Hammond River Angling Association

GETTING HANDS-ON IN THE HAMMOND

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Executive Summary

"The greatest threat to our planet is the belief that someone else will save it"

Since the Hammond River Angling Association's (HRAA) formation in 1977, our mandate has been to protect and preserve the Hammond River watershed through education, conservation, and community outreach.

All those who live, work, and play along the Hammond River have an important role to play in its preservation, and that was our overarching goal with this project- to get people "hands-on" and engaged with protecting this beautiful watershed.

With financial assistance from the New Brunswick Environmental Trust Fund (NBETF), we were able to create multiple opportunities to engage the surrounding community in a variety of environmentally educational activities.

From young to old, lifelong resident to newcomers- we all have a responsibility to protect the Hammond River!

ACKNOWLEDGEMENTS

The HRAA acknowledges that we are on land that has never been ceded or surrendered- the Mi'kmaq, in northern and eastern New Brunswick; the Wolastoqiyik (Maliseet), along the Wolastoq-Saint John River Valley; and the Peskotomuhkatiyik (Passamaquoddy) in the St. Croix River watershed. These three nations are part of the Wabanaki Confederacy, which also includes the Penobscot and Abenaki nations of Maine. Wabanaki is "Land of the Dawn" and designates a large area including Maine and the Maritime provinces.

The HRAA would like to thank the Saint John Laboratory Services (SJLS) for their continued assistance, support, and positive attitude while processing our water quality samples.

We would like to express our gratitude to the Kennebecasis Valley Scouts group, the Saint John Newcomers Society, and the Elizabeth Fry Society- your organizations have been phenomenal in helping with our activities!

To the team at DataStream- many thanks for all of your assistance in making our water quality data publicly accessible!

Thank you to our project partners- Hammond River Holdings, Encorp Atlantic, New Brunswick Invasive Species Council, Water Rangers, New Brunswick Salmon Council, the Kennebecasis Watershed Restoration Committee, and HRAA's Kids Fishing Club- your continued support has been phenomenal.

Last, but certainly not least, thank you to all of our dedicated volunteers for your passion on getting Hands-On in the Hammond River!

INTRODUCTION

Getting Hands-On in the Hammond

Getting Hands-On in the Hammond is a multifaceted approach to expanding our understanding of the Hammond River while increasing our capacity to engage the local community in citizen science opportunities.

This project maintains our water quality sampling within 12 index sites, and includes sampling in 3 new sites; additionally, The Riverkeepers Educational Unit upholds the United Nations *2030 Agenda for Sustainable Development Goals* by ensuring inclusivity and equal opportunity for education and ensuring sustainable management of water while taking action on the adverse impacts of climate change. The Riverkeepers Educational Unit compliments our water quality monitoring program by allowing residents to participate in water quality sampling and creating a lasting connection to their natural surroundings.

This project includes fish community composition, abundance, distribution and habitat surveys, invasive species monitoring, shoreline cleanup events, educational outreach opportunities, and environmental compliance monitoring.

These combined elements are designed to foster appreciation for the environment by focusing on the ways in which we can all meaningfully contribute to environmental conservation. By involving a vast array of ages and backgrounds into citizen science, this program can serve as a model for other watershed groups throughout the province seeking to expand on their own environmental education programs. The greater the hands-on learning, the greater the long-lasting impact contributing to fostering the next generation of environmental stewards.

METHODS

In addition to in-situ water quality testing with a YSI multiprobe (dissolved oxygen, air temperature, water temperature, salinity, conductivity, pH, total dissolved solids, and turbidity), HRAA collected monthly grab samples from 12 index sites, and 3 new sites, once a month for four months. Samples are collected in accordance with the Government of New Brunswick Department of Environment's (GNB DELG) sampling protocols and processed at the Saint John Laboratory Services (SJLS). Sample analysis includes:

Aluminum	Dissolved Oxygen	Nitrogen
Alkalinity	*E. coli*	Nitrate
Antimony	Fecal Coliforms	Nitrite
Arsenic	Fluoride	pH
Calcium	Iron	Phosphorus
Cadmium	Lead	Potassium
Chloride	Magnesium	Sodium
Copper	Manganese	Sulfate
Color	Mercury	Total Dissolved Solids
Conductivity	Nickel	Total Suspended Solids
Total Kjeldahl Nitrogen	Total Coliforms	Turbidity
Total Hardness	Total Organic Carbon	Zinc

METHODS

Once the sampling season has come to a close, and all results have been received, HRAA staff use the Water Quality Index calculator to determine the health of each site. The Canadian Water Quality Index (CWQI) provided by the Canadian Council of Ministers of the Environment (CCME) is a means to summarize large amounts of water quality data into simple terms (CCME, 2001). The Index is a series of calculations combining multiple parameters to produce a value for each site based on:

- The number of parameters that exceed guidelines.
- The number of times guidelines are exceeded.
- And the amount by which they are exceeded.

WQI Value	Rating	Degree of Impairment
0-44	Poor	Aquatic life is threatened, impaired, or even lost
45-64	Marginal	Aquatic life is potentially threatened or impaired
65-79	Fair	Aquatic life is protected, but at times may be threatened or impaired
80-94	Good	Aquatic life is protected, with only a minor degree of threat or impairment
95-100	Excellent	Aquatic life is not threatened or impaired

Site	WQI Score	WQI Category
Hanford Brook	85.8	Good
O'Dell Brook	85.2	Good
South Stream	80.7	Good
Palmer Brook	80.1	Good
Hammondvale	77.9	Fair
Germaine Brook	77.8	Fair
Salt Springs Brook	72.5	Fair
McGonagle Brook	71.4	Fair
Brawley Brook	45.1	Marginal
Jenny Langstroth	43.5	Poor
Bradley Brook	42	Poor
Snow Brook	41.2	Poor
Hillsdale	41	Poor
Fowler Brook	40.7	Poor
Prospect Brook	38.4	Poor
Scoodic Brook	37.7	Poor

METHODS

Prior to beginning electrofishing, HRAA staff secure a Section 52 Scientific permit. Water temperature must be <20°C. Trained staff will use the single-pass method with the electrofisher in 100m² sections of the watercourse. Captured fish will be identified and counted, and individuals of the salmonid family, (Atlantic salmon and brook trout), will be measured for total length (mm) and weight (g). Atlantic salmon will be classified as fry (< 80 mm) or parr (≥ 80 mm). All data is entered into HRAA's 40+ year electrofishing dataset.

In November, HRAA staff and volunteers perform redd count surveys to document Outer Bay of Fundy Atlantic salmon spawning nests, called "redds". Volunteers are provided training and a “Redd Alert” identification sheet. Participants are divided into groups with an experienced Team Lead to survey stretches of the river with a GPS and document number and size of spawning nests.

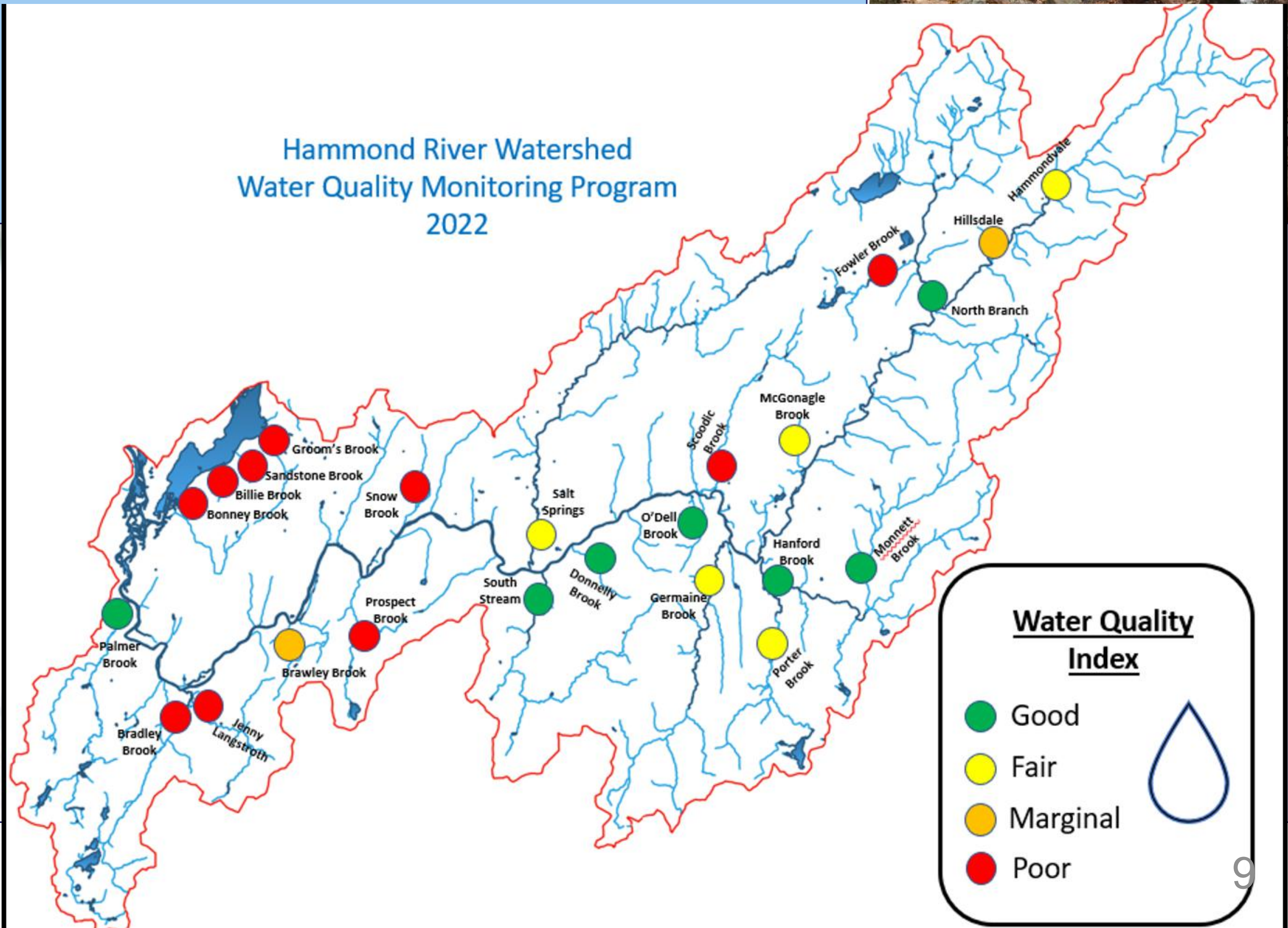
Habitat assessments are done throughout the season, and document substrate, embeddedness, flow, crown cover, bank stability, in-stream debris, barriers to fish migration, erosion, and vegetation (including documentation of invasive species). Stream Habitat Assessments are one of the most powerful tools to observe and collect data and it provides us with vital information, including identifying which areas are in need of monitoring and/or restoration, identifying pollution sources, and provide us with the ability to identify and remediate activities that are negatively impacting stream quality.

WATER QUALITY SAMPLING & RESULTS

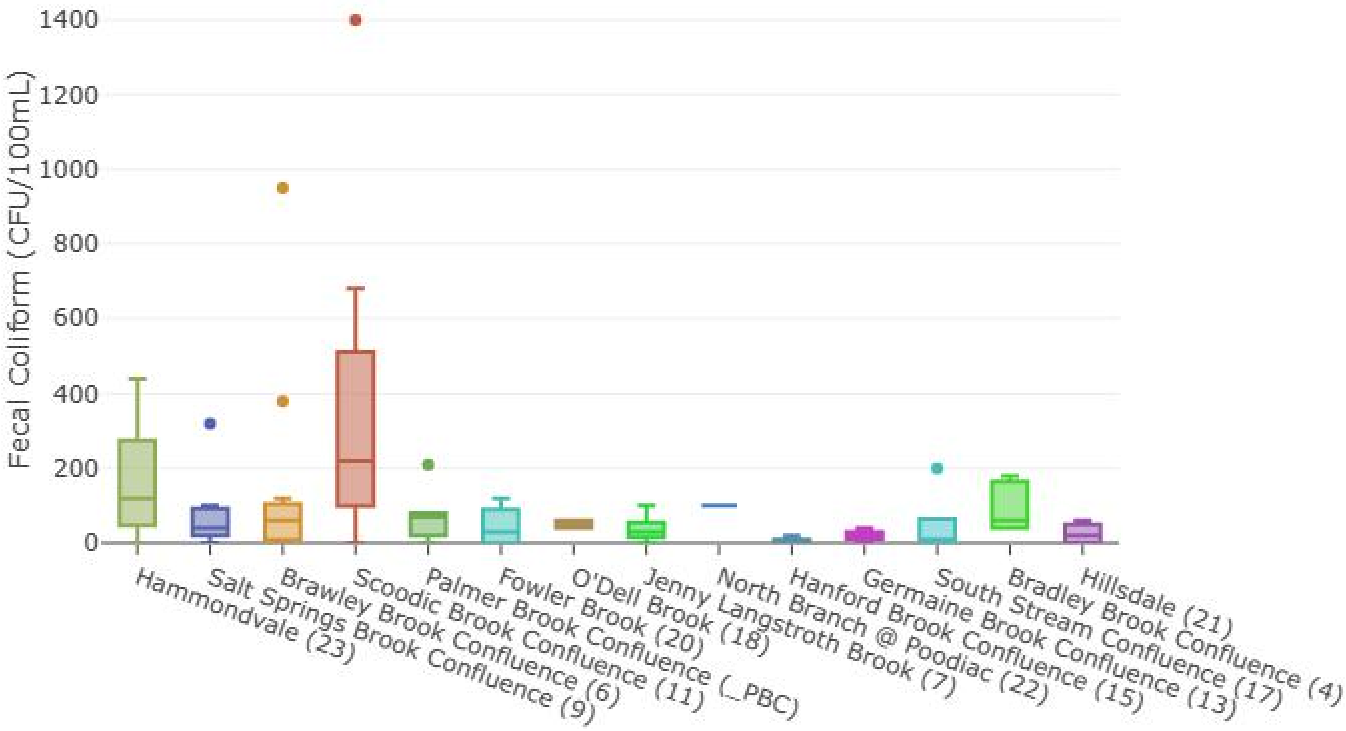
During the 2022 sampling season, HRAA staff collected monthly water quality samples from 12 index sites and 3 new sites, once a month for four months.

Based on the water quality index calculations, the majority of areas that ranked "poor" are located in the lower portion of the watershed, while the sites that ranked "fair" and "good" can be located in the mid and upper portion of the watershed. This indicates that there are additional stressors impacting water quality in the lower watershed, particularly land use practices.

Many of the sites in the lower watershed lack a substantial riparian buffer zone, which is increasing nutrient input into these streams. Priority should be placed on remediation through restoration in the lower watershed in the near future.



Fecal Coliforms



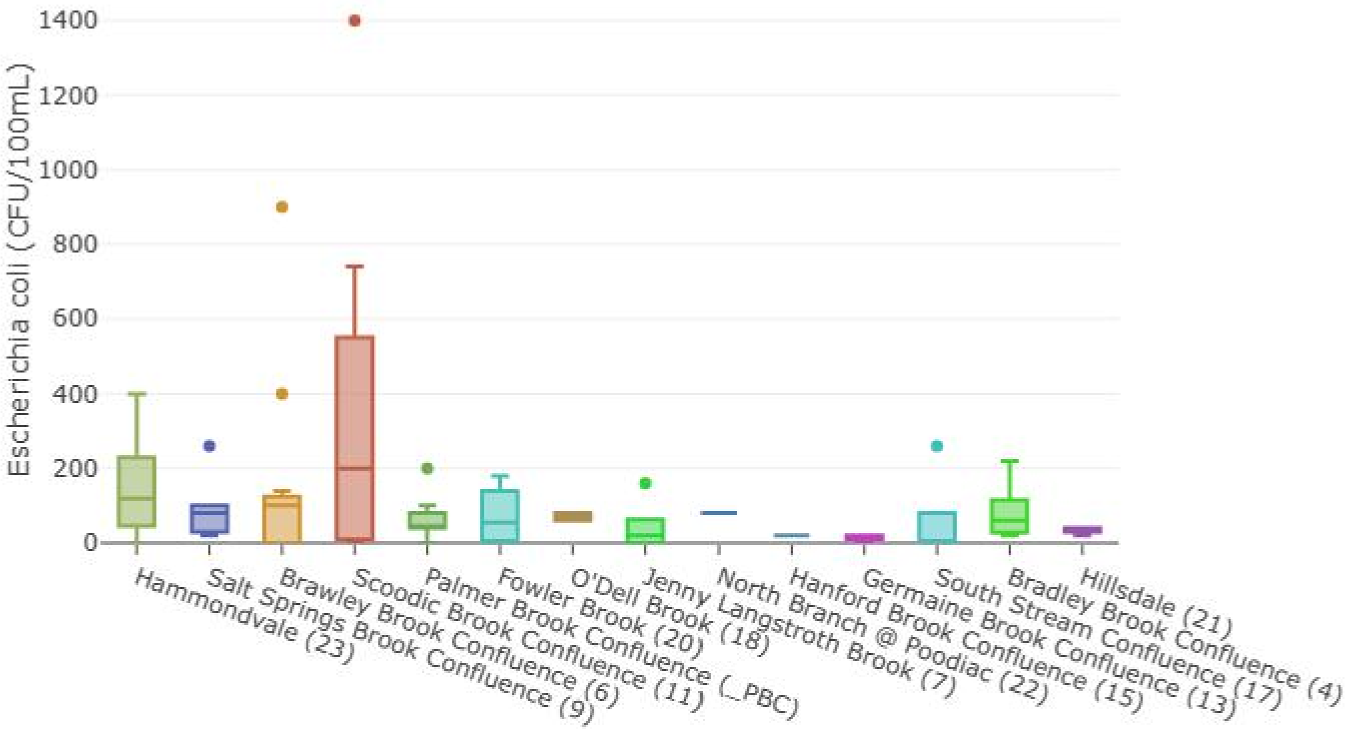
Coliform bacteria are a type of bacteria mainly found in the intestines of people and warm-blooded animals (and excreted in feces). They are also found in soils. There are different measures of coliform bacteria including *total coliform* (which includes all types), *fecal coliform*, and *Escherichia coli (E. coli),* a type of fecal coliform. Numbers of fecal coliform bacteria (including *E. coli*) in water are influenced by human or animal waste entering the water, such as through farm runoff and poorly treated human sewage. Fecal coliform bacteria can also come from droppings from birds like ducks and geese.

Fecal coliform bacteria typically don't survive more than a few days in a river or lake. If there are infrequent inputs of fecal coliform (e.g., following heavy rains that cause stormwater and agriculture runoff) then we would expect to see high bacteria counts for a few days and low counts the rest of the time. If fecal coliform levels are consistently high, it indicates that the source of contamination is entering the water regularly.

Scoodic Brook consistently contains higher quantities of fecal coliforms, as cattle have direct, unfettered access to the brook. Hammondvale, while barely exceeding guidelines of >400 CFU/100mL, has little riparian buffer, and fertilizer is spread in the field right to the water's edge.

Water Quality Results

E. Coli

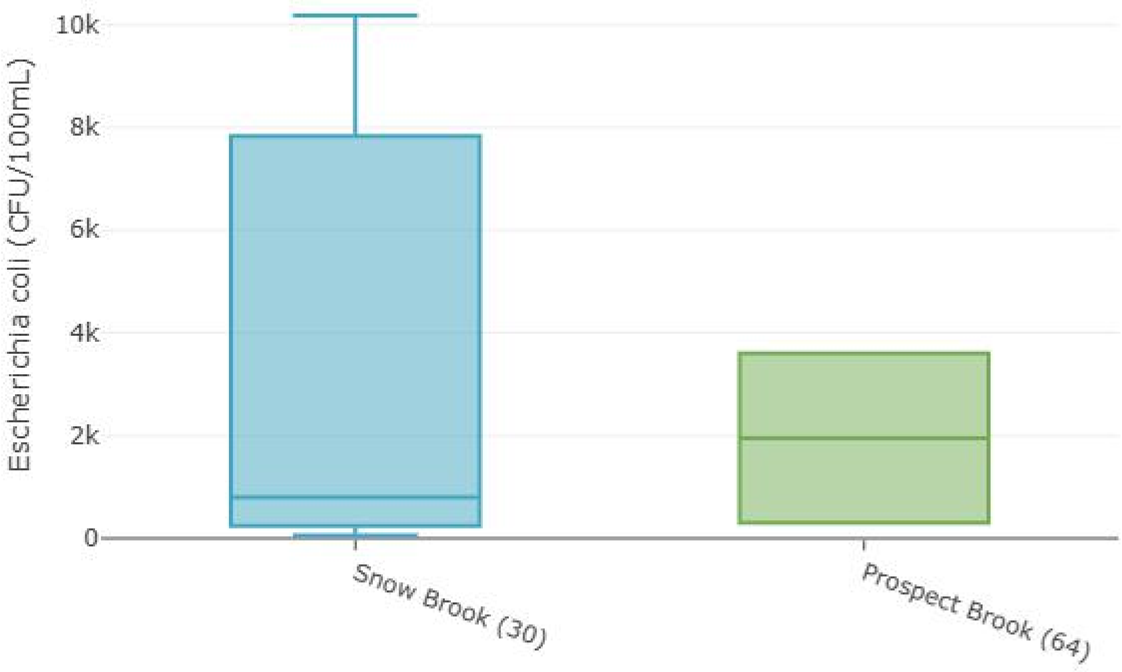


Regional recreational water quality guidelines for average *E. coli* abundance vary across Canada, ranging between about 100-200 per 100 mL of water. There are even lower thresholds for drinking water (set nationally), where no *E. coli* should be detected per 100 mL of water.

Acceptable levels of *E. coli* for the protection of aquatic fish health are ≤ 400 MPN/ 100 mL (Health Canada, 2012). *E. coli* Used as an indicator of microbial concentrations in water, sources of contamination include human and animal fecal matter. The velocity of transport is dependent on the land type (e.g., run off on non-developed land is sopped up by vegetation leading to increase infiltration into the ground and an overall reduction of runoff entering that waterway). Seasonal fluctuations are expected; often an increase in bacteria is associated with heavy rainfall, or higher coliform counts during hotter summer months.

Similar to the fecal coliform results, Hammondvale and Scoodic Brook contain the highest content of e. coli. Scoodic Brook, in particular, reached a peak concentration of 1400 CFU/100mL after a heavy rainfall event in August.

E. Coli- New Sites

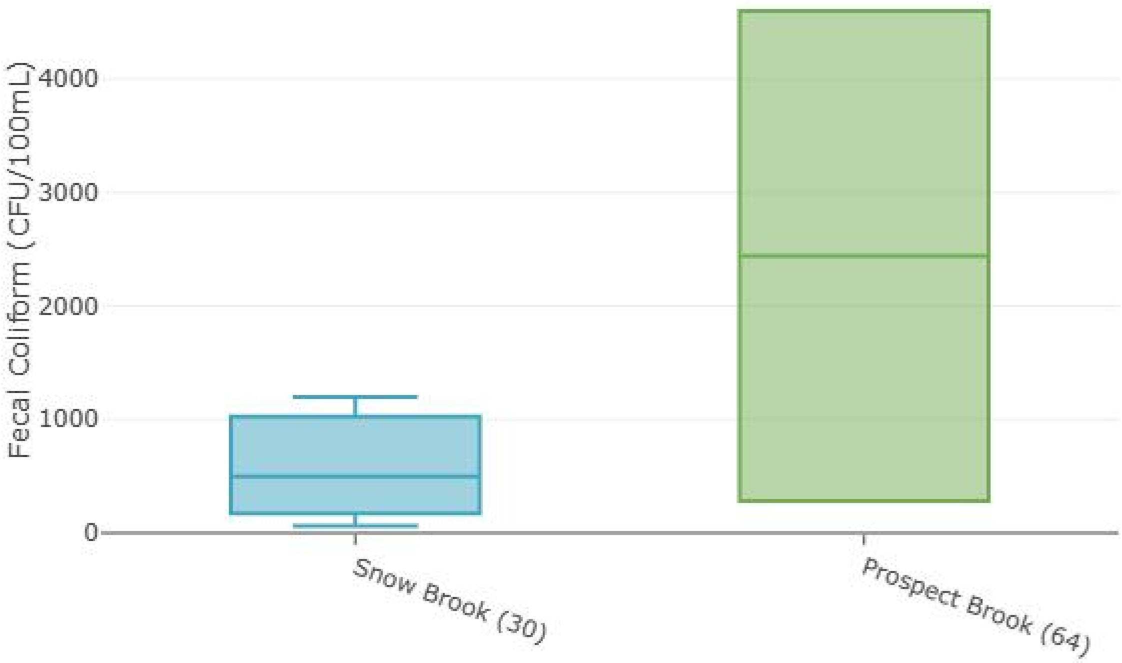


Two of our new sites, Snow Brook and Prospect Brook, could not be included with the other index site results, given that they contained significantly higher levels of e.coli and fecal coliforms (it skewed the charts, and they were better off isolated from the rest of the sites).

To date, HRAA field staff are uncertain why these tributaries are recieving such high levels of baterial loading. The surrounding land use for both tributaries is minimal, and perhaps these levels of fecal coliform and e. coli are naturally occuring.

It is reccomended that both Snow Brook and Prospect Brook remain on our water quality monitoring program in 2023, to better determine the potential source of these parameters.

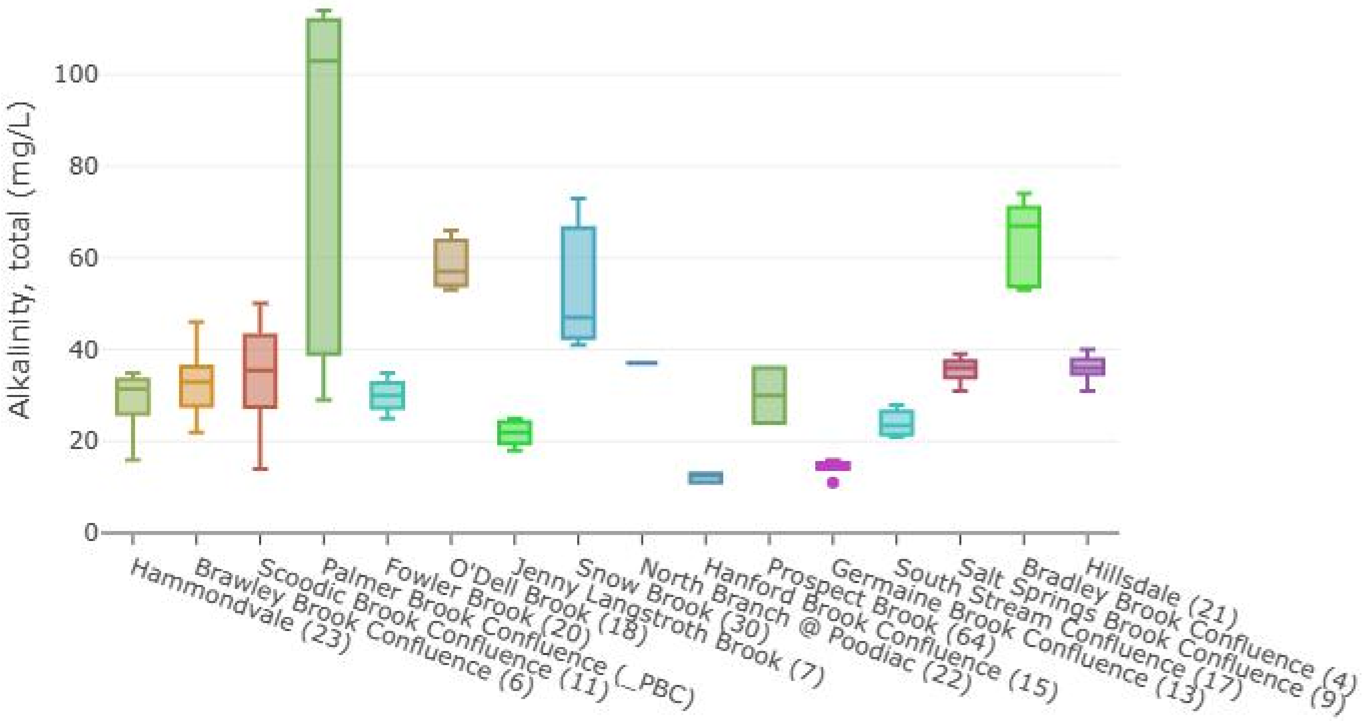
Fecal Coliforms- New Sites



As previously mentioned during the discussion on Snow Brook and Prospect Brook E. coli results, their results for fecal coliforms needed to be presented separately from the other index sites in order to not skew the chart.

Additional investigation into the bacterial results of these two new tributaries is warranted in the future. Shown below: Snow Brook.

Alkalinity

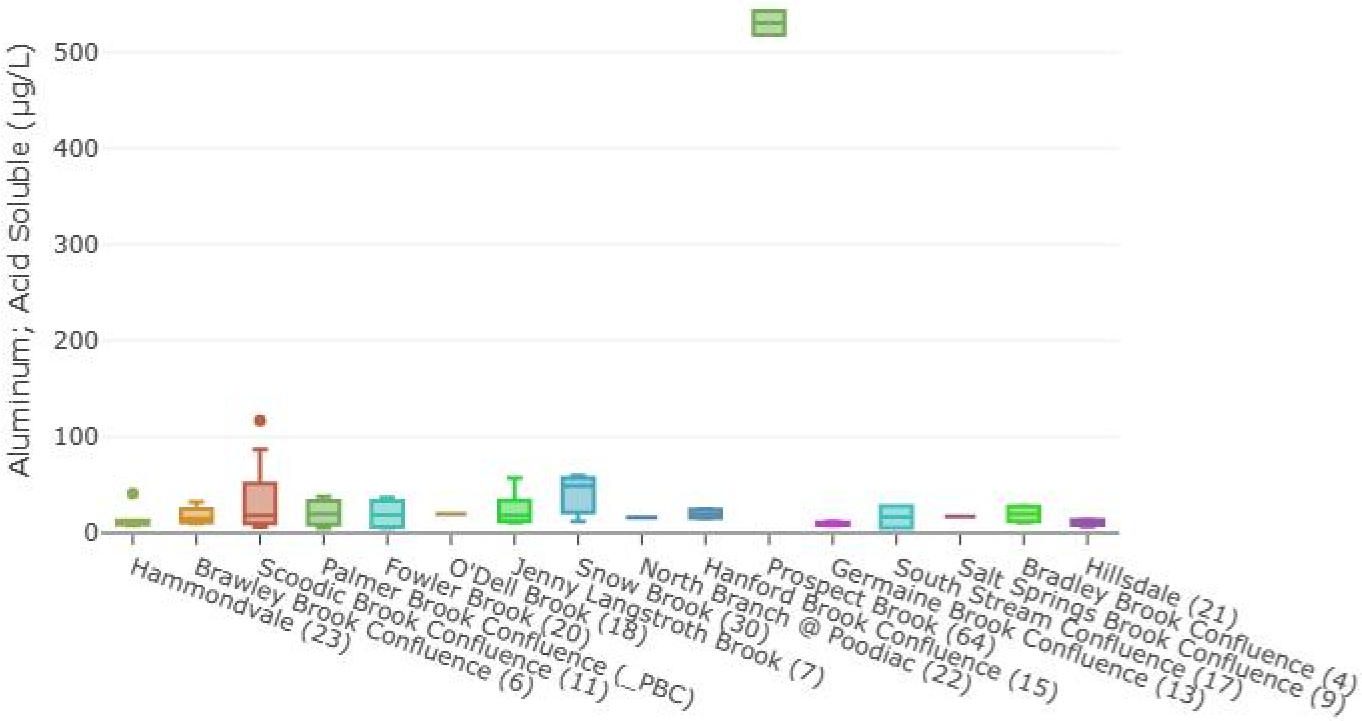


Alkalinity measures the stream's buffering capacity to fluctuations and changes in pH. Higher levels of alkalinity indicate the waters capacity to resist changes to pH or neutralize an acid. Alkalinity is derived from the presence of carbonate ions and is closely related to hardness. Water that is too alkaline causes non-toxic ammonia to become toxic, in which fish may have trouble breathing. It can also affect the fish's fins and tails, damaging their growth and making them look ragged. Ultimately, fish in a highly alkaline environment may fail to thrive and can eventually die.

Freshwater's alkalinity is affected by soil, bedrock, plants, and industrial waste. For example, limestone, which is softer and dissolves in water more easily, tends to make water have higher alkalinity.

While it appears that Palmer Brook has exceptionally high alkalinity compared to the other sites, it falls within a "moderate" range (50-150 mg/L). The tributaries with the lowest alkalinity level are Hanford Brook and Germaine Brook, due to a different bedrock composition.

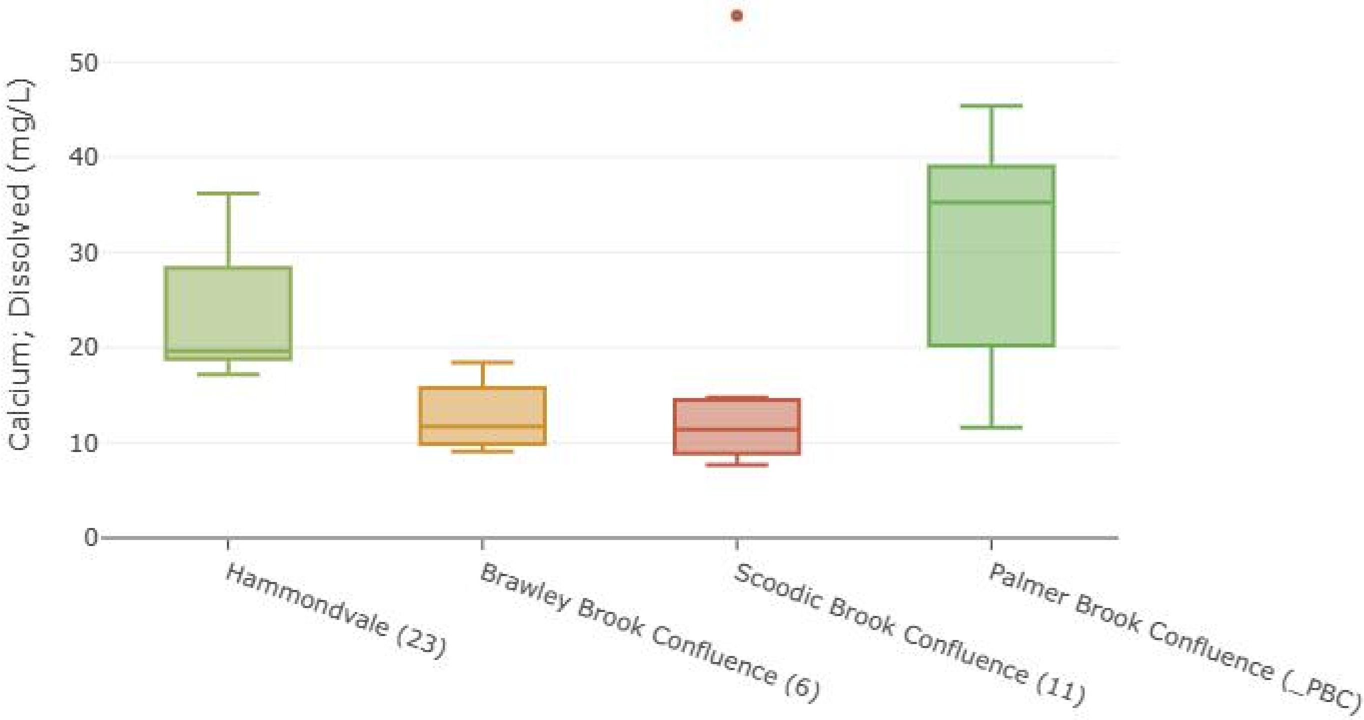
Aluminum



The acceptable levels of aluminum for the protection of aquatic fish health is 0.005 ug/L if pH is 6.5. Aluminum is an extremely abundant metal in the earth's crust and is often found in the form of silicates such as feldspar. Elevated levels of aluminum can affect some species ability to regulate ions, like salts, and inhibit respiratory functions, like breathing. Aluminum can accumulate on the surface of a fish's gill, leading to respiratory dysfunction, and possibly death. The oxide of aluminum, known as bauxite, provides a convenient source of uncontaminated ore. Aluminum can be selectively leached from rock and soil to enter any water source. Sources include treatment plants using aluminum-based coagulants as well as naturally occurring aluminum that is found in groundwater.

Until 2022, Scoodic Brook historically contained the highest level of aluminum throughout the watershed due to its bedrock composition; however, it has been usurped from the top spot by Prospect Brook, our new site. Prospect Brook is atop of Prospect Mountain, and its aluminum concentrations may also be due to bedrock composition, but further investigation is necessary.

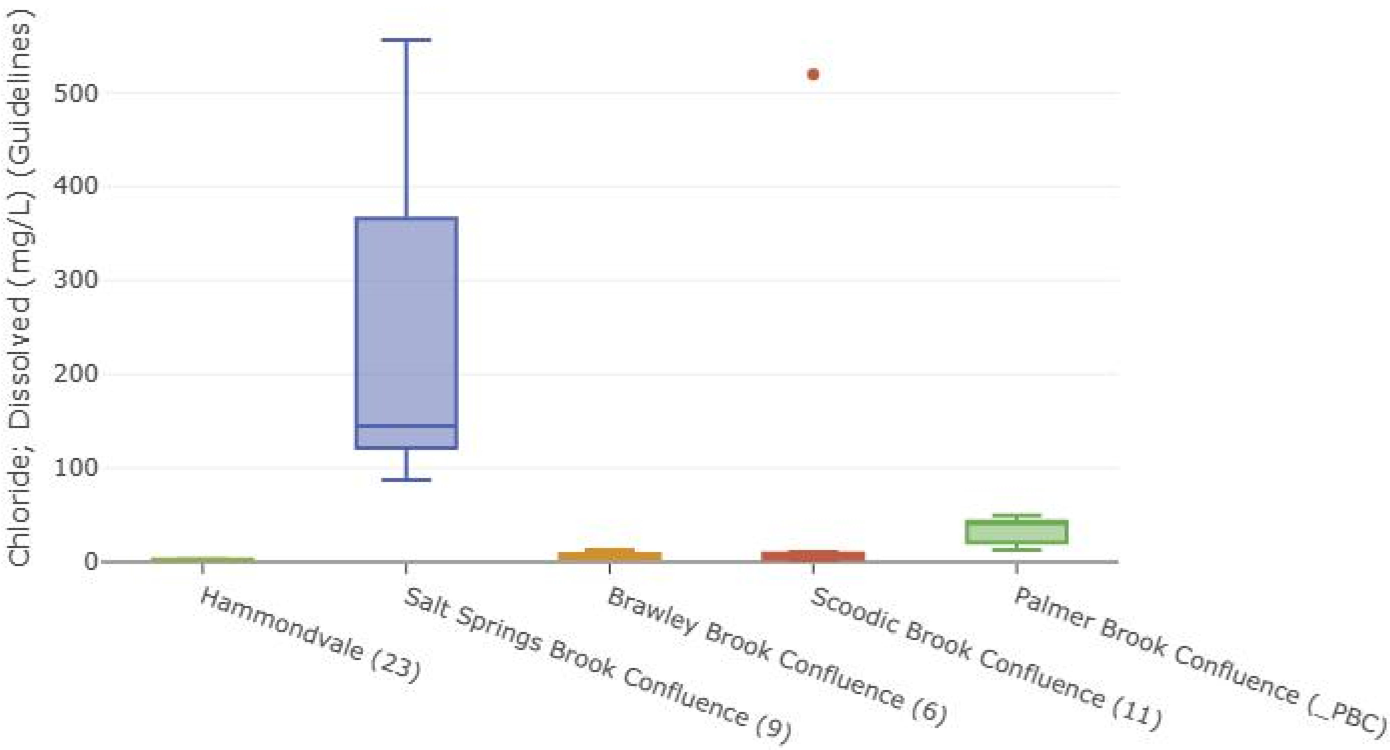
Calcium



Calcium is naturally occurring from erosion and weathering of soils and minerals. It is an essential component of bone and cartilage for aquatic and terrestrial species. Calcium regulates the uptake of nutrients, promotes muscle tone and regular heartbeat in aquatic species. Typical freshwater calcium levels range from 4-100 mg/L. 7. Typical seawater contains 400 mg/L of calcium. Like all living animals, freshwater fish need calcium for bones, scales, teeth, and other biological functions. Fish can absorb calcium from the water through their gills and their diet.

The vast majority of our index sites do not contain calcium above detection limits. Calcium is not one of the parameters included in the Water Quality Index Calculator.

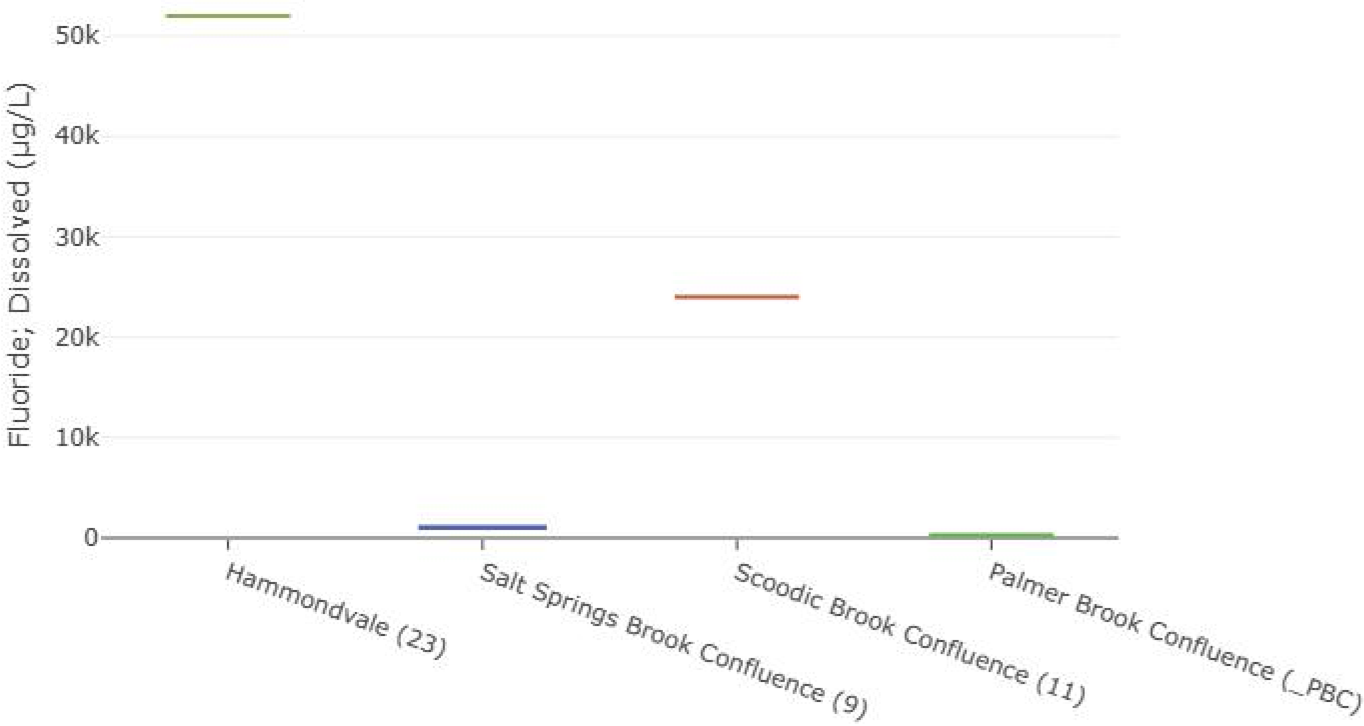
Chloride



The acceptable level of chloride for the long-term protection of aquatic fish health is ≤ 120 mg/ L and in the short term is 650 mg/ L. Chloride is naturally occurring and is a component of salt. Sources include industrial effluents, highway salt, sewage, irrigation and naturally occurring salt deposits as well as the potential intrusion of sea water. Use of salt for deicing roads and parking lots in the winter is a major source of chloride. Other sources include wastewater treatment, septic systems, and farming operations as well as natural sources of salt and brine in geologic deposits. Exceedances of chloride can have a negative impact on fish's ability for osmoregulation.

Salt Springs Brook, as its name suggests, contains high levels of salt and chloride, due to the natural underground salt caverns beneath the brook. It is interesting to note that although Salt Springs Brook exceeds recommendations for the long-term and short-term exposure to chloride, it is one of the most productive brooks in the watershed, containing the highest density of juvenile salmon, and the second highest density of spawning adult salmon.

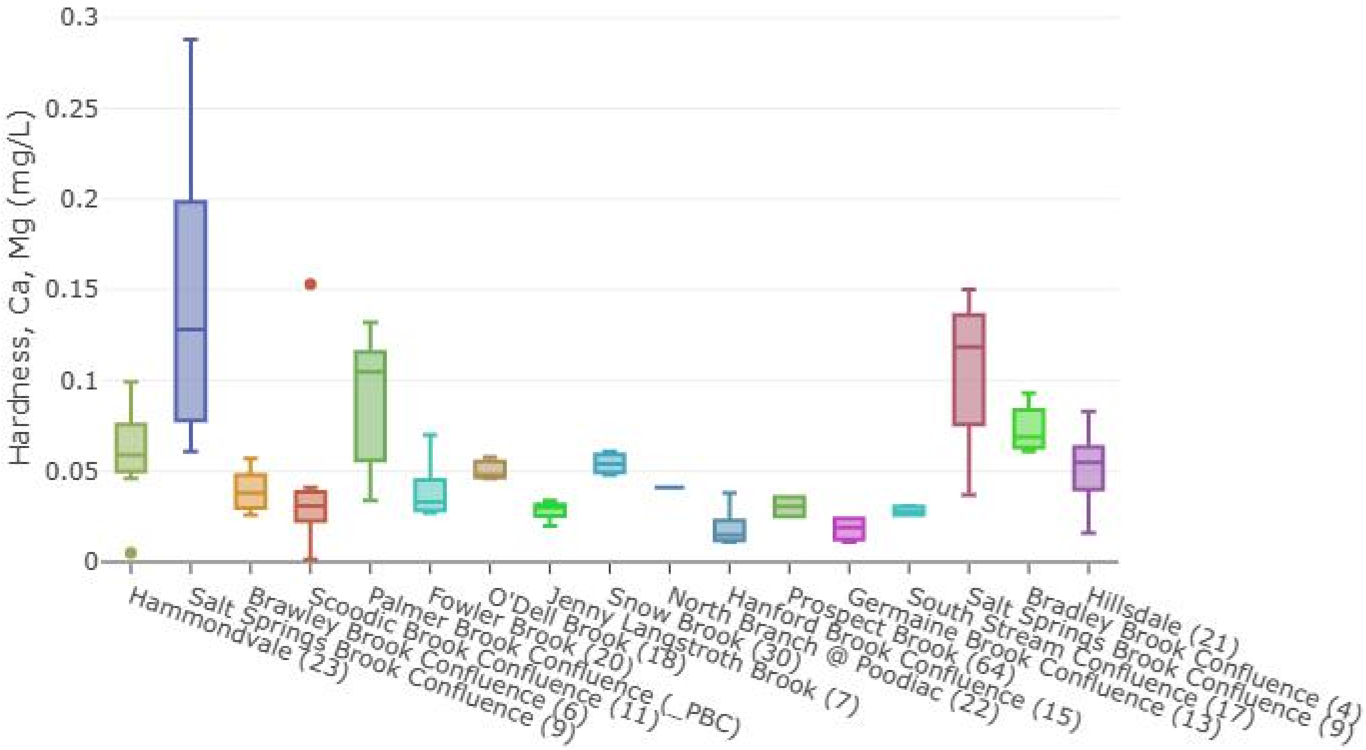
Fluoride



Acceptable levels of fluoride for the protection of aquatic fish health with long term exposure is 120 µg/L. Fluoride is a naturally occurring element from soil and rock erosion. High levels of fluoride can result in fish and aquatic invertebrate toxicity.

Only four tributaries yielded one positive test result for fluoride during the 2022 sampling period. It is interesting to note that the occurrence of fluoride corresponds with four tributaries that are experiencing high levels of erosion, and that these levels may be indicators that riparian restoration is required within these stretches. All positive fluoride results occurred post-heavy rainfall events in July. Shown below: erosion at Hammondvale.

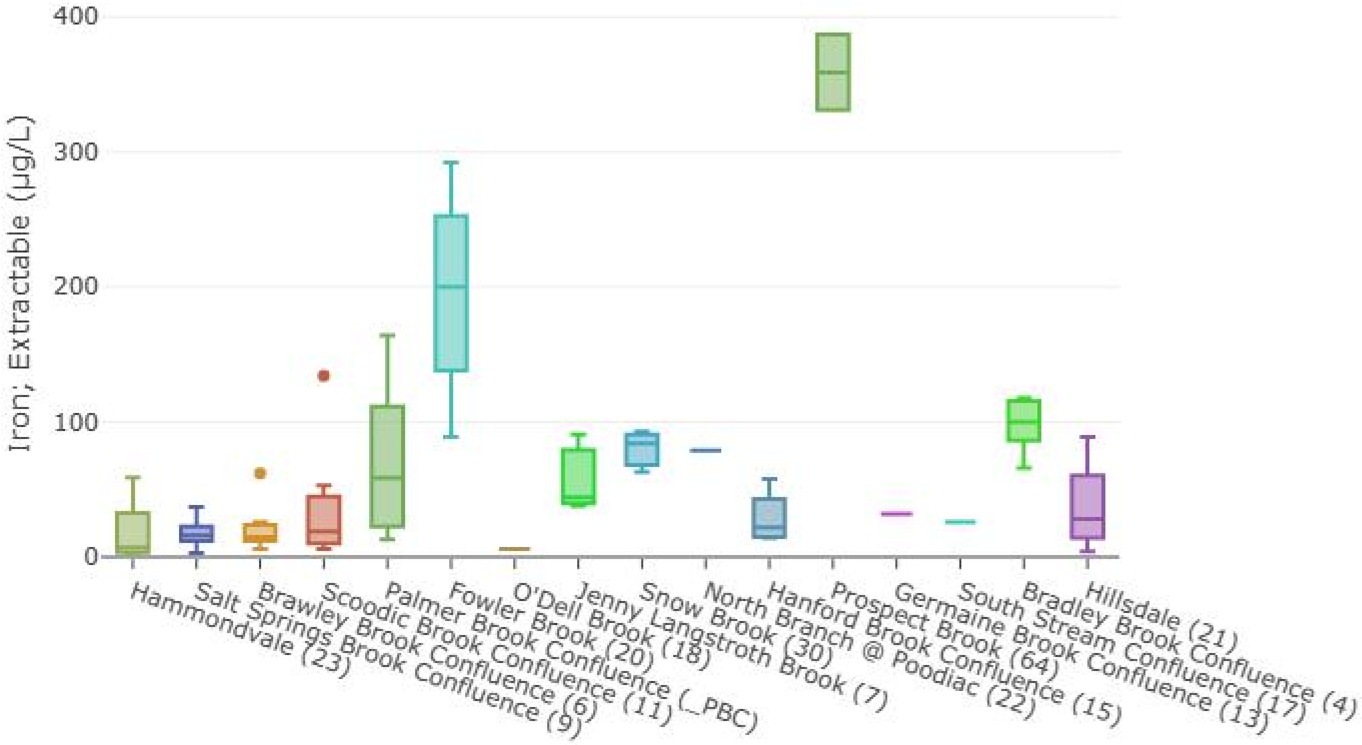
Hardness



Hardness is a measure of dissolved minerals in water – primarily calcium and magnesium. The types of rocks (and the minerals they contain) in an area will influence the hardness of the water. For example, limestone is rich in calcium and is easily eroded by water. Generally, the harder the water, the lower the toxicity of other metals to aquatic life. In hard water some of the metal ions form insoluble precipitates and drop out of solution and are not available to be taken in by the organism.

Salt Springs Brook (both the upper survey site and the lower survey site) contain higher levels of magnesium compared to other sites within the watershed, and this is impacting its level of hardness. These results have been determined to be naturally occurring, and do not appear to be negatively impacting aquatic life.

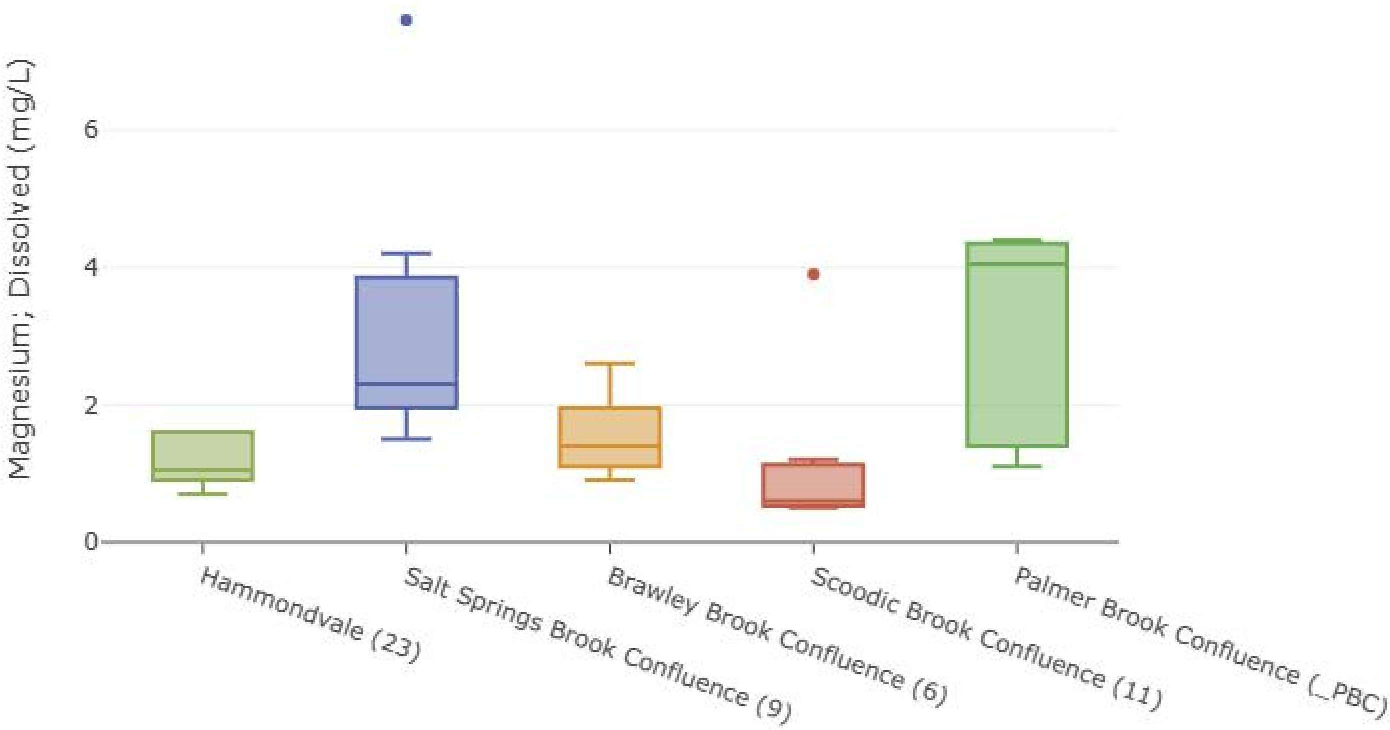
Iron



Acceptable levels of iron for the protection of aquatic fish health is 0.3 mg/L. Naturally occurring through mineral and rock erosion. Iron fertilization or contamination affects the reproduction and feeding habits of fish and other animals. High concentrations of iron sometimes result in increased acidity of water—killing or hurting aquatic life. Industrialized and sewage effluents are a common source. High levels of iron will build up in tissues and can cause toxicity in fish. Acceptable levels of iron can assist with fish species’ ability for tissue oxidation and electron export.

Historically, Fowler Brook has consistently maintained the highest level of iron input, until 2022, when we added Prospect Brook into the water quality monitoring program. Once again, Prospect Brook has surpassed an index site in its trace metal concentrations, and further sampling is required to fully determine if the source is naturally occurring, or anthropogenic in nature.

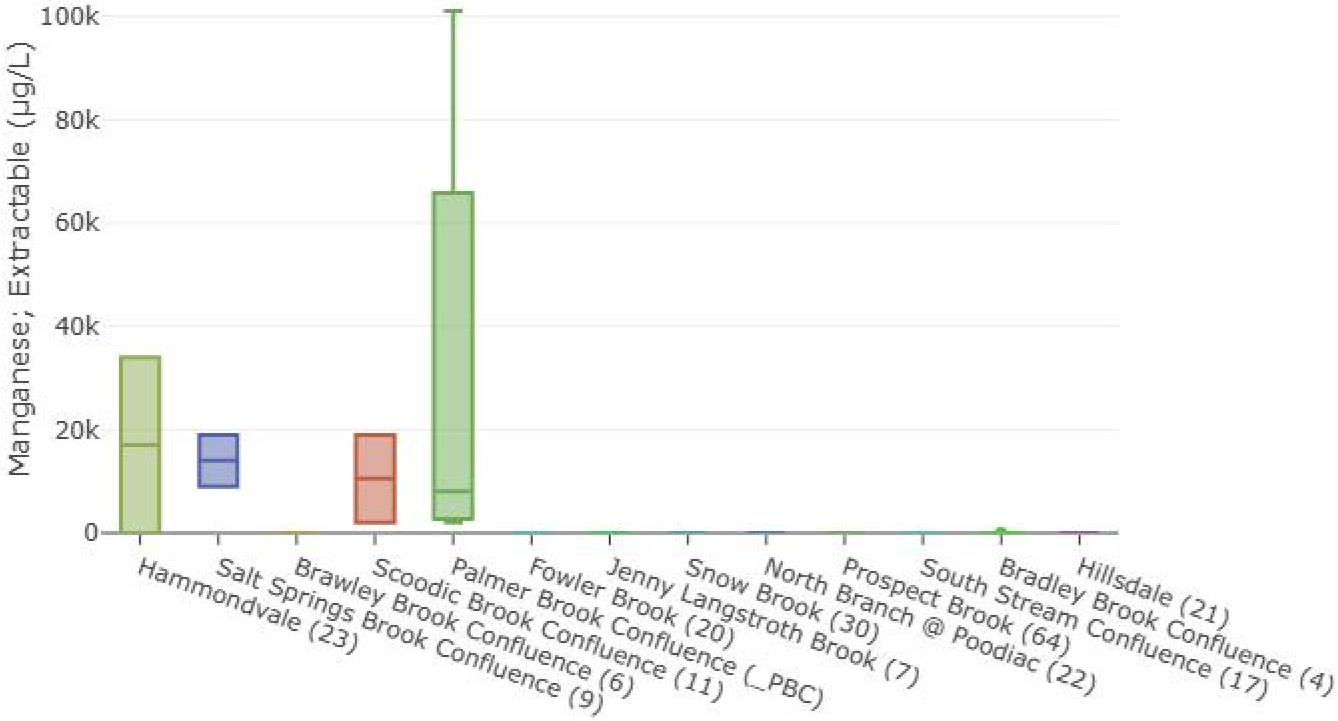
Magnesium



Typical freshwater magnesium levels range from 5-50 mg/L, and magnesium is not one of the parameters included in the Water Quality Index Calculator. Magnesium dominance is rarely seen in natural water. Fresh water is usually dominated by calcium, while in alkaline water sodium is the main element. In most water bodies, magnesium concentration falls between 1 mg/L to 40 mg/L. The calcium to magnesium ratio in natural water has a certain relationship. In water where the total dissolved solids (TSD) are less than 500mg/L, the ratio ranges from 4:1to 2:1. If the TSD increases further, the concentration of magnesium will exceed calcium by several times. Fresh water contains much more calcium than magnesium due to the abundant calcium in the earth’s crust.

All sites surveyed that do contain magnesium contain <50 mg/L, and fall within an acceptable range. No negative impact to aquatic life is anticipated.

Manganese

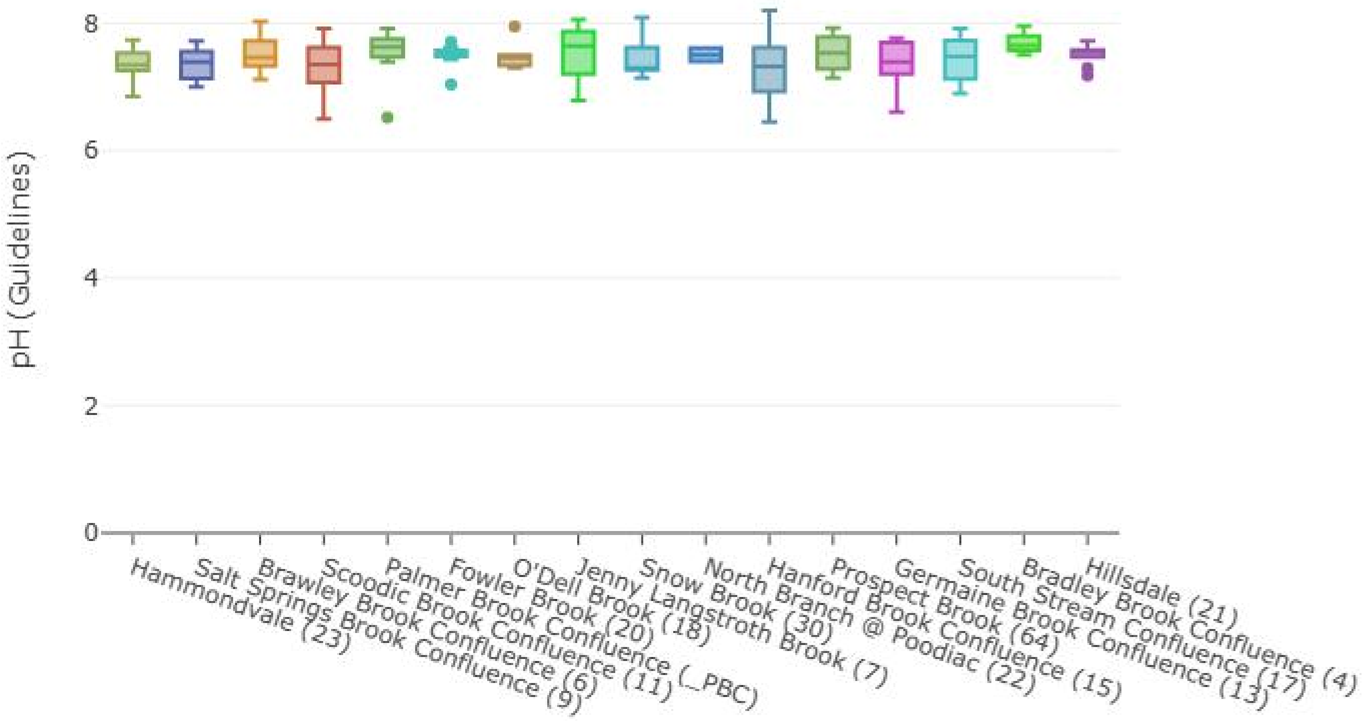


Total manganese concentrations in natural fresh waters seldom reach 1.0 mg/L and are usually less than 0.2 mg/L, while seawater typically contains about 0.002 mg/L manganese. Aquatic organisms have exhibited toxic responses to manganese in surface waters and regulatory bodies in some jurisdictions have established guidelines for levels of manganese in surface water to protect aquatic life. In British Columbia, a range of 0.6 mg/L at a hardness of zero to 1.9 mg/L at a water hardness of 325 mg/L CaCO3 was established by the Ministry of Environment, Lands and Parks, although it was recognized that the scientific data on which this guideline was based were weak (Reimer, 1985).

It was speculated in the 2008 and 2015 *Watershed Management Plans* that Palmer Brook's high levels of manganese may be correlated to the prevalence of industrial spills or industrial byproduct, sewage plants, traffic density, and treatment plants, respectively (CCME, 2014). Have these exceedances been caused by anthropogenic factors, or are they a result of the geology of the lower Hammond River, or perhaps a combination of both? This area has been the focal point for gold exploration from the 1890's to the 1980's, and other minerals commonly occurring with gold are silver, manganese, antimony, quartz, iron, lead, zinc, chromium, and copper.

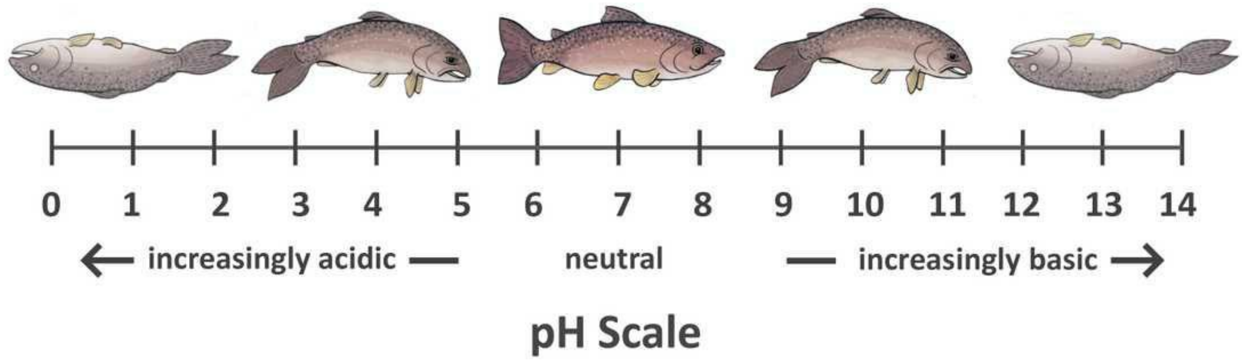
Water Quality Results

pH



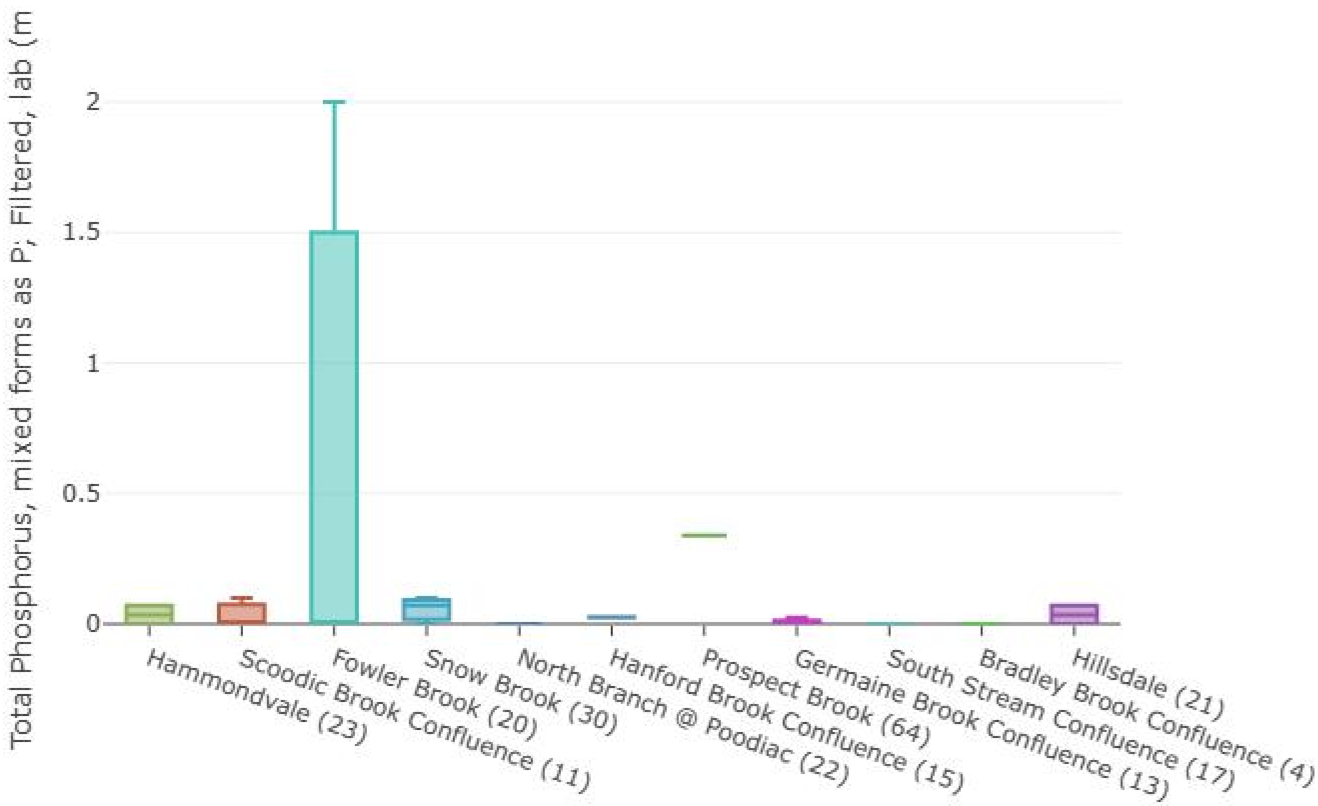
Most North American rivers, lakes and streams fall within the range of pH 6.5-8.2. National guidelines recommend pH of 6.5-9.0 for the protection of aquatic life in freshwaters. Most fish prefer to live in water that ranges in pH from around 6.4 to 8.4. Fish eggs grow and survive best at a narrower range of pH; from 6.0-7.2. Low pH can reduce how many fish eggs hatch and can make life difficult for fish and macroinvertebrates (the backbone of our water ecosystems).

Fortunately, all sites surveyed in 2022 (as well as historically) fall within acceptable limits for pH to maintain aquatic life.



Water Quality Results

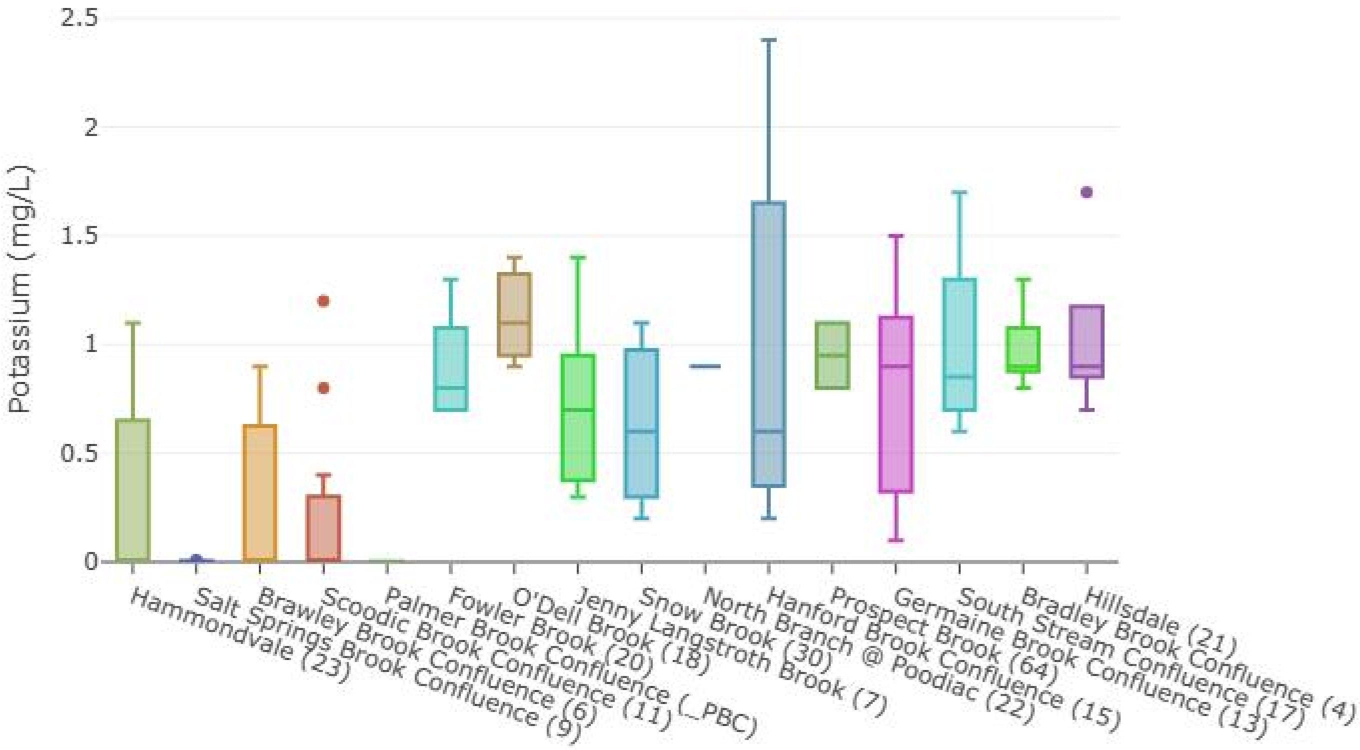
Phosphorus



The concentration of total phosphorus in most surface waters that are not significantly affected by human activity ranges from about 10-50 µg/L, but this can vary. Acceptable levels of phosphorus for the protection of aquatic fish health is 0.03 mg/L. Phosphorus will stimulate the growth of plankton and aquatic plants which provide food for fish. This may cause an increase in the fish population and improve the overall water quality. Too much phosphorus can cause increased growth of algae and large aquatic plants, which can result in decreased levels of dissolved oxygen– a process called eutrophication. High levels of phosphorus can also lead to algae blooms that produce algal toxins which can be harmful to human and animal health. Phosphorus is a limiting nutrient for photosynthesis in fresh water and too much phosphorus can cause eutrophication in water bodies. Phosphorus is a common constituent of agricultural fertilizer, manure, organic wastes in sewage and industrial effluents. Adverse effects only occur at extreme levels.

Fowler Brook is relatively new on HRAA's water quality monitoring program- it contained higher levels of phosphorus in 2021 as well; however, we have yet to locate the source of the input.

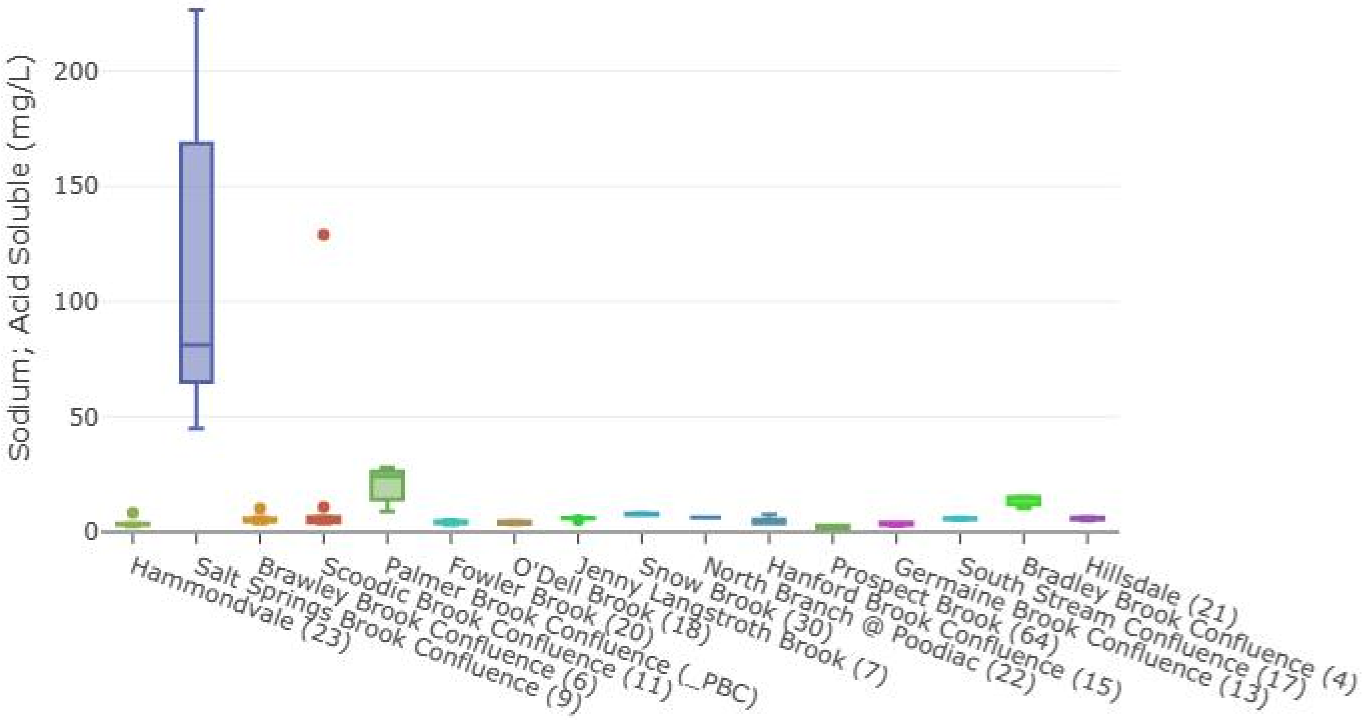
Potassium



Rivers generally contains about 2-3 ppm potassium from naturally occurring sources. Calcium rich granite contains up to 2.5% potassium, and freshwater sources with granite as bedrock composition may contain higher levels of potassium (as in Hanford Brook and Germaine Brook areas).

The headwaters area (Hammondvale, Hillsdale, North Branch and Fowler Brook) have relatively higher levels of potassium, which is the third key ingredient in many agricultural fertilizers; however, it may be possible that the higher levels of potassium are from the potash deposit in the area, or perhaps a combination of both a geological resource being exposed to groundwater and deposited into the watercourses from fertilization practices. The bacterial content and potassium content may be increasing algal growth in this area, decreasing dissolved oxygen, and increasing water temperatures. Given the area's high importance level for salmonids, it is imperative that the HRAA continue to engage surrounding landowners and encouraging them to maintain best practices with regards to their agricultural practices. Elevated levels of potassium may also indicate a brine spill in the headwaters, which contains the brine line from the Potash mine to the ocean.

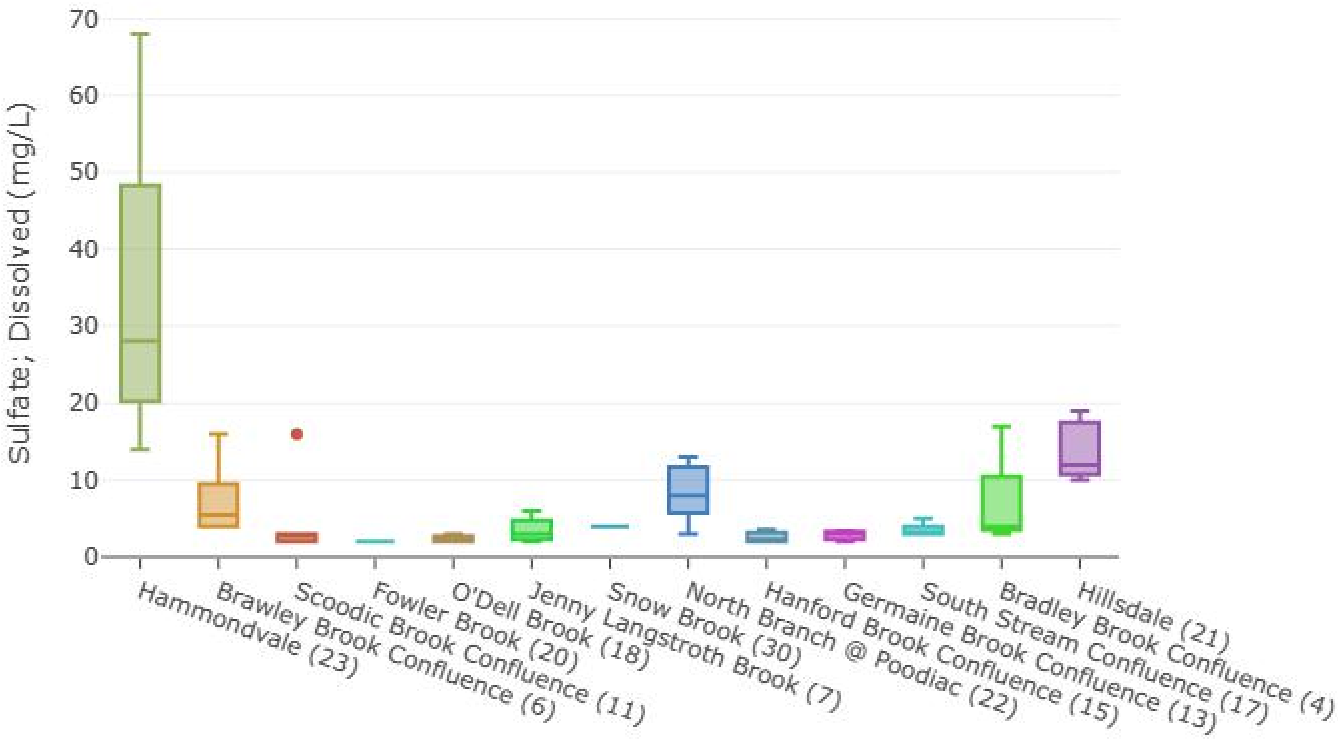
Sodium



All natural waters contain sodium; nearly all sodium compounds readily dissolve in water, and it naturally leaches from rocks and soils. The sodium ion, the sixth most abundant metallic ion in the earth's crust, is a natural constituent of both food and water from several sources.

It is no surprise that Salt Springs Brook contains higher levels of sodium in comparison to other index sites within the watershed, from its naturally occurring salt caverns. Shown below: lower Salt Springs Brook.

Sulfate

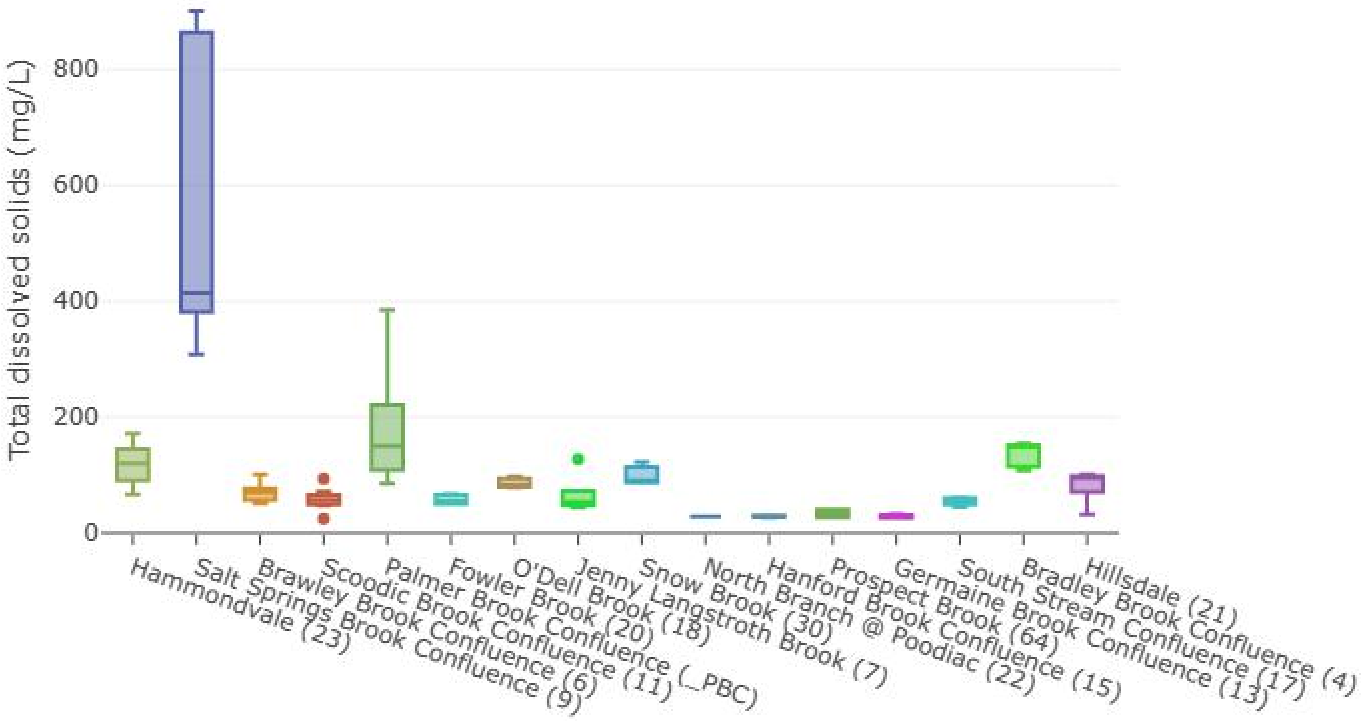


While the CCME does not currently have a guideline for aquatic species protection for sulfate exceedances, recent research suggests that elevated sulphate concentrations may have indirect effects on aquatic ecosystems in terms of increasing phosphorus availability and susceptibility to eutrophication and excessive algal growth, and mercury mobilization (Meays et al., 2013).

High levels of sulfate in the waterbody typically indicate that fertilizer is running off into the receiving environment; indeed, this is most definitely the case for Hammondvale. The area surrounding the index site is regularly treated with fertilizer; however, there is almost no riparian buffer, and fertilizer is spread right up to the water's edge.

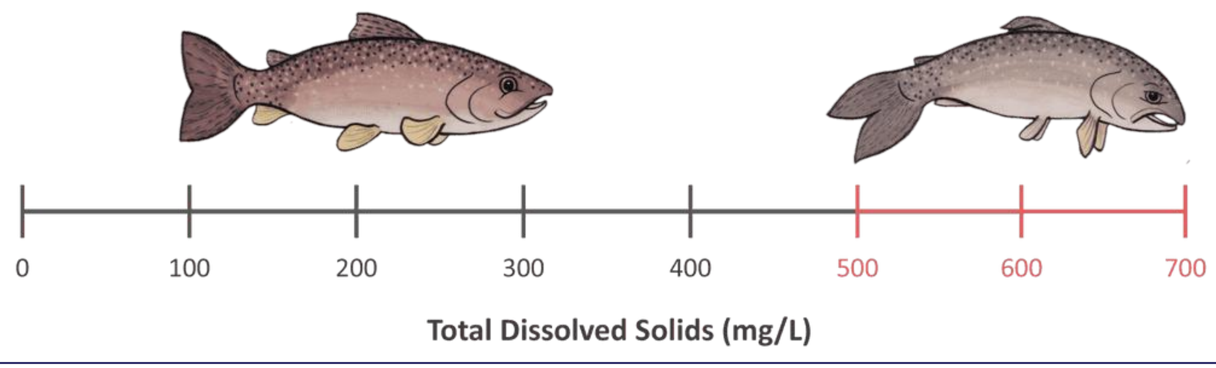
HRAA field staff have attempted to work with the landowner in 2020 and 2021 for riparian planting- while the landowner was willing for planting to occur, they lease their land to a corn farmer, who has consistently mowed down all riparian planting attempts. Not only is this leading to additional erosion and sedimentation in critical salmon spawning grounds, but it is allowing higher levels of fertilizer to leech into the waterbody.

Total Dissolved Solids

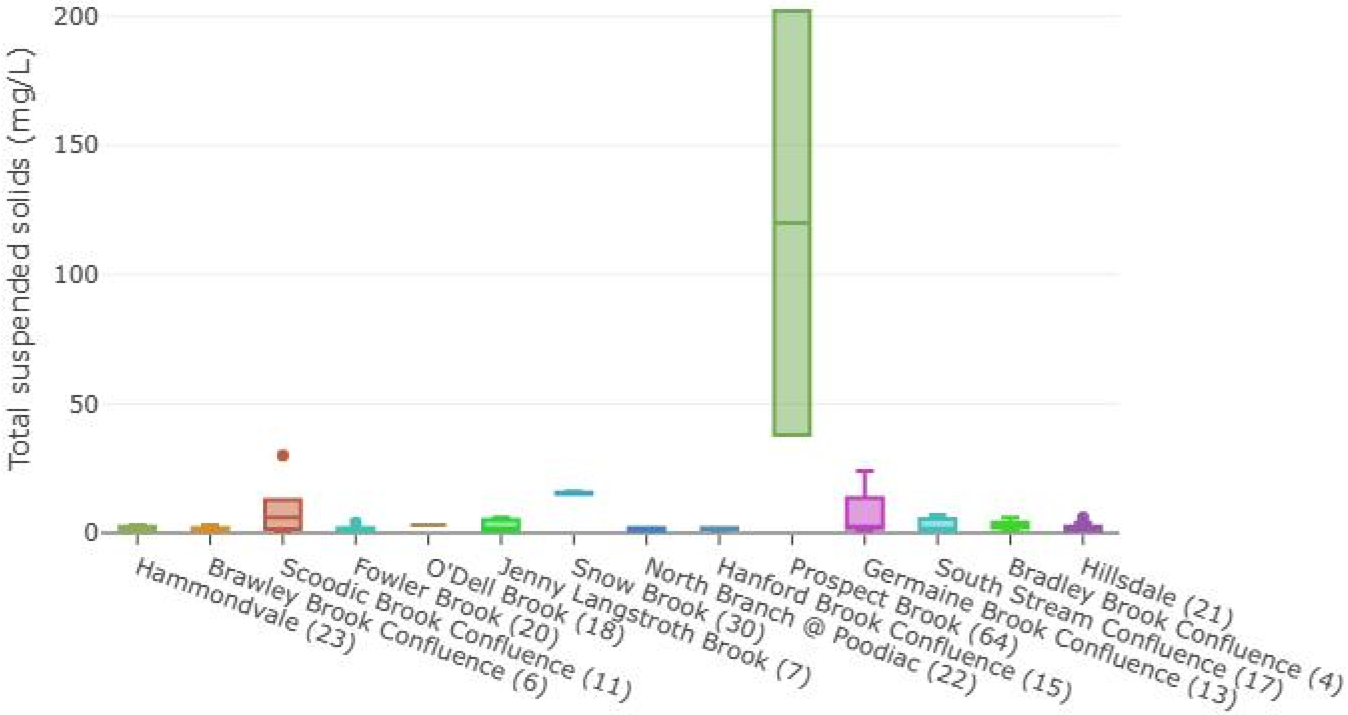


Total dissolved solids (TDS) include dissolved minerals and salts in the water. As a result, TDS is often closely related to conductivity, salinity, alkalinity, and hardness measures. Most freshwater fish and bugs cannot tolerate high TDS because they are not adapted to saline (salty) water, like marine fish are. TDS is usually low for freshwater sources, at less than 500 ppm. Seawater and brackish (mixed fresh and seawater) water contain 500–30,000 and 30–40,000 ppm TDS, respectively.

Given the high mineral content of Salt Springs Brook, it is no surprise that it has higher levels of TDS in comparison to other sites, but it does not appear to be negatively impacting the fish community or abundance of salmonids.



Total Suspended Solids

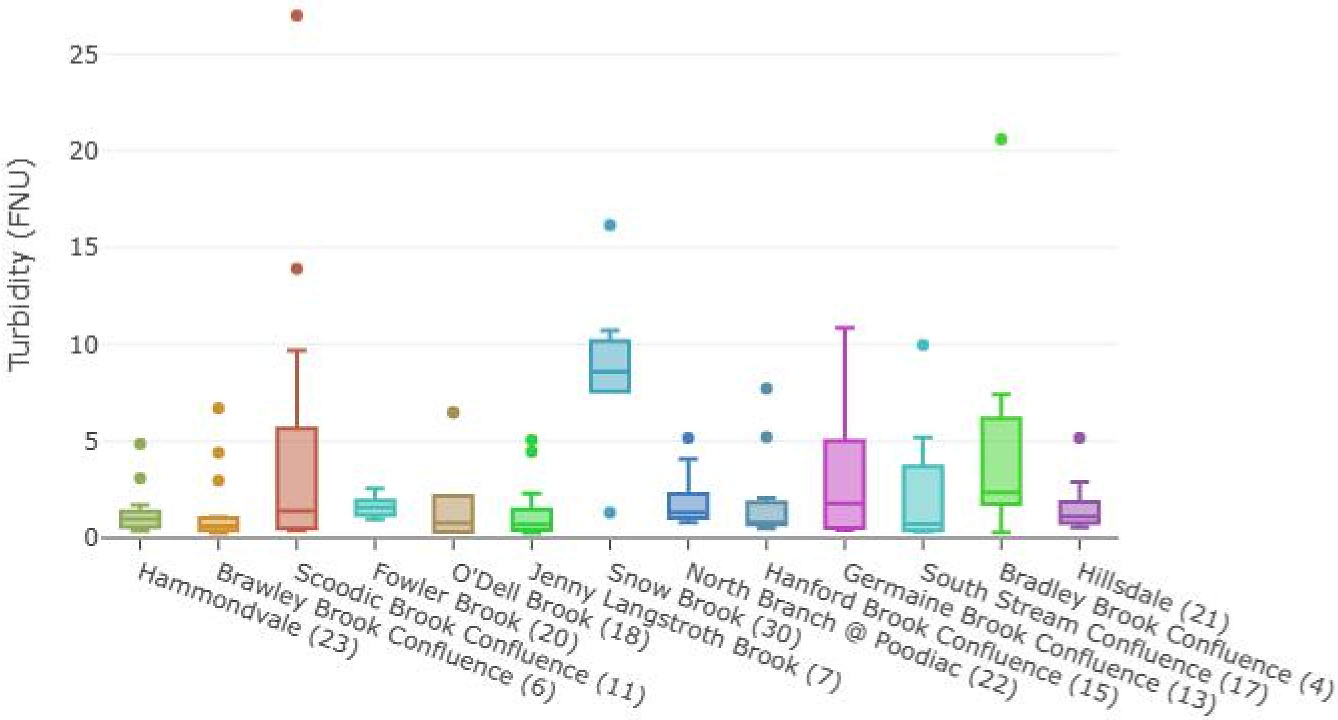


Total suspended solids (TSS) values are often related to the turbidity (cloudiness) of water. If TSS is high and the water is murky then light from the sun will not travel well through the water, making it difficult for plants and algae to grow. This, in turn, can reduce productivity (the amount of plant and animal life that a river or lake can support) and oxygen generation. Lots of soil and silt in the water can also clog fish gills and, if it settles to the bottom, bury fish eggs.

While turbidity and TSS do not have CCME guidelines for the protection of aquatic life, long-term exposure to high levels of turbidity and can impact feeding and nesting behaviors, as fish often flee areas of high turbidity for new territories. For the fish that remain in the turbid environment, suspended sediment can begin to physically affect the fish by clogging gills (Myer & Shaw, 2006).

Once again, our new site of Prospect Brook is standing out from the index sites, and it is becoming increasingly clear why this site is ranked the second lowest within the watershed.

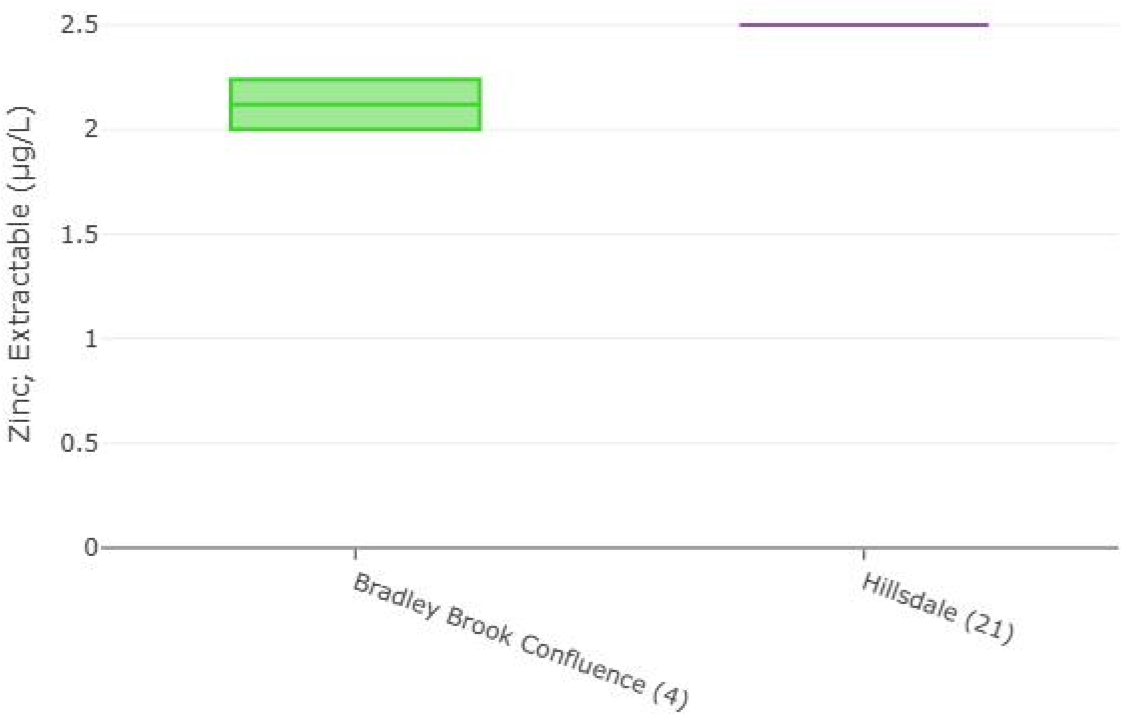
Turbidity



Acceptable levels of turbidity based on the Surface Water Monitoring Data as provided by the New Brunswick Department of Environment and Local Government is 10 FNU. Turbidity is an important indicator of the amount of suspended sediment in water, which can have many negative effects on aquatic life. Large amounts of suspended soils or clay may clog the gills of fish and kill them directly. High turbidity can also make it difficult for fish to see and catch prey, and it may bury and kill eggs laid on the bottom of lakes and rivers. The suspended sediments that cause turbidity can block light to aquatic plants, smother aquatic organisms, and carry contaminants and pathogens, such as lead, mercury, and bacteria. Sources of turbidity include clay, silt, and inorganic matter from natural sources. Turbidity is a measure of water clarity. Increased turbidity may be associated with an increased occurrence of bacteria or pathogens within the water.

Prospect Brook had to be isolated from this chart, as its levels were too high, and skewed the chart's readability. Its seasonal average was 190 FNU, and it peaked at 200 FNU after a heavy rainfall event in July.

Zinc



Acceptable levels of zinc for the long-term protection of aquatic fish health is ≤ 30 mg/L. Zinc is naturally occurring. High quantities of zinc are toxic to fish; however, zinc is also important for fish species wound healing abilities, provided it is within acceptable limits.

Zinc was only detectable in two locations in the watershed, and would not be considered as elevated, nor a threat to aquatic life.

PALMER BROOK

45.43934 -65.91748

The Palmer Brook sub-catchment is located in the lower reaches of the Hammond River watershed and is 19.5 km² in size. Historically, the index site for water quality monitoring was closer to the confluence area, as the adjacent field was formally used for agricultural purposes, and it was advantageous to sample in close proximity; however, land use practices have shifted, and the field is now barren of cattle. As such, HRAA staff have moved the sampling site further upstream by approximately 900m, as the historical site required scaling a very steep slope to access the tributary.

The area surrounding Palmer Brook has been delineated as a Provincially Significant Wetland Area, and staff have documented a plethora of rare and endangered species within this zone. Unfortunately, the upper portion of Palmer Brook faces extreme pressure from industrial development, including new developments within the wetland area. It is paramount to continue to monitor Palmer Brook's water quality to ensure that these industrial expansions are not having a negative impact on the water quality, as the confluence of Palmer Brook serves as a critical staging area for migrating Atlantic salmon.

In 2022, Palmer Brook receives a WQI rating of "Good", which is a vast improvement from its former classification in the early 2000's as "Poor", and it is important to note that the bacterial loading within this brook has substantially decreased.

BRADLEY BROOK

45.43934 -65.91748

Bradley Brook is 8.2km in length, and its headwaters are Bradley Lakes (two conjoined lakes), situated in an area with a high concentration of residential dwellings, aggregate extraction, and farming. Bradley Brook has historically been ranked as a "Class C" brook, according to NB's Water Classification Guide, for its continued exceedances of organic and inorganic parameters- in 2022, it has once again ranked as "Poor", despite many years of restoration, debris removal, and landowner engagement.

The confluence zone is almost completely void of a riparian buffer zone, while the upper portion of Bradley Brook is impacted by illegal dumping activities. Throughout the sampling season, Bradley Brook contained the second highest level of fecal coliforms and e. coli throughout the watershed.

Bradley Brook is characterized by its slow flow and undercut banks on both the right and left bank. The substate is comprised of 50% sand, 40% fines, and 10% gravel, and the substrate is 80% embedded. The upper portion of Bradley Brook has decent crown coverage and overhanging vegetation, which is keeping the upper portion cooler than the confluence area.

Despite these stressors, Bradley Brook continues to support aquatic life, including stickleback, blacknose dace, slimy sculpin, American eels, brook trout, and smallmouth bass.

JENNY LANGSTROTH BROOK

45.423366 -65.877852

Jenny Langstroth Brook is a minor tributary, and eventually merges into Bradley Brook. The site is primarily a run (95%), with a small holding pool below the bridge (5%) and its sinuosity is 10% straight and 90% winding. The riparian zone is well vegetated with 80% or greater of the banks comprised of trees and shrubs. Minimal erosion is present (<10%) and the banks are stable.

In peak summer months, the flow of Jenny Langstroth almost entirely ceases, and filamentous algae proliferates, almost entirely enveloping the substrate in a slick, green slime. The surrounding land use has a high density of mines and gravel pits, and complaints were received and investigated by HRAA staff that extra sedimentation was being deposited into the brook from the construction of a subdivision.

In 2022, Jenny Langstroth Brook received a WQI rating of "poor", failing tests for dissolved oxygen, aluminum concentrations, and iron concentrations. Elevated levels of aluminum can affect some species ability to regulate ions, like salts, and inhibit respiratory functions, like breathing. Aluminum can accumulate on the surface of a fish's gill, leading to respiratory dysfunction, and possibly death. High levels of iron will build up in tissues and can cause toxicity in fish.

Continued water quality monitoring and fish community composition surveys of Jenny Langstroth Brook are warranted.

BRAWLEY BROOK

45.46254 -65.80463

Brawley Brook is 5 kilometers in length and has dropped down the WQI rankings from the 2021 period, from "Good" to "Marginal". Sodium, sulfate, and chloride were high in comparison to other index sites; however, it is anticipated that this is a result from road salts entering the watercourse from the bridge that crosses Brawley Brook near the confluence point.

Land use is mainly forest with minor residential development, and the substrate is a mishmash of bedrock (10%), boulder (20%), rock (30%), cobble (20%) and gravel (20%), and the substrate is <20% embedded. Exceptional crown cover on both the right and left bank, as the brook winds its way through a rich mixture of mature trees that range in species and age class. Shade on the brook is approximately 80%. The majority of the brook remains as it naturally occurs, with minimal disturbance.

Juvenile smallmouth bass have consistently been documented in Brawley Brook during electrofishing surveys and indicates that the brook contains ideal nursery habitat for smallmouth bass. Unfortunately, the upper portion of Brawley Brook contains a severely hung culvert (one that has since experienced failure, which will be discussed later on), and acts as a barrier to fish passage, creating habitat fragmentation with the upper reach of Brawley Brook.

Salt Springs Brook

45.476234 -65.728018

Salt Springs brook is the longest cold-water tributary within the Hammond River watershed, with a total length of 22.5km. The land use varies throughout the Salt Springs region, ranging from agricultural, residential, industrial, and natural forest.

A mineral-rich deposit was documented in 1828 in the aptly named and newly formed settlement of Salt Springs. The salt deposit stretches the entire length of the tributary (the longest within the watershed) and connects to the North Branch of the Hammond River. “Indeed, so many saline springs discharge their streams into this river in this neighborhood that the taste of the water is perceptibly affected” (Weekly Observer, 1928).

Salt Springs Brook has consistently maintained one of the highest densities of juvenile Atlantic salmon and spawning salmon redds within the entire watershed. Given that salmon are anadromous, perhaps they are attracted to Salt Springs Brook's saltier profile.

There is a fair amount of erosion occurring along the lower portion of the tributary, and the HRAA has submitted two proposals for funding to perform riparian restoration in the 2023 season. Should these proposals not be successful, it would be prudent to continue to seek out funding for riparian improvements in this tributary- it has one of the greatest impacts on the overall recovery potential of Outer Bay of Fundy salmon in the Hammond River watershed.

South Stream

45.463947 -65.725337

South Stream is located in Barnesville, and has a length of 13.5 kilometers, with its headwaters in the Caledonia highlands region of Upham Mountain. Beautiful crown closure along the upper portion of this tributary, with a mix of older hardwood and softwood trees. The lower portion of the brook, however, has minimal crown closure or riparian vegetation in the agricultural section.

South Stream receives a Water Quality Index rating of "Good", and it had one E. coli spike in July- this is a common occurrence for this tributary, as cattle have unfettered access near the confluence point, and E. coli spikes are fairly common in peak summer months when the cows are seeking out cold water resources to cool themselves. It is recommended that HRAA engage the landowner in 2023 and discuss limiting cattle access to the brook- HRAA has a longstanding history of working with landowners to install fencing which allows cows to have one access point to water instead of free-range within waterbodies.

South Stream acts as a critical thermal refuge for Atlantic salmon- even during peak summer months, the brook maintains a very cold-water source flowing from the mountain. It is therefore no surprise that this brook offers excellent nursery habitat for juvenile Atlantic salmon and brook trout. From an aesthetic point of view, South Stream is a rare gem within the watershed- its giant boulders, cascades, and swirling pools sets it apart from most other tributaries in the watershed, and it is indeed worth continued conservation efforts.

Scoodic Brook

45.49147 -65.64833

For over 20 years, Scoodic Brook consistently ranks as having the worst water quality within the watershed, which is very unfortunate, given that it flows into the known salmon holding pool of Firehall Pool. With a total length of 8.2 kilometers, the substrate is a mix of rock (20%), cobble (20%), gravel (20%), sand (20%), and silt (20%), and it is 50% embedded.

It is interesting to note that both the upper and lower sites of Scoodic Brook both exceeded levels of aluminum for the protection of aquatic life; however, the upper site contains an abundance of juvenile brook trout- juvenile Atlantic salmon have not been documented within this tributary in at least a decade. Arsenic has also been detected within this tributary; however, the levels are below guideline limits of 1.5 μg/L. In the early 2000's, HRAA worked with the landowner to limit cattle access to the brook; unfortunately, those fence posts have deteriorated, and cattle are now allowed to roam freely within a large section of Scoodic Brook, resulting in E. coli spikes above guideline limits, hitting peak contributions of 1400 CFU/100mL in 2020, 740 CFU/100mL in 2021, and 500 CFU/100mL in 2022, all occurring in the month of July.

Trace metals and nutrient loading are not the only issues plaguing Scoodic Brook- during August, it is common for the lower portion of Scoodic Brook to dry up almost completely, with no flow entering the Hammond River. Dissolved oxygen is consistently low, and water temperature is consistently high.

Hanford Brook

45.467878 -65.629917

Hanford Brook has a very large drainage area of 5,022 hectares, and receives water from Porter Brook, Isaac Brook, Jenny Lind Brook, Quigley Brook, Fletcher Brook, Porcupine Lake, Henry Lake and Tracy Lake- given its magnitude, HRAA staff will be forming an investigative proposal specifically around Hanford Brook.

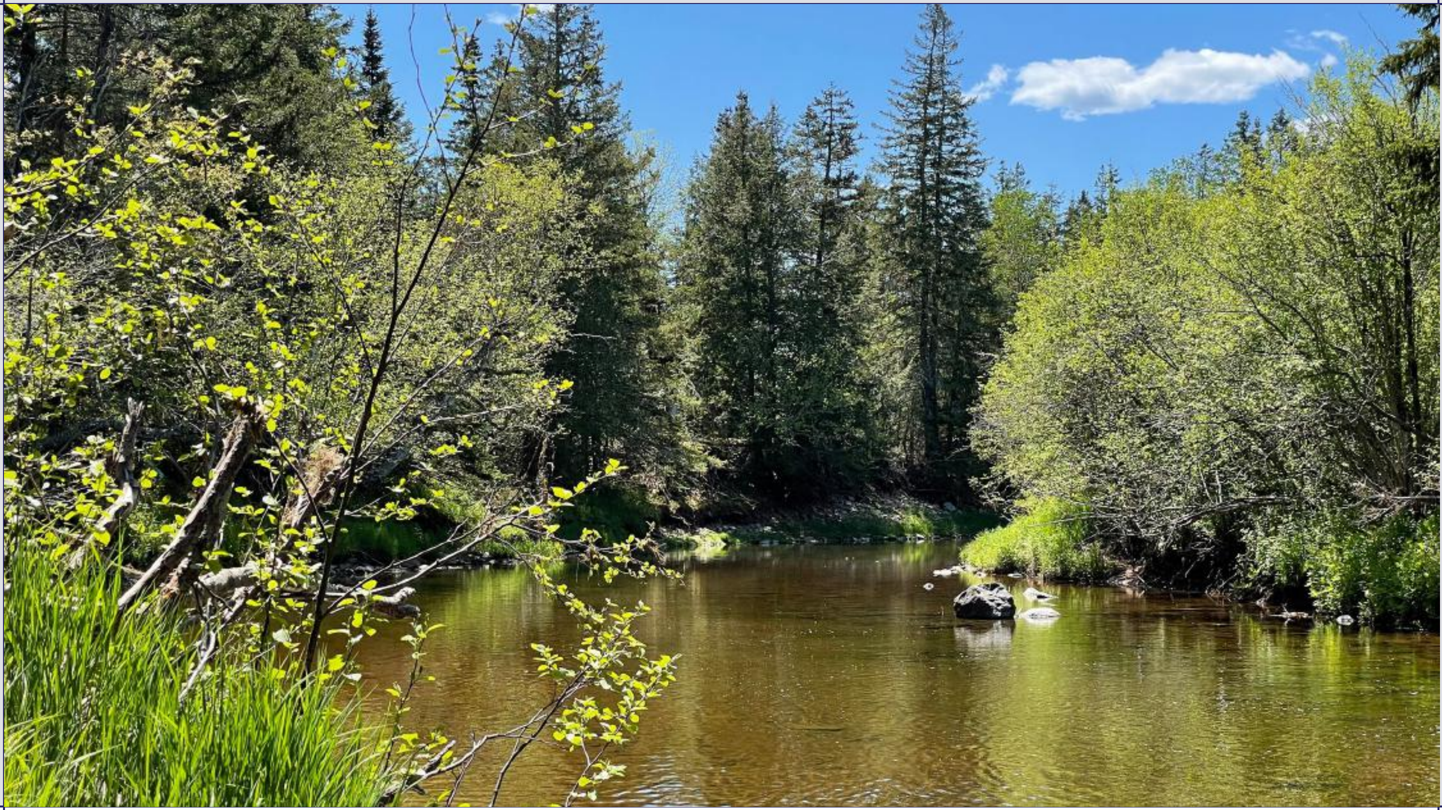
Once again, Hanford Brook receives the top spot for the Water Quality Index. The vast majority of the brook is at it naturally occurs, with few anthropogenic stressors. The upper portion of Hanford Brook contains some of the Province's most significant fossil deposits, including trilobites, brachiopods, and other marine fossils. Several fossil specimens have been removed from Hanford Brook and are showcased in museums across the world.

Similar to Salt Springs Brook, Hanford Brook contains a high density of juvenile Atlantic salmon, and offers excellent spawning substrate for adults to make their redds. During the 2022 field season, HRAA staff noted all-terrain vehicle tracks along the beach and into the brook itself- should this behavior continue, it may be prudent to install signage encouraging the public to avoid driving vehicles in the waterbody and potentially impacting spawning salmon, their nests, or their young.

Hanford Brook is indeed a stunning stretch, and one that deserves a full, in-depth exploration in the near future.

Hillsdale

45.539116 -65.554189



Hillsdale is part of the main stem of the Hammond River, located in the upper portion of the watershed. By mid-summer, Hammondvale and Hillsdale begin to develop significant algal growth during peak summer temperatures, and the water becomes increasingly turbid and tannin in color, indicating a shift from oligotrophic to mesotrophic.

The riparian zone is well vegetated with the majority of the banks comprised of trees and shrubs; however, there has been some scouring from ice that has led to erosion along the right bank. The weaker right bank vegetative riparian buffer and poor water drainage may contribute significantly to reductions in water attenuation, and filtration. Significant in-stream vegetation, including large patches of native milfoil, duckweed, filamentous algae, and grass are present.

Agriculture, particularly the use of fertilizers, is the main stressor in this area, resulting in Hillsdale receiving a Water Quality Index of "Poor". Nitrate, sulfate, phosphate, and potassium levels are contributing to its lower score, and all of which can be associated with fertilizer entering the waterbody. Additionally, the fertilizer input is contributing the growth rate of the aquatic plants and filamentous algae, thus reducing dissolved oxygen levels, and increasing water temperatures. Hillsdale offers critical salmon spawning area, and engagement with landowners to reduce their use of fertilizers in this area is warranted.

North Branch

45.571935 -65.556933

North Branch veers off from the Main Stem at the Hillsdale Bridge and travels northernly towards Cassidy Lake for 13.1km and receives water from Fowler Brook. The substrate in the lower section of North Branch is bedrock (30%), boulder (30%), cobble (20%) and gravel (20%). It offers excellent substrate for fish habitat and nursery area. Substrate is <20% embedded and its cascades and riffles offer excellent dissolved oxygen levels.

The North Branch offers excellent salmonid habitat and consistently produces juvenile Atlantic salmon during electrofishing surveys and environmental DNA sampling. During the 2022 freshwater mussel survey, HRAA staff documented a high abundance of Eastern Pearlshell mussel- not only are these mussels a great indicator of excellent water quality, but they also indicate a strong salmonid presence within the waterbody, as this species of mussels require salmonids as host species for their larva.

In 2022, staff noted that significant clear cutting had begun along the upper reach of the North Branch- monitoring turbidity and nutrient inputs will be critical in the 2023 season to determine if the cutting is having negative impact on its pristine water quality and excellent fish habitat. Additionally, the brine line runs parallel to the North Branch, and ongoing water quality should remain as a top priority for this stretch in order to ensure that any potential brine leaks are addressed immediately, or else they could have detrimental impacts.

Fowler Brook

45.554972 -65.572080

Despite its beautiful crown coverage, flow, dissolved oxygen levels, and excellent substrate (20% bedrock, 30% cobble, and 50% gravel, <25% embedded), Fowler Brook is the third lowest ranking tributary, according to the Water Quality Index. Fowler Brook shares its headwaters with Scoodic Brook in a large wetland complex, as well as sharing several exceedances common with Scoodic Brook, including failed tests for aluminum, iron, and manganese.

Despite these shortcomings, Fowler Brook contains juvenile Atlantic salmon, brook trout, fallfish, chub, shiners, dace, and slimy sculpin. During the 2022 freshwater mussel survey, HRAA staff found Eastern Pearlshell, indicating salmonid presence, as well as a plethora of fingernail clams- the only site in the watershed to produce this species. Fowler Brook's water is extremely dark- it is very difficult to see the bottom, making surveying this stretch relatively difficult, as one becomes very unsure of footing.

The lower portion of Fowler Brook contains stunning aesthetic properties, including multiple cascades and miniature waterfalls, increasing dissolved oxygen content while still allowing fish passage. Water temperatures are consistently cool, even during peak summer months, as a result of the pristine overhanging vegetation and mature trees. HRAA staff released approximately 200 unfed fry into this tributary in 2022, and we are looking forward to seeing if juvenile densities increase as a result of this decision in the fall of 2023.

Hammondvale

45.57578 -65.50306

It is very difficult discussing Hammondvale- this site is a former HRAA restoration site, in which over 750 willow stakes were planted along its banks in 2020 with landowner approval; however, the landowner leases this land (shown above), and the leasee effectively ploughed under all of the willow stakes, and erosion is continuing in this area at an exponential rate.

What makes this even more frustrating is the fact that Hammondvale consistently produces salmon redds; indeed, salmon redds were documented in 2022 in the area shown above. If land use continues, without immediate restoration, the sediment transport will eventually completely embed the gravel substrate and effectively eliminate this spawning site.

HRAA has secured funding through the World Wildlife Fund Canada for riparian restoration- our intentions are to once again have a discussion with the landowner, and hopefully engage the leasee in this conversation. The banks will require re-grading, with rip rap, and extensive re-planting; however, this undertaking will only occur provided the leasee signs an agreement stating that they will not destroy the undertaking. Additionally, Hammondvale exceeds guidelines for phosphate and bacterial input, as this area is regularly treated with fertilizers, decreasing its water quality. It is also anticipated that this nutrient loading is also impacting Hillsdale's water quality, and this needs to be a priority for 2023 in order to protect critical salmon habitat.

Snow Brook

45.503958 -65.796630

Snow Brook is a new addition to HRAA's water quality monitoring program, as a result of 1 grab sample in 2021 yielding exceptionally high levels of iron, aluminum, and e. coli (a whopping 10,180 CFU/100mL). The area surrounding Snow Brook is a historical dump site- it operated in the early 1970's, operated by the Department of Transportation, as 1 of the 11 dumpsites within the Fundy Region. This dumpsite was operable until approximately 1989, when Minister of Environment, Vaughan Blaney, closed the site. According to landowners, the site's closure and remediation were limited to trucking in fill and dumping it on top of the dumpsite, given that there were no regulations regarding what sort of material can be deposited into landfills, and how landfills should effectively be closed after use. DELG staff recommended testing Snow Brook on a regular basis, with a focus on trace metals, BTEX, phenols, cyanide, and hydrocarbons; however, budgeting constraints did not allow for these additional parameters, and this should be revisited in the future.

Turbidity, total dissolved solids, and total suspended solids remained high in comparison to other tributaries throughout the 2022 sampling season, and e. coli and total coliforms exceeded guidelines in July.

It is recommended that HRAA expand the water quality parameters for Snow Brook in 2023, as well as include this site in our fall electrofishing, to determine fish composition within this stressed tributary.

Prospect Brook

45.464986, -65.775086

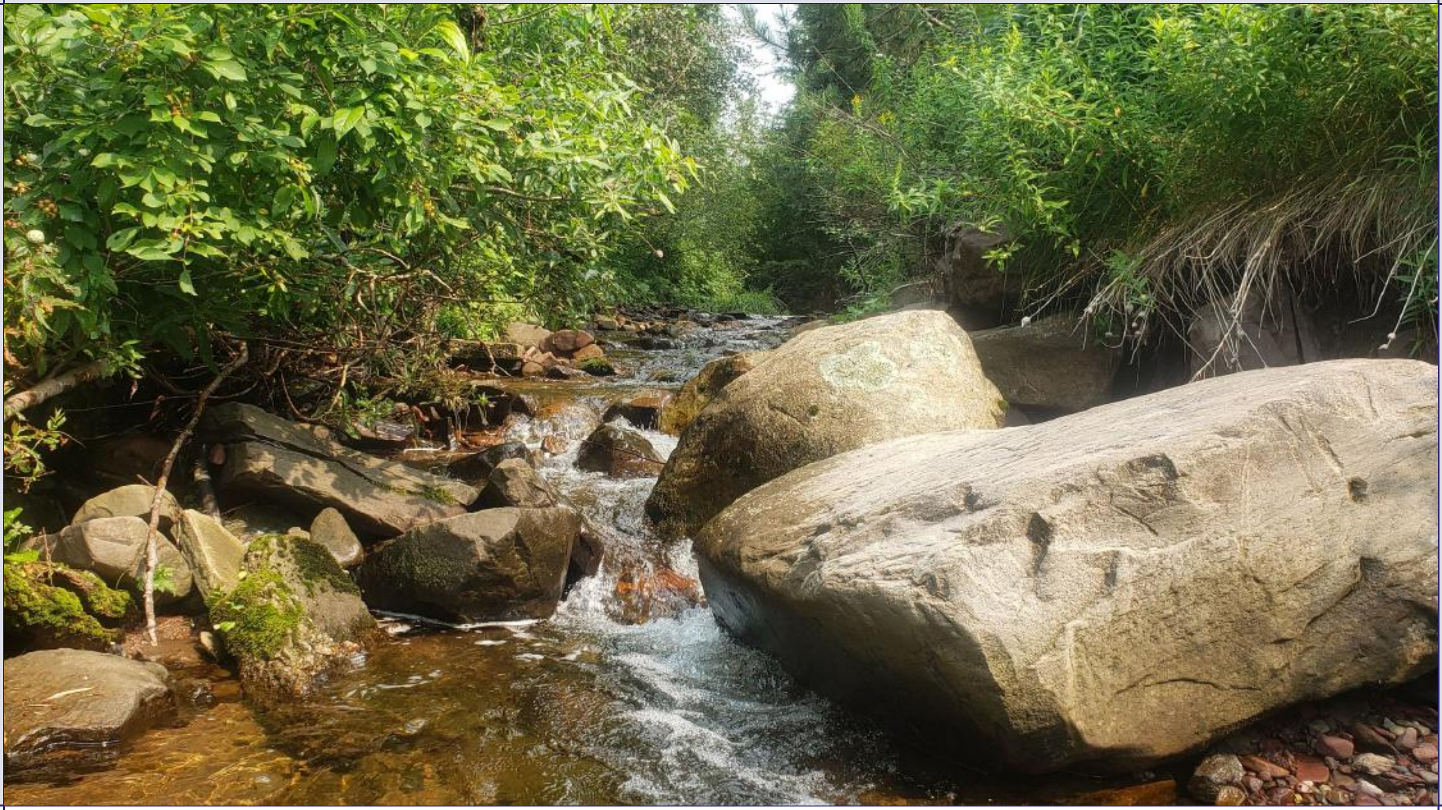
In 2021, HRAA expanded our water quality dataset to include 6 new mountainous tributaries, with great success. These 6 new sites contained excellent water quality and were flowing into the main stem in known salmon spawning areas. In 2022, HRAA wanted to expand this mountainous dataset to include Prospect Brook- originally, we had anticipated that this brook would follow the trend of providing excellent thermal refugia and water quality to sustain salmonid populations; however, we were very surprised by our findings.

Located atop of Prospect Mountain near Smithtown, Prospect Brook ranked the third lowest tributary according to the Water Quality Index. Aluminum concentrations are above guidelines, with a seasonal average of 500 µg/L; iron average of 360 µg/L; and contains elevated levels of potassium and sulfate, and its peak e. coli levels reached 3,600 CFU/100mL. Turbidity levels reached a high of 203 FNU in August, with 202 mg/L of total suspended solids.

Approximately 600 meters of this brook was surveyed in 2022- further surveys are warranted to determine the source of these exceedances. This tributary is not adjacent to any residential dwellings or agriculture; however, clear cutting is occurring in this region. The headwaters for Prospect Brook is an unnamed lake, which HRAA staff did not have the time or resources to survey in 2022- this should be included in our 2023 field season. Perhaps some of these exceedances are naturally occurring; however, further investigation is needed.

O'Dell Brook

45.489371 -65.657313



O'Dell Brook is a new addition to our water quality monitoring program as of 2021 and continuing in 2022. In 2021, O'Dell Brook ranked second highest within the watershed, with a ranking of "Excellent"- it maintains the second highest ranking; however, it has dipped slightly to "Good", as a result of lower dissolved oxygen content.

O'Dell Brook is a historic HRAA restoration site- it once completely lacked riparian buffer zone, and cattle were allowed free access into the brook, drastically increasing its nutrient loading. HRAA planted an abundance of willows and mountain ash, as well as installing fence posts and limiting cattle access- it has become one of the best examples of improved water quality as a result of HRAA's restoration efforts.

It is very interesting to note that O'Dell Brook is adjacent to, and runs parallel to, Scoodic Brook, and the vast difference between their water quality rankings. O'Dell Brook is approximately 13 kilometers in length, and the upper portion transitions into bedrock outcroppings. O'Dell Brook was included in the 2022 electrofishing survey, and it contains an abundance of brook trout, dace, slimy sculpin, and stickleback. Some erosion is beginning to occur along its lower reach- in order to preserve the integrity of this brook, HRAA staff planted 150 native trees and shrubs along this eroded section in 2022. O'Dell Brook should remain on the water quality monitoring program for the long-term.

McGonagle Brook

45.496929 -65.612410

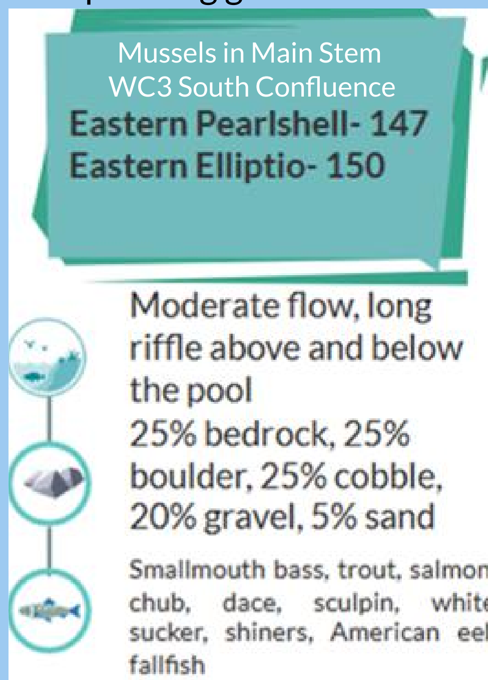
McGonagle Brook was formerly an index site for water quality monitoring in the late 1990's; however, it dropped off the program until 2021, and was included in the 2022 water sampling program. McGonagle Brook is yet another HRAA riparian restoration success story- in 2000, over 500 willows were planted along the lower reach of McGonagle Brook, and a fjord was installed to allow cattle crossing. These efforts assisted in decreasing the nutrient input into the brook.

In 2022, the McGonagle Brook confluence area was included in a riparian restoration effort, as the main stem and confluence point were experiencing erosion. Over 200 native trees and shrubs were planted along this stretch. McGonagle Brook was also included in the 2022 freshwater mussel survey; however, this brook did not yield any mussels.

Habitat assessments were performed in the upper reach of McGonagle Brook, as this area had been previously undocumented. HRAA staff surveyed approximately 850m of the upper stretch of McGonagle Brook- we noted that the culvert below Route 820 is degrading, and under low flow conditions will not allow fish passage- many brook trout were documented in the outflow pool. The upper portion of McGonagle Brook offers excellent salmonid habitat, and it is recommended to engage in conversations with the Department of Transportation to encourage them to consider an open span culvert or bridge when replacing/remediating the McGonagle Brook culvert in the future.

ENVIRONMENTAL COMPLIANCE MONITORING

In 2020, environmental DNA samples were collected from WC3 South; however, results were not available for the 2021 year end monitoring report. We now have the results, and the watercourse tested negative for salmon presence; however, it is not out of the realm of possibility that juvenile salmon may use this tributary as nursery habitat in the future, given its proximity to spawning grounds at Robichaud Pool.



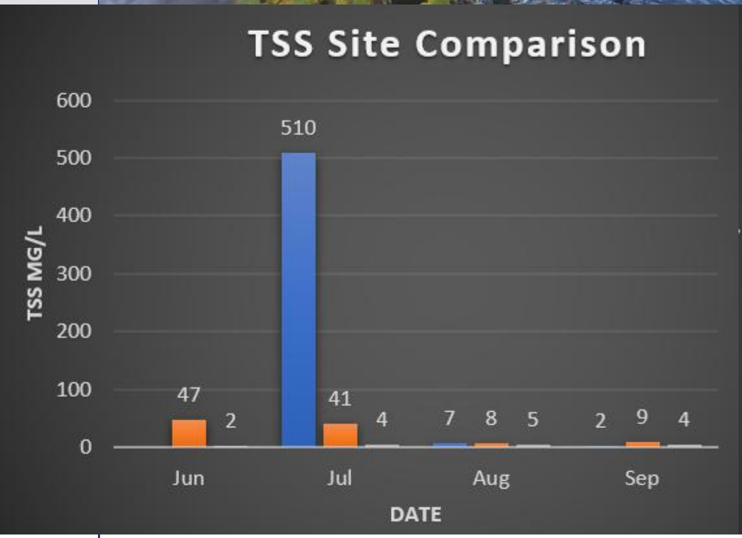
Simpson's Diversity Index:
High (top ranked site in 2022)

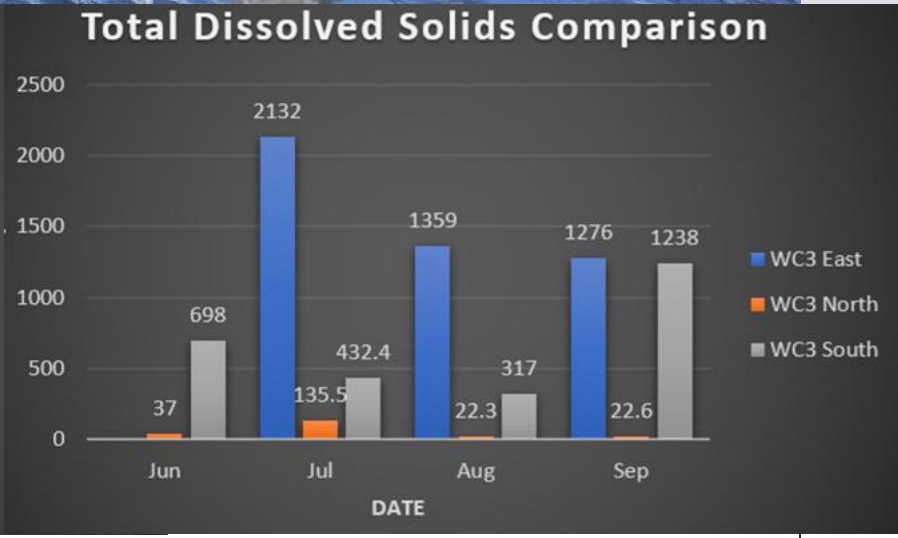
Average Trout Fork Length:
75.57mm

Redd Count in Robichaud Pool:
4 small, 1 communal

WC3 SOUTH

45.474143 -65.629747



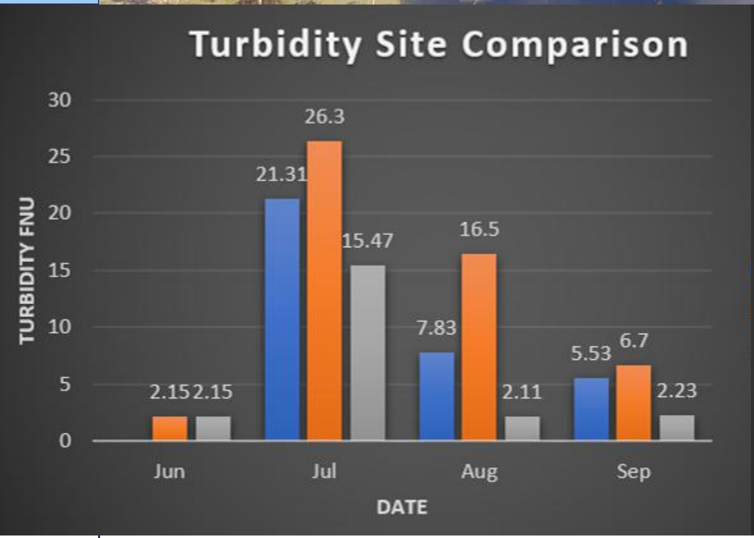


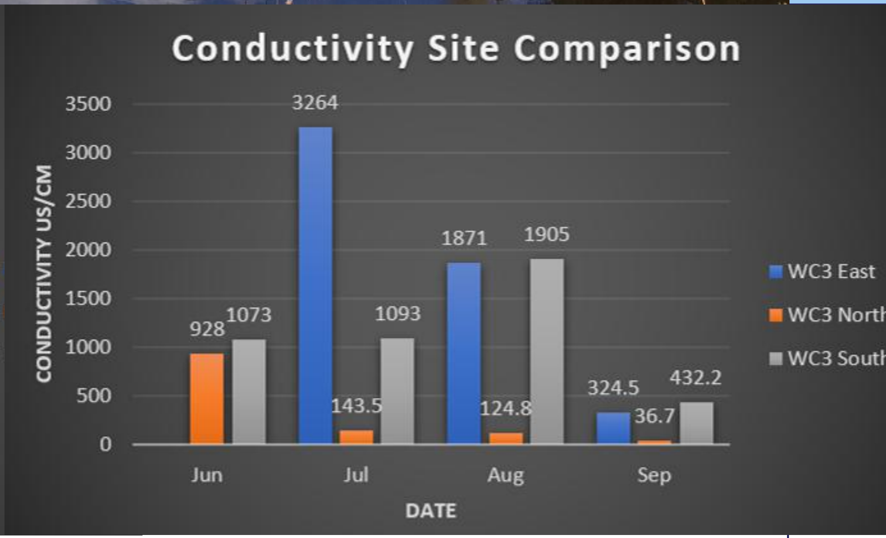
This monitoring program is intended to provide an independent assessment of potential effects of the Upham East Gypsum Mine on water quality, fish habitat, and fish. The monitoring program focuses on the potential effects associated with discharge from the Project, erosion associated with the Project, and any changes in the watercourse morphology due to Project activities that may be detrimental to aquatic biota.

As per conditions set out in the Environmental Impact Assessment, total suspended solids (TSS) in WC3S should not exceed 25 mg/L above the monthly average. Throughout the sampling season, the HRAA did not record any exceedances of TSS in WC3S, with the majority of the samples resulting in lower than detection limit. Similar to results in 2020 and 2021, WC3 East maintains the highest input of TSS; however, this is not as a result of project activities.

WC3 EAST

45.484525 -65.625700



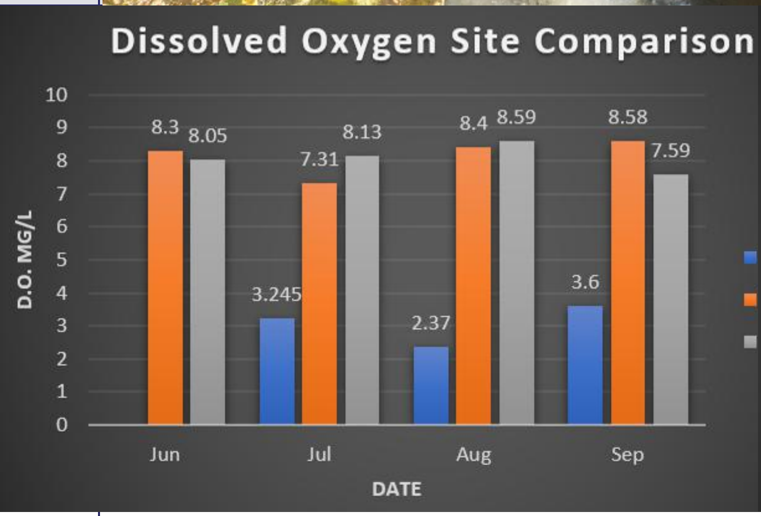


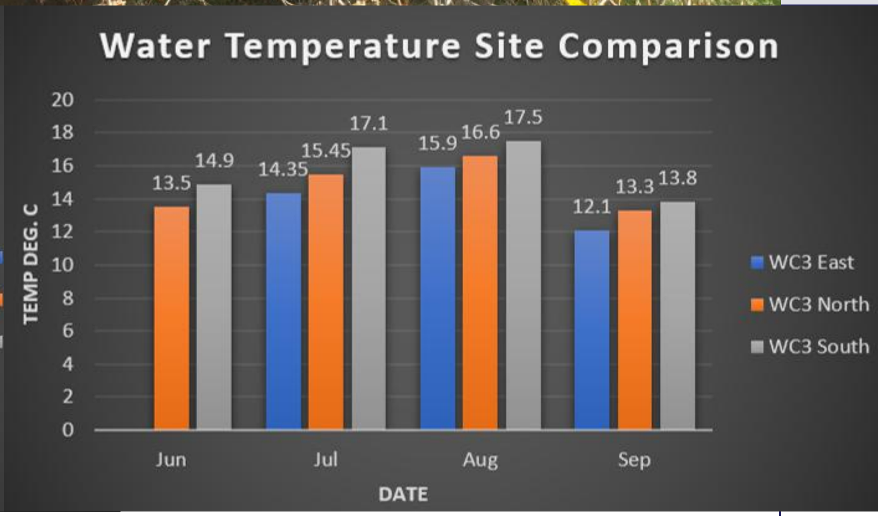
Similar to monitoring results in 2020 and 2021, WC3 South maintains the lowest level of turbidity during the sampling period, with the highest results stemming from WC3 North, followed by WC3 East; it is therefore assumed that mining project activities are not having an adverse environmental impact from turbidity in the receiving environment of the main stem of the river.

The types of rock and soil in an area will influence the conductivity of the water- rocks that break down more easily will raise conductivity. Given gypsum's brittle nature and its high mineral content, it is increasing the conductivity levels in comparison to WC3 North and WC3 East. WC3 South maintains a higher level of conductivity than the other 2 sampling sites, and this is due to its proximity (and potential groundwater influence) of the gypsum resource. One conductivity spike occurred in July in WC3 East due to heavy rainfall.

WC3 NORTH

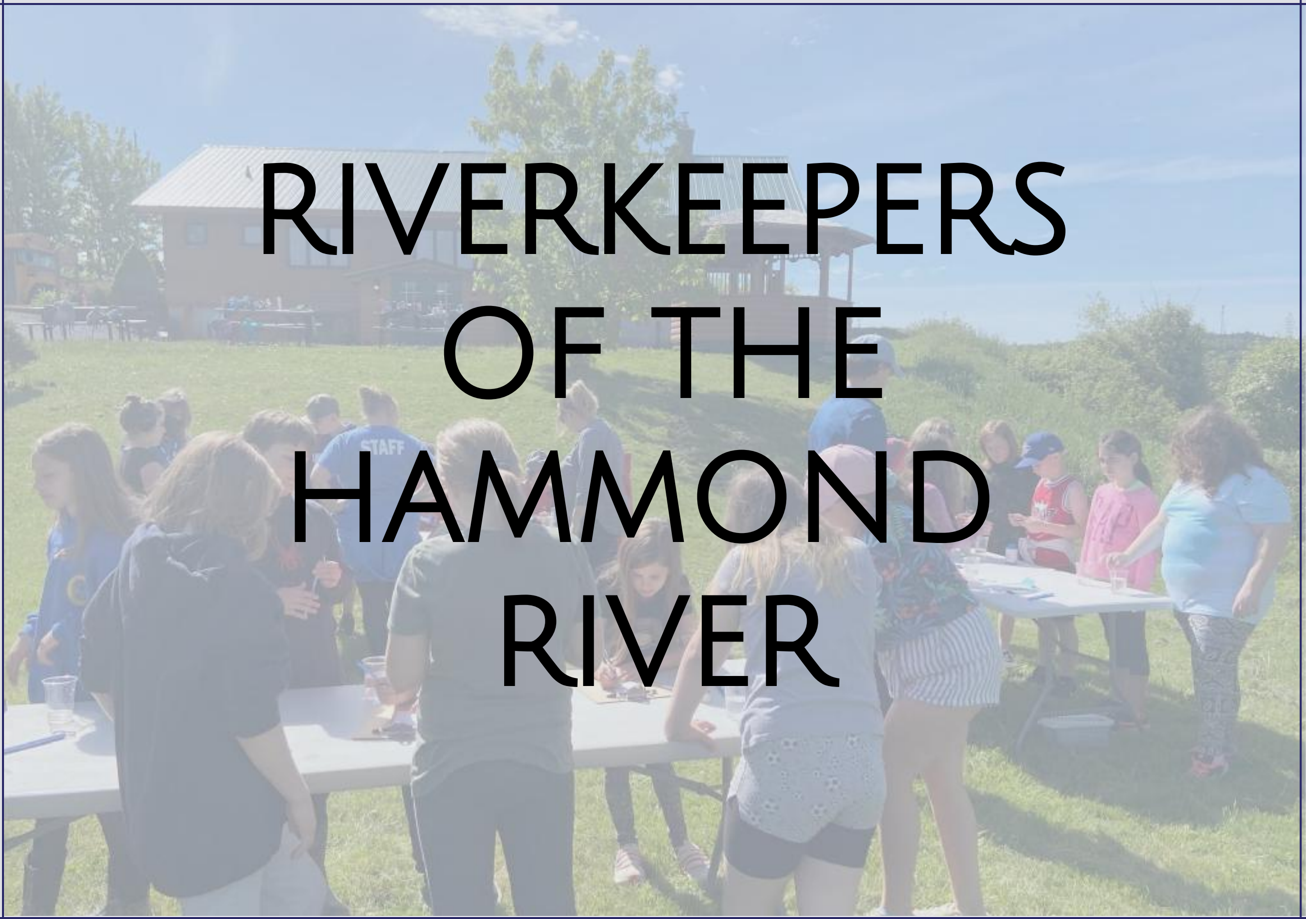
45.486418 -65.631415





According to the Canadian Council of Ministers of the Environment, dissolved oxygen levels should be >9.5mg/L in freshwater to sustain early life stages of aquatic life and should be >6.5mg/L to sustain all other life stages of aquatic life. WC3 South was just below levels to support early life stages of aquatic life; however, our electrofishing survey disputes these results, given a high abundance of juvenile trout within the tributary. WC3 South and WC3 North both have excellent dissolved oxygen levels to support all other life stages of aquatic life.

Water temperature was not included as a parameter in 2020 or 2021; however, we have determined that this is a critical parameter and will be included for the remainder of project life. WC3 South maintained the warmest water temperature throughout the sampling season in comparison to the 2 other sampling sites; however, the temperatures are low enough to support aquatic life, providing cold water refugia for juvenile trout.



RIVERKEEPERS OF THE HAMMOND RIVER

The HRAA firmly believes the best way to promote ecological awareness is through proactive education. Environmental education programs are essential to protect and conserve the environment, as they educate students on threats to our ecosystems and foster a sense of responsibility in our youth. Stewardship begins when students garner an understanding of ecosystems and receive 'hands-on' experience of what they can do to protect and conserve it. These classes educate and raise awareness about the state of our environment, giving students the foundation to teach others, to ask more questions, and learn more about what truly interests them.

The purpose of the Riverkeepers project is to connect students, adults, and newcomers of all ages and backgrounds with the importance of water quality sampling and precipitation monitoring, and how these have an impact on wildlife. Our goal with this environmentally educational class was to engage the general public, regardless of age or previous experience, with water quality testing to increase connection with nature and wildlife. We used a multi-faceted educational approach to teach participants about the importance of healthy, functioning ecosystems.

The Riverkeepers program is based on the use of the Water Rangers Test Kits and partnership with the Water Rangers organization.

Riverkeepers of the Hammond River

The Riverkeepers Educational unit begins with a presentation to introduce participants to the concepts of water quality monitoring. Participants learn about the concept of a 'watershed', the differences between different watersheds (flow, shade, vegetation, geology, size, width, depth), the concept of baseline data, the importance of regular water quality monitoring, and what to look for as part of their observations (change in flow, change in watercolor, change in smell etc.). The presentation emphasizes that understanding leads to connection- when something is difficult to understand, you often feel disconnected; however, when you start to understand how to monitor water quality, you begin to connect with issues affecting water quality and can then take action. People have more power to change things than they think! When we work together, when the community cares about water quality, it gets protected!

Once participants have a solid grasp on why we test water quality, it is time to learn how to test the water quality! Using the Water Rangers test kits, students are able to use a thermometer to determine the air temperature, and how air temperature impacts water temperature. Participants learn about the direct connection between air and water temperature- as air temperature increases, so too does water temperature.

Water Sampling in the Hammond River

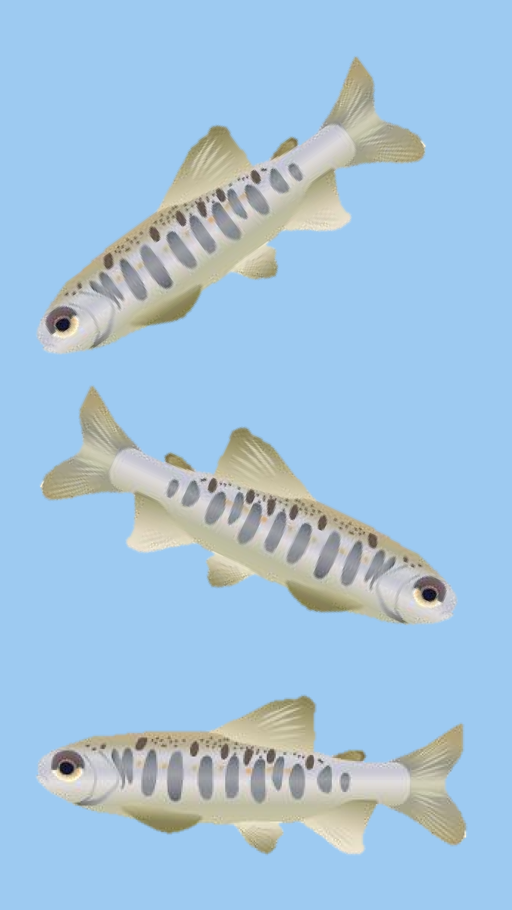
The next parameters include pH, alkalinity, hardness, and chlorine. Participants use pH test strips and dip them in water samples to test for the aforementioned parameters. Participants learn how changes in pH and alkalinity can affect water quality, which can then lead to impacts on wildlife. Participants learn that if the water is either too acidic or too basic, it can lead to fish death. They also learn that hardness can be a result from excess minerals in the water, such as gypsum, limestone, magnesium and iron.

Conductivity is water's ability to pass an electrical current due to dissolved salts or inorganic materials in the water column, and that conductivity readings can be used to estimate the water's salinity. Higher levels of conductivity may imply that pollution is occurring in the waterbody, or it may indicate salt deposits underground. Many fish and wildlife species have very limited tolerances to salinity, so it is very important to test the water's conductivity level!

Participants are given field sheets to record their findings, including their visual, audio, and olfactory observations. They take their sample from the river, and record their findings, and then they are brought to the HRAA pond to collect an additional sample and compare the results and discuss their findings.

Throughout the lesson, students are encouraged to pick up any litter that they can spot- keeping debris and deleterious substances out of the watercourses is one of the many ways that we can get hands-on in protecting our waterbodies! At the end of the lesson, field observations are collected by HRAA staff, and uploaded onto the Water Rangers website.

Riverkeepers demonstrates the relationship between water quality and quantity and how these impact the biodiversity of our riverine systems, creating active stewardship roles that span all physical ages and cultural backgrounds!



SPLASH DAY

Releasing Un-Fed Fry into the Hammond River

In collaboration with the New Brunswick Salmon Council, HRAA delivered Atlantic salmon eggs to 10 local schools, to raise in their classroom tanks. During delivery of the eggs, HRAA staff provide classes with a presentation on the Atlantic salmon lifecycle and explain why their tank set up is important. Students learn that Atlantic salmon eggs require cold, clean water, and that placing Styrofoam around the outside of the tanks helps keep them dark, as they would be in the wild. Students are then responsible for tracking the water temperature of their tanks, and recording emergent fry as they hatch. Students learn about the life stages of their salmon, from egg, to fry, to parr, to smolt, to adult. Students learn about the threats that salmon face, both in freshwater and marine settings, and what they can do to help decrease these threats.

In June, the schools arrive at the Conservation Center for Splash Day, whereby they get to release their fry into the Hammond River! Before releasing their salmon, students are provided with the Riverkeepers Educational Unit, and test the water quality in advance of releasing their fish. This creates a direct connection between the importance of good water quality and survival rates of aquatic species.

The HRAA also raised approximately 200 fry at the Conservation Center and released them in in the upper portion of the watershed, and captured the release on video, which can be found on our YouTube channel.

REDD COUNT SURVEY

Youth Event

The word “redd” is a Scottish word meaning “to make clean or tidy”- it is a nest that the female Atlantic Salmon will create, by using her tail to create a depression in the gravel for her to lay her eggs. Once the eggs have been laid, she will use her tail to cover the eggs with additional gravel. The surface area of a redd is approximately 2-5 meters squared and consists of a raised mound or dome of gravel, under which the eggs are located. The gravel will appear clean, or bright, compared to other rocks in the river. Redds are usually found at the tail of pools on the upstream side of riffles, with relatively high-water velocity, and water depths of 15-70cm.

The HRAA begins performing preliminary redd count surveys towards the end of October, and throughout the month of November. The first Sunday of November, the HRAA hosts one of our most popular volunteer-based events- the Annual Redd Count Survey! Weather permitting, HRAA has been hosting this hands-on event for over 2 decades!

In 2022, the HRAA field staff wanted to engage more youth in our redd count event, so we created a second survey specifically for youth! We partnered with the Kennebecasis Valley Scouts division, as well as HRAA's Kids' Fishing Club for a Youth Redd Count Survey. Before starting the survey, all participants were provided with the Riverkeepers Educational Unit, as water quality is key for successful spawning. We surveyed approximately 800m of the river in French Village, and documented 2 small redds! After the redd count survey was complete, we provided participants with garbage bags, and they assisted us in a shoreline cleanup event. At the end of the survey, they all joined us for treats and snacks at the Conservation Center!

Redd Count Survey

HRAA maintains the largest and most consistent redd count survey dataset within the entire province. A fellow watershed association, the Nashwaak Watershed Association, reached out to the HRAA in October for guidance on how to perform their own redd count surveys. Our field staff provided them with a copy of our Redd Alert volunteer guide sheet, a template for their collected data, created a presentation on tips and tricks for how to successfully host a redd count event, and created collaborative targeted outreach materials to support their event!

After the Youth Redd Count event was complete, we had adult volunteers join us for the afternoon surveying the Hammond River watershed for spawning nests. In total, we had 22 participants for our main redd count event, and we were able to survey 13 different sites, extending from the lower portion of the watershed to the upper reach in Hammondvale. We found a total of 57 redds, many of which were large communal redds.

Electrofishing

Within the Kennebecasis & Hammond Rivers

In the fall of 2022, the HRAA began our electrofishing survey within the Hammond River watershed. Originally, we did not believe that we would have the time to perform electrofishing due to unpredictable weather patterns and requested an adjustment to the scope of the project to replace electrofishing with environmental DNA; however, we were able to perform the majority of the electrofishing (target: 12 sites; complete: 10 sites total).

Additionally, we were approached by the Kennebecasis Watershed Restoration Committee (KWRC) to assist them with their electrofishing survey. The Hammond River is a tributary of the Kennebecasis River, and this provided us with an opportunity to increase our understanding of the distribution of Outer Bay of Fundy Atlantic salmon betwixt our watersheds. Given the overall theme of this project of "getting hands-on", we felt that this collaborative effort was well within the overall scope of this project, as partnership is a key overarching goal.

The HRAA performed electrofishing within 4 sites in the Hammond before jumping into the Kennebecasis River with the KWRC and performed electrofishing in a total of 6 sites. During the 6th site, our electrofishing backpack unit experienced major technical difficulties- we experienced a high level of fish mortalities and took the backpack unit to an electrician who has serviced the backpack in the past. It has been determined that the unit's output no longer match the settings, nor does the emergency shut off switch work. As a result, electrofishing ceased for the season, and a replacement unit will be generously donated to the HRAA from one of our Board of Directors for the fall 2023 survey.

Results & Analysis

In order to analyze the results of the electrofishing efforts, HRAA staff use the Simpson Diversity Index (SBI). The Simpson's Diversity Index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, so diversity increases. The value of diversity ranges between 0 and 1.

0.00	Absence of diversity
0.01 - 0.40	Low degree of diversity
0.41-0.60	Moderate degree of diversity
0.61-0.80	Moderately high degree of diversity
0.81-0.99	High degree of diversity
1.00	Perfect Diversity

Two sites surveyed in 2022 yielded salmon- one site in the Kennebecasis, and one site in the Hammond. Other than the Mine Discharge Brook, the other 3 sites in the Hammond had not been electrofished (either ever, or not within the past decade). Our historic sites that contain salmon were not included in the 2022 survey due to the malfunction of the electrofishing backpack unit. The salmon found in the Kennebecasis is classified as a parr, and the salmon found in the Hammond in Porter Brook is classified as a smolt.

River	Site	Salmon Presence/Absence	SBI Number	SBI Ranking
Hammond	Mine Discharge Brook	No	0.81	High Degree
Kennebecasis	Smith Creek @ Manning Rd.	No	0.74	Moderately High
Kennebecasis	Kennebecasis @ Adair	No	0.71	Moderately High
Kennebecasis	Trout Creek @ Bucanon	No	0.7	Moderately High
Hammond	Porter Brook	Yes	0.65	Moderately High
Hammond	O'Dell Brook	No	0.64	Moderately High
Kennebecasis	Smith Creek @ Oldfield Rd.	No	0.62	Moderate
Kennebecasis	Kennebecasis at Dunsinane	Yes	0.6	Moderate
Hammond	McGonagle Brook	No	0.47	Moderate
Kennebecasis	Trout Creek @ Creek Rd.	No	0.05	Low Degree

SHORELINE CLEAN-UP EVENTS

Throughout the 2022 season, the HRAA hosted 3 shoreline cleanup events, one of which was in collaboration with Encorp Atlantic and the Kennebecasis Scouts Division. These cleanup initiatives took place in the Spring after the freshet, in the summer, and in the fall in advance of fall flooding.

Face masks continue to be an issue, despite regulations requiring face masks easing up. These pose a greater threat to wildlife, as wildlife can become entangled in the elastic bands of the masks. We are hopeful that we have removed the vast majority of masks from the watershed, and we are equally hopeful that this issue will soon cease.

During our cleanup events, we target 5 main locations, all of which are hotspots for littering: French Village Bridge, Smithtown Bridge, Tabor Bridge, Silver Hill, and the Deep Hole Pool. In total, we collected 30 bags of garbage, 5 bags of recyclables, and various larger objects (a car door, pylons from road repairs, old playground equipment, rebar, fence posts with nails, and a plethora of shoes/sandals).

While not a glamourous initiative, shoreline cleanups are one of the most impactful events for protecting the environment!

NB SCIENCE WEEK

Inland Fishes of New Brunswick

This is HRAA's second year participating in New Brunswick's Science Week! This is a virtual learning opportunity for schools across the province to learn about different science-based topics, and we are pleased that we have been selected once again to create a presentation for youth!

Our 2022 presentation focused on the Inland Fishes of New Brunswick. Participants got to learn about all the different types of fish that call New Brunswick home, from the very smallest fish (sticklebacks, dace, minnows) to the very largest fish (muskie, striped bass, salmon), and everything in between! Students learned about fish requirements, and the importance of maintaining good water quality, and what they can do to help ensure our waterbodies stay healthy and clean.

Students also got to learn about the various threats that fish face, and were introduced to fishing regulations and size regulations, and the importance of catch and release. HRAA staff also used this opportunity to promote our monofilament recycling bins (picture above features our EcoTech, Josh, showing the kids one of the fishing line collection bins). Students learned that while fishing line may seem harmless to leave on the ground, that it actually takes over 600 years for the fishing line to decompose, and that it entangles, injures, and kills, thousands of wildlife every year.

One of the highlights from this presentation included a discussion on how Atlantic salmon are known as "leapers", and having all of the kids stand up and see if they could jump as high as salmon- they were all amazed at the salmon's ability to jump 2-3 meters high! NB Science Week is a unique opportunity to reach a large amount of youth in a virtual setting, and we are hopeful that we will present again during 2023's Science Week!

Invasive Species Monitoring

Eurasian Water Milfoil, Emerald Ash Borer & Wild Parsnip

Invasive milfoil detected in Darlings Lake

In collaboration with the New Brunswick Invasive Species Council, HRAA field staff installed two emerald ash borer prism traps within the watershed. These traps contain pheremones to attract nearby emerald ash borers, and an extremely sticky surface to which the emerald ash borer (EAB) becomes trapped. Both of the sites that HRAA staff selected contain ash trees- EAB's are extremely destructive on ash populations- once infected, the ash tree will lose its canopy within the first or second year, and the entire tree will die within the third or fourth year.

This is HRAA's second year deploying prism traps, and we are happy to report that we have yet to collect any EAB's from the traps!

Wild parsnip is another invasive species that the HRAA is monitoring and raising awareness on. The plant forms dense stands that outcompete native plants, reducing biodiversity, and its prolific seed production can last dormant in the soil for up to 100 years! Its sap can cause intense skin burns if activated by sunlight.

Wearing protective clothing, HRAA staff removed over 40 large garbage bags worth of wild parsnip from the Conservation Center property, and we will continue to make best efforts in its entire removal from the property.

Flora, Fauna & Avifauna of the Hammond

The HRAA is extremely fortunate that one of our Board of Directors is a phenomenal wildlife photographer (two of his photographs are highlighted here).

While our HRAA field staff collect hundreds of photographs during the field season, they simply do not compare to professional-grade photography. As such, we created an entire educational series on Mr. Blenis's wildlife photography, educating the public on the many different types of flora, fauna, and avifauna within the Hammond River watershed.

By incorporating a large mixture of plant and animal life into our educational outreach posts, we are sure to inspire the community to get out into nature! Throughout the 2022 season, we created a total of 21 flora, fauna, and avifauna social media posts.

These beautiful photographs, as well as their educational writeups, help encourage people to get involved with events like the Great Backyard Bird Count, Christmas Bird Count, and BioBlitz events!

Theobald Lake

Nature Legacy

For the past 2 years, the HRAA has actively participated in and actively promoted GNB' Nature Legacy initiative, whereby the government has committed to doubling its permanently protected land and freshwater from 4.6% to 10%!

In early 2021, the HRAA submitted a candidate for protection for GNB's consideration- we strongly feel that Theobald Lake, the Jenny Lind Brook headwaters, and Irish River are more than worthy of permanent protection. This 494-hectare area is now "pending formal protection", and the HRAA is very hopeful that our candidate area will soon gain formal protection!

In the summer of 2022, the HRAA promoted, and participated in, the iNaturalist Bioblitz, and our field staff focused our efforts on the Theobald Lake area! In total, we uploaded 49 observations from the Theobald Lake area into the iNaturalist app, including species like the ghost pipe (seen to the left). Bioblitzes provide an excellent opportunity to get hands-on in your natural surroundings, regardless of age or experience!

Brawley Brook Culvert Assessment

In 2020, the HRAA field staff performed an in-depth culvert assessment project and ranked the Brawley Brook culvert as top priority for remediation. Not only did the culvert not allow fish passage, but it was extremely compressed, rusted, and immanent failure was predicted. HRAA staff alerted the Department of Transportation on our safety concerns for Brawley Brook culvert; however, we did not receive a response.

After a heavy rainfall event in late fall of 2022, the culvert did indeed collapse, with one section of the culvert ending up in Brawley Brook. The road has since been opened to one lane of traffic, with the cement blockers placed to the side near the erosion.

HRAA field staff, with assistance from experienced HRAA Board of Directors, performed an additional survey to determine if the upper reach of Brawley Brook contains suitable fish habitat- indeed it does. As such, HRAA Board of Directors submitted correspondence to the Minister of the Department of Transportation, requesting that a clear span structure (bridge or open-bottom culvert) be installed at this location upon its remediation, which will reconnect fish passage.

Social Media Engagement

Project Promotion

Social media is one of our most important tools for engaging the surrounding community in our projects and events!

The HRAA maintains a consistent presence on Facebook, Twitter, YouTube, Instagram, and we have expanded our outreach by creating videos for TikTok in 2022!

https://www.facebook.com/hammondriveranglingassociation

https://www.facebook.com/groups/7422885398

https://www.twitter.com/hammondrivernb

https://www.instagram.com/hammondrivernb

https://www.youtube.com/@hammondriveranglingassocia8116

https://www.tiktok.com/hammondrivernb

1,375
Followers on Facebook Main Page

578
Followers on Facebook Group

540
Followers on Instagram

325
Subscribers to Newsletter

97
Followers on Twitter

24
Followers on YouTube

14
Followers on TikTok

Protecting Our Environment

Priority Area Measures: Protecting Our Environment	Management Actions	Delivered
	WMP Goal 2 Action 11: Track Bacterial Loading	60 Samples Collected
	WMP Goal 2 Action 12: Water Quality Monitoring	60 Samples Collected
	WMP Goal 2 Action 13: Expand WQ Sites	3 New Sites Added
	WMP Goal 2 Action 20: Riverside Cleanup	3 Cleanup Events
	WMP Goal 2 Action 26: Mountainous Tributary Characterization	1 New Tributary Added
	WMP Goal 2 Action 30: Culvert Assessments	Brawley Brook Culvert Assessed
	WMP Goal 2 Action 31: Sediment & Turbidity Monitoring	15 sites Monitored for Turbidity
	WMP Goal 2 Action 33: Document Salinity in Salt Springs	4 Samples Collected
	WMP Goal 2 Action 35: Compliance Monitoring Gypsum Mine	Monthly WQ, Electrofishing
	WMP Goal 2 Action 39: Increase Citizen Science	Riverkeepers Class
	WMP Goal 3 Action 48: Riparian Planting McGonagle	250 Trees Planted
	WMP Goal 3 Action 50: Create Riparian Planting Database	1 Database Created
	WMP Goal 3 Action 51: Review Planting Success at Hammondvale	1 Assessment Performed
	WMP Goal 3 Action 57: Work with GNB on Theobald PNA	1 Protected Natural Area
	WMP Goal 4 Action 65: Stream Habitat Assessments	15 Habitat Assessments Performed
	WMP Goal 5 Action 70: Expand Electrofishing Sites	2 New Sites Added
	WMP Goal 5 Action 72: Revamp Fish Friends	12 Classes Engaged
	WMP Goal 5 Action 73: Identify Stocking Sites	2 Sites Stocked with Salmon Fry
	WMP Goal 5 Action 75: Educate Public on Fishing Regulations	6 Social Media Posts
	WMP Goal 5 Action 87: Create Electrofishing Master Dataset	1 Master Dataset Created
	WMP Goal 6 Action 96: Host BioBlitz Events	1 Bioblitz Event
	WMP Goal 6 Action 102: Invasive Species Survey	3 surveys (EWM, EAB, parsnip)

All Management Actions come from HRAA's Watershed Management Plan 2020. In our original ETF proposal, we had stated that we would perform 110 Management Actions; however, we interpreted this as each water sample collected represented an "Action Item". Our official total for Management Actions for this project is 23.

Priority Area Measures

Increasing Environmental Awareness

Priority Area Measures: Increasing Environmental Awareness	Activity	Engaged
	Active Learning: Riverkeepers Educational Unit	12 Schools/229 Students
	Active Learning: Riverkeepers Educational Unit	17 Community Participants
	Active Learning: Riverkeepers Educational Unit	300 Nature Camp Participants
	Active Learning: Riverkeepers Educational Unit	30 Participants Newcomers Center
	Active Learning: Youth Redd Count Survey	13 Participants
	Active Learning: Adult Redd Count Survey	22 Participants
	Active Learning: Riverside Cleanup Events	3 events/19 Participants
	Active Learning: Water Quality Monitoring	2 New Employees Trained
	Active Learning: BioBlitz	8 Participants
	Active Learning: Splash Day	6 Schools/115 Participants
	Active Learning: Electrofishing with KWRC	6 Participants Trained
	Observing: Redd Count Training to Nashwaak	1 Presentation/3 Participants
	Observing: NB Science Week Presentation	575 Participants
	Observing: Riverkeepers YouTube	22 Views
	Observing: Salmon Release YouTube	35 Views
	Observing: Salmon Release TikTok	277 Views
	Observing: Facebook/Twitter/Instagram Educational Posts	36 Posts/8,927 People Reached

Proposed
Active Participants: 562
Actual
Active Participants: 761

30% Increase

Proposed
Active Duration: 56 hours
Actual
Active Duration: 70 hours

22% Increase

Observing Outreach: 9,839 Engaged in Presentations

Active Participants + Engagement Outreach: 10,600 People Hands-On in Conservation!

Conclusion

The relationship that participants have built with the river through this program will foster the development of future conservationists who will work to protect local waterways and conserve wildlife resources. The Riverkeepers class will increase environmental awareness through education about environmental issues, such as conservation and protection of biodiversity and our waterways. By encouraging this vast array of participants to take care of the environment, we expect that they will also encourage their friends and families to do the same.

This project has increased the HRAA's capacity to deliver on exceptional quality events and programs. We were able to train additional staff to assist in water quality monitoring; we were able to partner with the Kennebecasis Watershed Restoration Committee and train their staff on electrofishing techniques; we were able to partner with Nashwaak Watershed Association and train their staff on how to perform redd count surveys. We engaged the surrounding community in a plethora of hands-on volunteer events, and we are so pleased by the number of youth who joined us for these events!

With financial assistance from the New Brunswick Environmental Trust Fund, we were able to expand our knowledge on the Hammond River watershed by including new sites into our water monitoring program, while simultaneously maintaining our extensive historic dataset. We are looking forward to partnering with the NBETF in the future, and we shall remain hands-on in the Hammond for decades to come!

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