	<0.25	<0.25	1	—	0.4	26	0.046

Table 35: Inorganics results for ScdF, 2019

SITE ScdF: HEAVY METALS AND OTHER ELEMENTS																				
Date (yy-mm-dd)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Cd (µm/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Rb (mg/L)	Sb (mg/L)	Sr (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
19-06-26	0.368	<0.001	0.005	0.030	0.00002	0.0003	<0.001	<0.001	1.01	0.0006	0.077	<0.0001	<0.001	0.0006	0.0006	<0.0001	<0.001	0.0001	0.001	0.008
19-07-24	0.360	0.001	0.004	0.041	0.00002	0.0007	<0.001	<0.001	1.9	0.0007	0.209	<0.0001	<0.001	0.0010	0.0011	<0.0001	<0.001	0.0002	0.002	0.010
19-08-21	0.295	0.001	0.005	0.052	0.00002	0.0007	<0.001	0.002	1.31	0.0007	0.287	0.0001	<0.001	0.0015	0.0019	<0.0001	<0.001	0.0002	0.002	0.003
19-09-26	0.387	<0.001	0.004	0.038	0.00002	0.0004	<0.001	<0.001	0.92	0.0009	0.089	<0.0001	<0.001	0.0006	0.0008	<0.0001	<0.001	<0.0001	<0.001	0.005

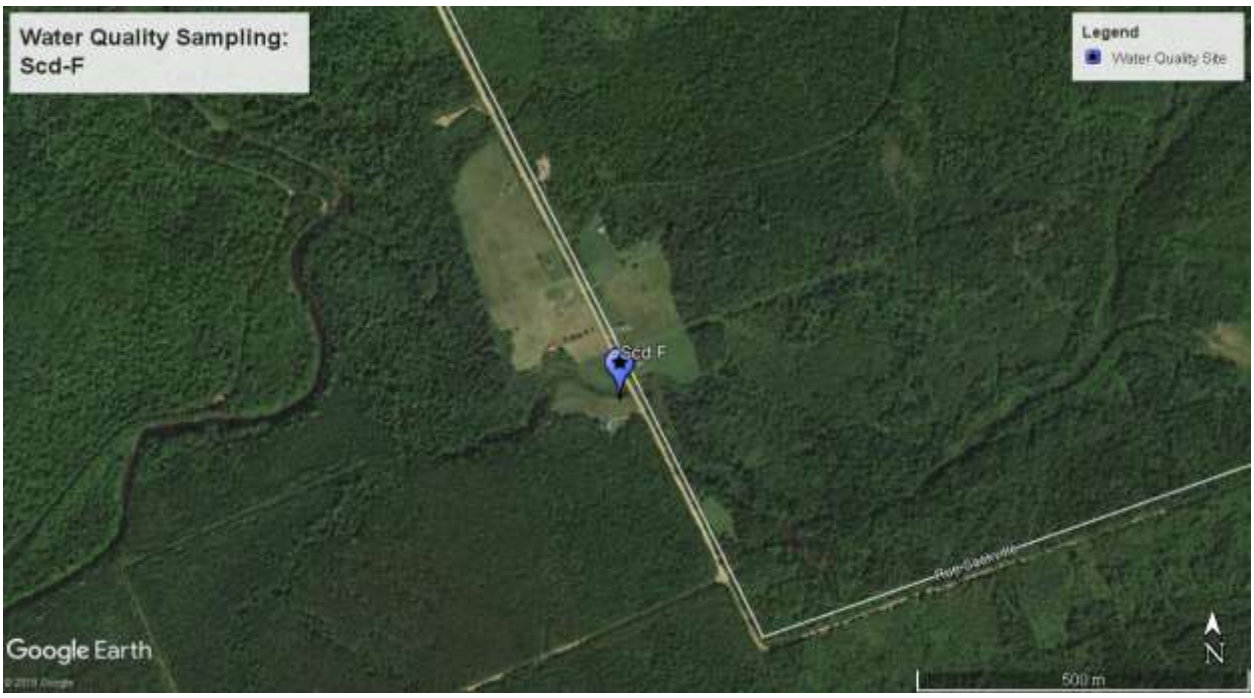


Figure 20: ScdF site location and surrounding land uses

Figure 21: Site photos for water quality sampling site ScdF, (photos July 2018)

3.3 Scoudouc River – ScdH

This water quality sampling site is located in the Cornwall Brook, accessed through a farmer's road, with permission. This small road is located passed the end of Promenade Harbour View, behind the *Seaside Chevrolet Dealership*. The surrounding land uses includes; residences, agricultural fields, cattle fields, Highway 15, a mineral extraction pit, transmission power lines and the Scoudouc Industrial Park.

The farm fields on both sides of the sampling site has buffer zones ranging from 10 -30 metres. There is a beaver dam directly above the sample site, and beaver activity has reduced the density of trees in the buffer zone. Other clear cut fields upstream now serve as cattle pastures, and seem to have buffer zones > 25 m. The sand/gravel pit upstream (approx. 3 ha.) has a forested buffer over 400 m. However, there seems to be drainage near the pit that flows towards the brook. The headwaters of the Cornwall Brook is located near the industrial park. There is forested land between the industrial zone and the wetlands, and based on approximate land elevations, there does not appear to be drainage heading towards the brook.

The water sampling results for the site ScdH, for 2019, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen. However, levels of dissolved oxygen was slightly below the recommendation (6.5 mg/L) for general cold water organisms in August 6.33/mg/L).

Total phosphorus levels for long-term eutrophic conditions, according to the CCME Guidance framework for Phosphorus, were in the meso-eutrophic range (0.020 – 0.035 mg/L) in July, and in the eutrophic range (0.035 – 0.100 mg/L) in June, August and September.

Concentration results for the nitrate ion (NO3) are below the short term (124 mg/L) and long term (2.9 mg/L) CCME recommendations for direct toxicity to sensitive freshwater life (these guidelines do not consider indirect effects due to eutrophication, nor does this interpret results for assessment of eutrophic conditions).

Concentrations of aluminum exceeded the CCME water quality guideline (0.100 mg/L when the pH is ≥6.5) for the samples taken in June and September. Concentrations of iron exceeded the CCME water quality guideline (0.300 mg/L) for all the samples taken in in 2019. The highest iron level was in June (0.60 mg/L).

Bacterial levels did not exceed the maximum concentration of *E. coli* from the Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 36: Water chemistry data and *E. coli* results for ScdH, 2019

SITE ScdH: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																	
Date (yy-mm-dd)	Temp (°C)		SAL	DO	E. coli (MPN /100mL)	ALK_T	CLRA	COND (µS/cm)		HARD	Lang_Ind	pH (pH)			TDS (mg/L)		TURB
	Air	Water	(ppt)	(mg/L)		(mg/L)	(TCU)	Field	Lab	(mg/L)	(20°C)	Field	Lab	Sat (20°C)	Field	Lab	(NTU)
19-06-26	16.0	12.7	0.10	9.66	305.8	46	98	0.160	212	39.2	-1.37	7.2	7.2	8.6	135.85	123	2.7
19-07-24	19.0	16.7	0.19	7.71	134.0	95	27	0.326	399	75.9	-0.40	7.5	7.6	8	251.55	204	1.6
19-08-21	17.0	17.8	0.21	6.33	186.6	78	48	0.375	441	68.3	-0.54	7.4	7.6	7.6	282.10	229	1.5
19-09-26	—	12.6	0.09	11.86	132.0	40	100	0.147	198	27.8	-1.58	6.6	7.2	8.8	124.80	52	7.3

Table 37: Nutrient results for ScdH, 2019

SITE ScdH: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO3 (mg/L)	Br (mg/L)	Ca (mg/L)	CO3 (mg/L)	Cl (mg/L)	F (mg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH3T (mg/L)	NH3_Un (mg/L)	NO2 (mg/L)	NO3 (mg/L)	NOX (mg/L)	SO4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (mg/L)
19-06-26	45.9	0.06	12.9	0.068	35.7	0.21	0.94	1.70	26.0	<0.05	<0.001	<0.05	0.140	0.140	<1	—	0.6	16.0	0.043
19-07-24	94.6	0.10	25.2	0.354	61.0	0.19	1.60	3.15	46.9	<0.05	<0.001	<0.05	0.200	0.200	<1	—	0.5	6.9	0.030
19-08-21	77.7	0.12	22.7	0.291	76.7	0.24	2.06	2.83	57.7	<0.05	<0.001	<0.05	0.090	0.090	8	—	0.5	10	0.040
19-09-26	39.9	0.06	9.03	0.059	33.0	0.31	0.42	1.28	26.5	<0.25	<0.001	<0.25	<0.25	<0.25	6	—	0.4	15.4	0.046

Table 38: Inorganics results for ScdH, 2019

SITE ScdH: HEAVY METALS AND OTHER ELEMENTS																				
Date (yy-mm-dd)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Cd (µm/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Pb (mg/L)	Rb (mg/L)	Sb (mg/L)	Sr (mg/L)	U (mg/L)	V (mg/L)	Zn (mg/L)
19-06-26	0.157	<0.001	0.090	0.055	0.00001	0.0003	<0.001	<0.001	0.6	0.0007	0.181	0.0005	<0.001	0.0003	0.0007	<0.0001	<0.001	0.0001	<0.001	0.005
19-07-24	0.040	<0.001	0.208	0.079	0.00001	0.0002	<0.001	<0.001	0.34	0.0011	0.270	0.001	<0.001	<0.0001	0.0013	<0.0001	<0.001	0.0002	<0.001	0.001
19-08-21	0.067	<0.001	0.285	0.087	0.00001	0.0002	0.001	<0.001	0.32	0.0012	0.207	0.0014	<0.001	0.0002	0.0015	<0.0001	<0.001	0.0002	<0.001	0.002
19-09-26	0.195	<0.001	0.125	0.042	0.00001	0.0002	<0.001	<0.001	0.48	0.0006	0.054	0.001	<0.001	0.0003	0.0008	<0.0001	<0.001	<0.0001	<0.001	0.002

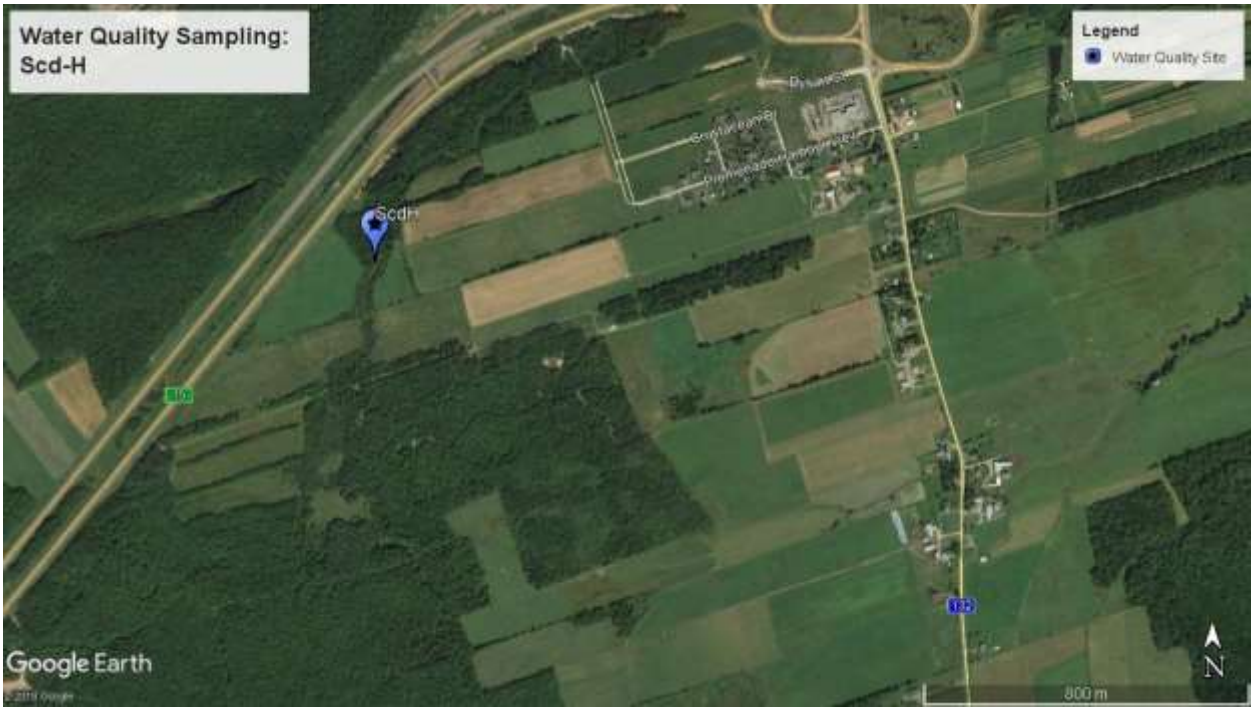


Figure 22: ScdH site location and surrounding land uses

Figure 23: Site photos for water quality sampling site ScdH, (photos May 2018)

3.4 Bacterial Sampling Summary

The bacterial levels measured in the 2019 sampling of the Shediac and Scoudouc River are summarized below.

For the Shediac River, there are 4 samples that surpassed the Canadian Recreational Water Quality Guideline (400 MPN/100 mL): the site ShdB in August; the site ShdC September, and ShdE in August and September. The site ShdC also had elevated levels of *E. coli* in July and August. There was no rainfall in the 24 hours prior to the sampling in August. There was an occurrence of rainfall light rain (> 5 mm) in the 24-hour period prior to a sample was in the month of September.

For the Scoudouc River, only 1 site had higher levels of E. coli in June; ScdH (305.8 MPN/100 mL), but did not surpassed the Canadian Recreational Water Quality Guideline (400 MPN/100 mL). Levels remained below the guideline at this site despite the presence of beavers upstream of the sampling site.

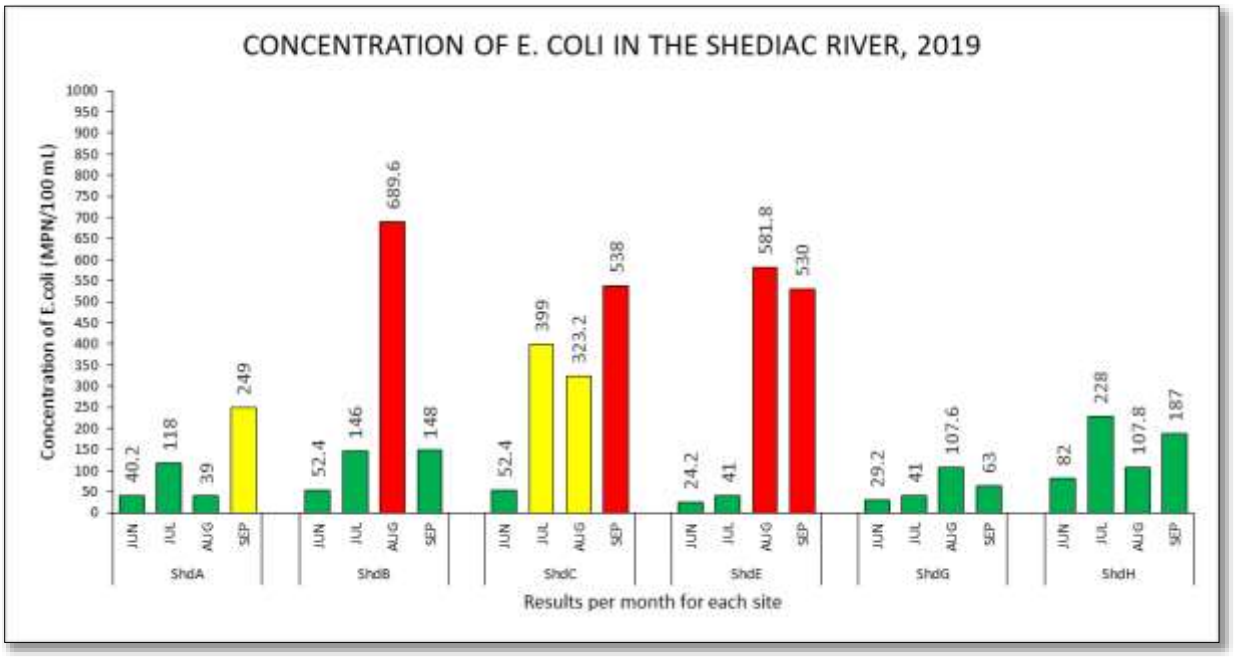


Figure 24: Summary of water quality results for *E. coli*, Shediac River sampling 2019

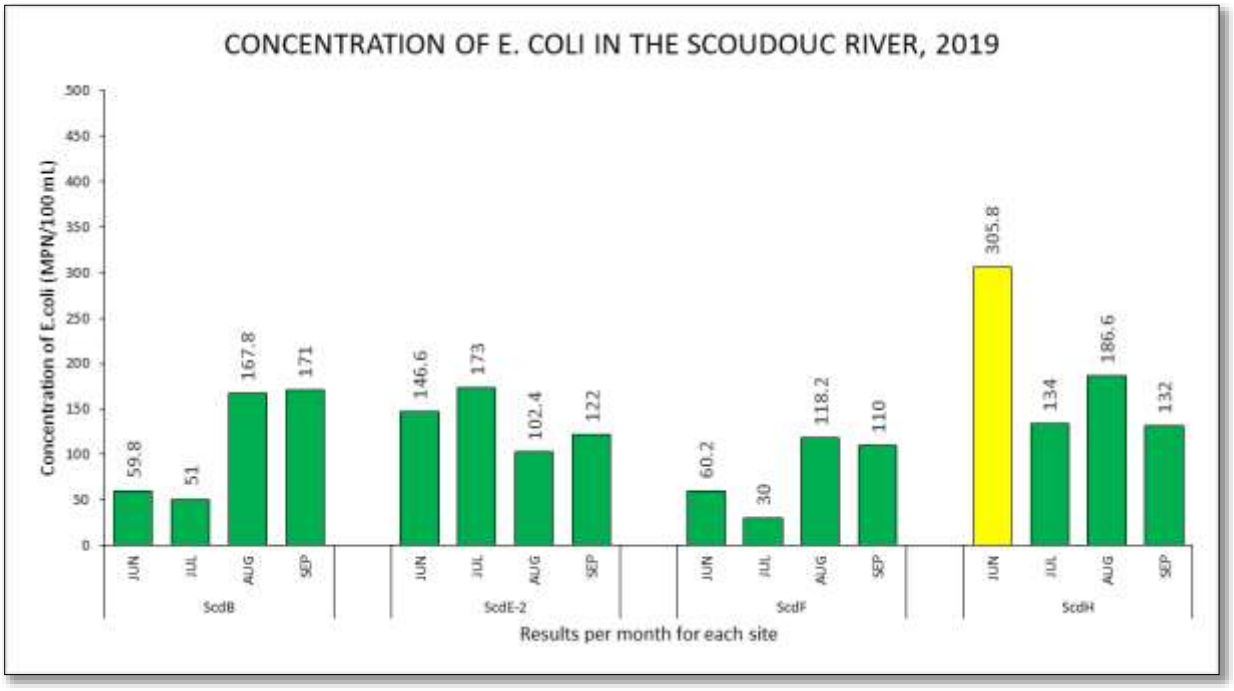


Figure 25: Summary of water quality results for E. coli, Scoudouc River sampling 2019

4. WATER TEMPERATURE MONITORING

This part of the project is done in partnership with the "*Institut national de la recherche scientifique*" (INRS-ETE) in the province of Quebec. This partnership began in 2016, where INRS-ETE provided the SBWA with 3 temperature loggers, and an additional 4 loggers were purchased by the SBWA (HOBO light pendants). Having a total of 7 loggers, the strategy is to monitor temperatures fluctuations in strategic locations. Areas of interest are those determined to be high risk for thermal stress in juvenile salmonids and other cold water species. Other areas of interest are those determined to be colder zones suitable for thermal refugia, i.e. habitats containing colder water that provides a refuge for fish from high water temperatures.

Table 39: Thermograph monitoring Sites information, SBWA 2019

Site ID	Watercourse Name	Latitude	Longitude	Installation date	Date of retrieval
T-ShdA	Shediac River	N46° 11' 36.7"	W64° 48' 56.0"	05/31/2019	Lost
T-ShdE	Shediac River	N46° 14' 41.5"	W64° 39' 56.3"	05/31/2019	10/01/2019
T-ShdE-2A	Weisner Brook	N46° 14' 24.1"	W64° 39' 46.0"	06/11/2019	10/01/2019
T-ShdM	Weisner Brook	N46° 12' 27.1"	W64° 40' 21.0"	06/11/2019	10/01/2019
T-ShdB	McQuade Brook	N46° 13' 54.9"	W64° 44' 31.9"	05/31/2019	10/01/2019
T-ScdD	Scoudouc River	N46° 11' 2.3"	W64° 30' 39.8"	06/11/2019	Lost
T-ScdB	Scoudouc River	N46° 08' 39.2"	W64° 33' 36.6"	05/31/2019	10/01/2019

The temperature loggers were installed on May 31st and June 11th, and retrieved on October 1st. See Table 39 for site placement details. In 2019, two temperature loggers were unfortunately lost, one in each watershed. There were many heavy rain storm events that happened this year that could have taken out the loggers.

The following section of this report shows the thermograph data (daily maximum temperatures) recorded. The recommended temperature limits indicate the threshold for thermal stress beginning at 22.5°C for juvenile Atlantic salmon, and lethal limit of 25°C or greater (Crisp 1999).

Temperature monitoring Shediac River

Five sites are monitored in the Shediac River and its tributaries. The temperature logger "T-ShdA" was lost this year (no data).

Figure 26: Installation of a water temperature logger in-stream

4.1 Water temperature monitoring Shediac River

Five sites are monitored in the Shediac River and its tributaries. The temperature logger "T-ShdA" was lost this year (no data).

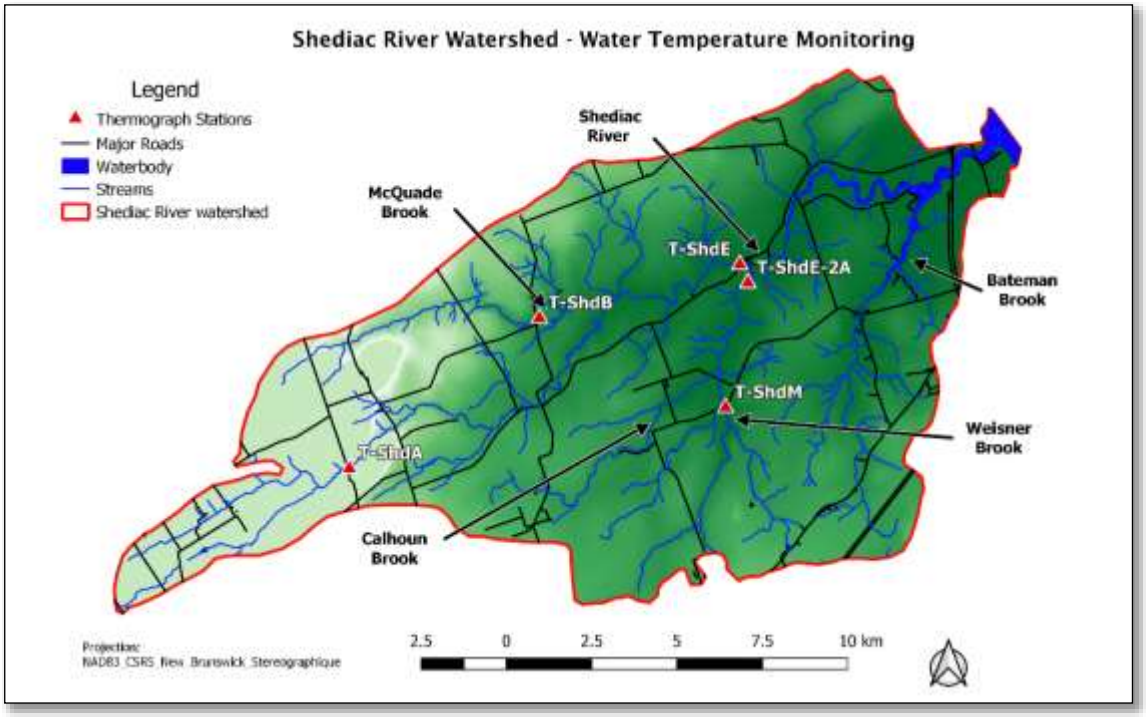


Figure 27: Map of temperature logger placement in the Shediac River

4.1.1 Water Temperature Monitoring Site - T-ShdB

This temperature logger was installed in the McQuade Brook, approximately 35 metres downstream of the fish ladder and upstream of the electrofishing site EShdB-02.

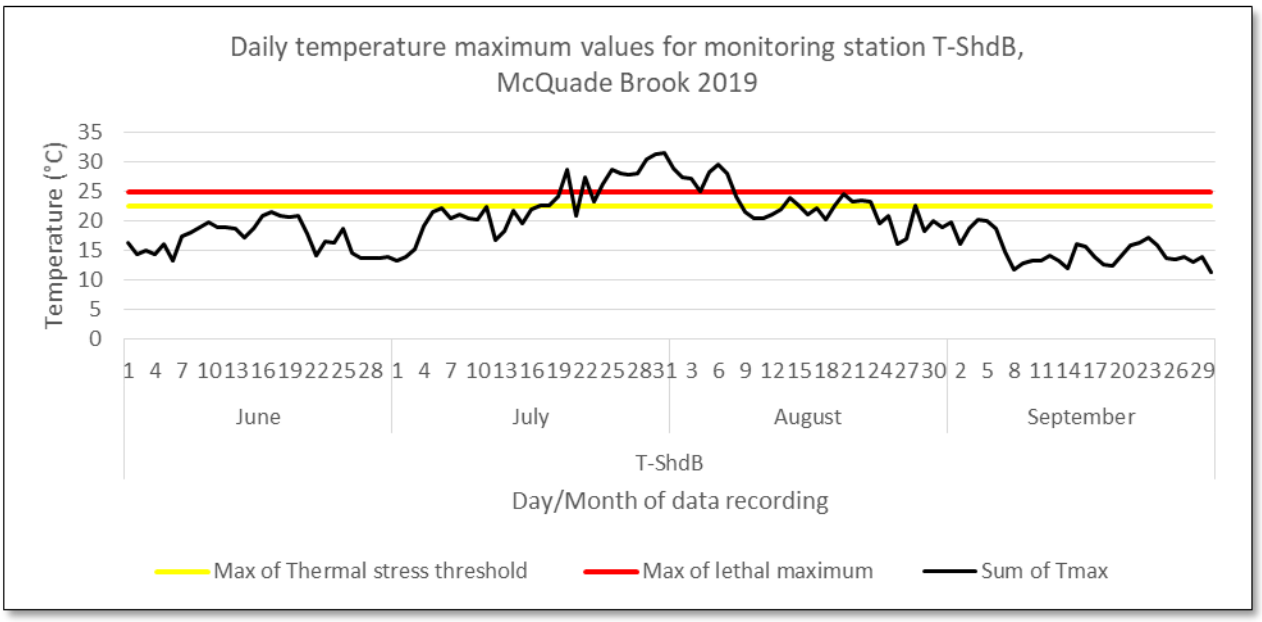


Figure 28: Thermograph data chart for monitoring station ID T-ShdB, McQuade Brook 2019

The thermograph shows the maximum daily temperature between June 1st and September 30th. The maximum temperatures exceeded the thermal stress threshold on 30 occasions during the peak of the summer months. During theses 30 days, the maximum temperatures exceeded the lethal limit on 17 occasions. The lethal maximum temperature was exceeded for 15 consecutive days (July 24 to August 7). The highest maximum temperature recorded at this station was 31°C, and lasted for 2 consecutive days (on July 30 and July 31). The highest average daily temperature was 23.35°C.

4.1.2 Water Temperature Monitoring Site - T-ShdM

This temperature logger was installed in the Weisner Brook, a tributary of the Shediac River. This logger was predicted to show cooler temperatures, as the brook is recognized as a summer resting area for mature brook trout by the *Department of Natural Resources and Energy Development*, due to its colder characteristics. This stream has an excellent tree coverage; undeveloped forested lands along the majority of the brook. It also has a lot of input of cold water from natural underground springs. These conditions of shade from the forest and cold water springs are great to keep the water temperatures cool.

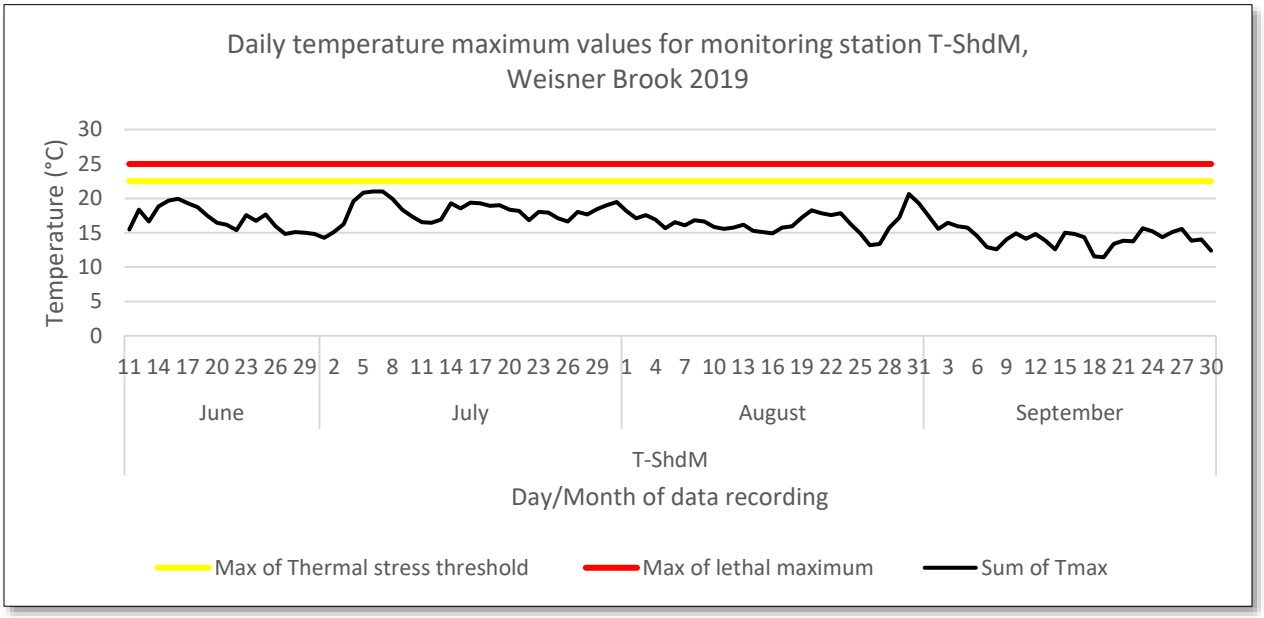


Figure 29: Thermograph data chart for monitoring station ID T-ShdM, Weisner Brook 2019

The thermograph shows the maximum daily temperatures between June 11th and September 30th. The logger was installed on June 1st but it did not start recording until the 11th, the cause of the glitch is unknown. The maximum temperatures did not exceed the lethal limit or the thermal stress threshold. The highest temperature recorded was 21°C on July 6 and July 7. The highest daily average temperature for this site was 19.22 °C.

4.1.3 Water Temperature Monitoring Site - T-ShdE

This temperature logger is located in the mid to lower reaches of the main branch of the Shediac River, near the covered bridge. This area was predicted to have warmer waters due to the lack of canopy coverage, and its wide and shallow channel.

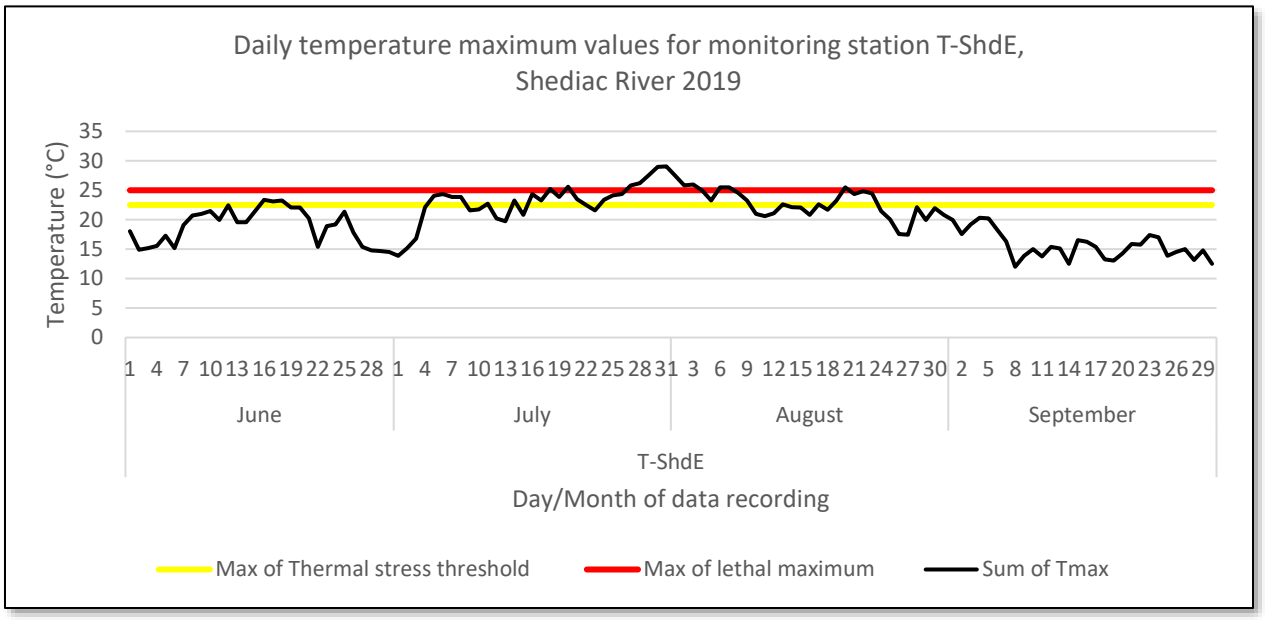


Figure 30: Thermograph data chart for monitoring station ID T-ShdE, Shediac River 2019

The thermograph shows the maximum daily temperature between June 1st and September 30th. The maximum temperatures exceeded the thermal stress threshold on 40 occasions during the peak of the summer months. Of those 40 days, the maximum temperatures exceeded the lethal limit on 13 occasions. The lethal maximum temperature was exceeded for 8 consecutive days (July 27 to August 3). The highest maximum temperature recorded at this station was 29.05°C on August 31st and the highest average daily temperature was 25.27°C.

4.1.4 Water Temperature Monitoring Site - T-ShdE 2A

This temperature logger was installed in the Weisner Brook, approximately 300 metres upstream from its convergence with the Shediac River. This site is used to compare with the station of the covered bridge (T-ShdE), as it is the closest source of cold water for migrating fish looking for thermal refuge during high temperatures. This site is located approximately 5 km downstream from the second logger in the Weisner Brook; T-ShdM. Just like the other site in this brook (T-ShdM), the surrounding canopy coverage of the forested land and the input of cold water from natural springs contributes to the overall colder water temperatures.

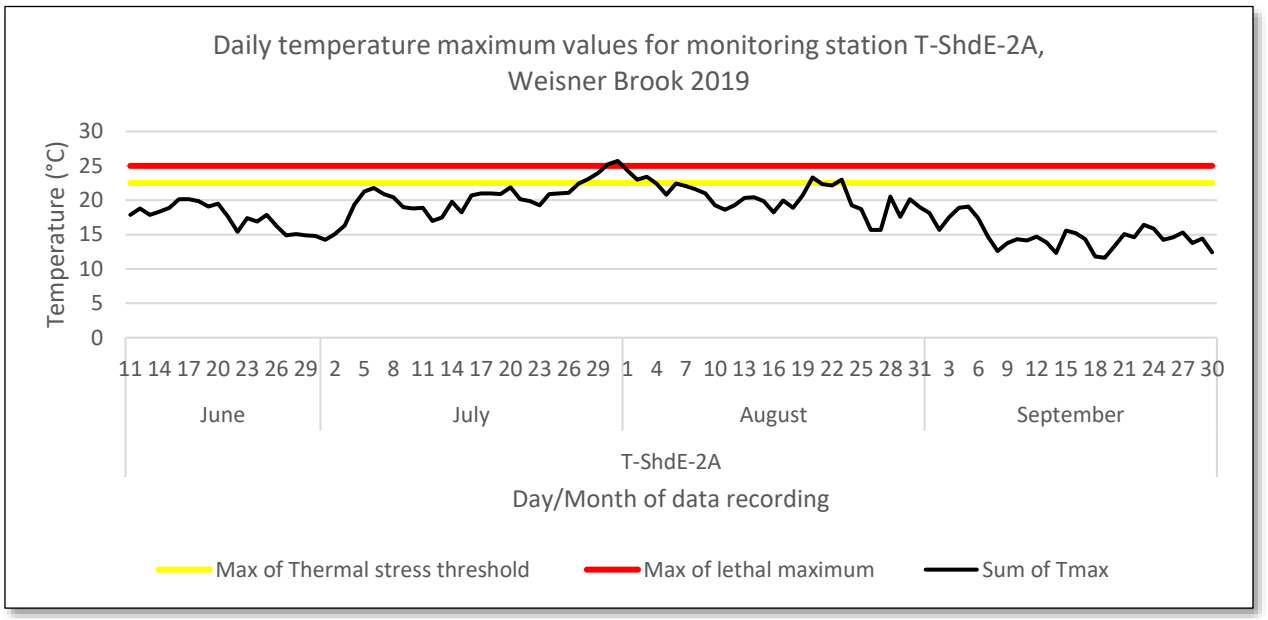


Figure 31: Thermograph data chart for monitoring station ID T-ShdE-2A, Weisner Brook 2019

The thermograph shows the maximum daily temperatures between June 11th and September 30th. The temperature was installed on June 1st but it did not start recording until the 11th, the cause of the glitch is unknown .The maximum temperatures exceeded the thermal stress threshold on 9 occasions during the peak of the summer months. Of those 9 days, the maximum temperatures exceeded the lethal limit on only 2 occasions (July 30 and July 31). The highest maximum temperature recorded at this station was 25.71°C on July 31 and the highest average daily temperature was 21.91°C.

4.2 Temperature monitoring Scoudouc River

Two sites are monitored for water temperature in the Scoudouc River. The temperature logger "T-ScdD" was lost this year (no data).

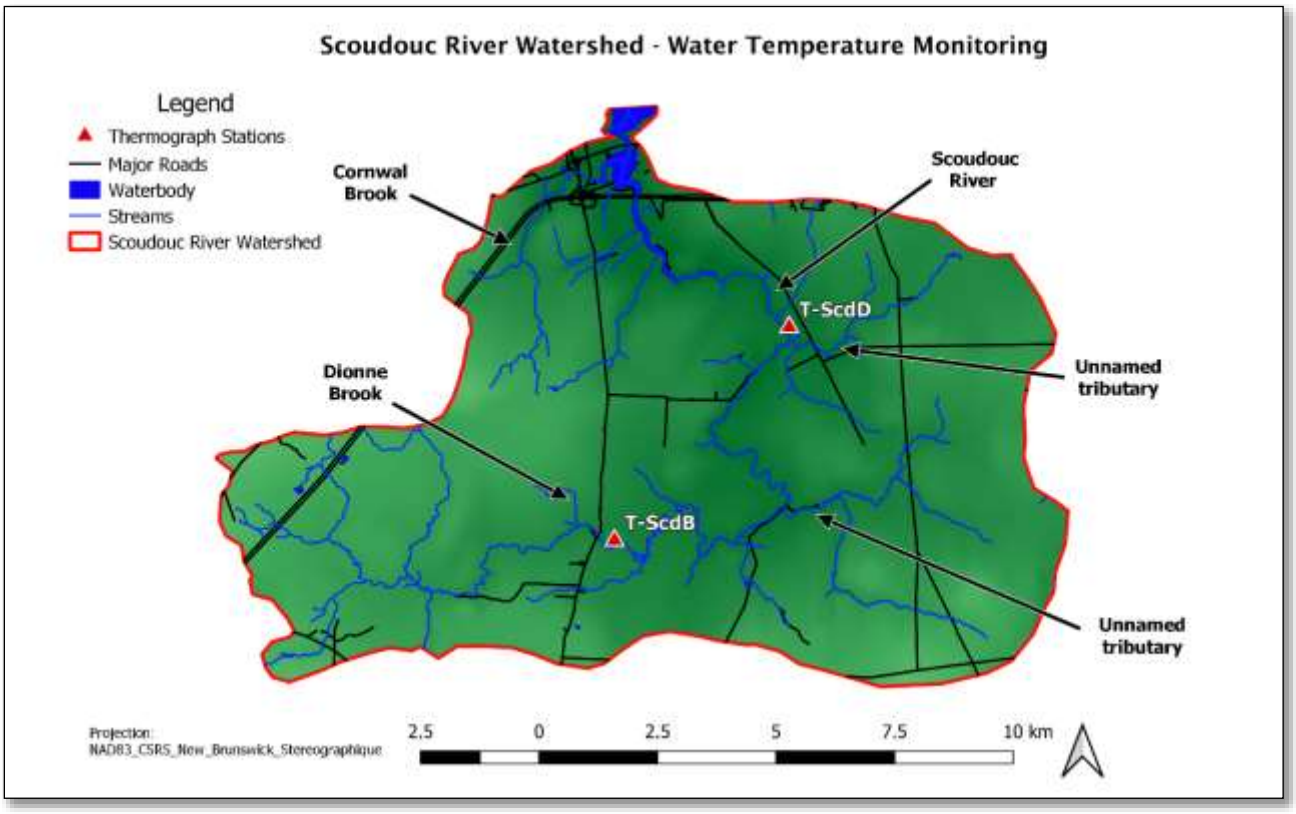


Figure 32: Map of temperature logger placement in the Scoudouc River

4.2.1 Water Temperature Monitoring Site - T-ScdB

This temperature logger was installed in the main branch of the Scoudouc River, next to the *Greater Shediac Sewage Commission's* treatment lagoons in Scoudouc.

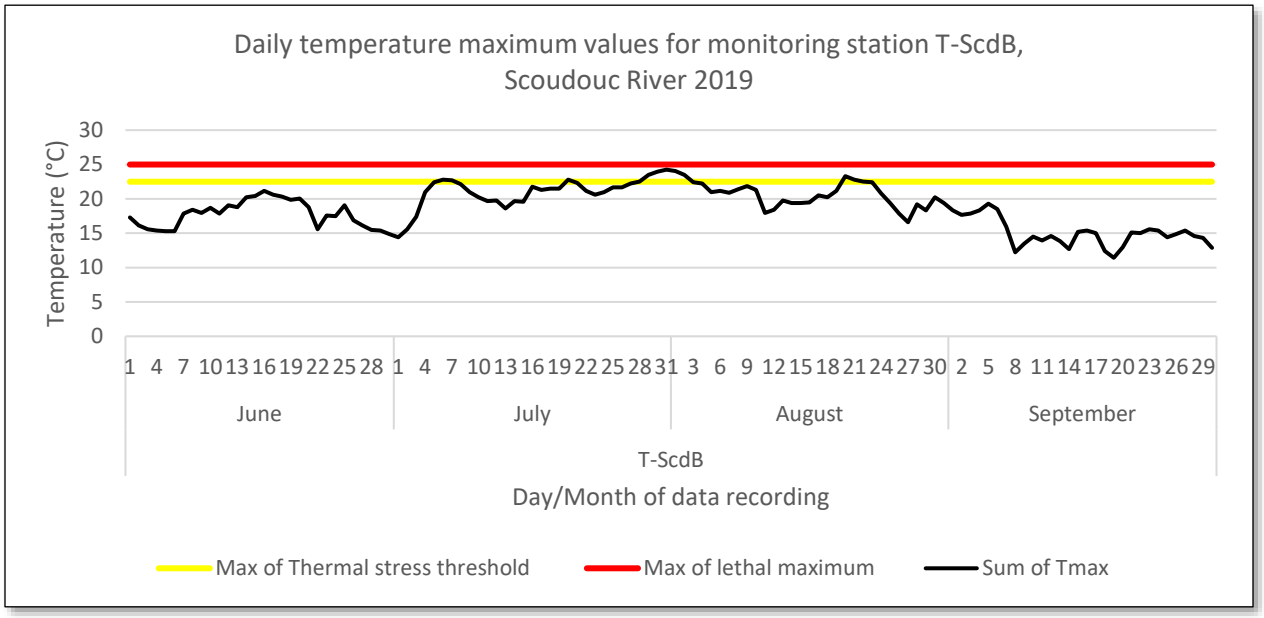


Figure 33: Thermograph data chart for monitoring station ID T-ScdB, Scoudouc River 2019

The thermograph shows the maximum daily temperatures between June 1st and September 30th. The maximum temperatures exceeded the thermal stress threshold on 12 occasions during the peak of the summer months. The maximum temperatures at this site did not exceed the lethal limit. The highest temperature recorded during this time period was 24.26°C on July 31. The highest average temperature daily temperature for this site was 23.05°C.

5. DISCUSSION

The first disclaimer is that SBWA does not by any means proclaim to be water quality experts. The purpose of this project is to collect samples, organize the data, look at surrounding land uses and buffer zones, then pass on the information to experts. We can point out trends from our limited sampling results, but changes occur so quickly that general patterns are not always evident. Our sampling is simply a snapshot of the results on that collection day. It would be very expensive to monitor water quality changes on a daily or even weekly basis. As a non-profit environmental organization, we do not have the resources or capacity for this. Our goal is to look for gross abnormalities in general patterns and hope to identify possible causes.

Many of the flagged parameters above can have a wide range of negative impacts on various aquatic species when concentrations exceed their threshold of tolerance. This threshold varies depending on species, life stage, and sometimes concentrations of other parameters.
The concentrations for the following metals were below their respective detection limits for all samples at every site. These metals were not included in the above tables; Silver (Ag), Beryllium (Be), Bismuth (Bi), Selenium (Se), Tin (Sn), Tellurium (Te), Thallium (Tl).

Most sites were under the limits for E. coli based on Health Canada Recreational Guidelines, except for ShdB, ShdC and ShdE (4 samples in total were above 400 MPN/100 mL).

All pH levels were found to be within the guidelines; between 6.5 and 9. However, dissolved oxygen fell below the recommended 6 mg/L for the protection of aquatic life, for early life stages of cold-water species, at these sites: ShdB (1x), ShdE (1x), ShdH (1x), ScdB (x2) and ScdH (1x).

Looking at total phosphorous levels, most of our site falls within the mesotrophic to eutrophic range. This year, only one site (ShdB) had a sample with total phosphorous levels low enough to be classed in the oligotrophic range (4-10 µg/L).

Inorganic's results that were over the CCME recommended water quality guideline were mainly iron and aluminum. The province of New Brunswick is known to have higher levels of naturally occurring aluminum.

Copper and lead were flagged in a few samples this year. The site ScdE-2 had 1 sample where copper was at the CCME limit, but did not exceed it. The site ScdF, a tributary of the Scoudouc River, had the same copper value but also had 2 samples where lead was flagged as being equal or exceeding the CCME guidelines. More investigation and consultation with experts and academics is needed to interpret these inorganic results.

There are 2 levels of temperature that are evaluated: thermal stress (22.5°C) and lethal limits (25°C). These extreme temperatures can change behaviour in fish such as salmonids, forcing them to migrate in search of colder water. The longer these temperatures remain, the higher the risk of fish mortality. Water temperature monitoring using loggers is a widely used tool to monitor temperature fluctuation in watersheds. The goal is to identify hot spots and cold zones suitable for

thermal refuge in periods of thermal stress among fish. The data is used to measure changes over time, due to the impact of human activities and development as well as climate change.

This year, the McQuade Brook had the highest recorded temperature; 31°C which lasted for 2 consecutive days. The logger recorded thermal stress levels on 30 occasions and lethal limits on 17 occasions, of which there was 17 consecutive days with temperatures exceeding 25°C.

The covered bridge area of the Shediac River was the second-warmest site in 2019; the highest temperature reading was 29.05°C, and thermal stress levels were reached 40 times. The lethal limits were exceeded 13 times, with 8 of them being consecutive days.

There are two loggers monitoring the Weisner Brook, the coldest tributary of the Shediac Bay watershed due to its long stretches of forested riparian habitats and cold springs input into its tributaries. As described in the section 3.5, the Weisner Brook is recognized by the Department of Natural Resources as a "summer resting refuge for mature trout", due to the cooler temperatures. The logger site T-ShdM recorded temperatures below 22.5°C during the 2019 season; the highest recorded temperature was 21°C. However, further downstream before the convergence of the Weisner Brook with the Shediac River, the second logger T-ShdE-2A recorded temperatures exceeding the thermal stress threshold on 9 occasions, and the lethal limits on 2 occasions. The highest recorded temperature was 25.71°C.

In the Scoudouc River, the logger at the site T-ScdB recorded temperatures exceeding the thermal stress threshold on 12 occasions, but did not exceed 25°C.

Our summers our becoming increasingly hotter. Longer periods without rainfall combined with extreme heats can cause water levels to drop and become warmer than is safe for cold water loving species. Temperatures will continue to be monitored to measure the impacts of our ever-changing climate.

6. HABITAT AND WATER QUALITY ENHANCEMENT

Fish habitat restoration and water quality enhancement is a major initiative of the SBWA. Areas where bank erosion occurs causes an excess of sediment in the watercourse. Sedimentation can cause various issues for aquatic ecosystems; it can suffocate fish and fish eggs, bury aquatic insects, can carry harmful pollutants such as heavy metals and excessive nutrients that can further worsen conditions of the ecosystem, etc.

Blockage to fish migration are both naturally occurring and man-made, like debris jams, hanging culverts, and man-made dams. When these barriers occur in lower areas of a watershed, it can close off a large amount of suitable spawning grounds for important migratory fish species like the Atlantic salmon.

In 2019, two sites were selected for habitat enhancement. Work continued at the existing restoration site known as Edna's Pond, along the Scoudouc River. The second restoration site includes maintenance of a problematic culvert, clearing of woody debris along the stream, and buffer zone enhancement for riverbank stabilization.

Figure 34 : Native tree planting for riparian restoration is a technique used by the SBWA

6.1 Edna's Pond Restoration Site

In 2017, an area in the Scoudouc River surrounding a precious salmon habitat, was selected for major restoration efforts intended to reduce sediment runoff from a sloped ATV trail and to halt the river bank erosion. Ongoing efforts are being carried out every year to maintain the previous restoration work of the area.

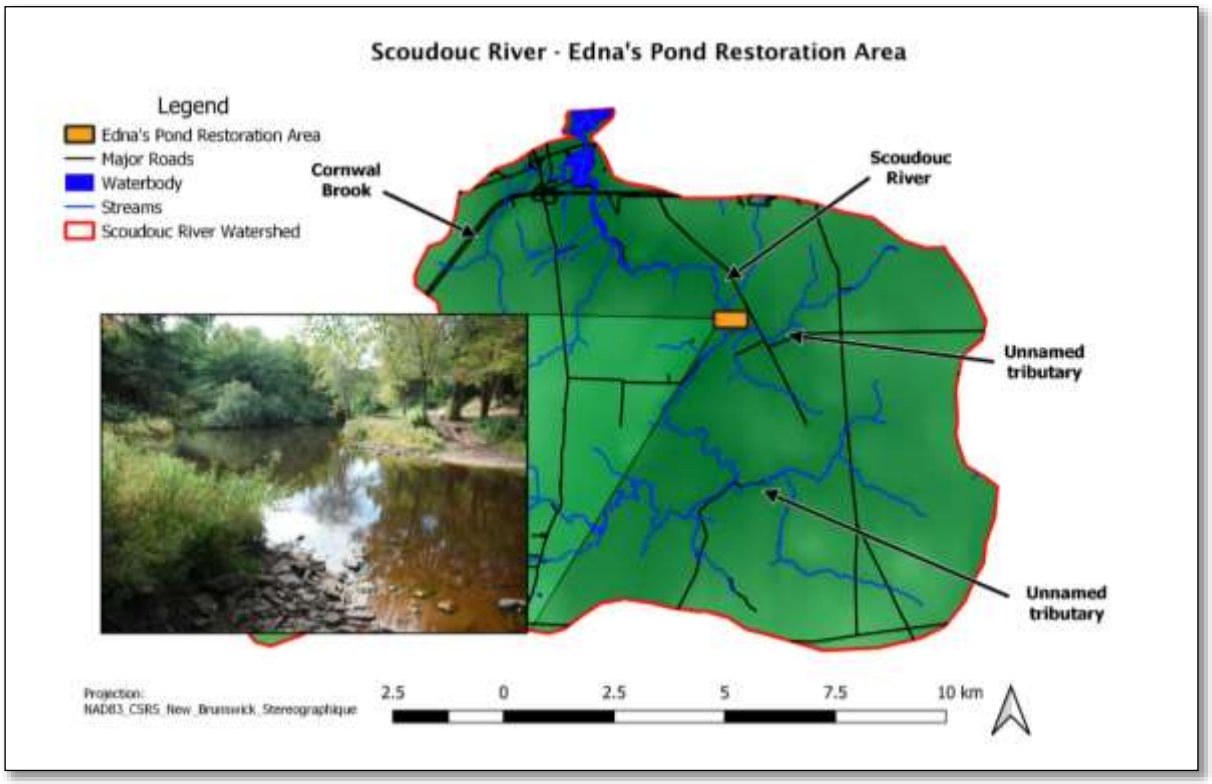


Figure 35: Map of Edna's pond restoration area

The five sediment deflectors in the area require constant maintenance every year. They capture sediments from runoff which causes a sediment buildup on the logs. In the spring of 2019, small trenches were dug by shovel to eliminate the sediment build up on the stabilizers and also to help direct the runoff towards the forested areas.

Actions have been taken this year to block two illegal river crossing access trails. Three large posts made out of a fallen birch tree was set deep in the middle of the two river access trails and cement was poured in the holes to help secure them. Along with the posts, straw bales were set in the trails. This will hopefully discourage ATV from trying to use the river access trails and also will help capture sediment from runoff. These were installed with student volunteers from Shediac Cape School.

In addition, 7 native trees and grass seeds have been planted on the slope and around the river bank to further stabilize the soil of the area. The trees used were provided by the SBWA tree nurseries.

A sign was installed at the southernmost river access indicating the trail blockages and the negative implications of crossing the river with motor vehicles to this sensitive habitat.

Figure 36: Before and after photos of ATV access blockage and sediment control (hay-bale check dam)

Figure 37: ATV access blockage and sediment control (hay-bale check dam)

Figure 38: New signage designed for Edna's pond restoration site, 2019

6.2 Culvert Restoration – Scotch Settlement

Aquatic connectivity is very important for the biodiversity of a watershed. Culverts modify the morphology and the hydrology of a stream, and can sometimes hinder that connectivity by creating barriers. The presence of an outflow drop, steep culvert slopes, deteriorating culverts, and the presence of beaver dams or debris blockages within the culvert, can all negatively influence fish passage. Problematic culverts in terms of passage prevent fish to access upstream habitats. Other issues includes erosion of stream banks and road washouts caused by flooding and improperly sized culverts.

In 2018, the SBWA field team received training and conducted culvert assessments within the Shediac Bay watershed. The objective of these assessments was to target culverts located on Atlantic salmon and/or Brook Floater host fish bearing streams, then classify them as either passable, partial barrier or full barrier to fish passage.

In 2019, four problematic culverts were revisited. Two of these culverts had been replaced by the *Department of Transportation and Infrastructure* during the summer. The two other culverts were

now free of the debris that classified them as partial or full barriers to fish passage. Other culverts deemed to be possible fish barriers were also revisited. While stopped at a culvert known to have issues in the Scotch Settlement area, a local resident confirmed that debris frequently blocks the culvert and leads to flooding during heavy rain events. The stream is a tributary of the McQuade Brook, an important branch of the Shediac River.

The issue was caused by shrub overgrowth directly upstream of the culvert, which causes debris to build up every spring. These blockages caused impediments to water flow, leading to flooding and fish passage issues. The area surrounding the culvert showed evidence of streambank erosion and sedimentation, due to a lack of a vegetative buffer zone, flooding and agriculture activities in the surrounding farmland.

The landowner was then contacted, and permission was granted to the SBWA to clear the obstructions at the mouth of the culvert, clean the excess of woody debris up the stream and plant native shrubs along the buffer zone to enhance fish habitat.

Figure 39: Map of the Scotch Settlement stream restoration, 2019

On September 12, the team trimmed the overgrowth at the culvert using manual tools. The stream was cleaned of excessive woody debris on a distance of approximately 235 meters upstream of the culvert. The native shrubs planted were Red Osier Dogwood, for its strong roots and its capacity to stabilize stream banks and prevent erosion. A total of 28 native shrubs were planted on a distance of approximately 60 meters. The farmer did not want reforestation beyond the planting of shrubs, but he may be willing to continue in future years if the project goes well.

Figure 40: Before and after photos of the shrub thinning upstream of the culvert

6.3 Farm restoration in Scoudouc

The Shediac Bay Watershed Association met with a local farmer in Scoudouc and the department of agriculture in the spring of 2019 to discuss project possibilities to restore the buffer zone and divert runoff coming from the barn and manure storage areas.

A swale was built during the summer to divert stormwater away from the stream and into the field where it can be absorbed in the soil.

The SBWA identified a zone to reforest in order to create a vegetated buffer zone between the barn and the stream. The planting was planned for the fall of 2019. Unfortunately, hurricane Dorian hit the region on September 7th and the farmer and SBWA staff were diverted to clean up work relating to the storm. The SBWA will reach out to the farmer again in spring 2020.

6.4 Restoration Nurseries

In 2017, four restoration nurseries were implemented in partnership with the local schools and community gardens. More than 500 seedlings have been planted to be used in restoration projects in 2019. The advantage of the tree nurseries is to increase the survival rate and provide three-year-old trees at an affordable price.

A tree planting activity was accomplished with the students of Shediac Cape School during the adopt-a-stream field trip. More reforestation activities will be organized with the students to transplant the trees next to marshes and watercourses.

A presentation on using native trees for environmental restoration was given on September 21st during the TD tree day activity in Shédiac. The manager of the SBWA, Rémi Donelle gave a presentation on the importance of trees in protecting wetlands. He emphasized on establishing a good buffer zone and increasing the biodiversity of the area by planted various species of native trees.

Figure 41: Example of one nursery bed

A presentation were given to students Shediac Cape school June 11th. The students participated in weeding and planting trees in the nursery. Acadian forest and the importance of trees to improve water quality.
Throughout the field season, the SBWA employees has been engaged in picking up garbage alongside various roads and rivers, where a cleanup feels needed.

6.5 Garbage removal from streams in the watershed

A variety of plastics and debris can be found in the watersheds from illegal dumping and littering. With the help of the summer students problematic areas near our sampling sites and within the municipality of Shediac were identified to clean during the summer.

On June 19, 2019, the team picked up trash along a section of the Shediac River road and the covered bridge. A total of 2 full garbage bags, one tire, and a variety of bigger pieces like metal bars, pipes and plastic were collected.

\+ **Figure 42 : Garbage from Shediac river road**

Figure 43: Map of clean up from the Shediac river road

On August 6th 2019, the team picked up trash along a section of the stream beside Shediac Bakery, off of Main Street in Shediac. A total of 3 full garbage bags, one big flower pot, and a variety of bigger pieces including a tire and a pieces of metal siding were collected.

Figure 44: Map of clean up by the Shediac Bakery

On August 8, the team picked up trash at three separate locations. The first location was at the covered bridge, by the Shediac River road. This was the second time that the team picked up the trash this season in that area. The second place was at the culvert, on St Phillipe road and the third place was at a culvert on Bateman Mill road. One full garbage bag was filled with trash between the three sites.

Figure 45: Map of clean up at the covered bridge

Figure 46: Map of clean up at a culvert on Bateman Mill road

Figure 47: Map of clean up at a culvert on St Phillipe road

6.6 Road side garbage clean up in Grande-Digue

Garbage found in ditches along roadways eventually find their way to the watercourses and the Shediac Bay.

The Shediac Bay Watershed Association was approached by a group of citizens from Grande-Digue in March 2019 to help organize a roadway clean up. Since the SBWA has capacity in organizing environmental activities the association took the lead in coordinating the activity with the support of local volunteers.

The public was invited to join the association May 11 from 9 am to noon at the Notre Centre community centre. A total of 32 volunteers came together to clean a total of 35 km of roadways. An impressive 640 kg of trash was collected and brought to the Eco 360 disposal site. Bottles and cans were separated and given as a donation to the Pépère Boite a Lunch, a local organism supporting Grande-Digue school.

A Facebook post was shared on May 15 and a newspaper article was published in the Moniteur Acadien.

The committee aims to repeat this initiative on May 23, 2020.

Figure 48 :Volunteers with garbage collected on May 15th

7. TD TREE DAY 2019

Since 2015, the Shediac Bay Watershed Association (SBWA) teams up with Toronto Dominium Canada Trust and members of the community to plant trees as part of the TD Tree Days events throughout Canada.

On September 21, 2019, 17 motivated volunteers including TD employees and the SBWA staff planted 129 native trees around the Shediac walking trail at the end of Chesley Street and on the side of Highway 15. Everyone gathered at the site starting at 9 am on a sunny and warm morning. Toronto Dominium provided coffee, water and snacks.

To begin the event, Rémi Donelle of the SBWA, gave a presentation on how to plant the trees. He emphasized the importance of establishing good natural buffer zones and the importance of increasing biodiversity of the area by planting various species of native trees. After the presentation, everyone grabbed a shovel to plant the 126 native trees in the designated areas.


Figure 49 : Photos of the volunteers planting trees

Only native trees were chosen for this tree planting event. The larger trees (37 trees) were purchased from two nurseries: Sunrise Nursery and Sun Nurseries Inc. The remaining 92 trees were taken from SBWA`s tree nursery at the MFB School and the ``Vert l`Avenir`` farm woodlot. Large trees were planted at the trail by the highway exit ramp entering the Chesley traffic circle and around the walking trail parking lot. For the section between the walking trail and Highway 15, coniferous trees were selected to be planted on approximately 325 metres of the trail to create a good natural barrier. See figures 2 and 3 for maps of the zones that were reforested.

After the event, SBWA staff returned on the sites to verify each tree and ensure they were planted properly. Brightly coloured stakes were added next to the trees that were planted on the side of Highway 15 to protect against brush cutting. The table below shows the quantity of trees planted per native species.

Table 40 : Total trees planted per species

Total trees planted for TD Tree Days		
Tree spp.	**Common name**	**Quantity**
Picea glauca	White Spruce – Épinette Blanche	67
Abies balsamea	Balsam Fir – Sapin baumier	5
Quercus rubra	Red Oak – Chêne rouge	9
Acer saccharum	Sugar Maple – Érable à sucre	8
Acer rubrum	Red maple – Érable rouge	14
Betula alleghaniensis	Yellow birch – Bouleau jaune	25
Sorbus americana	American mountain ash – Sorbier d`Amérique	1
	Total	**129**

Figure 50 : Aerial view of the TD Tree Days site around the Shediac walking trail at Chesley Street

Figure 51: Arial view of the TD Tree Days site at the trail on the side of Highway 15

Figure 52 : Group photo of the volunteers of TD Tree Days 2019

The TD Tree Days event was a success. All the 129 trees were planted in just two hours, which is very impressive considering all the different tree planting sections.

The SBWA would firstly like to thank the municipality of Shediac for giving permission to have this wonderful event around the municipal walking trail. The SBWA would also like to thank PWA for their generosity in lending their shovels for the event.

8. WATERSHED MANAGEMENT COMMITTEE

A committee was formed by the government of New Brunswick in order to develop a watershed management plan for the Shediac Bay. The committee is composed of several stakeholders and government departments. The watershed management plan will use water quality information from this report and other sampling programs. Other components of the plan will include land usage, socioeconomic data and biodiversity. The committee is currently active and the plan will be drafted in 2020.

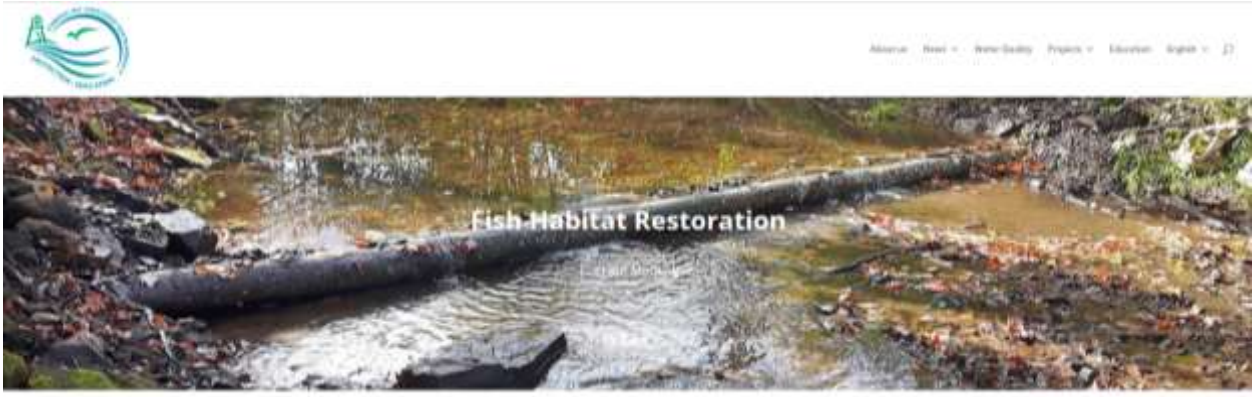
9. MEDIA OUTREACH

9.1 Newsletter

A bilingual newsletter was produced during the 2019-2020 fiscal year. The newsletter display information and photos on the various projects that the SBWA has been doing in the year. The newsletter is now distributed electronically by email list and is available on our website and Facebook page.

9.2 Socials Medias and Website

The SBWA is working to keep its website and social media up to date, posting photos and short description of activities and projects. The SBWA now has a dedicated employee who focuses on outreach and communications, and the design and production of educational materials. See Table 45 for details.



www.shediacbayassociation.org www.facebook.com/#!/shediacbaywatershedassociation

Table 41: SBWA Social Media Outreach 2018

Posted	Type	Lifetime Post Total Reach
4-02-19	Photo	426
4-22-19	Status	418
5-06-19	Photo	509
5-06-19	Link	544
5-09-19	Link	90
5-15-19	Photo	3113
5-16-19	Link	170
5-21-19	Photo	3515
5-31-19	Photo	182
6-06-19	Link	82
6-08-19	Link	71
6-12-19	Photo	485
6-24-19	Photo	273
7-08-19	Photo	1127
7-24-19	Video	588
7-24-19	Video	2130
9-12-19		3595
9-23-19	Photo	279
10-10-19	Photo	162
10-21-19	Photo	527
11-05-19	Link	186
2-07-20	Link	412
2-07-20	Link	78
	Total Reach	**18962**

10. CLOSING COMMENTS

The Shediac Bay Watershed Association had a successful year in 2019-2020, thanks to the support of the NB Environmental Trust Fund. The Association has met its targets regarding the monitoring and partnerships created to improve water quality in the Shediac Bay watershed. Sampling results will help in the development of the watershed management plan for the Shediac Bay Watershed. The watershed management plan will be a good base for the SBWA to prepare an action plan to address contamination sources. Recommendations from this report will help guide future activities of the association.

Habitat restoration projects for fish have been funded by different organizations in 2019-20, including the Atlantic Salmon Conservation Fund, the NB Wildlife Trust Fund and the NB Environmental Trust Fund. The support received allowed for more projects to be realized. The restoration sites will be monitored in future years to ensure our activities will have positive impacts on water quality and fish populations.

Partnerships are essential for environmental groups to accomplish their work. The Association is building good relationships with the town of Shediac, the local schools and other local groups. We hope to diversify our activities to involve more people in the protection of water quality in Shediac Bay. The next step for the association is to start working more with the agricultural sector.

The Shediac Bay Watershed Association will continue to monitor water quality in the Shediac and Scoudouc rivers and implement environmental improvement initiatives in the years to come thanks to the support or the NB Environmental Trust Fund.

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APPENDIX A - WATER CHEMISTRY METHODOLOGY

Table 42: RPC Laboratory Analytical Methods

RPC LABORATORY ANALYTICAL METHODS				
Analyte	Parameter	RPC SOP Number	Method Reference	Method Principle
Ammonia	NH_3T	4.M47	APHA 4500-NH3 G	Phenate Colourimetry
pH	pH	4.M03	APHA 4500-H+ B	pH Electrode - Electrometric
Alkalinity (as CaCO3)	ALK_T	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	Cl	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	F	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	SO_4	4.M45	APHA 4500-SO4 E	Turbidimetry
Nitrate + Nitrite (as N)	NO_X	4.M48	APHA 4500-NO3 H	Hydrazine Red., Derivitization, Colourimetry
Nitrite (as N)	NO_3	4.M49	APHA 4500-NO2- B	Ferrous Ammonium Sulfate Colourimetry
Phosphorus - Total	TP-L	4.M17	APHA 4500-P E	Digestion, Manual Colourimetry
Carbon - Dissolved Organic	TOC	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	TURB	4.M06	APHA 2130 B	Nephelometry
Colour	CLRA	4.M55	APHA 2020 Color (A,C)	Single Wavelength Spectrophotometry
Conductivity	COND	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	—	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES

Table 43: RPC Laboratory Analytical Methods for E. coli

RPC LAB ANALYTICAL METHODS FOR E. COLI		
Method	ID	Max Detection Limit
Membrane Filtration	FSA-01	10000 MPN/100 mL
Colilert	FSA-10	2419.6 MPN/100 mL