The Friends of the Kouchibouguacis

2021-2022 Activity Report

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Acknowledgements

Much like the environment, our successes are the result of many complex interactions and relationships.

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****** All permits and licenses are kept on file digitally and physically and can be seen anytime if needed.***

1.0 Introduction

This report presents an overview of all activities performed by TFK during the 2021 season. Recommendations and needed adjustments for next year will be discussed also. This report has been created for the stakeholders and partners involved in this project, and for future reference of the organization.

A salmon restoration program has been in motion on the Kouchibouguacis River since the 1990's and has been evolving through the years. In addition to past efforts in the Kouchibouguacis Watershed, the recent collaborative "Atlantic Salmon Restoration Project" has partnered The Friends of the Kouchibouguacis with Kouchibouguac National Park and Kopit Lodge from Elsipogtog First Nation. This project has expanded from continuing efforts in the Kouchibouguacis Watershed, and implementing these same efforts in the Kouchibouguac Watershed, and the Richibucto Watershed. Salmon population enhancement, habitat restoration, fish population monitoring and stewardship are all critical components of this program.

The Friends of the Kouchibouguacis (TFK) is proud to be apart of an Atlantic salmon population restoration project with Kouchibouguac National Park (KNP). This project focuses on: assessing salmonid habitat; collecting and analyzing DNA samples of salmon specimen captured through electrofishing and box-net fishing activities; and determining lineage of salmon populating the Kouchibouguac and Kouchibouguacis River systems to help verify the effectiveness of the incubation project.

In 2012, an Atlantic salmon egg in-stream incubation initiative began in order to provide protection to the eggs from potential predators, improve egg hatching rates, and other environmental factors. This initiative would also contribute to the reestablishment of the Atlantic salmon population in the Kouchibouguacis River; the ultimate goal is to restore the Atlantic salmon populations to a healthy quality and quantity.

2.0 Salmon Egg Incubation

The following section is a detailed description of the incubation project that outlines the multiple steps and procedures taken during each stage.

2.1 Salmon Egg Incubation Jordan-Scotty Salmonid Egg Incubators

Salmon broodstock collection for the purposes of in-stream incubation has been carried out annually on the Kouchibouguacis River since 2012 (except for 2014 due to rearing tank component resulting in entire project being cancelled – rearing tank yielded very poor results and which later led to focusing on in-stream incubation instead). Two smelt box-nets are installed in the river and a select few of the mature Atlantic salmon caught are temporarily retained. These fish are transported to the Miramichi Salmon Conservation Centre (MSCC) where spawning/fertilization is performed (further details of the broodstocking process is provided in the following section). The broodstock collection provides fertilized eggs for the incubation exercises. Funding from the Atlantic Salmon Conservation Foundation, New Brunswick Wildlife Trust Fund, the Department of Fisheries and Oceans (Coastal Restoration Fund), and KNP; allowed our incubation project to continue this year within the Ruisseau de la Truite (Latitude: 46.702325, Longitude: -65.093784). TFK completed our Atlantic salmon egg incubation efforts again this year; the amount of eggs collected and incubators installed within the Kouchibouguacis tributary -

Ruisseau de la Truite, is described in detail below. Kouchibouguac National Park (KNP) successfully completed Atlantic salmon incubation stocking efforts within the Kouchibouguac watershed (Black River and Rankin Brook). These efforts were repeated in the same streams again this season with the help of KNP. TFK's partner group, Kopit Lodge of the Richibucto watershed successfully incubated Atlantic salmon eggs this year after not being able to collect broodstock since the 2018-19 season. The Kouchibouguac watershed details and full report is being compiled by Parks Canada.

Jordan-Scotty Salmonid Egg Incubators were used for the incubation of the salmon eggs. The incubators were ordered through the Scott Plastics Ltd. company located in Sidney, British Columbia. The recommended incubator plates varied in colours that determine the size of the escape holes; the recommended colour for Atlantic salmon eggs is red. Clear incubators are also available for educational purposes. One incubator "unit" is comprised of two matching plates made up of 200 individual chambers referred to as cells. One cell provides shelter for one egg. Therefore, a dead or infected egg will not affect neighbouring eggs; this was one of the main attractive features in acquiring this type of incubator.

Since 2015, TFK has been making modifications and alterations to the incubators in an attempt to better the survival rate of the eggs. Originally these efforts included tying 1-2-inch square steel tubing to the base of the incubator in order to lift the incubator off the substrate. This was implemented as a means to increase water flow through and under the incubators, and clear sediment build-up that can clog the cells and ultimately smother the eggs. Sedimentation was not the only factor hindering the success of the hatch rates. Organic debris such as branches, rocks, and ice flows were also damaging the incubators and at times, dislodging it from where it was originally installed. Last year, a new experimental method was used in an attempt to avoid both of the previously mentioned issues (sedimentation and destruction of incubators). Developed in partnership with KNP, a standard milk crate was equipped with two ropes at the bottom running parallel that were tied roughly three inches above the bottom of the crate. Acting similarly to the base plates used in past seasons, these ropes allow the incubator to be lifted off the substrate, while also allowing for a shaking action to occur – which can help wash away sediment during the incubation period. This will also provide increased circulation through the plates preventing sediment build-up, while also offering better cushioning during turbulent flows. The fully loaded incubator is then placed on the bottom ropes and a bungee cord is looped over the incubator and hooked on to the opposite side of the crate. The side where the bungee cord hooks are attached is pointed downstream to prevent it from lifting and/or coming loose. Should this take place, as a precaution a second rope was attached at the top on the opposite side of the crate and looped over the incubator, as well. This rope was then fastened with a zip tie (or carabiner depending on which was available at time of installation). This installation protocol using milk crates was performed again this year, after this method displayed great results in 2020 with a high hatch rate and well-preserved incubators. TFK also modified 4 incubators and milk crates for an experimental design by cutting them approximately in half to allow for these units to be installed in lower water depths. TFK insured that any cell left was fully enclosed to allow for proper function and protection of any eggs placed inside – any exposed cells were not loaded with eggs. Each "low-profile" incubator held 580 eggs, and 4 were installed at Ruisseau de la truite – the results of these modified incubators will be evaluated upon collection next year (2022).

All empty milk crates were previously installed in the stream with rebar earlier in the season. This allowed for better scouting of prime locations within the waterway that ensured the incubators would remain submerged during low flow. This new setup allowed for installation time on incubation day to be decreased, which aided in the safety and efficiency of the technicians as less effort is spent attempting to tie incubators within the stream in near freezing temperatures.

Photo of empty milk crate design in-stream

Photo of milk crate design with loaded incubator installed

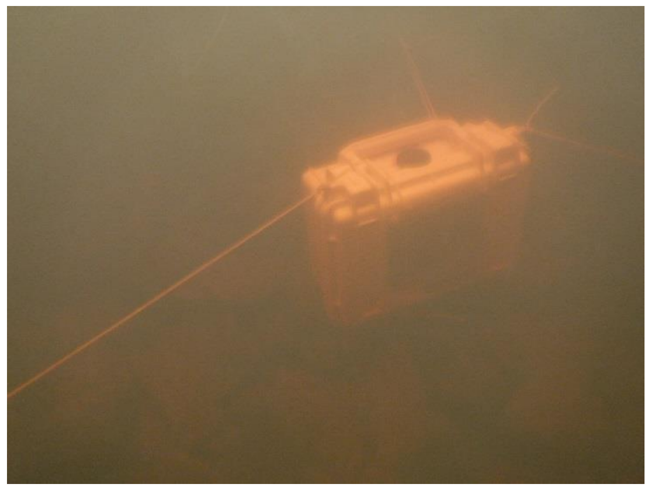
Last year, an empty incubator that was installed within the Kouchibouguacis River near the 126 Highway as an experiment to see if this site could be used in the 2021 season was lost (likely washed away), due to time constraints and staffing shortages TFK decided not to pursue this as a second incubation site – though it does display sufficient conditions (e.g., depths, flows, etc.) for incubation and is being considered for 2022. Another potential incubation site may be available on Ruisseau a baptiste in the coming years after some restoration work is performed in 2022 (depending on funding application results) which involves the replacement of 2 culverts and removal of 3 inactive beaver dams that are currently obstructing water/fish passage and polluting the watercourse with high sediment loads. Locating new incubation sites in other streams will help diversify the incubation project to more than just one stream, and stand as a fail-safe in the case of extreme flooding events like the one seen in the winter of 2018 which resulted in the damage and loss of multiple incubators.

This year an underwater camera was installed in order to gain a batter understanding of what conditions incubators experience in the winter and fall (e.g., washed away, covered with debris, ice conditions, etc.). Only one camera was installed as a trial run to test the feasibility and effectiveness of such an endeavor; should the camera prove effective more will be installed in the future. The camera itself is a relatively standard trail-cam which was placed within a waterproof pelican case to provide water proofing and protection. The case was initially solid plastic but was modified by the installation of a clear plexiglass window to allow picture taking through the case. The camera was then installed in the stream by being tied to three rebar driven into the substrate, very similarly to how incubators are installed. The camera also had a rebar installed along the back of the case itself as a guide in order to hold the camera at the correct angle to take pictures. It was ensured the case was suspended above the substrate to some degree to avoid rubbing. Currently the camera was installed a few feet from the targeted incubator, hopefully close enough to take pictures in the somewhat murky underwater environment.

Fall incubation offers its advantages and disadvantages; the prime disadvantage lies within egg vulnerability. The very recently laid eggs are especially delicate 48 hours following fertilisation (2.

Flanagan, Jason J., 2003.); at this stage the eggs are not yet eyed and are called "green eggs". The challenge here is to successfully accomplish the needed tasks within the 48-hour period post fertilisation. The 48-hour period is the only time allotted for handling the eggs without causing irreversible damage. It should also be noted that the hatchery used for the spawning of the adult salmon, the Miramichi Salmon Conservation Center, is situated in South Esk New-Brunswick; a one-hour drive away from where the project takes place (Saint-Louis-de-Kent and Saint-Ignace area). Alternatively, the advantage of doing this project during the fall months is the comfort in knowing that the allowance of a backup plan could be possible in case the installation of the incubator was impossible due to unforgiving fall weather. Since eggs from Maritime Atlantic salmon eye up in March and only hatch in April (3. Flanagan, Jason J., 2003.), the incubators could be loaded up with eyed eggs and installed in the brook in early spring. Even though eggs are tougher when eyed, TFK still does not consider spring incubator installation as first preference for fear that ice and snow would add more challenges to incubation efforts as well as compromising safety. TFK also prefers to minimize the amount of time eggs/fish are kept in captivity, to educe any ill effects of human interference; and to also maximize time spent in their natural habitat.

Underwater camera unit with attached rebar



Underwater camera installed in stream

2.2 Incubation Methodology

The following section outlines all steps taken prior to and the day of incubation. A <u>transfer permit</u> request for the transfer of Atlantic salmon eggs was submitted to the department of Fisheries and Oceans Canada. The request included a stocking plan for the stocking of the eggs. It should be noted that a fish health analysis was not mandatory prior to transfer because as indicated in the disease status section of the request, the eggs will be disinfected using an iodine solution (Ovadine) before incubation. Once the transfer permit was received, a signed copy was added to the pack of field equipment. As indicated in the permit, the signed copy accompanied the personnel responsible for transferring the eggs from the Miramichi hatchery to Saint-Louis-de-Kent, and again when the eggs were transported to the brook for incubation. A DFO field supervisor was notified of the intentions and activities prior to the transfer of eggs.

To help prevent the transfer of diseases and pathogens to the sensitive eggs, an Ovadine solution was used as a disinfecting agent for both the eggs and any equipment used in the process.

Once at the incubation site(s):

Several tasks are divided up and assigned to the team members present at each site on the day of incubation. Team members keep the same assignments throughout the entire day for the sake of instilling routine and in turn, encouraging faster processing time.

The field work includes two segments: the environmental parameter segment and the incubation segment. TFK decided that the environmental parameter segment would only need to be performed whenever a new site would be set-up or whenever significant changes were visible after arriving at the site. Information taken and recorded at each location is as follows: names of team members; date; site code; start and finish time; name of basin; name of water body; site photos; air temperature; longitude and latitude coordinates using a GPS unit; and water parameters using the YSI Professional Plus (Pro Plus) meter. Water parameters recorded at the sites included water temperature, dissolved oxygen, and pH levels.

To avoid temperature shock, after arriving at the site the Ovadine solution and the transportation jar containing the salmon eggs are placed in the stream. This allows the temperature of the disinfecting solution and the temperature of the water that the eggs were transported in to acclimate to the water temperature in the stream before incubation.

The Ovadine disinfecting solution and egg jar(s) are then retrieved from the brook and the temperatures verified and recorded. The temperatures are compared with the water temperature in the brook and once both are all within 3˚ Celsius of one another (and the eggs are left undisturbed in water long enough for hardening), the incubation preparations begin.

TFK and Kopit Lodge staff transferring hardened eggs to Ovadine solution

Photo illustrating three stages of disinfection; Ovadine solution, rinse bin, fresh brook water

The Ovadine solution is poured in the disinfecting container. The lot of the eggs and water are then carefully poured from the jar into the 600 μm sieve that is in a container of fresh brook water (the brook water acts as a cushion so the eggs do not hit against the disinfecting container). The sieve containing the eggs is then transferred to the disinfecting container and left in the disinfection solution for 10 minutes.

Once the allotted disinfecting time has passed, the 600 μm sieve of eggs is then transferred to a rinsing container. The sieve is moved around to assure that the eggs are well rinsed and then transferred again to a container of fresh brook water.

Once all are disinfected, the eggs are ready to be carefully transferred to the loading trays. A loading tray is set on top of the container of fresh water (in case eggs fall off the loading tray each can be safely caught and reused). One person gently collects a small handful of eggs from the sieve to place on the loading tray and then begins pushing the eggs around with a plastic (disposable) inoculating wand in order to fill up the compartments of the tray.

Once all of the individual compartments of the loading tray are occupied with an egg, all of the extra eggs sitting on the tray are wiped off into the fresh water and transferred back to the sieve. Any dead eggs are removed from the loading tray with the use of a plastic (disposable) inoculating wand. Once the loading tray is filled, it is passed along to the other two team members for transfer to a plate. The plate is placed on top of the loading tray and while holding the plate and tray tightly together, the designated member flips the pair upside down in order to have the loading tray on top of the plate. A squirt bottle is then sprayed over the now inverted loading tray to encourage the fertilized eggs to transfer into the cells of the incubation plate. As the plate is being filled, another loading tray is being prepared. The tray is lifted from the incubation plate and inspected for any remaining eggs. If eggs are still present in the tray, the tray is placed back on the plate and squirted with fresh water until the loading tray is completely empty. Once the loading tray is empty and the plate is full, another plate is placed on top of the now competed unit. Plastic nylon bolts are then run through the completed unit to help the plates stay together while the remaining plates are loaded. The unit is then placed in a container of fresh water from the stream with a team member (or heavy object such as a rock) pushing down on top of the plates in order to prevent them from floating in the container and separating from one another.

This process is repeated for the remaining four units (5 pairs of plates creating a full incubator equalling 1000 incubated eggs per unit), or in the case of the modified low-profile incubators a full unit holds 580 eggs. Stacking each one on top of another assuring all cells are covered with fresh water and passing the bolts through all completed units. Once all the units are filled with eggs, stainless-steel nuts are screwed on to the bolts assuring that the plates are tightly clamped together. As previously mentioned, this season instead of securing the incubators with base plates and installing each in the stream fully exposed, the incubators were instead placed in milk crates specifically designed to lift the incubator off the substrate and protect it from potential debris (e.g., logs, ice flows, rocks, etc.).

The eggs will hatch in the following spring. Once the fry has used up all of the contents of its yolk sac, the fry will leave the incubator and merge into the water current and flow a few meters downstream to finally hide within the substrate. The fry will use the substrate as shelter and will begin feeding. The incubators will be recovered from the brook at the beginning of the following summer (June 2022 in this case). The eggs remaining in the incubators will give an approximate count of egg survival for each site. Doing this at the end of June will permit enough time for all eggs to be hatched and assure to not disturb the development of embryos from any possible late hatchers that may still present in the incubators.

Water temperature data loggers (brand name ONSET) were attached on one incubator at each site. The temperature data loggers were secured low enough to assure that each will always remain submerged. The devices were launched and programmed to register one reading per hour. The data logger will be recovered from the incubator during retrieval.

2.3 Kouchibouguacis River Incubation

Spawning and Egg Collection

The spawning of the first female (83.5cm total length) took place on October 29th, 2021. The Miramichi Salmon Conservation Center (MSCC) gave TFK 24 hours notice before spawning so that TFK would be available to participate/assist in the spawning and collection process. Prior to spawning, the females were set in a mild anesthetic bath for a few minutes. The eggs from both females were mixed and divided into six separate bowls with each bowl being fertilized by one of the 2 male salmon (89cm and 47cm total lengths respectively) that had been captured and brought to the hatchery. Water was added to the egg and milt mixture, and it was left to sit for a few minutes in order to allow fertilisation to occur. After sufficient time had passed, the eggs were rinsed with freshwater, and all were placed in the same bowl. A displacement calculation was used to determine the total amount of eggs collect. TFK initially estimated that the first Kouchibouguacis female had produced approximately 6,465 eggs; additionally, hatchery staff attempted to extract eggs from the second female, the female was not ready to fully release her eggs, but 85 additional eggs were produced as a result (estimated total 6,550). This proved to be an under estimation as in actuality 7,560 eggs were used for incubation, with an unknown number of eggs discarded following signs of mortality. This underestimation discrepancy could have been due to the method used to estimate egg counts during water displacement counting. Where the eggs are in the water hardening process, if not handled quickly, the water displacement number may vary as the eggs get larger with water absorption.

MSCC staff collecting eggs from female salmon

Fertilized eggs being placed in container for transportation to incubation site

The spawning of the second female (80.5cm total length) took place on November 1st, 2021. Hatchery spawning procedures were followed in an identical fashion to the spawning of the first female. TFK initially estimated that the second Kouchibouguacis female had produced approximately 6,563 eggs. This proved to be an under estimation as in actuality 6,957 eggs were used for incubation, with an unknown number of eggs discarded following signs of mortality. In total 14,517 eggs were incubated in the Kouchibouguacis river in 2021

Following the displacement calculation, the eggs were placed in a wide-mouth sanitized plastic container for transportation to the incubation site. It should be noted that the jar (as per protocol) was half-filled with fresh water prior to adding the eggs. The water acted as a cushion for the eggs when they were transferred to the jar. It is best not to hit the eggs on hard surfaces at this point as the hardening process is not yet complete and the eggs are still very sensitive. With that being said, TFK was advised not to place the eggs in the incubators for transportation for this reason. It was determined that it would be best that the eggs move around in the jar as a whole mass rather than being in solitude and hitting against the walls of the cell within the incubator. The jar was then topped off with fresh water and the lid was placed on tightly for the voyage back to the Kouchibouguacis River. TFK was also advised to leave the eggs in the water for at least 2 hours before handling. This allotted time would allow the eggs to fully water-harden.

2.4 Temperature, Oxygen and pH Level Guidelines

The recommendations for freshwater aquatic life set by the Canadian Environmental Quality Guidelines indicates that ambient oxygen levels should remain within 5.5 mg/L to 9.5 mg/L (5. CCME 1999), and pH levels should remain within 6.5 to 9.0 (6. CCME 1999).

The Best Management Practices Bulletin offered by the Ontario Ministry of Natural Resources (OMNR) indicates that the water temperature used during the disinfection process should not change more than 3˚ Celsius and direct sunlight should be avoided (4. OMNR, 2009).

Temperature Levels: Temperature levels of the brook on the first incubation day, October 29th, measured 8.0˚ Celsius. The jar of eggs and Ovadine solution were placed in the brook and after 20 minutes of the acclimation process, the water temperature level of the water within the jar of eggs was recorded at 6.5˚ Celsius, and the disinfectant at 7.0˚ Celsius. The range in temperature between the brook water and the egg container as well as the Ovadine solution was a difference of 1.5˚ Celsius. This temperature difference was well within the acceptable limit set for the disinfection process.

Temperature levels of the brook on the second incubation day, November 1st, measured 9.6˚ Celsius. Following identical procedure to the first incubation day the water temperature level of the water within the jar of eggs was recorded at 9.5˚ Celsius, and the disinfectant at 9.8˚ Celsius. The range in temperature between the brook water and the egg container as well as the Ovadine solution was a difference of 0.3˚ Celsius. This temperature difference was well within the acceptable limit set for the disinfection process.

Oxygen Levels: Oxygen levels in the brook measured on the first and second day of incubation were 11.60 mg/L and 12.28 mg/L respectively. These results, when compared with the recommendations set for freshwater aquatic life by the Canadian Environmental Quality Guidelines, were well above the approved levels.

pH Levels: The pH levels in the brook on the first and second day of incubation measured 8.13 and 8.5 respectively. These results, when compared with the recommendations set for freshwater aquatic life by the Canadian Environmental Quality Guidelines, were within approved levels.

2.5 2020 Incubation Results

In June and July of 2021 TFK set out to retrieve the salmon egg incubators that were installed in the Ruisseau de la Truite in the fall of 2020. Incubators installed in 2020 were the first to use a new protocol of installing incubators in the stream within a standard milk crate; that is, the entire incubator unit is placed within the crate and then firmly secured in place. This was done to further protect the incubator unit from detrimental stream conditions and improve hatch rates, this may be reflected in the 2020 hatch results. The results are as follows:

Observations of Ruisseau de la Truite (RT) 2020 Site:

RT-1: Good condition;

RT-2: Good condition;

RT-3: Good condition;

RT-4: Good condition;
RT-5: Good condition;

RT-6: Good condition;

RT-7: Good condition;

RT-8: Good condition;

RT-9: Incubator unit dislodged from point of installation by winter/spring stream conditions, recovered downstream;

RT-10: Good condition;

RT-11: Signs of wear present on bottom of incubator;

RT-12: Good condition;

RT-13: Incubator absent from installation site and never recovered, partially filled at time of installation;

Egg Mortality counts:

Counting the dead eggs left inside the incubators will give TFK an approximate value on the survival ratio for this type of stocking. The crew assigned for filling up the plates on incubation day the previous season, removed any visible dead eggs prior to assembling the units. These numbers are subject to a certain margin of error depending on many variables and TFK is always working to refine this method further. **Table 1** below shows the total counts of dead eggs and the estimated hatch rate of the incubators that were installed during the incubation period between fall of 2020 through to summer of 2021. The average hatch rate across all recovered incubators was **92.7%**. This is an improvement over 2019/2020's average hatch rate at Ruisseau de la Truite of **80.5%**. It is possible this **12.2%** increase is due the new installation methods employed for the first time in the 2020/2021 season, that is the use of milk crates. Subsequent year's data will be required to determine whether this is causation or simply the result of a season with favourable stream conditions. This year's average survival rate of **92.7%** is a significant improvement on the natural egg survival rate of **10%**.

Further analysis was considered and documented following the assessment of the retrieved 2020/2021 incubators. TFK and Kopit Lodge technicians counted all observable mortalities and ensured to document which plates on every individual incubator had remaining eggs. This analysis aids in potential future modifications and alterations to incubators that could aid in greater survival rates of all eggs regardless of plate placement. **Figure 1** on the following page illustrates the total egg mortality in each plate of all 12 recovered incubators from the 2020/2021 season collectively. Though TFK considers the results of the 2020/2021 incubation season a success, increasing the survival rates each year is always a goal. TFK will continue to plan new changes in the methods used to further improve the results obtained from the installed incubators. The counts and calculations for past and present seasons which include: the different parameters; notes taken; and survival ratios will be compared to determine future successes of this stocking method. All data has been entered in a new in-house data bank created for this purpose.

Incubator Hatch Rate Evaluation 2020-2021

Site #	# of dead eggs & approximate hatch % (200 eggs per apartment (Apt.))											
	Apt. 1		Apt. 2		Apt. 3		Apt. 4		Apt. 5		Total/Avg	
	# dead eggs	%	#	%	#	%	#	%	#	%	#	%
RT-1	9	95.5%	35	82.5%	53	73.5%	79	60.5%	33	83.5%	**209**	**79.1%**
RT-2	3	98.5%	9	95.5%	9	95.5%	11	94.5%	3	98.5%	**35**	**96.5%**
RT-3	6	97.0%	3	98.5%	4	98.0%	2	99.0%	0	100.0%	**15**	**98.5%**
RT-4	0	100.0%	2	99.0%	1	99.5%	0	100.0%	5	97.5%	**8**	**99.2%**
RT-5	6	97.0%	43	78.5%	16	92.0%	27	86.5%	4	98.0%	**96**	**90.4%**
RT-6	2	99.0%	11	94.5%	0	100.0%	0	100.0%	0	100.0%	**13**	**98.7%**
RT-7	2	99.0%	1	99.5%	8	96.0%	5	97.5%	6	97.0%	**22**	**97.8%**
RT-8	7	96.5%	9	95.5%	4	98.0%	20	90.0%	2	99.0%	**42**	**95.8%**
RT-9	34	83.0%	22	89.0%	11	94.5%	10	95.0%	3	98.5%	**80**	**92.0%**
RT-10	30	85.0%	81	59.5%	104	48.0%	80	60.0%	4	98.0%	**299**	**70.1%**
RT-11	3	98.5%	5	97.5%	5	97.5%	5	97.5%	4	98.0%	**22**	**97.8%**
RT-12	5	97.5%	7	96.5%	12	94.0%	10	95.0%	1	99.5%	**35**	**96.5%**
RT-13												
Total	**107**	**95.5%**	**228**	**90.5%**	**227**	**90.5%**	**249**	**89.6%**	**65**	**97.3%**	**876**	**92.7%**

Table 1: Counts of dead eggs found in each incubator installed during fall of 2020 and retrieved in spring/summer 2021

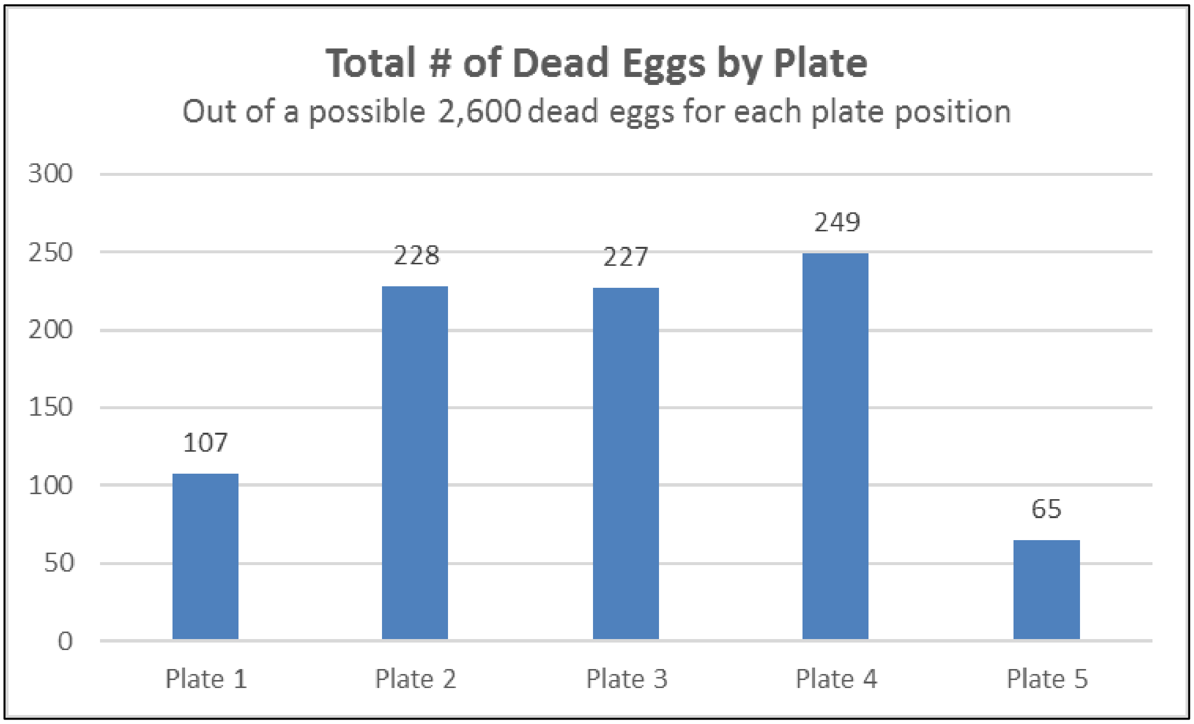


Figure 1: Comparing total egg mortality in each plate of all 21 incubators from the 2019/2020 season (plate #1 is situated upstream, plate #5 is situated downstream)

3.0 Electrofishing

An annual electro-fishing exercise that is part of a broader monitoring program for the Northumberland Strait Rivers (South-eastern NB) has been active on the Kouchibouguacis River since 1996 (with a few exceptions). This exercise was held again in 2021 on several rivers in the Northumberland Strait. The closed-site/diminishing returns method was used upstream and downstream of each incubation site (Ruisseau de la truite, Rankin brook, Black river), while open-site and catch per unit efforts (500 seconds) was used on the remaining sites KS3 and KS4 on the main branch of the Kouchibouguacis river (2 total).

Since 2018, TFK has assisted DFO with electrofishing within the Kouchibouguac and Kouchibouguacis watersheds. Unfortunately, due to various restrictions caused by COVID 19 TFK was unable to assist DFO with the exercise this year. DFO did continue the research on these rivers however, and while the data from these sites for the 2020/2021 seasons was requested, it was not available yet to be included within this report. Once the data is received TFK will store the information within the in-house data bank and include it in the 2022 report next year.

The results of the 2021 electrofishing season for TFK are presented below:

A crew of at least 3 people using a Smith Root APEX backpack electrofisher (provided by Kouchibouguac National Park Canada) was appointed for the 2021 TFK sampling season on the Kouchibouguacis River. The frequency was set to a range of 30-45 Hz, the voltage between 400-450V, and the duty cycle remained at 12% for each site. All adjustments to the settings were made based on the reaction and recovery of the specimens collected in each individual watercourse. Due to a change in protocol increasing time requirements of each sample session; COVID-19 restrictions; weather conditions (e.g., unseasonably warm water temperatures, significant precipitation when water was finally cool enough, etc.); and shortage of staff; TFK was not able to perform electrofishing at all sites typically surveyed. Sites that were not surveyed this year included two sites (KS1 and KS2) on the main branch of the Kouchibouguacis River (though DFO did their sampling as usual this year and those results will be provided at a later date). These sites are expected to be surveyed in the 2022 season once all restrictions have been lifted and a larger team is available. However, the most important sites for research purposes were those located on incubated streams, and those were completed successfully.

A signed copy of the license to fish for scientific purposes was carried by the license holder while conducting the electrofishing activity and while in possession of fish caught during fishing activities as stated under the authorized license. A copy of our electrofishing certificate was also carried during this monitoring period. The regional field supervisors from the Conservation and Protection office were duly notified of the intended time and location of our fishing activities prior to commencing. The persons working under the authority of the licence carried a copy of the licence while conducting the fishing activities, and other related activities stated on the assigned permit. A summary report on the project activities was submitted to the Chief, Licensing at Fisheries and Oceans Canada once the work depicted on the permit was completed**.**

3.1 TFK Electrofishing Results

Site sheets developed by TFK were filled out at each sampling site; excluding those sampled with KNP staff, where sheets provided by park staff were used instead due to some differences in procedures. The information collected and recorded will be entered in the TFK in-house database and shared with relevant partners. Once the exercise was completed, the fish processed and fully recovered, all specimens were returned to the river. No fish were retained, however, all Atlantic salmon fry and parr captured were sampled for DNA (small clipping of adipose fin). All equipment used for collecting DNA was sanitized in between each sample collection. As part of the project with Kouchibouguac National Park (KNP), TFK and KNP performed electrofishing on Rankin Brook, Black River, and Tweedie Brook to compare incubated streams (Rankin Brook and Black River) with a non-incubated stream (Tweedie Brook). Each site was fished a minimum of three sweeps with additional sweeps performed until ten or less salmon were collected in accordance with the updated protocol. This method was also used on Ruisseau de la truite. Each stream had two sites sampled; in the incubated streams, the selected sites were upstream and downstream of where incubators were located last year and arbitrary up and downstream sites were used in the control stream to maintain consistency. This year TFK completed electrofishing at 6 sites in total: RTEF (D/S), RTEF (U/S), KS3, KS4, TB (D/S), and TBEF (U/S). The coordinates are as follows: RTEF (D/S) (N46.70209° W65.09286), RTEF (U/S) (N46.70330° W65.09524), KS3 (N46.64758° W65.25289°), KS4 (N46.69785° W65.08779°), TB (D/S) (N46.783428° W65.117077°), and TBEF (U/S) (N46.782055° W65.134828°).

The following section details the results from each of the electrofishing sites this season. The tables provided also show the abundance of fish caught during each exercise and if DNA samples were collected (only Atlantic salmon were sampled, genetic information will be available at a later date).

TFK and Kopit Lodge staff electrofishing within a closed site on Tweedie Brook

RTEF (D/S) (Ruisseau de la Truite Down Stream):

Table 2 below shows the results of the electrofishing sampling at RTEF (D/S). twenty-six Atlantic salmon were captured following three sweeps of the area. Other fish captured during this sweep were 148 blacknose dace, 5 white suckers, 10 creek chubs, and 3 lampreys. Total fish abundance captured at RTEF (D/S) was 187 with a species richness of 5.

Species	Quantity	DNA Sample (Y/N)
Atlantic Salmon	26	Y
Blacknose Dace	148	N
White Suckers	5	N
Creek Chub	10	N
Lamprey	3	N
Total	**187**	

Table 2: Fish captured during electrofishing sampling at site RTEF (D/S)

RTEF (U/S) (Ruisseau de la Truite Upstream):

Table 3 below shows the results of the electrofishing sampling at RTEF (U/S). A total of eight Atlantic salmon was captured at this site following three sweeps. Other fish captured at this site included 104 blacknose dace, 3 white suckers, 8 creek chubs, and 2 lamprey. Total fish abundance captured at RTEF (U/S) was 125 with a species richness of .

Species	Quantity	DNA Sample (Y/N)
Atlantic Salmon	8	Y
Blacknose Dace	104	N
White Sucker	3	N
Creek Chub	8	N
Total	**125**	

Table 3: Fish captured during electrofishing sampling at site RTEF (U/S)

KS3 (Kouchibouguacis Main Branch):

Table 4 below shows the results of the electrofishing sampling at RBEF (D/S).A total of four Atlantic salmon were captured at this location. Other fish captured following three sweeps at this site were 25 Blacknose Dace, 1 Stickleback, and 1 Creek Chub. Total fish abundance captured at RBEF (D/S) was 31 with a species richness of 4.

Species	Quantity	DNA Sample (Y/N)
Atlantic Salmon	4	Y
Blacknose Dace	25	N
Stickleback	1	N
Creek Chub	1	N
Total	**31**	

Table 4: Fish captured during electrofishing sampling at site KS3

KS4 (Kouchibouguacis Main Branch):

Table 5 on the following page shows the results of the electrofishing sampling at KS4. A total of four Atlantic salmon were captured at this location. Other fish captured following three sweeps at this site were 125 blacknose dace, 1 creek chub, and 1 stickleback. Total fish abundance captured at RBEF (D/S) was 31 with a species richness of 4.

Species	Quantity	DNA Sample (Y/N)
Atlantic Salmon	4	Y
Blacknose dace	125	N
Stickleback	1	N
Creek Chub	1	N
Total	**31**	

Table 5: Fish captured during electrofishing sampling at KS4

TBEF (D/S) (Tweedie Brook Downstream):

Table 6 below shows the results of the electrofishing sampling at TBEF (D/S). 101 Atlantic salmon were captured at this site following four sweeps. Other fish captured included 65 slimy sculpins, 63 blacknose dace, 3 brook trout, and 1 lamprey. Total fish abundance captured at TBEF (D/S) was 235 with a species richness of 5.

Species	Quantity	DNA Sample (Y/N)
Atlantic Salmon	101	Y
Slimy Sculpin	65	N
Blacknose Dace	63	N
Brook Trout	3	N
Lamprey	1	N
Total	**235**	

Table 6: Fish captured during electrofishing sampling at site TBEF (D/S)

TBEF (U/S) (Tweedie Brook Upstream):

Table 7 on the following page shows the results of the electrofishing sampling at TBEF (D/S). 80 Atlantic salmon were captured at this site following three sweeps of the area. Other fish captured included 81 slimy sculpins, 2 brook trout, 43 blacknose dace, and one lamprey. Total fish abundance captured at TBEF (U/S) was 213 with a species richness of 5.

In total, the number of Atlantic salmon collected during the 2021 electrofishing season included 222 juvenile Atlantic salmon (an organizational record for TFK). All were measured and sampled for DNA. The complete count for the remaining specimens captured are as follows; 5 brook trout, 406 blacknose dace, 20 creek chub, 13 lamprey, 1 stickleback, 146 slimy sculpin, and 8 white suckers.

Species	Quantity	DNA Sample (Y/N)
Atlantic Salmon	80	Y
Slimy Sculpin	81	N
Brook Trout	2	N
Blacknose Dace	43	N
Lamprey	7	N
Total	**213**	

Table 7: Fish captured during electrofishing sampling at site TBEF (U/S)

3.2 DFO electrofishing 2020 results

2020 DFO electrofishing results have not been received yet but will be updated within TFK's in-house database as soon as possible.

3.3 Electrofishing Certification

It should be noted that TFK's coordinator (Mike Rushton) received electrofishing certification in 2019 (re-certification is required every 5 years, therefore expires in 2024) and will require re-certification in 2024. The certification was acquired through the University of New Brunswick, through the Canadian River Institute branch and consisted of an online component and a field practicum. The learning objectives of the online portion of the course included the identification of the various parts of the backpack electrofisher unit by appearance and function; the identification of necessary personal safety gear; the identification of the safety standards that must be taken to competently and safely operate a backpack electrofisher; identify suitable and unsuitable electrofishing conditions; show how to modify settings of the electrofisher to make sure effective fishing under varying circumstances; and to show how to properly treat and handle fish in order to minimize stress and harm. In-the-field training allowed students to personally attach electrodes; install batteries; identify the safety features and equipment and demonstrate their uses; and properly operate the electrofisher unit; and collect samples as the unit operator and as the scoop net person. This exercise was done using the safety standards previously learned in the online portion of the course. Two technicians (Caleb Cain and Francois Gallant) were certified under the UNB Backpack Electrofishing course this year and were in possession of valid first aid certifications.

4.0 Box-net Population Monitoring and Broodstock Collection

Smelt fishing box-nets were installed at two sites at a newly designated location in the Kouchibouguacis River near Saint-Louis-de-Kent, New Brunswick (roughly 500 meters upstream of the Highway 11 bridge). These trap-nets enable TFK to passively collect species of all varieties that are present in the Kouchibouguacis River. Using this style of fishing allows for insight into not only Atlantic salmon migration populations, but the abundance of other species that all contribute to and represent the complexity of the river. The box-net fishing program within the Kouchibouguacis River has been on-going since 2005 with exception in 2014 when certain programs and budgets were cut due to various reasons resulting in retraction of the box-net fishing season of the same year.

The main objectives of this initiative are:

- Assess the upstream migration population of Atlantic Salmon
- Monitor all aquatic species and water quality within the waterway
- Collect adult salmon for broodstock and fish/egg stocking purposes

A stocking plan was presented to the Department of Fisheries and Oceans (DFO) and a fishing permit for scientific purposes along with the related tags were obtained from the said department prior of the beginning of the project.

The required permit was duly signed by DFO authorized staff and the licence holder. The regional field supervisors from the Conservation and Protection office were notified of the intended time and location of the fishing activities prior to commencing. The persons working under the authority of the licence carried a copy while conducting the fishing activities, and other related activities stated on the assigned permit. All fishing gear utilised during the fishing period were identified in a legible manner. The identification information was readily visible at all times; the name of the organization (licence holder), office telephone number, and the licence number. A summary report on the project activities was submitted to Fisheries and Oceans Canada once the work outlined on the permit was completed**.** The two nets were fished and checked every 24-48 hours. If the fishing was unable to be performed for longer than 48 hours (e.g. due to bad weather), TFK staff would fish the nets the day(s) prior and then close to opening to prevent any species from entering and becoming stressed over the extended time period. Several water quality parameters, such as water temperature, dissolved oxygen, conductivity, salinity, and pH were monitored and recorded. A period of 2 to 4 hours/day/net was typically necessary to accomplish the task, though there were multiple days where work extended longer due to debris and storm damage. The Atlantic salmon captured were measured, sexed, sampled for scales, tagged and released back to the river (with a few exceptions due to either escape, or risk of irreversible harm to the fish). All salmon caught had DNA samples collected as well for parentage analysis. The DNA and scale samples will be brought to the Kouchibouguac National Park for genetic analysis at a later date. See **Annex B** for age approximations and total lengths from the 2020 season.

Salmon being released following sampling and tagging

Age estimation for the Atlantic salmon sampled in 2021 have yet to be analysed and will be available at a later date. All other species caught during the population monitoring exercise were identified, counted and released back in the river. Four salmon, (2 female and 2 male) were used for the purpose of broodstock collection and incubation within the Kouchibouguacis River. Only 4 broodstock were collected this year due to poor catch numbers which could be due to various reasons (e.g., altered migration patterns, improper net function, fish evading nets, etc.); typically we collect 8 broodstock (6 males and 2 females) to maximize genetic diversity in our incubation efforts. A half-ton truck equipped with a disinfected fish tank and aeration system was used for the transfer to and from the MSCC hatchery. A transfer permit needed in order to make these transfers was obtained from the DFO. The persons working under the authority of the licence carried a copy of the licence while conducting the stated activities, and other related activities identified on the assigned permit. A schedule I report was returned to the NB introduction and Transfer Committee Chair once the transfers were completed.

Female salmon being placed in transportation tank to be returned to the river following spawning

5.0 Results from Fishing Efforts

This year's population monitoring program totalled 14 unique salmon captures which consisted of 10 females, and 4 males. There were 2 instances of recaptured salmon tagged by TFK in other years (#3399, female, 80/84cm; #2628, female, 82/84). There were 0 instances of recaptured salmon for TFK sampling this year, as well as 0 fish captured with tags marking them as having also been sampled this year in other rivers (Richibucto and Kouchibouguac rivers). The lengths of the measured fish ranged from 53-fork/526.5-total(cm) to 85-fork/88-total(cm). Salmon that were captured in the nets were measured, sex identified, sampled for scales and DNA, tagged and then released following recovery; excluding recaptures and those tagged in other rivers. The full Atlantic salmon results of the 2021 population monitoring program are available in **Table 8** on the following page. A detailed excel spreadsheet with complete results is formatted with Department of Fisheries and Oceans standards and is available at the TFK office.

The total number of salmon caught **(see Table 9** on the following page**)** from 2002-2015 ranged from 4 to 14 (with the exception of 20 in 2011). Catch totals from 2016-2018 ranged from 29 to 65. Whether or not these increasing catch totals seen in 2016-2018, and 2020 respectively, are directly correlated to our incubation efforts cannot be verified without further genetic analyses. TFK has observed an emerging pattern that has stood out from 2016-2020 (with 2019 being the exception due a lower than average salmon count, and improper net operation. This anomaly was also reported with various other organizations including partnering groups, Kouchibouguac National Park and Kopit Lodge). This pattern appears to be that a four-year cycle brings higher returns after each incubation year, and has appeared to convey larger salmon populations in the Kouchibouguacis river system. The four-year cycle may consist of the salmon spending its first two years in freshwater, and then heading out to sea and returning after two years at sea for spawning. For example, TFK's incubation started in 2012, and an exponentially higher salmon return population was observed in 2016, and the same occurred four years after the 2013 incubation in the 2017 fishing season. It is worth noting that in 2014 TFK did not perform the incubation project, and following the logic of the pattern, the salmon return population appeared to drop in contrast to the last two years mentioned (2016 and 2017). Though, on a positive note, TFK's salmon count in 2018 was still higher than previous years on record, so it seems to show that momentum carried over from previous years.

Research for the population monitoring program also includes age estimates for all salmon caught during the fishing season. These estimates are determined through scale samples which are processed at the Kouchibouguac National Park once all fishing has been completed. Total length measurements and estimated ages of all salmon captured in the 2020 box-net fishing season are listed in **Appendix B** due to the extensive size of the results. Age estimations for the 2021 season have yet to be determined and will therefore be included in the 2022 report.

Date	Box Net	Sex	Fork/Total Length (cm)
07-Sep	Net 1	F	77/82
23-Sep	Net 1	F	74/78
23-Sep	Net 1	M	58/63
29-Sep	Net 1	F	80/82
04-Oct	Net 2	M	85/88
12-Oct	Net 1	F	85/88
12-Oct	Net 1	F	79/83.5
12-Oct	Net 1	F	76/80.5
12-Oct	Net 1	M	85.5/89
14-Oct	Net 2	M	53/56.5
18-Oct	Net 1	F	74/76
22-Oct	Net 1	F	80/84
01-Nov	Net 1	F	73/75
07-Nov	Net 1	F	82/84

Table 8: Trap-net fishing results

In 2018, TFK began collecting DNA tissue samples from the salmon genitors used in the incubation project and in 2019 TFK launched a new initiative, in collaboration with KNP, to collect DNA samples from salmon specimen during the electrofishing and box-net fishing exercises. A small tissue sample cut from the adipose fin is stored in ethanol vials and the genetic analyses will be used to determine the lineage of juvenile and adult salmon populating both Kouchibouguac and the Kouchibouguacis rivers to verify if the adults are a product of the incubation efforts. TFK continued the initiative this year and the 14 adult salmon captured in the box-nets had DNA samples taken. DNA sampling from this year also included the 222 juvenile salmon that were collected during electrofishing.

Year	# ♀ Salmon	# ♂ Salmon	Sex Unknown Salmon	#♂ grilse	#♀ grilse	Sex Unknown Grilse	Total Salmon Caught	Total Mature Salmon	Catch Date First/Last
2002	3	5		0	5		13	13	Oct. 16th/Oct. 30th
2003	3	1		5	0		9	9	Oct. 25th/Nov. 7th
2004	1	2		3	0		6	6	Sept. 25th/Oct. 28th
2005	4	3		6	1		14	14	Sept. 26th/Oct. 9th
2006	2	0		2	0		4	4	Oct. 2nd/Oct. 5th
2007	5	1		8	0		14	14	Sept. 24th/Oct. 18th
2008	6	1		5	0		12	12	Sept. 24th/Oct. 27th
2009	7	1		3	0		12*	11	Sept. 26th/Oct.19th
2010	1	2		6	0		9	9	Sept. 30th/Oct. 28th
2011	11	0		8	1		20	20	Sept. 14th/Oct.24th
2012	6	2		5	0		13	13	Sept. 20th/Oct.13th
2013	6	2		1	0		9	9	Oct. 11th/Oct. 31st
2015	3	1		7	1		12	14	Sept. 26th/Oct. 28th
2016	38	4		18	2		62	62	Sept. 17th/Oct. 24th
2017	30	9		23	1	1	65*	64	Sept. 18th/Oct. 26th
2018	10	2		12	1		28*	25	Sept. 20th/Oct. 25th
2019	3	1		2	0		6	6	Sept. 20th/Oct. 29th
2020	57	53	3	TBD	TBD		113	113	Sept. 1st/Oct. 31st
2021	10	4		TBD	TBD		14	14	Sept. 2nd/Nov. 7th

Table 9: Yearly salmon catches in the Kouchibouguacis River since 2002 One parr was captured 2017 and three in 2018. Though not considered mature, parr were included in "Total Salmon Caught" total

Population count was also collected for all other captured species. This count can be seen in **Table 10** on the following page. Species identified as "Others" in **Table 10** include killifish, shiner, and mummichog.

The total count for other species for the entire 2021 fishing season is 7,719 of which the most dominant species counted in this category was white perch totaling 4,937.

Species	**Net 1**		**Net 2**	
	Total (36 Days)	**Max (1 Haul) *if above 1**	**Total (36 Days)**	**Max (1 Haul) *if above 1**
White Sucker	940	206 (Oct, 4)	663	120 (Oct, 4)
Striped Bass	466	65(Nov, 4)	221	79 (Sept, 2)
Atlantic Salmon	12	4 (Oct, 12)	2	1 (Oct, 4 & 14)
Rainbow Smelt	30	11 (Oct, 20)	44	24 (Oct, 14)
Atlantic Tomcod	9	3 (Sept, 23)	3	2 (Nov, 4)
Flounder	30	6 (Sept, 20)	7	4 (Sept, 9)
Gaspereau	N/A	N/A	371	370 (Sept, 2)
American Eel	9	6 (Sept, 2)	N/A	N/A
White Perch	3569	1684 (Sept, 2)	1368	688 (Sept, 2)
Others	19	6	8	8

Table 10: Fish species caught with 2 smelt fishing box-nets installed on the Kouchibouguacis River in 2021. Exercise held for salmon brood stock collection, fish migration and fish presence evaluation

Water temperature readings were collected each day the nets were fished using a YSI Pro-Plus (with a few exceptions), these can be seen in **Figure 2** on the following page. The highest recorded water temperature this year was 23.0˚ Celsius, recorded on September 2nd. Though we typically do not fish when water temperatures exceed 20.0˚ Celsius it was deemed safer to remove the fish from the nets due to the unusually warm weather during the season this year as opposed to allowing them to remain confined to the nets. The lowest water temperature was 7.7˚ Celsius recorded on October 30th, 2021. The average water temperature for the 2021 fishing season was 14.1˚ Celsius. The data readout provided by the ONSET data logger installed can be seen in **Figure 3** on the following page. The highest temperature recorded was on September 25th measuring at approximately 19.9˚ Celsius, and the lowest temperature recorded was on November 8th measuring at approximately 7.9˚ Celsius. ** The data Logger was not installed on the box net until September 5th, 2021.*

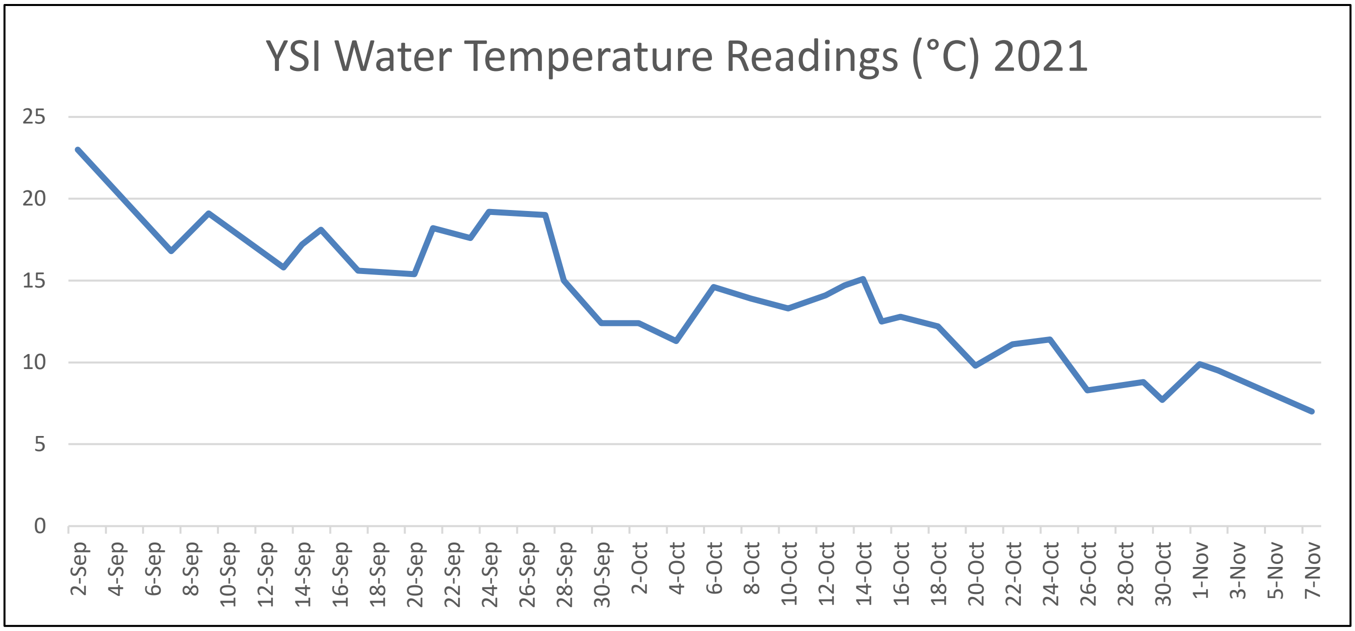


Figure 2: Daily water temperature readings during 2021 fishing season

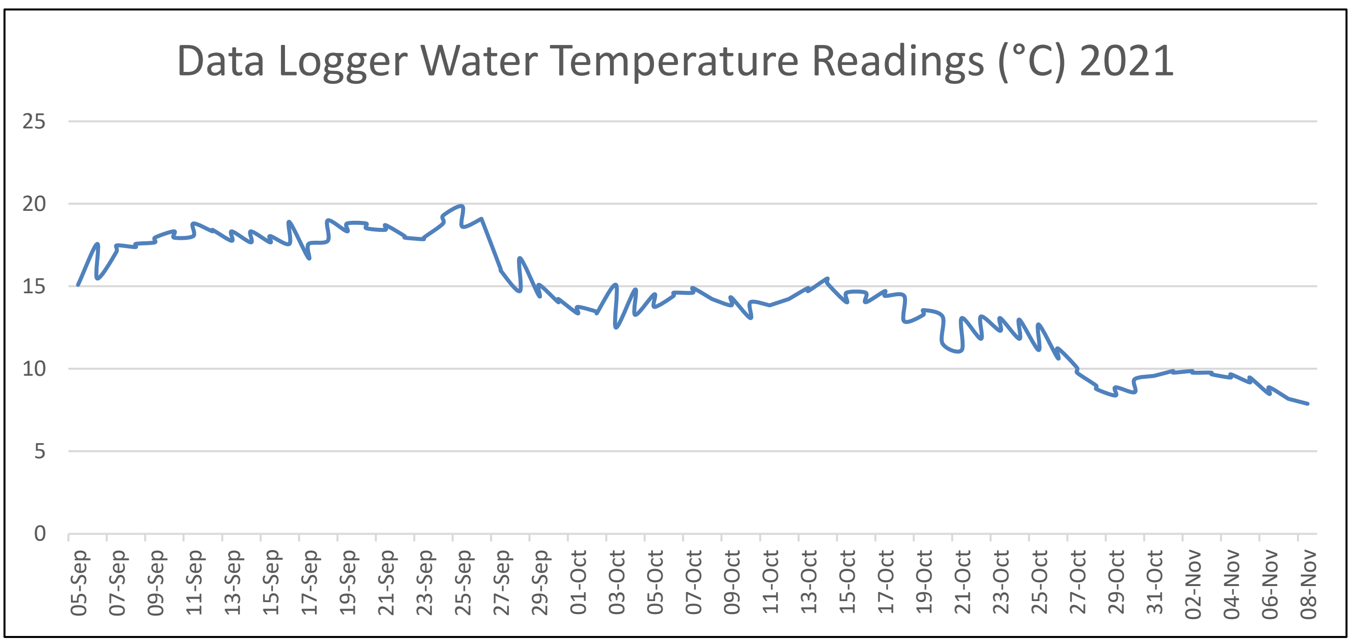


Figure 3: ONSET water temperature data logger readout (12-hour intervals); channel shifting caused data logger to be closer to surface resulting in warmer temperatures, surface water temperature not representative of overall water column

6.0 Stream Survey

In 2021 TFK conducted stream surveys and aquatic habitat inventories in order to assess indicators of ecological health and habitat potential of the aquatic environment. Areas of assessment include substrate composition and embeddedness, water quality and related measurements, shoreline vegetation and environment composition, area surveyed by habitat composition, site parameters of each section were segmented down by habitat, stream canopy cover, bank stability, and cold-water/groundwater inputs, among many others. The method of survey consisted of identifying a given "section" by habitat type (riffle, run, or pool; distinguished by depth, velocity, and other features) and obtaining set measurements of said section; the section ended upon the start of a new habitat type. In 2021 a total of approximately 2.6 kilometers of linear length was surveyed starting with the section identified as KR 224, coordinates N 46.71764° W 65.23569° (NAD 83), and ending with section KR 262, coordinates N 46.71732° W 65.26174°. a map of the area surveyed with start and end points identified can be found in **Annex A**.

Stream substrate was assessed due to its affects on fish life, such as reproduction or shelter, and because of its ability to indicate water quality impairments. Substrate was estimated by percentage within each section and then these estimates were averaged both by habitat type and as overall, in order to give an idea of the general composition. This breakdown of substrate composition can be found in **Table 11** below along with the corresponding size specifications, this information is then visualized in **Figure 4** below.

Average Substrate Composition Percentage by Habitat Type							
	Bedrock (Ledge)	Boulder (>460mm)	Rock (180-460mm)	Rubble (54-179mm)	Gravel (2.6-53mm)	Sand (0.06-2.5mm)	Fines (0.0005-0.05mm)
Riffle	5.28	11.39	34.72	24.17	12.22	12.78	0.00
Run	7.81	14.06	33.44	21.25	10.63	13.44	0.00
Pool	5.63	9.38	35.00	29.38	7.50	13.13	0.00
Overall	6.31	12.02	34.29	24.05	10.71	13.10	0.00

Table 11: Average substrate composition percentage by habitat type

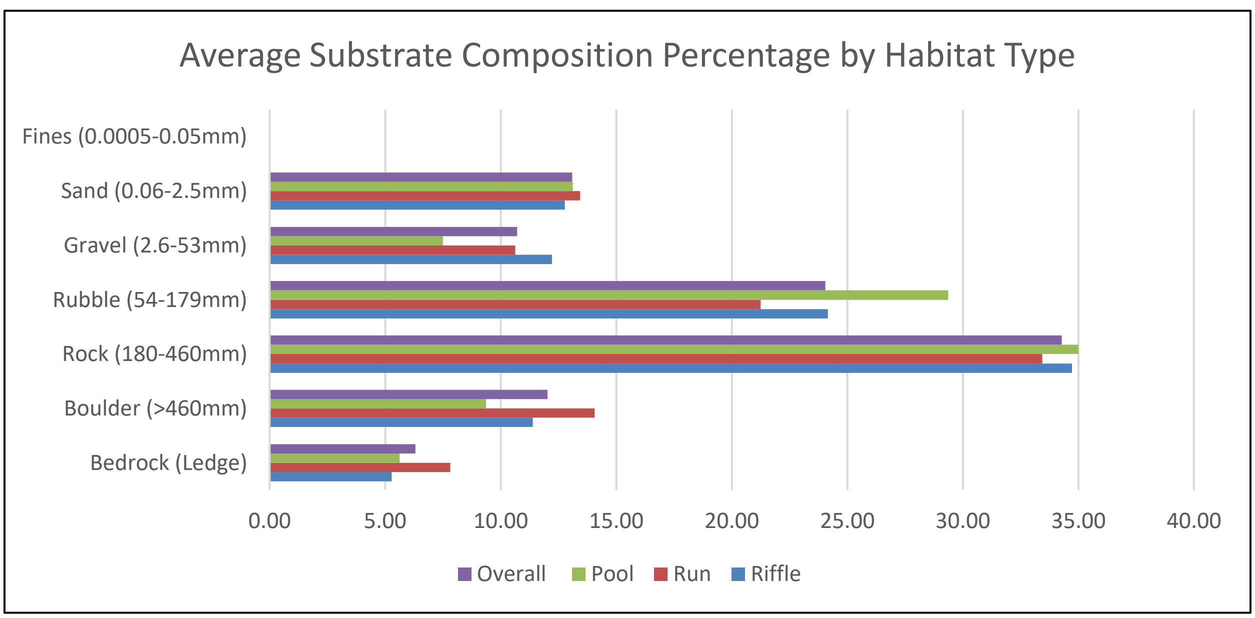


Figure 4: Average Substrate Composition Percentage by Habitat Type

Percent embeddedness, that is the percentage of substrate buried by fine particles, was also estimated in each section due to its implications of stream health, across all sections was an average embeddedness of 19.6%.

Parameters of water quality and related ambient environmental factors were also measured in order to give an assessment of ecological health. Parameters assessed include ambient air temperature, water temperature, dissolved oxygen, pH, water velocity and conductivity. These results were averaged by habitat type and as an overall value across all sections. These results and their units of measurement can be found in **Table 12** below.

Average Water Measurements						
	Air Temp (°C)	Water Temp (°C)	Dissolved Oxygen (ppm)	pH	Velocity (m/s)	Conductivity (uS/cm)
Riffle	23.8	19.6	10.76	7.09	1.25	50.32
Run	23.4	19.3	11.00	7.09	0.67	53.08
Pool	23.7	18.7	10.64	6.88	1.18	41.65
Overall	23.6	19.3	10.83	7.05	1.02	49.72

Table 12: Average Water Measurements

Riparian vegetation and habitat were assessed for their possible implication of stream habitat health. The percentage of each shore within each section belonging to a corresponding habitat type was estimated by percentage. These percentages when then averaged by each bank side and then along both banks in order to achieve an accurate average estimated composition of total shore length by percentage. These composition percentages can be found in **Table 13** below and are visualized in **Figure 5** on the following page.

Average Riparian Vegetation Composition (%)	
Lawn	0.00
Row crop	0.00
Forage/Cover crop	0.00
Shrubs	23.04
Hardwood forest	5.48
Softwood forest	5.48
Mixed forest	58.69
Meadow/ Tall grass	6.37
Wetland	0.95
Altered	0.00

Table 13: Average riparian vegetation composition (%)

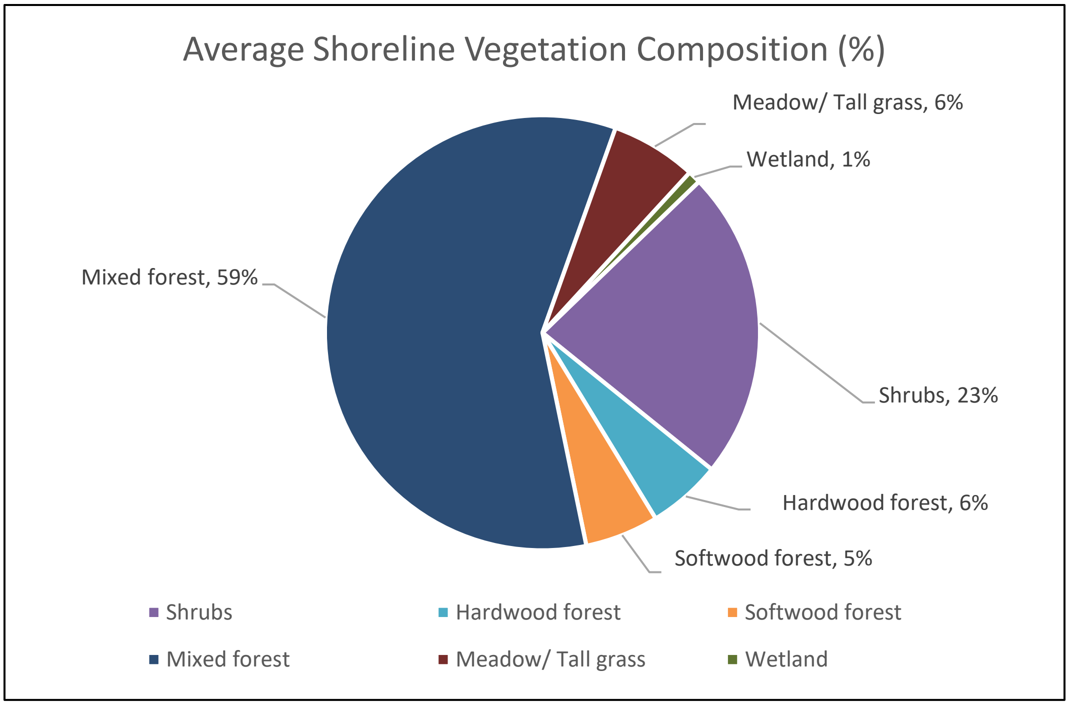


Figure 5: Average riparian vegetation Composition

The total flat area of stream survey was calculated in order give an idea of area of available habitat. The total was then further broken-down by habitat, accounting for both the area of the main section and the smaller "sub habitats" found within each section. Area was calculated using the measured length of each section and multiplying that by the averaged "wetted width" of each section. The total cumulative area of each habitat type and total area surveyed can be found in **Table 14** below, the breakdown by habitat is visualized in **Figure 6** on the following page.

Area Surveyed (m2)	
Riffle	18,843.7
Run	21,124.92
Pool	5,907.28
Total	45,875.9

Table 14: Area surveyed (m^2)

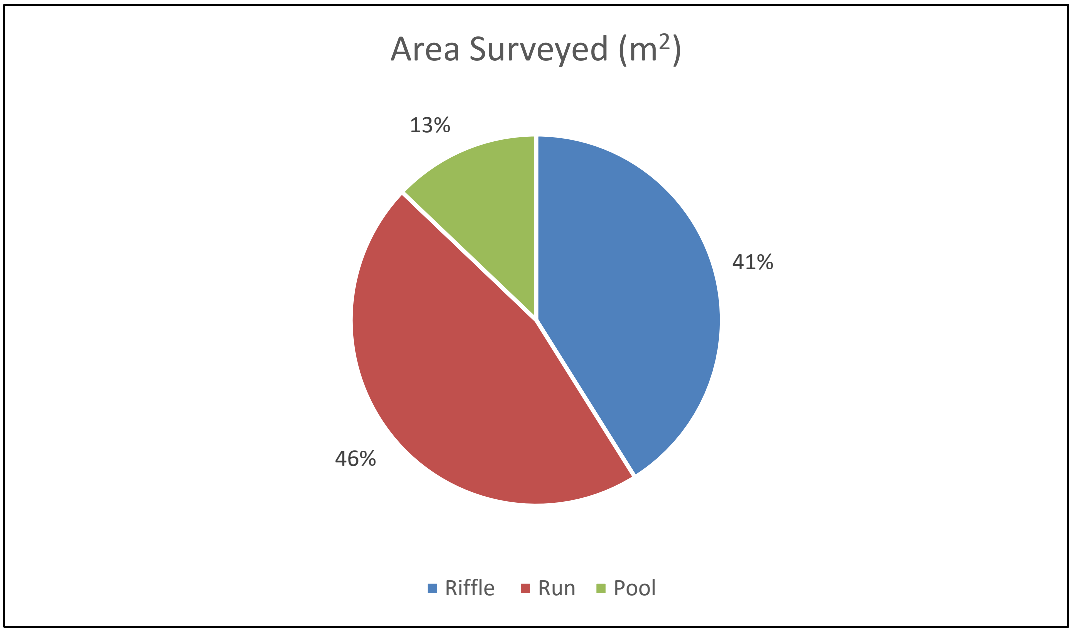


Figure 6: Area stream surveyed by habitat type

Site parameters of each stream section were measured in order to provided habitat and hydrological data. Measured parameters include average water depth, average wetted width, average bankfull width, average bankfull depth, and the average length of each section. These parameters were then averaged according to habitat type and as an overall value; these can be found in **Table 15 below** and visualized in **Figure 7** on the following page.

Average Site Measurement Parameters					
	Depth (cm)	Wet Width (m)	Bankfull Width (m)	Bankfull Depth (cm)	Average Length (m)
Riffle	23.92	16.37	18.49	32.61	56.82
Run	31.93	17.10	19.52	36.63	81.75
Pool	66.75	15.52	16.33	38.31	38.88
Overall	37.12	16.48	18.47	35.23	62.90

Table 15: Average site measurement parameters

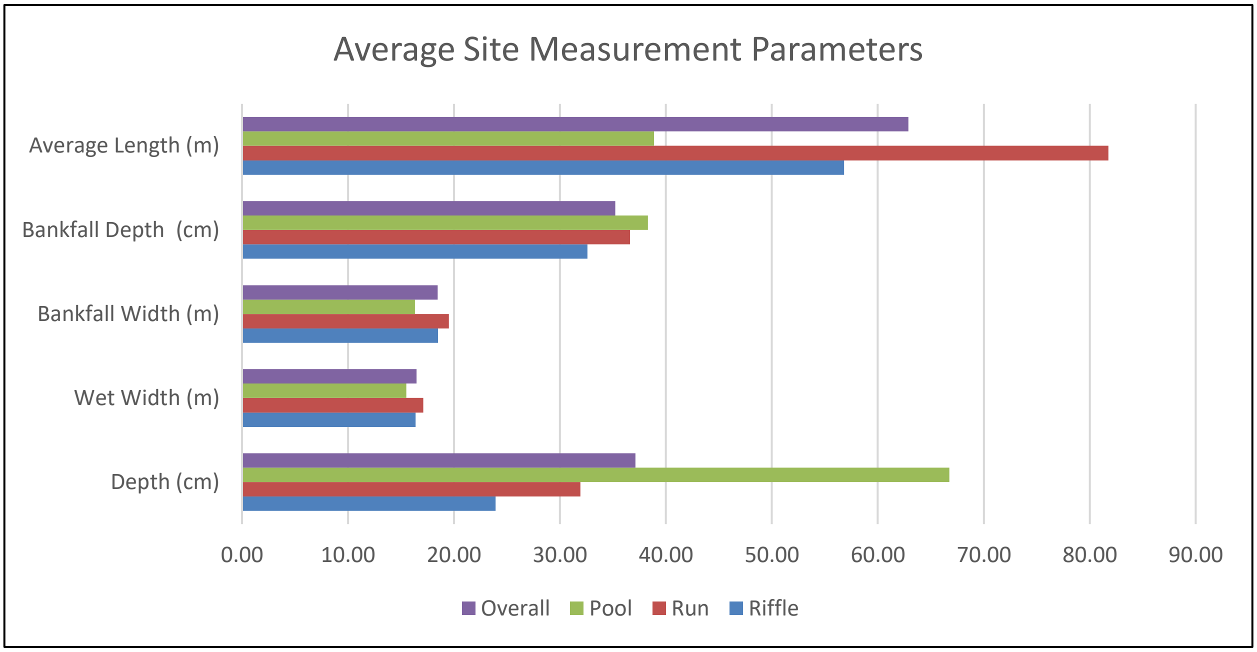


Figure 7: Average site measurement parameters

Several other parameters relating to potential habitat and ecological health were also assessed. In terms of stream shelter an average of 15.36% canopy cover, 116m woody debris, and 103m undercut was estimated across the entire section surveyed. The total bank stability, bank length free of erosion, was estimated as an average of 81.4% stable across the entire area surveyed. A total of three ground water inputs, which have the potential to create thermal refuges for fish, and were found to have an average temperature of 11.8 °C.

7.0 eDNA Sampling 2021

Friends of the Kouchibouguacis

During the 2021-2022 season the Friends of the Kouchibouguacis collected environmental DNA (eDNA) samples from 6 sites each within the Kouchibouguacis and Kouchibouguac Watersheds (12 sites total). The samples were collected in accordance with the protocol provided by the UNB Saint John laboratory. The sites and sampling locations were selected with guidance from specialists with DFO. Each sample was shipped to the laboratory at UNB Saint John for analyses to detect the presence/absence of Atlantic salmon and/or Brook Floater specimen at each site.

Any sites that result in a positive detection of presence will be used to help plan new sampling and monitoring initiatives (e.g., electrofishing, visual Brook floater surveying, etc.) that can be used to collect valuable data on the populations of said species. These sites will also be assessed for any potential hazards or risks to the habitat of the said species, and restorative work can be carried out immediately if feasible, or planned for the near future.

The eDNA analyses performed by UNB SJ Lab methodology is as follows:

A positive means that there were Atlantic salmon or Brook floater present at the site or somewhere upstream. UNB SJ deemed the site positive if at least one of the two field replicates produced all positive qPCR replicates in the lab. Each field replicate had four qPCR replicates. A weak positive means the neither field replicate produced all positive replicates in the lab, but a signal was still detected in at least half of the total replicates (i.e., 4/8). This could be because the eDNA signal was very near to the detection threshold. UNB SJ was conservative in what was considered a positive detection.

The negatives associated with the remaining sites does not mean that there are no species of interest in this area, only that any signal was below the detection threshold. There many factors that affect DNA signal including: sunlight, temperature, abundance of individuals present, organic material, etc.

There were three types of negative controls (field, extraction and quantitative PCR) used throughout the process to detect if contamination occurred at any step. DNA from either species was not detected in any of these negative controls, which means there was no contamination during sampling, and positive detections are a result of Atlantic salmon or Brook floater DNA being present at these sites. An internal positive control was also used on all samples to test whether PCR inhibition was present and preventing Atlantic salmon and Brook floater DNA from amplifying. This control found no inhibition present.

The site results for Brook floater analyses are displayed in **Table 16** below.:

Site No.	Coordinates	Stream Name	Sample Date	Sample Result
KR1	N46.71709° W65.26325°	Kouchibouguac	2021-08-15	Negative
KR2	N46.70787° W65.27198°	Kouchibouguac	2021-08-15	Negative
KR3	N46.70793° W65.27975°	Kouchibouguac	2021-08-15	Negative
KR4	N46.70318° W65.28874°	Kouchibouguac	2021-08-15	Negative
KR5	N46.70332° W65.30144°	Kouchibouguac	2021-08-15	Negative
KR6	N46.69270° W65.32610°	Kouchibouguac	2021-08-15	Negative
KS1	N46.59838° W65.34733°	Kouchibouguacis	2021-08-15	Negative
KS2	N46.59754° W65.34386°	Kouchibouguacis	2021-08-15	Negative
KS3	N46.66951° W65.14305°	Kouchibouguacis	2021-08-15	Negative
KS4	N46.67068° W65.14051°	Kouchibouguacis	2021-08-15	Weak positive
KS5	N46.69140° W65.09610°	Kouchibouguacis	2021-08-15	Weak positive
KS6	N46.69995° W65.08431°	Kouchibouguacis	2021-08-15	Negative

Table 16: Results of eDNA Brook floater analyses

The site results for Atlantic salmon analyses are displayed in **Table 17** below.

Site No.	Coordinates	Stream Name	Sample Date	Sample Result
KR1	N46.71709° W65.26325°	Kouchibouguac	2021-08-15	Positive
KR2	N46.70787° W65.27198°	Kouchibouguac	2021-08-15	Positive
KR3	N46.70793° W65.27975°	Kouchibouguac	2021-08-15	Positive
KR4	N46.70318° W65.28874°	Kouchibouguac	2021-08-15	Positive
KR5	N46.70332° W65.30144°	Kouchibouguac	2021-08-15	Positive

KR6	N46.69270° W65.32610°	Kouchibouguac	2021-08-15	Positive
KS1	N46.59838° W65.34733°	Kouchibouguacis	2021-08-15	Positive
KS2	N46.59754° W65.34386°	Kouchibouguacis	2021-08-15	Positive
KS3	N46.66951° W65.14305°	Kouchibouguacis	2021-08-15	Positive
KS4	N46.67068° W65.14051°	Kouchibouguacis	2021-08-15	Positive
KS5	N46.69140° W65.09610°	Kouchibouguacis	2021-08-15	Positive
KS6	N46.69995° W65.08431°	Kouchibouguacis	2021-08-15	Positive

Table 17: Results of Atlantic salmon eDNA analyses

Summary: Of all sites sampled in 2021, Atlantic salmon eDNA was detected at every site. Brook floaters were only detected (weak positive) at sites KS4 and KS5 (in the Kouchibouguacis watershed) and were not detected at any other site. As indicated by UNB SJ, this does not confirm the absence of these species for certain. TFK plans to do further sampling to continue to search for the presence of Brook floaters at different sites in both watersheds. While Brook floaters have yet to be observed in the Kouchibouguac watershed, TFK feels the close proximity and similar characteristics (e.g., water quality, geology, potential host fish species, substrate, etc.) to the Kouchibouguacis watershed (where Brook floaters are present) justifies additional investigation in the future.

Brook Floater DNA Swabbing:
TFK performed DNA swabbing of Brook floater specimen as part of an initiative with DFO and US Fish and Wildlife Services (USFWS). Two sites total were surveyed on August 17th, 2021 in the Kouchibouguacis River. Sites 1 and 2 (see map in **Annex A**) were selected based on previously successful specimen location and quick access due to time constraints. Results of DNA analyses have yet to be received.

Site 1: 5 specimens observed and sampled for DNA.
Coordinates: N46.71175° W65.06090°

Site 2: 1 specimen observed and sampled for DNA.
Coordinates: N46.70539° W65.07889°

8.0 Waterfront Stewardship Project

For over a decade, the Friends of the Kouchibouguacis (TFK) has participated in the *Waterfront Stewardship Project* which has provided numerous benefits to the local community and both the Kouchibouguac and Kouchibouguacis Rivers. By providing land owners with information on the advantages of improved land management practices, this project has been able to offer better protection of landowners' property, while also strengthening the health of the local rivers. Over the years, TFK has been able to educate numerous waterfront property owners on the benefits of this project while also offering recommendations and free trees/shrubs to aid in the management of the riparian zone. The following is a detailed summary of the 2021-2022 season.

In 2021, TFK evaluated two properties (one in the Kouchibouguacis watershed and one in the

Kouchibouguac watershed) through the Waterfront Stewardship Project. During the summer/fall months, TFK staff met with homeowners to review what vegetation was already present on the property while also observing any beneficial and/or problematic areas that could be better maintained/repaired through various techniques (e.g., planting vegetation, reducing land alteration activities, etc.). A land management plan was then compiled following the visitation. Each plan outlined all observations noted during the survey, as well as recommendations to improve the situation, catered specifically to each individual landowner. Additionally, TFK staff compiled a list of native trees and shrubs that could aid in the restoration of the properties. This year (2021-2022), the trees and shrubs were collected from Cornhill nursery as well as our own nursery, and delivered to the landowners along with the completed land management plan. All trees and shrubs were uniquely assigned to each property, based on existing environmental conditions (e.g., soil types, land types, needs/desires of landowner, etc.), and to benefit specific issues noted during the site visit.

The following is an overview of the trees each of the properties received:

Property #1:
Site Location: Saint Ignace
PID Number: 25015884
Address: 1849 Ch Desherbiers, Saint-Ignace, NB

A total of 10 trees and/or shrubs were delivered which included which are displayed in **Table 18** below.

Type	**Quantity**
Sugar Maple	4
Service Berry	2
Elderberry	2
Green Ash	2
Total	**10**

Table 18: Trees provided to property owner #1

Property #2:
Site Location: Kouchibouguac
PID Number: 25168337
Address: 344 North Kouchibouguac Road, NB
A total of 8 trees and/or shrubs were delivered which are displayed in **Table 19** below

Type	**Quantity**
Sugar Maple	2
Service Berry	2
Elderberry	2
Butternut	2
Total	**8**

Table 19: Trees provided to property owner #2

Due to restrictions – and we feel general apprehension of local residents to deal with visitations - caused by COVID 19, outreach for the 2021 Waterfront Stewardship Project was not highly productive (as was expected due to circumstances out of our control). However, we anticipate the project and participation will increase next year as life slowly returns to normal.

9.0 Tree Nursery and Propagation

This year, TFK planted seven different types of seeds to be propagated within our tree nursery. **Table 20** below is a breakdown of the species and number of seeds planted:

Species	**Number of seeds**
Green Ash	496
Sugar Maple	262
Striped Maple	240
American Beech	170
Eastern Larch (Tamarack)	108
Red Oak	18
Butternut	83
Total	**1377**

Table 20: Breakdown of the species and number of seeds planted

10.0 Invasive Species

Purple Loosestrife: This year TFK assisted Kouchibouguac National Park (KNP) staff with removal of an invasive species – Purple loosestrife on the following page from a stretch of land (area ~1200 m^2) adjacent to Hwy 11 (Coordinates: 46.756505, -65.032794). This is considered a mitigative measure to help slowly reduce the presence and propagation of this invasive species in wetland areas. Though very difficult to do successfully as it requires the removal/elimination of rhizomes in the root structure. Approximately 14 industrial sized garbage bags of Purple loosestrife were removed from the sites. Similar measures may be necessary in the future to help manage and mitigate the spread of this species.

Image displaying purple loosestrife

Image showing TFK and KNP crews removing purple loosestrife along HWY 11

Canary Grass: TFK was called by a local resident to come and inspect a patch of Canary grass (see images below) growing on their land (Coordinates: 46.712204, -65.032756). There was a significant patch on their shoreline, and it can be seen slowly spreading upland into their property. Canary grass has been observed in high abundance throughout the region and this is considered highly difficult to prevent or mitigate at this point. Various methods and strategies to help combat and reduce the spread/presence of Canary grass are being considered, and relevant experts (NB Invasive Species Council, KNP, etc.) are being consulted on possible options for next season. Regardless, it is good to be informed on the existence of this plant species which TFK will certainly keep an eye out for now and in the future, and if mitigative measures can be utilized where small amounts are observed – they will be implemented.

Image displaying canary grass along shoreline

Image displaying canary grass patch

Emerald Ash Borer: TFK participated in a pilot project with NB Invasive Species Council by placing two Emerald Ash Borer (EAB) traps (see images below) on Ash trees in the local area (Ash Trap 1 coordinates: 46.73985, -64.97419, Ash Trap 2 coordinates: 46.73492, -64.96919). This was a great learning experience for TFK's staff and is considered to be a valuable project to participate in and perform in the future on a wider scale. The traps did not reveal the presence of any EAB's – which is a positive result as they can be very destructive. Though this does not eliminate the possibility of their existence now, and they can certainly spread here by next year or in the future. This is something that requires minimal time and is worth investing efforts in to monitor for the presence or spread of EAB's to protect our vulnerable and valuable Ash trees.

Image displaying TFK crew assembling trap

Image displaying trap installed in Green ash tree

11.0 Reforestation

In 2021, TFK proposed a project sponsored by the New Brunswick Environmental Trust Fund that included a component of identifying properties throughout the watersheds that could potentially be reforested. Properties that were identified included those which appeared to be either abandoned or unused for their past purposes (e.g., abandoned farm fields, unmaintained/unharvested fields, etc.). These properties offer great potential to increase the amount of root density and vegetation throughout the watersheds which can: improve forest habitat for many species; allow for reduced pollution and erosion near waterways; increase greenhouse gas storage within soil; and help regulate water temperatures. In total, 9 sites were identified (4 in the Kouchibouguacis watershed and 5 in the Kouchibouguac watershed) that are considered to be potential reforestation candidates (**see map in Annex A**). TFK will work on identifying and contacting land owners for each to see if they would be interested in reforesting their land. Reforestation can take place through the planting of native tree and shrub species at various life stages; as the plant grow they will naturally propagate and spread additional seeds of their own over time. This can be an effective method of turning a field of grass back into the forested area it was years ago.

12.0 Challenges and improvements

Due to restrictions caused by COVID 19 as well as limited staffing this year, TFK was unable to perform many of the yearly monitoring and outreach programs. These included the Community Aquatic Monitoring Program (CAMP) as DFO cancelled that program for this year; benthic sampling for Canadian Aquatic Biomonitoring Network (CABIN) with Parks Canada (sampling was still performed in both the Kouchibouguac and Kouchibouguacis watersheds this year – however, TFK did not have extra staff to go assist them as usual); fall canoe run on the Kouchibouguacis River to monitor the health and any potential impacts to the waterway; scholastic activities and outreach programs to local schools (we still produced educational material that was shared online to maintain some outreach presence); and informational kiosks for community outreach as well as gaining volunteers for yearly programs.

The 2021 season brought numerous challenges and successes. This year, TFK was limited in terms of staffing as no summer students were able to be hired, and another contract was cancelled due to COVID-19. Furthermore, restrictions caused by COVID 19 cut all community outreach programs, scholastic activities, external training opportunities for both TFK to receive and offer, and kiosk sessions to provide locals with important environmental information as well as garner participants for restoration programs.

TFK has been collecting various types of data (age approximations, tagging, fish counts, etc.) on the different species that migrate in the Kouchibouguacis and Kouchibouguac watersheds for a number of years now through various programs such as box-net fishing, electrofishing, and stream survey. TFK has completed an updated version of a management plan for these watersheds (available on our website or at our office anytime). This management plan serves as a summary of our years of work and data collection, as well as a document that can help guide future work. Experts will also be consulted to help interpret the findings within the management plan and provide guidance on the next steps to be taken. The management plan is intended to serve as a living document that will be updated every year to continue adding to a real-time view of the conditions of the watersheds – and allow TFK to perform various initiatives (e.g., habitat restoration, etc.) in a consistent and methodical manner both now and in the future.

The locations selected for our trap-nets was a very productive in 2020, however, in 2021 not so much. Our 2021 season total for Atlantic salmon captured in our trap-nets was only 14 fish – compared to 113 unique individuals (140 including recaptures) in 2020. This was due in part to shifting substrates within the river that moves anchors – resulting in improper operation of the nets; but also due to lower numbers overall. Lower numbers were observed in multiple neighbouring river systems this year as well (Kouchibouguac and Richibucto rivers). The reasons for this decrease in numbers compared to 2020 is unknown and could be attributed to many reasons (e.g., warm water temperatures, death at sea, altered migration timing, evasion of nets, etc.); this will be investigated further with relevant experts and agencies. TFK will consider moving the trap-nets to a new location to avoid being so susceptible to shifting substrates and low-water levels that make setting up the nets in between fishing difficult.

TFK strongly suggest visiting every sampling, restoration, stocking site prior to the planned field day. A carefully planned day and assembled crew may have to be cancelled due to an unplanned shift in substrate, high water levels, new beaver dams, etc. New sites may have to be scouted out in order to achieve certain goals within given time constraints, but an early visit should allow enough time to mediate the situation or adapt plans.

13.0 Conclusion

Overall, despite many limitations and alterations, TFK considers the outcomes of this year a success. The Restoration of the Atlantic salmon populations in the Kouchibouguacis and Kouchibouguac watersheds is a project that the community takes to heart; various members of the community always look forward to the activities planned during the course of this project. The project not only contributes to the re-establishment of the salmon population, but also contributes to the education, awareness, and the stewardship of the community. Many people look forward to the activities planned during the course of the projects related to the Atlantic salmon population.

Partners have been extremely involved again this year, which shows the support and interest for our projects. The long list of people contacted at the many establishments that helped and encouraged the progress of this project is one the main reasons for its success. New Brunswick Wildlife Trust Fund provided funding for salaries, eDNA sampling, tree nursery work, fishing activities, stream survey work, and many other aspects of our projects. The Atlantic Salmon Conservation Foundation provided funding for many areas, including salaries, contract costs and travel expenses. The Kouchibouguac National Park provided TFK with funding, equipment and technical support again this year. New Brunswick Environmental Trust Fund provided funds for salaries, equipment, tree nursery supplies, and many other items that were valuable in completing the required work this season. The Village of Saint-Louis-de-Kent offered support through staff and equipment. Miramichi Salmon Association once again was available with hatchery services and technical support. The Saint-Ignace Golf Club offered generosity by supplying quick and easy access to the brook via the golf course and supply of golf carts. TFK is extremely proud to have developed a strong working relationship with Kopit Lodge from Elsipogtog First Nation as part of the “Atlantic Salmon Restoration Project”.

14.0 Financial Support

This project was financially supported by the New Brunswick Wildlife Trust Fund (NBWTF), Atlantic Salmon Conservation Foundation (ASCF), Kouchibouguac National Park (KNP) and Department of Fisheries and Oceans (Coastal Restoration Fund), Kopit Lodge, and New Brunswick Environmental Trust Fund (NBETF). In-kind support was offered by the Village of Saint-Louis-de-Kent, the Miramichi Salmon Conservation Center (MSCC), the St-Ignace Golf Club, the Department of Energy and Resource Development, Kopit Lodge, Elsipogtog Fisheries, Kouchibouguac National Park, UNB SJ Genomics Pavey Lab, and the Friends of the Kouchibouguacis (TFK). Staff members and volunteers from different organisations also contributed their time when participating in the incubation workshop.

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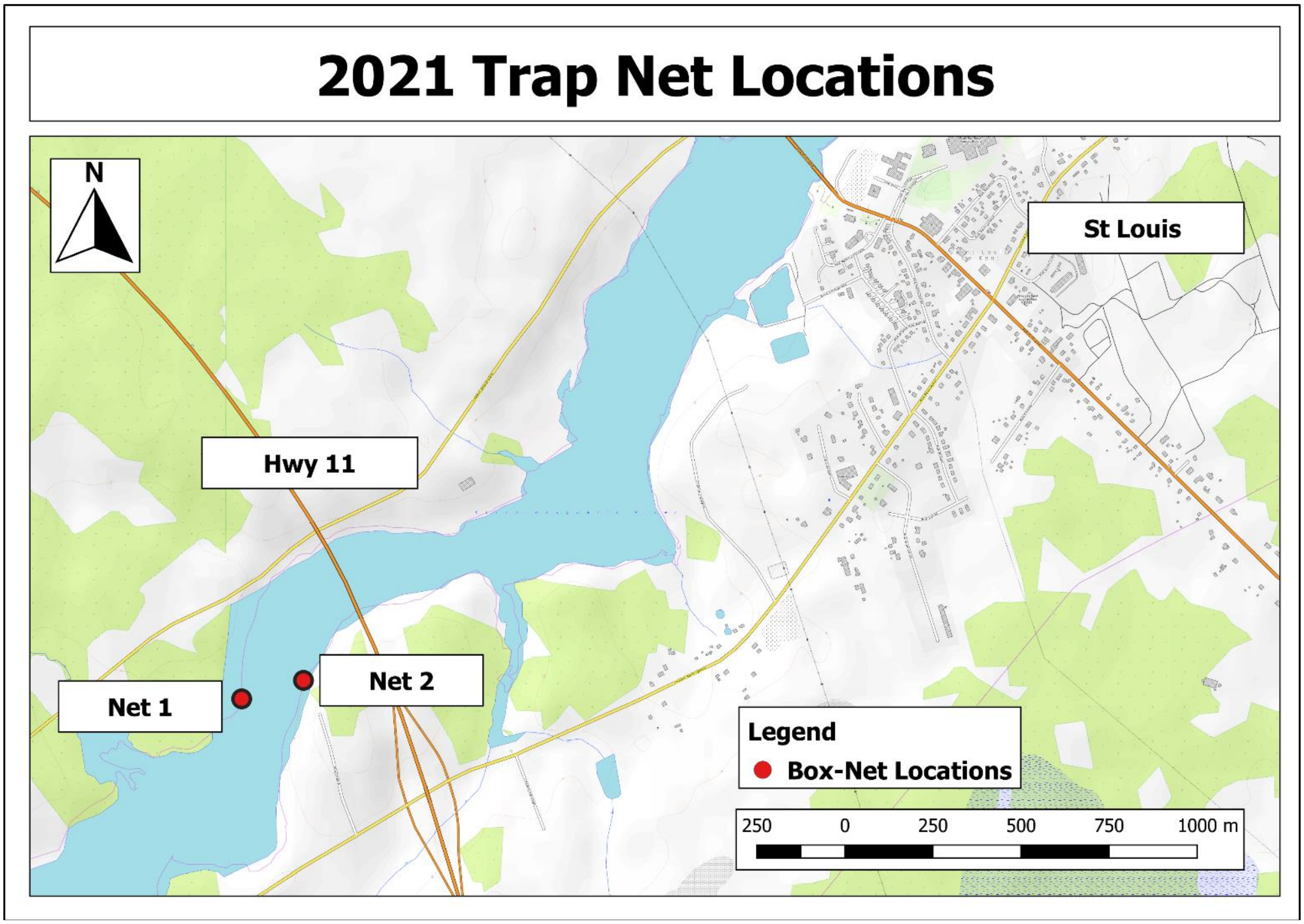
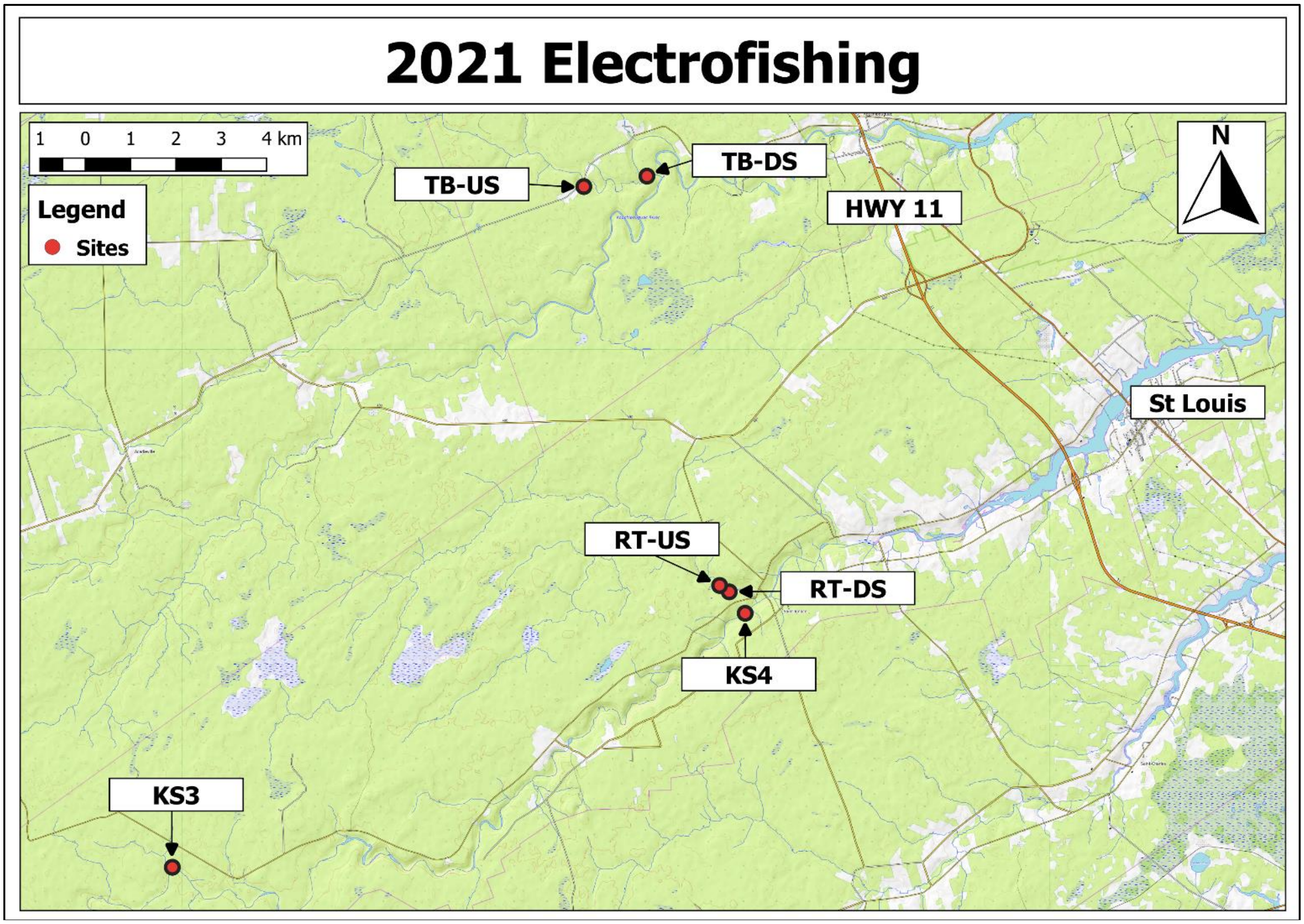
Annex A – Activity Maps (box-nets, electrofishing, incubation, stream survey, eDNA, Brook floater DNA swabbing, and invasive species)

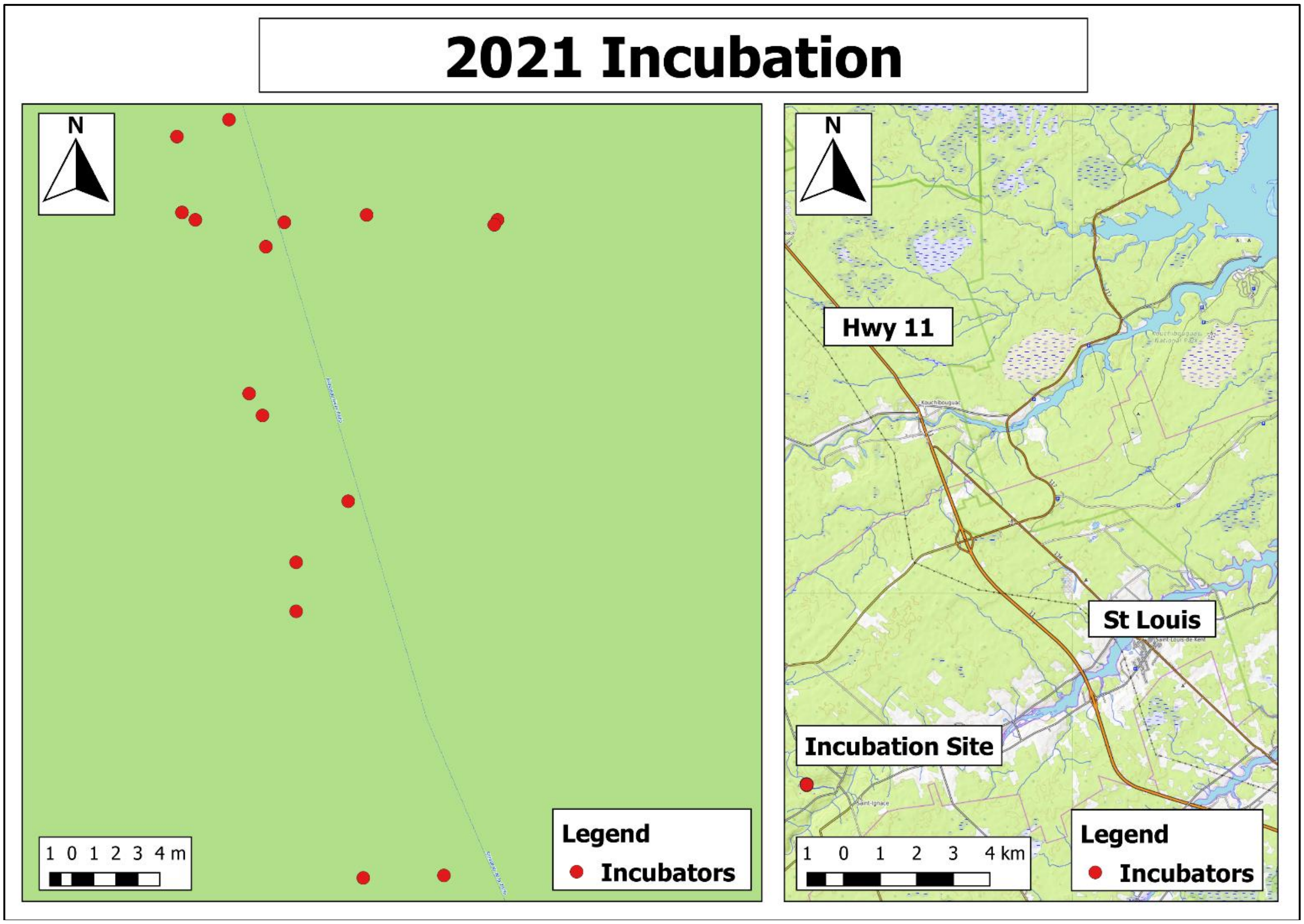
Map displaying box-net locations for 2021 season



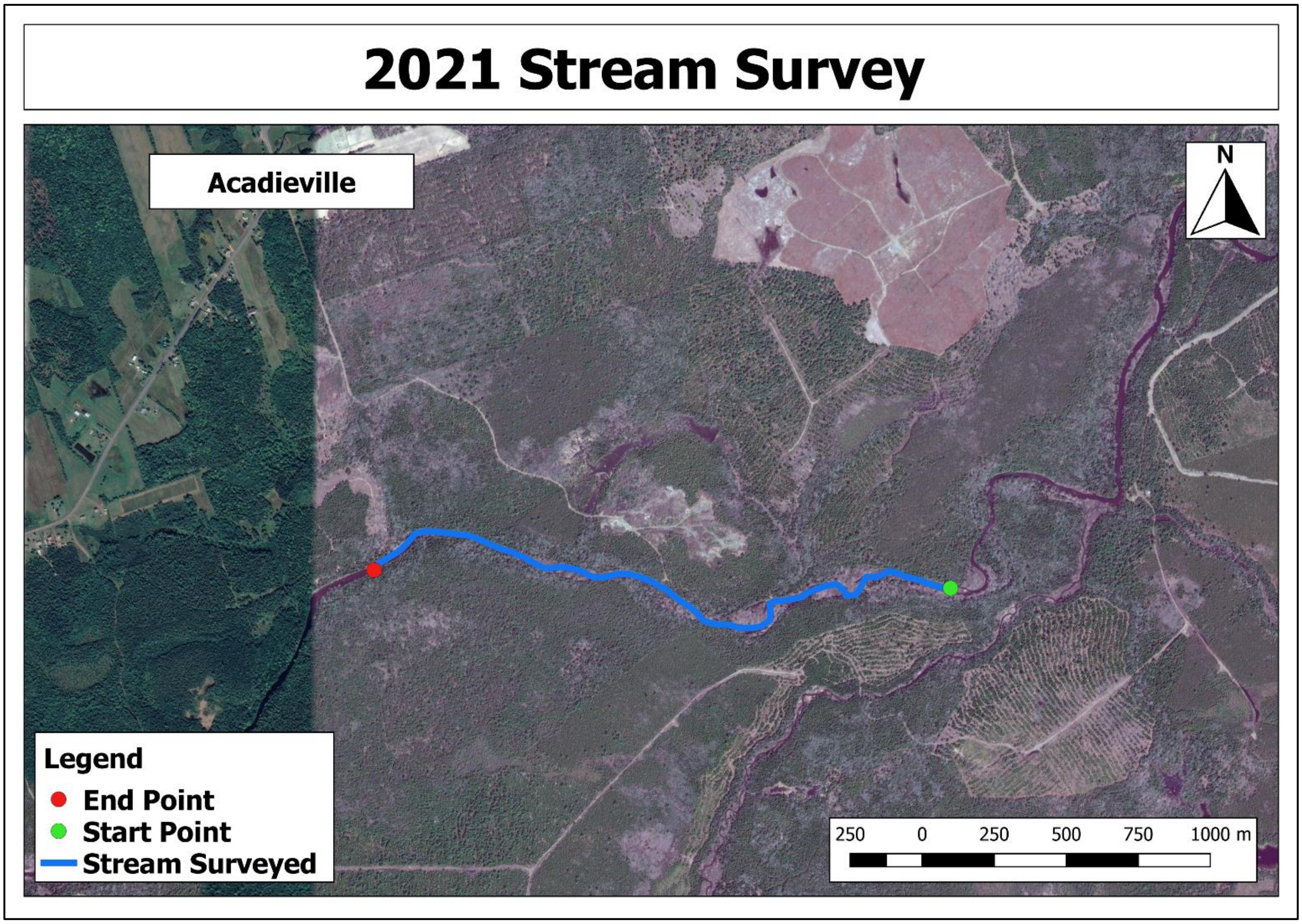
Map displaying 2021 electrofishing site locations



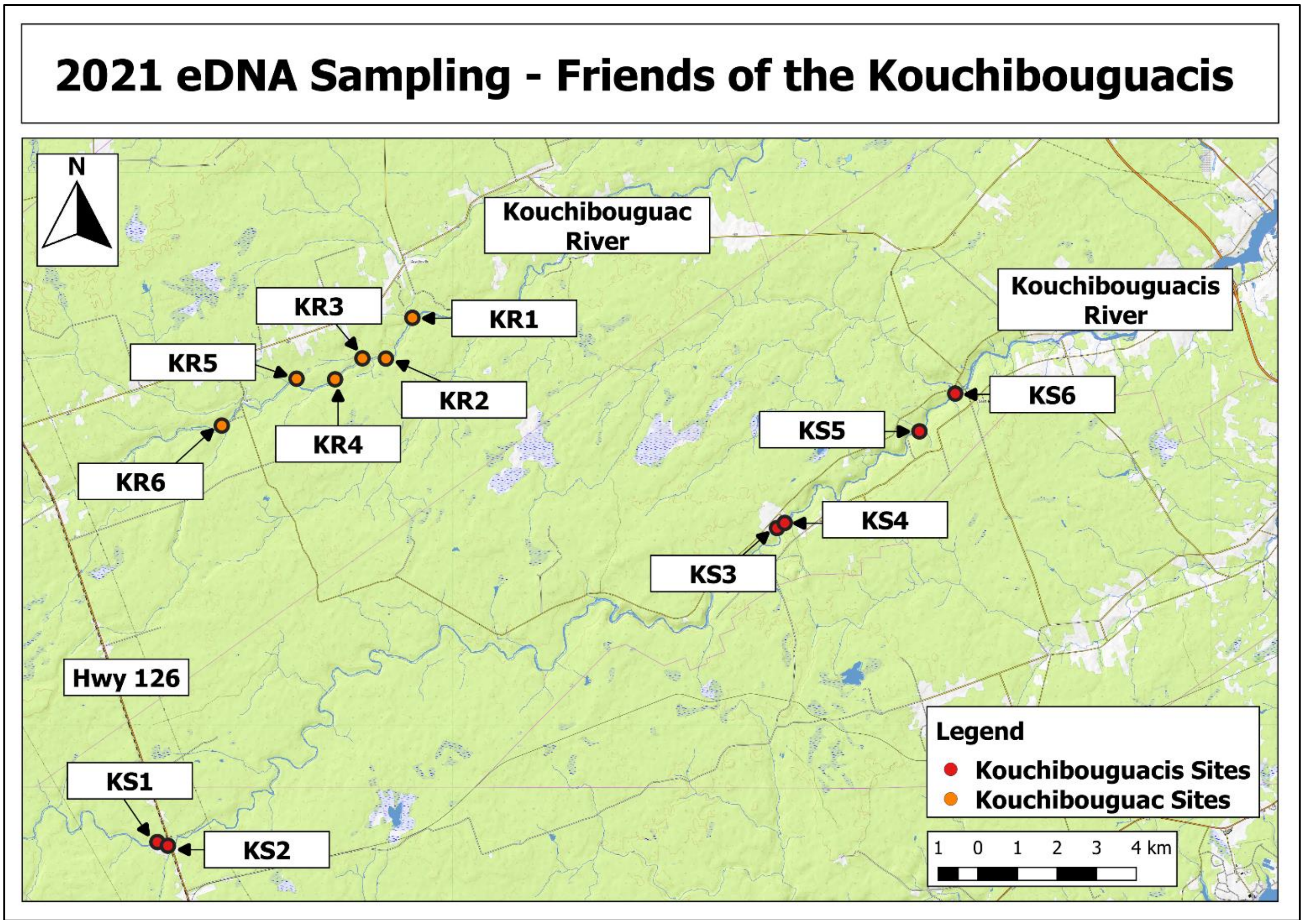
Map displaying 2021 incubation site locations



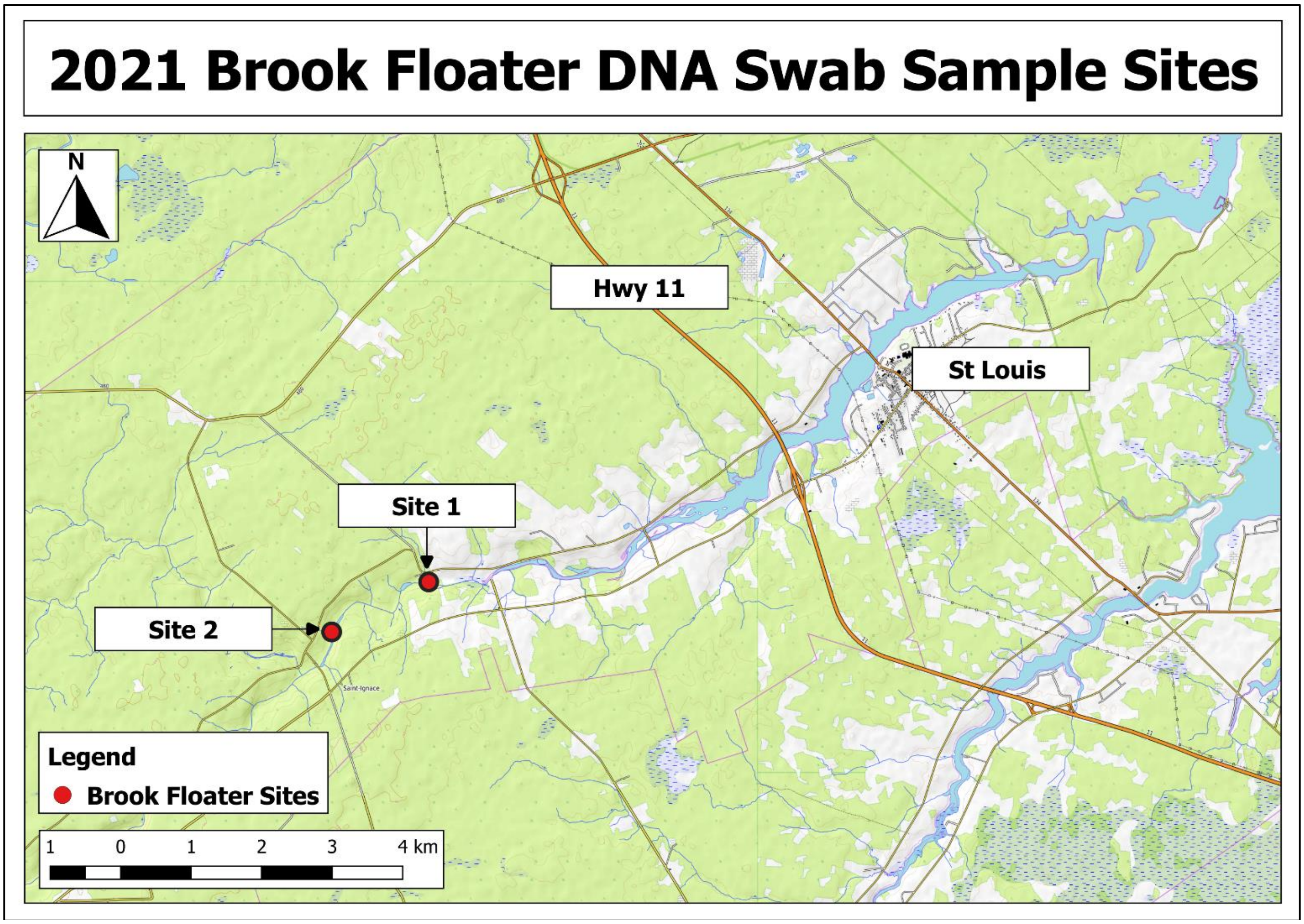
Map displaying 2021 Stream Survey



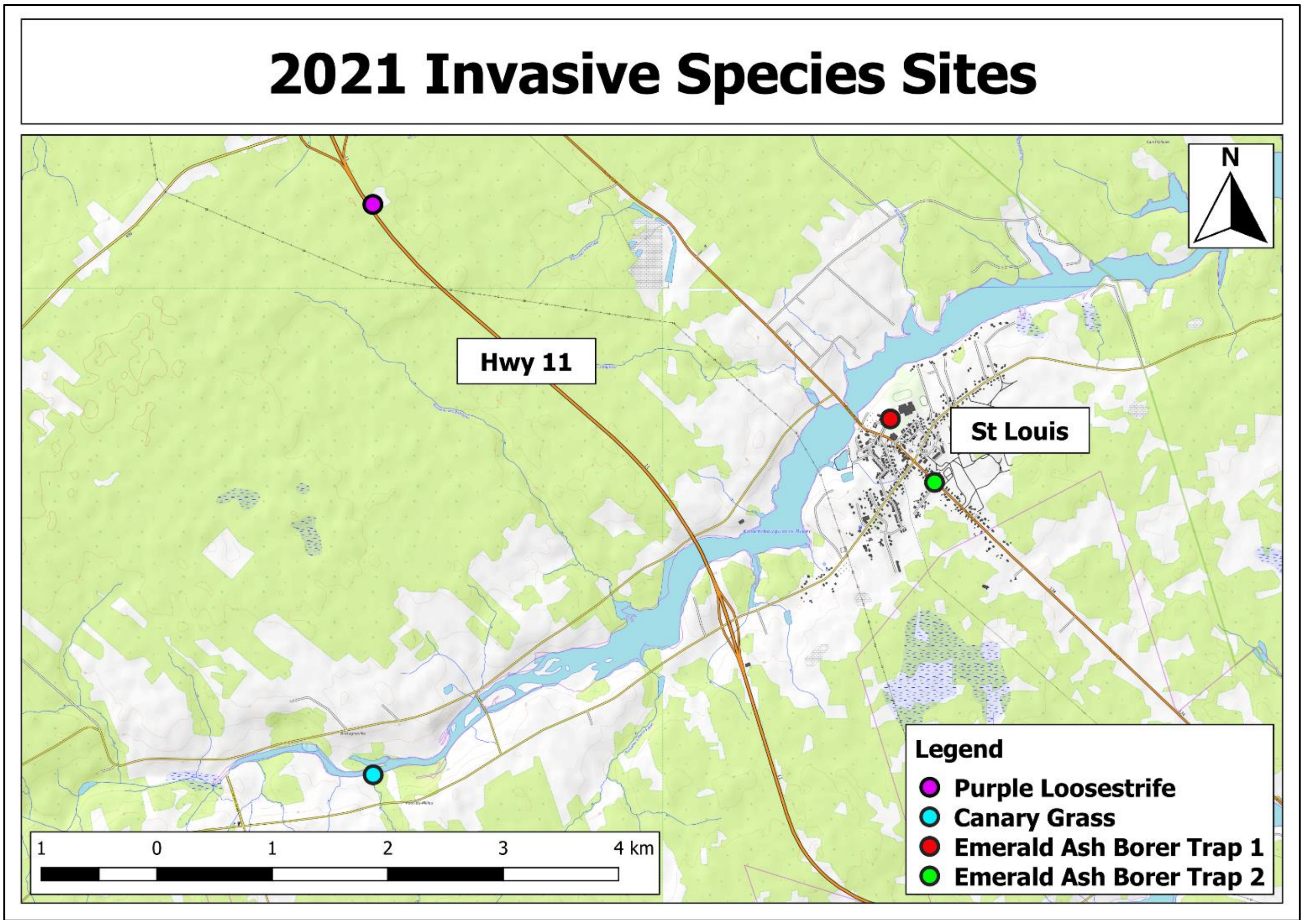
Map displaying 2021 eDNA Sites



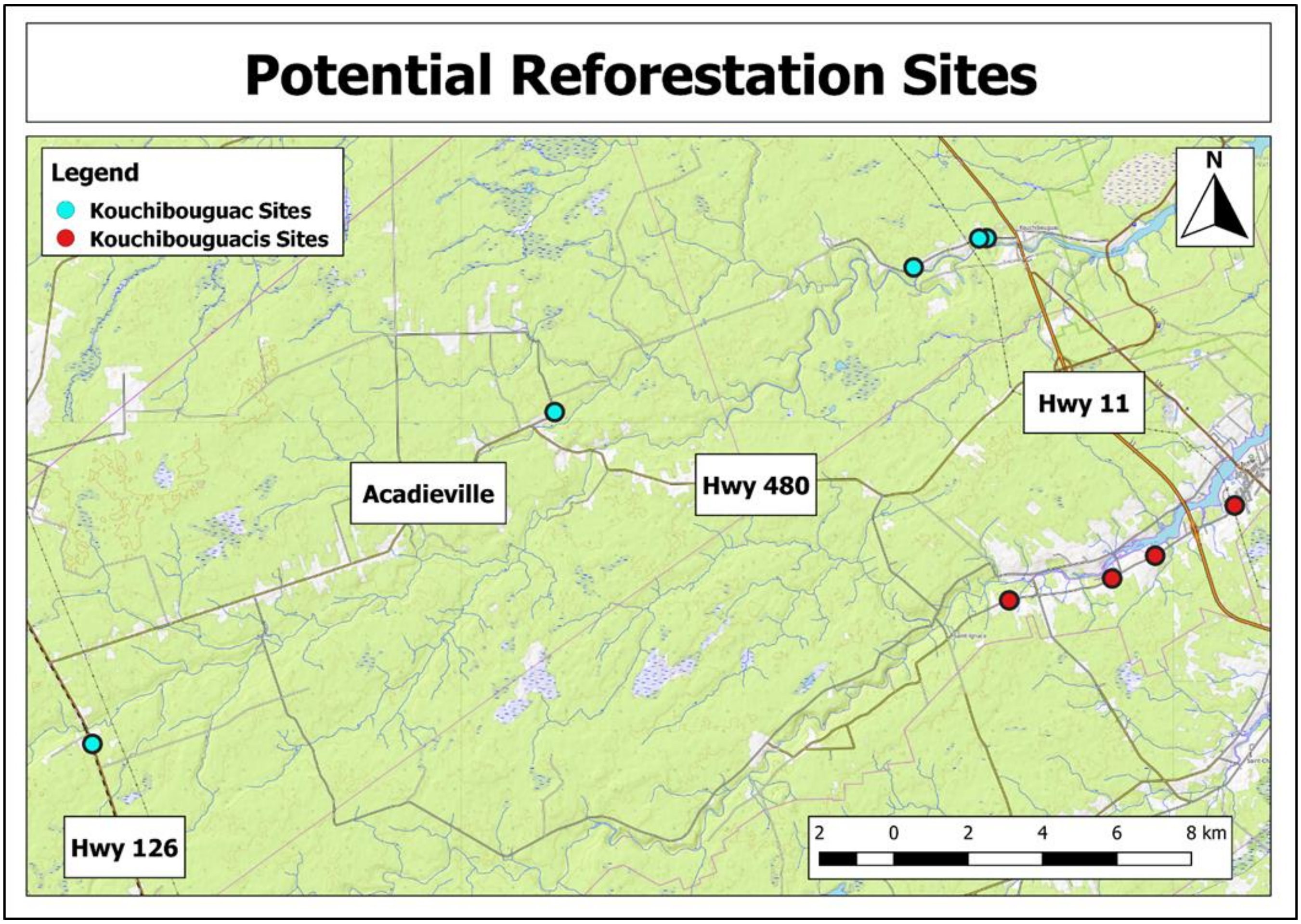
Map displaying 2021 Brook Floater DNA swab sample sites



Map displaying 2021 invasive species monitoring/mitigation sites



Map displaying potential reforestation sites



Annex B - Atlantic Salmon Results of Box-Net Fishing 2021

Date	Box-Net	Sex	Length (Fork-Total, cm)	Estimated Age Years (Years)
01-Sep	Net 1	Female	80-84	4.5
01-Sep	Net 1	Male	53-56	4.5
01-Sep	Net 1	Female	80-83	4.5
01-Sep	Net 1	Male	55-60	4.5
01-Sep	Net 1	Male	51-53	3.5
01-Sep	Net 1	Male	53.5-58	4.5
03-Sep	Net 1	Male	56-60	5.5
03-Sep	Net 2	Male	53.5-57	4.5
03-Sep	Net 2	Male	54-58	N/A
09-Sep	Net 1	Male	74-78	6.5
11-Sep	Net 1	Female	78-82	N/A
11-Sep	Net 1	Female	75-79.5	N/A
14-Sep	Net 1	Female	75-81	4.5
14-Sep	Net 1	Female	73.5-78.5	6.5
14-Sep	Net 1	Male	52.5-56	6.5
16-Sep	Net 2	Male	58-61.5	4.5
18-Sep	Net 1	Male	57.5-60.5	N/A
18-Sep	Net 1	Male	55.5-59.5	4.5
18-Sep	Net 1	Male	56.5-59	5.5
20-Sep	Net 1	Male	86-89	5.5
20-Sep	Net 1	Female	78.5-84	N/A
20-Sep	Net 1	Male	55.5-59	5.5
20-Sep	Net 2	Male	52.5-56	5.5
25-Sep	Net 1	Female	76-79	6.5
25-Sep	Net 1	Female	74-79	5.5
25-Sep	Net 1	Female	77.5-81.5	5.5
25-Sep	Net 1	Male	53-56	N/A
25-Sep	Net 1	Male	57-60.5	5.5
25-Sep	Net 1	Female	78.5-81	5.5
25-Sep	Net 1	Male	50-53.5	4.5
25-Sep	Net 2	Female	74-79	5.5
25-Sep	Net 2	Female	77-81	N/A
25-Sep	Net 2	Male	52-56	4.5
25-Sep	Net 2	N/A	N/A	N/A
26-Sep	Net 1	Male	82-86	4.5
28-Sep	Net 1	Female	76.5-80.5	3.5
28-Sep	Net 1	Female	71-76	4.5
28-Sep	Net 1	Male	52-56	6.5

28-Sep	Net 1	Female	78-83	5.5
28-Sep	Net 1	Male	50-52.5	6.5
30-Sep	Net 1	Female	72.5-76	N/A
30-Sep	Net 1	Female	81-87	N/A
30-Sep	Net 2	Male	76-80.5	N/A
01-Oct	Net 1	Male	86-90	5.5
01-Oct	Net 1	Female	75-79	N/A
01-Oct	Net 1	Male	73-78.5	4.5
01-Oct	Net 1	Female	69-74	5.5
04-Oct	Net 2	Female	68.5-72.5	N/A
05-Oct	Net 1	Male	74-79.5	6.5
06-Oct	Net 1	Male	59-62	5.5
06-Oct	Net 2	Female	78-81	4.5
07-Oct	Net 1	Male	79-83	5.5
07-Oct	Net 1	Female	74-78	5.5
07-Oct	Net 1	Male	83-88	5.5
07-Oct	Net 1	Male	60-63	N/A
07-Oct	Net 1	Male	57-60	4.5
09-Oct	Net 1	Male	Escaped	5.5
09-Oct	Net 1	Male	Recapture	5.5
09-Oct	Net 1	Female	Recapture	4.5
09-Oct	Net 1	Male	Recapture	5.5
09-Oct	Net 1	Female	78-81.5	5.5
09-Oct	Net 1	Female	78-83	6.5
09-Oct	Net 1	Female	76-81	N/A
09-Oct	Net 2	Female	Recapture	6.5
09-Oct	Net 2	Female	79.5-84	6.5
12-Oct	Net 1	Female	Recapture	Recapture
12-Oct	Net 1	Male	Recapture	4.5
12-Oct	Net 1	Female	75-79	4.5
12-Oct	Net 1	Male	Recapture	5.5
12-Oct	Net 1	Female	76-80	4.5
12-Oct	Net 1	Female	75-80	5.5
12-Oct	Net 1	Female	71-76	5.5
12-Oct	Net 1	Female	Recapture	6.5
12-Oct	Net 1	Female	79-84	N/A
12-Oct	Net 1	Male	52.5-56	4.5
12-Oct	Net 1	Male	Recapture	5.5
12-Oct	Net 1	Female	Recapture	3.5
12-Oct	Net 1	Female	81-84	5.5
12-Oct	Net 1	Male	58-62	3.5

12-Oct	Net 1	Male	58-61.5	6.5
12-Oct	Net 1	Male	55-59	4.5
12-Oct	Net 1	Female	Recapture	Recapture
12-Oct	Net 1	Male	50-54	5.5
13-Oct	Net 1	Female	81-86	5.5
15-Oct	Net 1	Female	78-82	N/A
15-Oct	Net 1	Female	79-84	N/A
15-Oct	Net 2	Female	75-81	5.5
16-Oct	Net 1	Male	58-61	N/A
16-Oct	Net 1	Male	Recapture	4.5
16-Oct	Net 1	Male	56-60	4.5
16-Oct	Net 1	Female	76-79	4.5
16-Oct	Net 1	Female	77-81	5.5
16-Oct	Net 1	Male	50-53	4.5
16-Oct	Net 2	Female	75-79	5.5
16-Oct	Net 2	Female	80-84	5.5
19-Oct	Net 1	Male	64-67	5.5
19-Oct	Net 1	Male	53-56	3.5
19-Oct	Net 1	Female	80-82	5.5
19-Oct	Net 1	Male	57-60	N/A
19-Oct	Net 1	Male	56.5-59.5	6.5
19-Oct	Net 1	Female	81-84	7.5
19-Oct	Net 1	N/A	Tagged Elsewhere	4.5
19-Oct	Net 1	Male	Recapture	3.5
19-Oct	Net 1	N/A	Tagged Elsewhere	5.5
19-Oct	Net 1	Female	69-73	6.5
19-Oct	Net 1	Female	51-54	4.5
19-Oct	Net 1	Female	76-79	5.5
19-Oct	Net 2	Female	90-94.5	5.5
20-Oct	Net 2	Female	81-85	4.5
20-Oct	Net 2	Female	72-75	N/A
22-Oct	Net 1	Male	82-86	3.5
22-Oct	Net 1	Female	Recapture	6.5
22-Oct	Net 1	Male	Recapture	4.5
22-Oct	Net 1	Female	83-87.5	4.5
22-Oct	Net 1	Female	Recapture	Recapture
22-Oct	Net 1	Female	Recapture	5.5
22-Oct	Net 1	Female	Recapture	Recapture
22-Oct	Net 1	Male	82-86.5	5.5
25-Oct	Net 1	Female	Recapture	3.5
25-Oct	Net 1	Male	Tagged Elsewhere	5.5

25-Oct	Net 1	Male	51-54	N/A
26-Oct	N/A (Broodstock)	Female	78-81	7.5
26-Oct	N/A (Broodstock)	Female	74-78	N/A
26-Oct	N/A (Broodstock)	Male	79-83	6.5
26-Oct	N/A (Broodstock)	Male	58-61	5.5
26-Oct	N/A (Broodstock)	Male	55.5-58.5	N/A
26-Oct	N/A (Broodstock)	Male	57-61	N/A
26-Oct	N/A (Broodstock)	Male	55-59	N/A
26-Oct	N/A (Broodstock)	Male	57-60	N/A
27-Oct	Net 1	Male	Recapture	5.5
27-Oct	Net 1	Female	Recapture	8.5
27-Oct	Net 1	Female	79.5-64	6.5
27-Oct	Net 1	Female	77-81	4.5
29-Oct	Net 1	Female	Recapture	4.5
29-Oct	Net 1	Female	Recapture	4.5
29-Oct	Net 1	Female	81-85	4.5
31-Oct	Net 1	Female	98-103	5.5
31-Oct	Net 1	Female	79-83	N/A
31-Oct	Net 1	Female	Recapture	5.5
31-Oct	Net 1	Male	Recapture	Recapture