2021 NASHWAAK WATERSHED AQUATIC CONNECTIVITY REPORT

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2021 Aquatic Connectivity Report

Objectives

The objectives of the project were:
1) To increase the capacity of the NWAI to survey for aquatic connectivity
2) To increase our knowledge of the aquatic connectivity and fragmentation of the watershed
3) To decrease habitat fragmentation within the Nashwaak watershed and create an overall increase in habitat availability for fish
4) To communicate the importance of watershed connectivity to the public.

Significant urbanization and industrialization have increased in the Nashwaak watershed during the last decade, leading to an increase in roads and associated stream crossings. Poorly designed, installed, or maintained culverts and dams can be a limiting factor for endangered diadromous fish species such as Atlantic salmon. These barriers prevent salmon and similar species from reaching upriver spawning habitat, feeding grounds, and cold-water refuges, which can have significant impacts on the population capacity of the entire watershed. A single barrier culvert can restrict fish from accessing several kilometres or more, of vital upstream habitat.

Besides being barriers to fish passage, culverts can also change the hydrology of the river system. They pose a risk of becoming blocked with debris, which may cause flooding and costly damage to infrastructure. Habitat fragmentation is a prolific issue in the Maritimes. The Clean Annapolis River Foundation found that 70% of culverts they assessed were barriers to fish passage and 80% of the culverts surveyed by the Petitcodiac Watershed Alliance in 2015 were either partial or full barriers to fish passage.

Prior to 2017, information regarding aquatic connectivity in the Nashwaak Watershed was largely unknown. It is because of this knowledge gap, that the NWAI requested funds to conduct a multi-year project to assess, prioritize, and restore barrier culverts in the Nashwaak watershed from the mouth of the river working upwards. It was a priority strategy to re-establish fish access to crucial upstream habitat, with 2021 being our fifth field season for assessment.

The Nashwaak River is crucial for the survival of Atlantic salmon at a variety of life stages. As a tributary of the greater Wolastoq river, the Nashwaak is one of DFO's priority index rivers listed in their 2014 "Recovery Potential Assessment". This work is also in line with the Atlantic Salmon Federation's 2018-2023 "Blueprint for saving Wild Atlantic Salmon". Habitat fragmentation and blocked access to cold-water , spawning habitats have long been recognized as limiting factors for salmon populations.

Deliverables

The objectives of the project were:
1) Conduct a desktop survey of the remaining culverts to visit
2) Conduct a field survey of at least 25 culverts in the central and upper watershed;
    a. clean-up all assessment sites of garbage and debris;
3) Map and prioritize them for remediation in terms of barriers to fish;
4) Conduct a hydraulic survey of the top barrier(s) with an engineering firm;
    a. Prepare stamped drawings
    b. Inform NBDTI, NBNRED, or other culvert owners and start conversation about remediation
5) Update our aquatic connectivity map of the watershed, which will be made public
6) Raise awareness about aquatic connectivity through outreach and social media

The end goals were to:
1) Gain more knowledge about the health and connectivity of our watershed

2) Increase the amount of available upstream aquatic habitat for migratory fish, especially endangered Atlantic salmon, by facilitating fish passage through culverts assessed as barriers
3) Communicate this information to the public through our outreach programs.

The long-term goals of this project are to increase fish populations and biodiversity by improving access to high quality habitat.

Results

Over the course of the last five years, NWAI's capacity to survey the Nashwaak watershed has greatly increased, as has our knowledge about the connectivity and fragmentation of our watershed. We have been able to inform the public about habitat fragmentation on our online platforms as well as through the distribution of printed resources. We have further solidified our working relationship with NB Department of Transportation and Infrastructure (NBDTI), and we have now completed four major remediation projects in collaboration. We have also partnered with multiple non-profit, municipal, and Wolastoqey groups to complete our largest barrier project to date: the removal of the Campbell Creek Dam.

There are approximately 985 stream-road crossings in the Nashwaak watershed. In May 2017, the NWAI began to map, assess, and improve these crossings. In our first field season we completed a full survey on 75 culverts and 70% were determined to be full or partial barriers to fish passage. In 2018, our second field season, we started by mapping out priority areas in the central watershed to survey, we then visited 114 sites and conducted a full survey of 67 crossings. We updated our survey form so that full surveys included collecting water temperature, pH, conductivity, DO, and total dissolved solids as well as some additional measurements and observations that were not included in 2017 surveys. For our third field season (2019), we visited 83 sites and conducted a full survey on 50 culverts. In 2020, we visited 50 sites and conducted a full survey on 24 culverts. We focused on culverts in the headwaters and on logging or forest service roads, which required more driving time. We cleaned all surveyed sites of debris and garbage. In our most recent 2021 field season we conducted surveys on 30 stream crossings and fully assessed 6. As these sites were largely focused on the upper watershed, which is less populous and industry heavy, many sites were deemed inaccessible. This season, over 45 sites were attempted for assessment but were not surveyable due to poorly maintained roads, flooding, or culvert blockages. In addition, an unseasonable rainy July season, accompanied by high waters impacted our ability to survey.

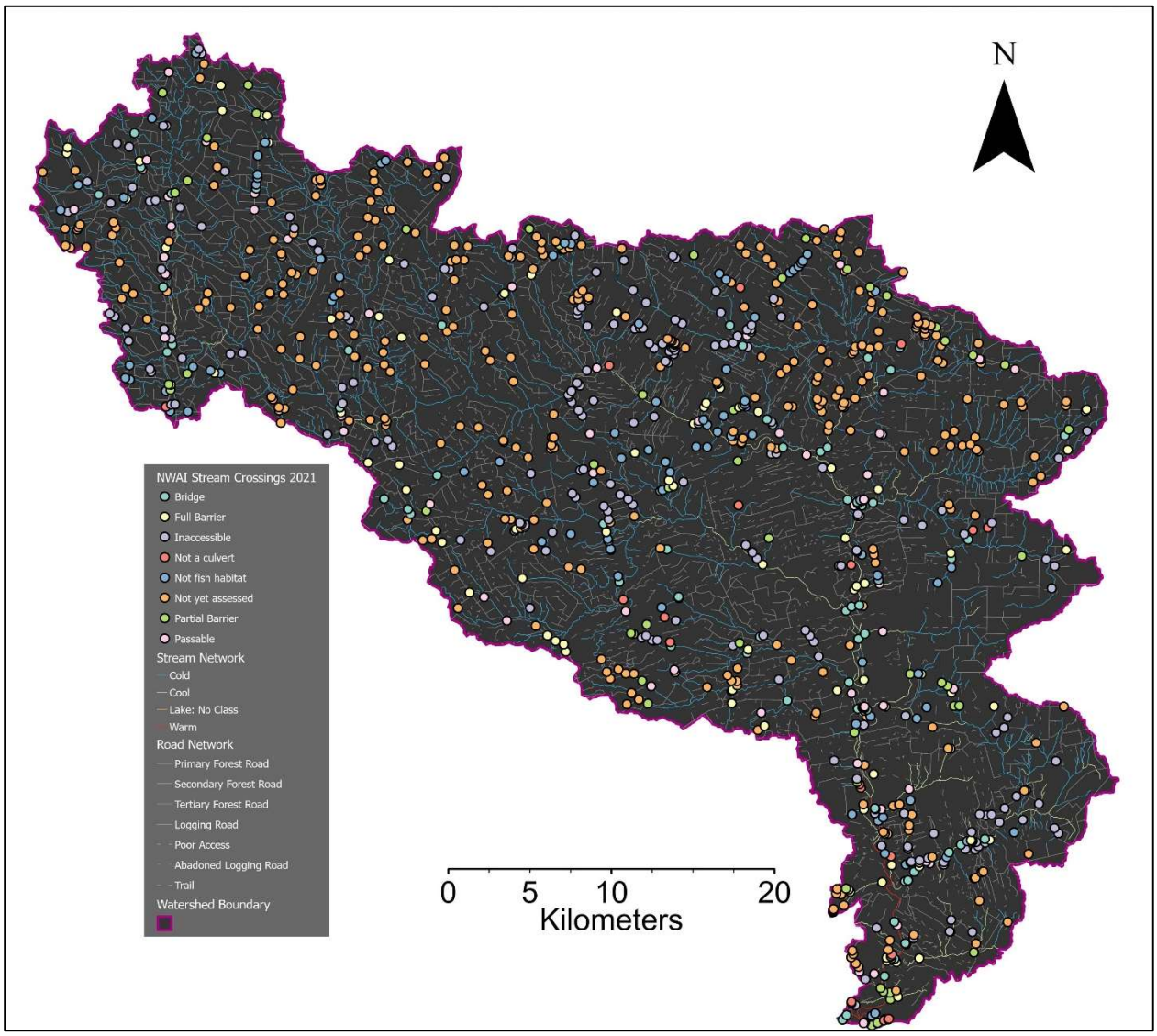

FIGURE 1. UPDATED GIS MAP WITH ALL CULVERTS SURVEYED TO DATE, CATEGORIZED IN TERMS OF PASSABILITY TO FISH

This survey information was entered into a central database and a GIS map, which will be shared with our partners at the end of the year. So far, we have visited 435 of the 985 crossings in the watershed (Fig 1 & 2) in the watershed (~50% complete) and we have done a full survey on 222 culverts. We have surveyed almost all the crossings on public paved roads and the main logging or forest roads. We have done at least 6 major debris removals and 15 smaller debris removals, which have improved flow and fish passage in those culverts and improved water quality in those streams. Of the 434 stream crossings surveyed in the watershed thus far, 212 were identified as fish habitat, and of those 172, or 76.8 % were full or partial barriers to fish passage. Our field experience and GIS survey have determined that only 538 stream crossings (56 %) in the watershed are accessible to survey, with many inaccessible culverts on trails or logging roads that are not currently maintained or abandoned. It is assumed therefore, that any stream crossings intercepting the fish habitat along these routes are full barriers. Of the remaining 526 barriers that have not yet been surveyed in watershed, only 104 are deemed accessible for survey by vehicle (Fig. 2), and will be targeted for future surveys from 2022 and beyond.

Over the past 5 years we have collated a long-list of all full and partial culvert barriers to fish passage that are larger than 75 cm in diameter. In 2021 we reduced this long-list over over 90 barriers to an action-able shortlist of ~ 20 barriers that have the highest potential for remediation in terms their condition, material, slope, outflow drop and recommended intervention.

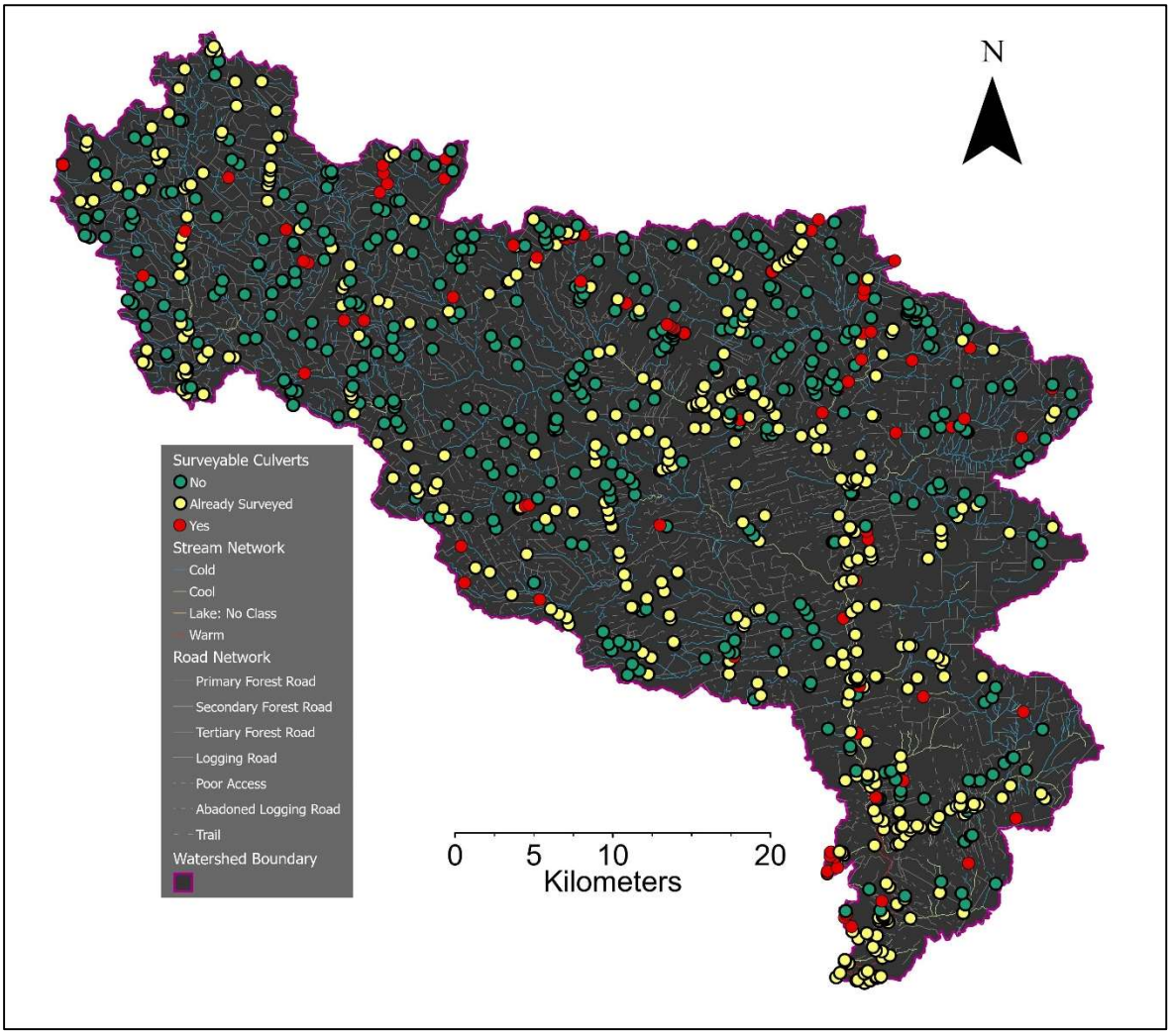

FIGURE 2. MAP OF SURVEYABLE CULVERTS IN THE NASHWAAK WATERSHED

In September of this year, we completed electrofishing assessments both above and below the rehabilitated culverts on Manzer, Limekiln, Mcgivney, and East Ryan Brooks with the help of DFO, St.Marys First Nation, and Aboriginal Fisheries Strategies. Electrofishing surveys were also conducted upstream and downstream from the Porters Brook culvert, a potential future culvert.

Past Projects

Over the years we have identified several target culverts for remediation. Post-remediation, we regularly check on each of these culvert sites to ensure they are structurally sound and working effectively. Each site is electrofished to give an accurate picture of the fish species that are above and below the culvert both prior to and post-remediation. Electrofishing data will vary based on the time and conditions at the time of sampling.

Manzer Brook

We have been regularly checking on the Manzer Brook fish ladder (Figure 7), installed in 2018. It survived the last three winters well and has not been catching debris. Electrofishing in August 2018 prior to the install of the remediation found seven species downstream and five species upstream (a total of 54 fish downstream and 55 fish upstream). Electrofishing in September 2020 found six species downstream and five species upstream (a total of 154 fish downstream and 104 fish upstream). In 2021, using a sweep and shock method, we determined there were 7 species downstream and 5 species upstream, with a grand total of 59 fish (Table 3).

FIGURE 3. THE MANZER BROOK FISH LADDER, INSTALLED IN AUGUST 2018

TABLE 1. ELECTROFISHING RESULTS FROM 2018, BEFORE THE MANZER BROOK FISH LADDER WAS INSTALLED

Site	American eel	Atlantic salmon	Black nose dace	Brook trout	Burbot	Creek chub	Sea lamprey	Slimy sculpin	White sucker	Grand Total
Manzer downstream	5	1	25	3	1			18	1	54
Manzer upstream			16	3		4	5	27		55
Grand Total	**5**	**1**	**41**	**6**	**1**	**4**	**5**	**45**	**1**	**109**

TABLE 2. ELECTROFISHING RESULTS FROM 2020 (POST-REMEDIATION)

Site	American eel	Black Nose dace	Brook trout	Common shiner	Sea lamprey	Slimy sculpin	Grand Total

Manzer downstream	1	67	11	69	2	4	154
Manzer upstream		43	11	32	8	14	108
Grand Total	**5**	**133**	**119**	**101**	**10**	**33**	**411**

TABLE 3. ELECTROFISHING RESULTS FROM 2021 (POST-REMEDIATION)

Site	American eel	Black nose dace	Burbot	Pearl dace	Slimy sculpin	White sucker	Grand Total
Manzer downstream	5	14	1	2	7	2	31
Manzer upstream		10		2	15		27
Grand Total	**5**	**24**	**1**	**4**	**22**	**2**	**58**

East Ryan

Through the 2019 fall and winter, we worked with NBDTI and HILCON Ltd. on the design of fish passage structures involving baffles and chutes for three barrier culverts, which were built and installed by Tek Steel. The East Ryan Brook fish passage project was completed in July 2020 and the Limekiln and McGivney Brook fish passage projects were completed in October 2020 (thanks to an extension on our Watercourse and Wetland Alteration Permit).

At East Ryan Brook, a cast in place 2,750 x 1,800 mm concrete box installed in the 1950s on Rte 107 was too steep (2.3% over 20 m) and had a 30 cm step at the outlet, preventing fish passage through the pipe. Water in the pipe was very shallow due to its wide, flat bottom. Electrofishing in 2019 showed that there were many brook trout using this cold-water stream along with a single American eel.

The remediation took place in two phases: First, a baffle was placed at the end of the enclosed pipe and another just before the drop (Fig 3). Baffle height was 350 mm and notch width and depth were 200 mm and 150 mm, respectively for both. These allowed the water in the pipe to back-flood and velocity to decrease. A short chute was installed over the drop at the end of the structure. The chute contained roughness bars to prevent sheet flow. The second baffle was fitted with a small slide to allow fish to swim up and over. The second phase, installed a few weeks later, involved three shorter baffles that extended 4/5ths of the way across the pipe (Fig 4). We alternated what side of the baffle was opened to create a sinuous channel through the pipe. These helped back-flood the remainder of the pipe. Large rocks were placed throughout the pipe to create microhabitat. Water will eddy behind the rocks and they will provide protection for small fish.

This project opened 1.8 km^2 of habitat and 800 m of stream length above it. Electrofishing results pre- and post-remediation showed similar numbers of the same species (mainly brook trout and a few American eel). A temperature logger installed over the summer of 2020 gave an average temperature between 21 June and 21 September of only 13.33°C and a peak temperature of 18.7°C, indicating that this brook is an excellent thermal refuge for salmonids in the summer. In 2021 electrofishing determined 16 brook trout below the culvert and 6 above it, with a grand total of 22 fish (Table 6).

FIGURE 4. BEFORE (LEFT) AND AFTER (RIGHT) OF THE EAST RYAN BROOK FISH PASSAGE PROJECT.

FIGURE 5. DETAILS OF THE EAST RYAN BROOK FISH PASSAGE PROJECT SHOWING THE CHUTE AND FIRST TWO BAFFLES (LEFT) AND THE UPPER THREE PARTIAL BAFFLES (RIGHT) AS WELL AS THE LARGE ROCKS PLACED TO PROVIDE MICROHABITAT IN THE PIPE.

TABLE 4. ELECTROFISHING RESULTS FROM 2019, BEFORE THE REMEDIATION STRUCTURES WERE INSTALLED.

Site	American Eel	Brook Trout	Grand Total
East Ryan downstream	1	50	51
East Ryan upstream		23	23
Grand Total	**1**	**73**	**74**

TABLE 5. ELECTROFISHING RESULTS FROM 2020, POST-REMEDIATION.

Site	American Eel	Brook Trout	Grand Total
East Ryan downstream	2	40	42
East Ryan upstream		19	19
Grand Total	**2**	**59**	**61**

TABLE 6. ELECTROFISHING RESULTS FROM 2021 (POST-REMEDIATION)

Site	Brook Trout	Grand Total
East Ryan downstream	16	16
East Ryan upstream	6	6
Grand Total	**22**	**22**

McGivney Brook

The McGivney Brook pipe is a cast in place concrete box (4,580 x 1,260 mm) on route 625. The remediation work at this site was completed in October 2020. This culvert was slightly too steep (0.9% over 9.8 m) to allow for fish passage. Its wide, flat bottom meant that there were only a few millimetres of water depth during low flow. Pre-remediation electrofishing found three species downstream and four species upstream (American eel was found upstream but not downstream). Similar numbers of brook trout were found up and downstream but higher numbers of black nose dace and slimy sculpin were found downstream compared to upstream. A total of 43 fish were found downstream versus 25 upstream. A temperature logger installed over the summer of 2020 gave an average temperature between 21 June and 21 September of only 15.04°C and a peak temperature of 20.6°C, indicating that this brook is an excellent thermal refuge for salmonids in the summer.

Remediation work involved the installation of one aluminum baffle and chute at the outlet of the pipe. The baffle was 300 mm high with a notch width and depth of 400 mm and 300 mm, respectively. The chute was 400 mm wide and 615 mm long. The baffle allows water to back-flood in the culvert, becoming deeper and slower (and easier for fish to swim in). The chute allows fish to swim into the culvert during low flow and it was fitted with roughness bars to prevent sheet flow. This project opened 10.2 km^2 of habitat and 8,913 m of stream length above it.

Post-remediation electrofishing in 2021 revealed 4 species up- and downstream of the culvert with a grand total of 42 fish (Table 8).

FIGURE 6. BEFORE AND AFTER OF THE MCGIVNEY BROOK FISH PASSAGE PROJECT

TABLE 7. ELECTROFISHING RESULTS FROM SEPTEMBER 2020 (PRE-REMEDIATION)

Site	American Eel	Black Nose Dace	Brook Trout	Slimy sculpin	Grand Total
McGivney downstream		16	13	14	43
McGivney upstream	1	5	18	1	25
Grand Total	**1**	**21**	**31**	**15**	**68**

TABLE 8. ELECTROFISHING RESULTS FROM SEPTEMBER 2021 (POST-REMEDIATION)

Site	White Sucker	American Eel	Black Nose Dace	Brook Trout	Slimy sculpin	Grand Total
McGivney downstream	5		5	6	14	30
McGivney upstream		1	1	6	4	12
Grand Total	**5**	**1**	**6**	**12**	**18**	**42**

Limekiln Brook

The Limekiln Brook pipe is a cast in place concrete box (3,000 x 2,400 mm) on route 620. The remediation work at this site was completed in October 2020. This culvert was too steep (2.11% over 28 m) to allow for fish passage. Its wide, flat bottom meant that there were only a few millimetres of water depth during low flow. Pre-remediation electrofishing found 4 species downstream and 2 species upstream. American eel and black nose dace were not found above the pipe. A total of 14 fish were found downstream versus 6 fish upstream. Post-remediation electrofishing will be completed in 2021. A temperature logger installed over the summer of 2020 gave an average temperature between 21 June and 21 September of 18.41°C and a peak temperature of 24.73°C, indicating that this brook would be an excellent thermal refuge for salmonids in early/late summer. However, in peak summer, it may be too warm (temperature exceeded 23°C on 20 days this summer).

The remediation involved the installation of 4 fish weirs spaced 7 m apart throughout the pipe. The baffles were 500 mm high with a notch width and depth of 300 mm and 200 mm, respectively. This project opened 7.25 km^2 of habitat and 10,732 m of stream length above it.

In 2021 we noted that the outflow drop in the fish ladder was higher than ideal and installed an additional weir to further facilitate fish passage (Fig. 9). Table 10 shows the post-remediation electro-

fishing results for Limekiln Book. We were pleased to note the presence of Atlantic salmon above the barrier.

FIGURE 7. BEFORE (LEFT) AND AFTER (RIGHT, BELOW) OF THE LIMEKILN BROOK FISH PASSAGE PROJECT.

FIGURE 8. A CLOSE-UP SHOT SHOWING THE WEIRS INSTALLED FOR THE LIMEKILN BROOK FISH PASSAGE PROJECT. THE WEIRS WERE NOT FULLY INSTALLED AT THIS POINT, SO WATER WAS JUST STARTING TO FLOW OVER THE CHUTE.

TABLE 9 ELECTROFISHING RESULTS FROM SEPTEMBER 2020 (PRE-REMEDIATION)

Site	American Eel	Black Nose Dace	Brook Trout	Creek Chub	Grand Total
Limekiln downstream	1	2	5	6	14
Limekiln upstream			2	4	6
Grand Total	**5**	**133**	**119**	**10**	**411**

TABLE 10. ELECTROFISHING RESULTS FROM SEPTEMBER 2021 (POST-REMEDIATION)

Site	American Eel	Atlantic Salmon	Brook Trout	Fall Fish	Grand Total
Limekiln downstream	3		1	1	5
Limekiln upstream	1	1	1		3
Grand Total	**4**	**1**	**2**	**1**	**8**

2021 Remediation Projects

2021 was largely focused on the removal of Campbell Creek dam and the technical preparation for the removal of Porters Brook culvert which involved numerous surveys, a habitat assessment, the development of a baseline conditions report and a management plan for the site.

In the fall of 2021, Limekiln Brook we installed an additional aluminium weir at the downstream side of the fish ladder to decrease the outflow drop and provide improved opportunity for fish passage (Fig 8). The new weir was installed at an angle and had the following dimensions: 300 mm high, with a notch depth of 200 mm and width of 300 mm.

FIGURE 9. LIMEKILN FISH LADDER BAFFLE INSTALLATION FROM EARLY 2021 (LEFT) AND AFTER AN ADDITION BAFFLE WAS INSTALLED IN FALL 2021 (RIGHT)

Campbell Creek Dam Removal

FIGURE 10 CAMPBELL CREEK DAM, LOOKING UPSTREAM IN THE SUMMER OF 2018

The removal of the Campbell Creek dam was part of a 4-phase project that began in 2019. The removal of the dam took place in the summer of 2021 with additional restoration and monitoring activities planned for 2022 through to 2024.

Project activities for this 2021 included:

- Baseline and pre-removal monitoring of biological, physical & chemical conditions of the stream (CABIN, flow-monitoring, electrofishing, eDNA sampling, water quality and temperature monitoring),
- Archeological surveying and monitoring,
- Over 20 meetings with project partners,
- Removal of the dam according to engineering design,
- Restoration and revegetation of the former headpond based on the revegetation and management plan developed in 2020, and
- Post-removal monitoring of biological, physical and chemical conditions of the stream, comparing these to pre-removal conditions in a baseline report.

Project Summary

Built in 1919, the Campbell Creek dam was a well-known landmark in Marysville. It once provided water to the Marysville Cotton Mill — the largest of its kind in the Maritimes. With the closure of the mill in the 1970s, the dam became obsolete and began to deteriorate.

Complete removal of the dam was recommended by engineers as it was a safety liability. The dam did not meet the Canadian Dam Association guidelines with respect to the hydraulic capacity of the spillways, stability, seepage and erosion, or public safety and fish passage was non-existent, negatively affecting fish habitat and aquatic connectivity for over a century.

With our rapidly warming climate affecting so many rivers, opening as much high quality, cold, clean water habitat as possible is a priority for creating a well-connected and resilient landscape. Wild brook trout, Atlantic salmon, American eel, and sea lamprey are among native aquatic species that stand to benefit from this work.

After funding from Department of Fisheries and Oceans was secured by the Maliseet Nation Conservation Council, Fredericton City Council decided to remove the dam in 2021. Additional funding for the project was provided to the Nashwaak Watershed Association from the Atlantic Salmon Conservation Foundation, along with a cost-sharing agreement with the City of Fredericton and in-kind support from many other partners.

In September 2021 the Campbell Creek Dam was fully removed, and free flow to the stream restored for the first time in 100 years. Multiple fish rescues were conducted throughout the removal process to mitigate fish mortality in the construction zone, and we were pleased to find numerous Atlantic salmon parr and American eel just downstream of the dam (Fig. 16).

After being tested thoroughly for potential toxins and contaminants the concrete of the dam was laid to rest on-site, buried and covered in topsoil to be revegetated. The newly-established stream channel was reconstructed to facilitate fish passage by roughening the stream bottom and creating a series of riffles and pools (Fig. 14).

The removal of the dam and restoration of fish passage now provides the opportunity for access to over 22 km of high quality upstream aquatic habitat. In addition, the restoration of the former headpond to upland Acadian forest will provide over 8 acres of habitat to terrestrial species. The overarching goal of site headpond restoration were to facilitate restoration of riparian and upland forest community and structure, while allowing more vulnerable sites to revegetate naturally.

The former headpond was planted with over 3000 native Acadian forest species including: red oak, eastern white pine, red spruce, yellow and white birch. Due to tricky site access, which did not allow vehicle entry into the headpond, all vegetation had to be carried into site by hand. Planting was carried with the support of a crew from Community Forests Canada, who planted the entire site in a single afternoon.

In addition to tree planting, over 900 native riparian shrubs where staked and planted along the newly established river banks and the construction zone was seeded with appropriate grass by hand to mitigate erosion and sedimentation.

The removal of old dams is critical for restoring ecosystem health, fish habitat, and fostering climate change resiliency. A free-flowing Campbell Creek provides improved water quality, landscape connectivity, and regulation of the flow of water and sediment downstream. The successful execution of largescale community-based projects such as this requires a multitude of committed partners. Such a positive outcome is a testament to the teamwork that brought this dream into reality.

FIGURE 11. PICTURE OF CAMPBELL CREEK LOOKING UPSTREAM IN 2019 (LEFT) AND 2021 (RIGHT)

FIGURE 12. A PICTURE OF THE NEWLY RESTORED CHANNEL IN CAMPBELL CREEK LOOKING UPSTREAM IN 2021

FIGURE 13. PICTURE OF CAMPBELL CREEK LOOKING DOWNSTREAM IN 2019 (LEFT) AND 2021 (RIGHT)

FIGURE 14 LEFT: PHOTO OF ONE OF SEVERAL FISH RESCUES CONDUCTED THROUGHOUT THE DAM REMOVAL PROCESS. RIGHT: DAM REMOVAL, MID-CONSTRUCTION. THE CREEK CHANNEL WAS DIVERTED SEVERAL TIMES DURING THIS PROCESS.

Post-removal

Going forward, NWAI will continue with post-removal monitoring and riparian planting. The monitoring will include water quality assessments, flow monitoring, temperature monitoring, rough population assessments and eDNA sampling for fish species and species-at-risk, and CABIN sampling.

Next Projects

Unfortunately, two potential culvert projects surveyed in 2020 were deemed not feasible for further work. Surveys for Sands Brook (Giant's Glen Road) and unnamed brook on Mclean Flats Road were completed, but it as determined that the culvert on Maclean Flats Road needs to be replaced with a bridge. The culvert on Sands Brook we were given permission from DTI to work on, however DTI was unable to find the original design drawings for this culvert without which our engineer was unable to design a fish passage solution.

From our culvert database we have created a shortlist of 20 potential culverts for future remediation activities. 12 of these culverts are full barriers and 8 are partial barriers. In 2022 we will meet with the

engineering company to assess remediation options for several of these culverts. We narrowed down what culverts to focus on by choosing culverts that were in good condition, at least 1 m wide, and were properly sized to handle increasing flows. If a potential culvert had a barrier culvert downstream, we determined if the culverts could be remediated sequentially.

Porters Brook

Porters Brook is a culvert located on Nashwaak West Road and is the property of NBDTI. It is understood that this culvert has been impeding fish passage in this cold-water tributary for many decades. The Porters Brook culvert is an 1,800 mm diameter corrugated steel pipe (Figure 15). The culvert does not meet DFO's stream crossing standard (slope is >0.5%, no baffles, perched outlet). A concrete headwall is visible on the upstream site, which appears to be older cast in place arch that was not removed when the culvert was replaced. Cobbles were mortared between the metal pipe and the concrete arch. Some of these mortared cobbles were seen in the stream below the culvert. It is unclear how far the concrete arch extends but it is not visible on the downstream side. There is a large crack in the left side of the headwall.

FIGURE 15. THE OUTLET OF THE PORTERS BROOK CULVERT IN HIGH WATER CONDITIONS IN 2017 (L) AND IN LOW WATER CONDITIONS IN 2020 (R)

FIGURE 16.THE INLET OF THE PORTERS BROOK CULVERT IN 2017 (L) AND IN 2020 (R). MANY LARGE TREES HAVE FALLEN IN THE STREAM AND DEBRIS HAS STARTED TO CLOG THE STREAM JUST ABOVE THE INLET.

NBDTI closed this section of Nashwaak West Road more than 15 years ago, with no plans to reopen it. Despite the road being closed, ATVs, Trucks and tractors are still driving through the blockade, which creates a safety liability for the province. As the road and culvert have not been maintained since the road was closed, the condition of both have deteriorated. Sediment fabric is visible hanging inside the pipe indicating that there are cracks in the top of the culvert (Figure 17). Significant erosion was noted both upstream (many large trees in the stream) and downstream in the plunge pool (Figure 15). The turbulent jet of water coming through the pipe is causing scour, which dislodges particles from the stream bed and banks. Deposition of that sediment is occurring in the pool at the mouth of the brook when water velocity slows. If the pipe and road were to collapse or washout, it would send road fill and sediment into the watercourse, which would irreversibly damage the brook as well as the important cold-water pool at the mouth. It is crucial to protect the integrity of this pool and prevent further damage due to ongoing sedimentation from the deteriorating culvert and plunge pool. Furthermore, fine sediments have already infilled many pools and spawning areas in the Nashwaak increasing the importance of protecting those that are remaining.

The survey for Porters Brook (Nashwaak West Road) was completed in 2021, which included flow monitoring, habitat assessment and site assessment. An electrofishing baseline survey was also performed with help from CIPS DFO (Table 11). In March 2021, a tentative plan for the removal of Porters Brook culvert was designed by the engineering firm HILCON LTD and presented to DTI. We are currently awaiting funding to move ahead with the project.

TABLE 11. ELECTROFISHING RESULTS FROM SEPTEMBER 2021.

Site	Brook Trout	Small Mouth Bass	Black nosed dace	Grand Total
Porters Brook downstream	13	1	1	15
Porters Brook upstream	9			9
Grand Total	**22**	**1**	**1**	**24**

McConaughy Brook Culverts

Two barriers of primary concern are in McConaughy Brook (Fig 18 and 19). These full barriers are blocking over 4.2 km^2 of functional upstream habitat. We plan to conduct a hydroengineering assessment of these barriers in 2022.

FIGURE 17. PICTURE LOOKING UPSTREAM IN MCCONAGHY BROOK (MC01). THIS SITE IS A FULL BARRIER TO FISH PASSAGE, BLOCKING 4.2 KM^2 OF VIABLE UPSTREAM HABITAT.

FIGURE 18. MCCONAGHY BROOK ON THE NB TRAIL LOOKING UPSTREAM (MC02).

We have updated our GIS aquatic connectivity map. We will share this information with our partners this fall and winter and carry out our "Healthy Nashwaak" social media campaign to further inform the public

about the importance of connected stream habitats. This winter we also continued to prioritize barriers for remediation using the Nature Conservancy's GIS Barrier Assessment Tool.

The Barrier Assessment Tool is a GIS add-on developed by The Nature Conservancy to prioritize culverts for assessment and remediation and quickly calculate upstream habitat gain, land use information, and other parameters. This is an extremely useful tool to have when approaching DTI and other culvert owners. This partnership has turned into a pilot project, where NWAI's culvert data was combined with NCC's newly released Freshwater Ecological Classification and Aquatic Blueprint. This partnership will eventually allow us to contribute our data to an international effort focused on restoring connectivity for both ecological and climate change adaptation (flooding – emergency services provisioning- risk to culverts) purposes: the North Atlantic Aquatic Connectivity Collaborative.

We are working hard to communicate the importance of connectivity of the river to the public via our social media channels, our annual newsletter, and conversations with landowners.

Evaluation and assessment of the project so far

The first four years of our aquatic connectivity project have been a huge success for NWAI. We surpassed our goal for number of culverts to map and survey. So far, we have trained seven staff, three board members, six summer students, and five volunteers on the survey protocol. This has increased the capacity of our organization to survey the aquatic connectivity of the watershed, as well as our knowledge about the fragmentation of the rivers in the Nashwaak watershed.

To date, we have been able to complete 5 restoration projects, opening more than 44 km in stream length that was previously inaccessible to fish.

We have increased our collaborative partnerships extensively over the past five years. In 2021, we partnered with the members from DFO's Collaboration of Indigenous Partners in Science, the Aboriginal Fisheries Strategy, and St Marys, Woodstock, Oromocto, and Kingsclear First Nations to electrofish our rehabilitation sites, as well as ACAP St John. NWAI, in collaboration with Maliseet Nation Conservation Council, City of Fredericton, Atlantic Salmon Federation removed the Campbell Creek Dam in 2021. This was a major achievement as this dam had been blocking upstream fish passage for over a century.

NBDTI has been generous with their time for reviewing drawings and answering questions.

Problems encountered & solutions:

We are still learning about the aquatic connectivity of the watershed, the scale or budgets of remediations that might be needed, how many culverts we can remediate in a year, and the timeline of getting DTI's approval to move forward on projects. The results of our surveys showed that remediation of the most severe barriers will be bigger, higher budget projects than expected. We also realized that most of the existing barrier culverts cannot be remediated to provide fish passage (for example, a collapsing wooden box culvert or one with a drop of >60 cm); they simply need to be replaced with new, properly designed and sized infrastructure. We have communicated these barriers to DTI, DNRED, and other owners. It has been challenging to find suitable projects that are within our budget, on structurally sound culverts, down accessible roads, and which have the potential to open sufficient upstream habitat to warrant remediation. With continued surveys we hope to find more potential project candidates.

Communications with DTI have improved, and we have now also started conversations with DNRED about culverts on woods roads. However, timelines for approval of projects and remediation remain long. There are also still many culverts that are not able to be surveyed in the watershed for a variety reasons, these

include: poorly maintained roads; being located on private land; and being too remote for easy access. Out of the total remaining culverts, only 104 can be surveyed (Fig. 2).
We will work with partners to develop a strategy regarding these sites access these sites, and will reach out to landowners who are responsible for their maintenance. A majority of the non-surveyable sites are on crown land that has been leased to logging companies. Many of these roads are either decommissioned, poorly maintained, or are not currently being maintained. Due to a lack of resources, the province is not well-positioned to enforce provincial guidelines regarding road-stream crossings. As a result, many of the companies have not adhered to these guidelines.

Our next steps will involve communicating our impediments and sharing our current data with the Department of Fisheries and Oceans (DFO), Department of Natural Resources and Energy Development (DNRED) and Department of Transportation and Infrastructure (DTI). In doing so, we hope to get additional resources to assess and remediate these inaccessible barriers.