Identifying Habitat of the Brook Floater (*Alasmidonta varicosa*) in the Shediac Bay Watershed

Prepared for:

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Habitat Stewardship Program for Species At Risk

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1. Introduction

The Shediac Bay Watershed Association (SBWA) is a not-for-profit organization located in Shediac, New Brunswick. The SBWA was founded in 1999 as a result of growing concerns among residents from various local communities over the ecological health of the Shediac Bay. A Board of Directors, representing the various communities found within the 420 km2 watershed boundaries of the Shediac Bay, oversees its activities. The Association deals with issues related to water quality and habitat integrity.

According to the Canadian Wildlife Federation (CWF), freshwater mussels are now among the most endangered freshwater invertebrates in the world. According to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 13 out of the 55 species of unionids in Canada are endangered, two are threatened and three are of Special Concern. The Brook Floater (Alasmidonta varicosa), is a medium-sized freshwater mussel that was found in scattered regions of New Brunswick, Nova Scotia and certain regions of the East Coast of USA. The population of this mussel was not abundant, representing only 1-5% of total freshwater mussel populations in the areas where it was found. In 2009, it was given the status of Special Concern by COSEWIC when the species disappeared from 2 historical sites and approximately half of its known locations in the USA, leaving the Canadian populations to represent the majority of the remaining global populations of the Brook Floater. In 2013, it was added to the Species At Risk Act, Schedule 1 (SARA).

The freshwater mussel surveys outlined in this report were conducted in the two main river systems in the Shediac Bay watershed; the Shediac River, Scoudouc River and their tributaries. The Shediac River is divided in two major water arms; the northern water arm is created by the convergence of the McQuade, Weisner and Calhoun Brooks, and the southern water arm is the continuation of the Bateman Brook. The water velocity in both rivers is weak due to the gentle regional elevation (Henderson, G. 1999).

In 2005, the SBWA conducted a study on freshwater mussels within the boundaries of its watershed. The main objective was to establish the biodiversity and population status of freshwater mussels in the Shediac Bay watershed.

During the surveys in 2005, a total of 122 Brook Floaters mussels were reported to have been found throughout the Shediac River, Scoudouc River and their tributaries. In 2014, the SBWA embarked on a new freshwater mussel project containing the following objectives: reconfirm the presence of the brook floater in the watershed; assess the health of the surrounding habitat; work with landowners to create a plan of protection for its habitat. Unfortunately, the rare species was never found in 2014, 2015, 2016 and 2017, therefore the SBWA continued its work with the same objectives in 2018. According to the Management Plan for the Brook Floater prepared by *Species at Risk Act* (SARA) in 2016, the timeline for presence/absence surveys should be conducted on a 2-5 year period. \

During this past year, the knowledge acquired in the first 4 years of this project was used to prioritize the areas that needed to be surveyed. The high priority sites include the areas that were

said to contain brook floater mussels in the 2005 study, as cited in the report Caissie C., D. Audet, 2006[1] "Freshwater mussel inventories in the Shediac and Scoudouc Rivers, NB", and the areas in the lower reaches of freshwater habitats of our rivers. In addition to those historical sites, the team expanded their search by visually scanning the riverbed in all suitable habitat for the brook floater that was accessible.

A new partnership with the *Department of Fisheries and Oceans Canada* was formed in 2017 to conduct *Environmental DNA* (e-DNA) sampling for the first time, in an attempt to detect Brook Floater mussels in select sites in the watershed. The first year was a pilot project, because eDNA had never been attempted for freshwater mussels. The protocol was modified and the sampling continued in 2018.

The Association has done habitat assessment and restoration for Brook Floater habitat. The habitat assessment looked at fish passage issues around culverts near potential Brook Floater Habitat. The restoration activities focused on riparian zone reforestation and the mitigation of ATV use in river habitat.

The present report describes the work accomplished to find this rare Brook Floater mussel in the Shediac Bay watershed.

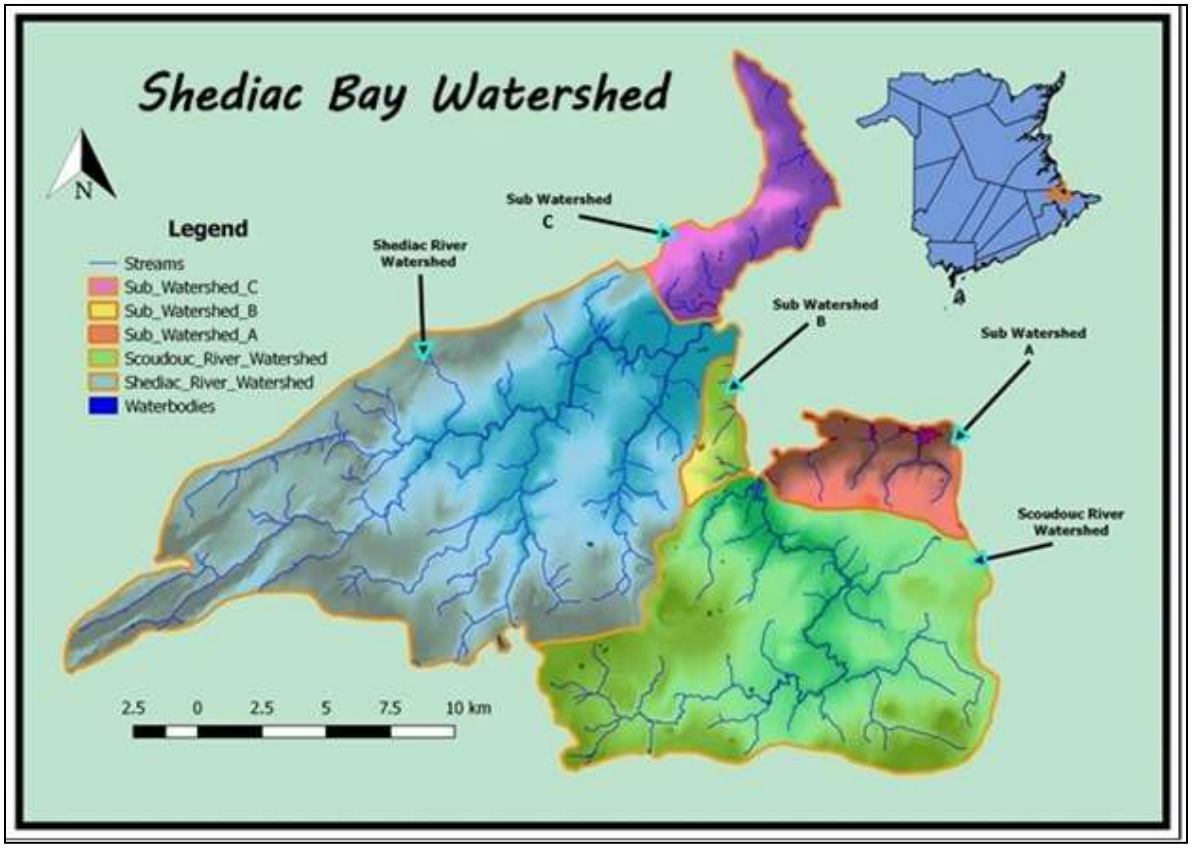

Figure 1: Map of the Shediac Bay Watershed boundaries

2. Material and Method

2.1 Sampling Protocol

The method used for the freshwater mussel inventory is the 4 hour-person Time-Search protocol, as described by Metcalfe-Smith et al. (2000) and Beaudet et al. (2002). This method consists of visually locating and counting all freshwater mussels found in a fixed and standardized amount of time. This time-based count of freshwater mussel is done on the first visit only, any following visits are search-based only.

The method was not used during the 2017 and 2018 having already collected information on other mussel species. The priority was changed to habitat search-based surveys to cover more ground and increase the chances of finding the species at risk.

During the search-based surveys, the field team walked the rivers in search of appropriate brook floater habitat. All habitats deemed suitable were thoroughly searched for the presence of the rare mussel, either by seeing the mussel on the surface of the substrate or by the detection of valves indicating a burrowed mussel.

All areas searched have been recorded using GPS coordinates at the beginning and end of each sweep. For the complete survey information in 2018, refer to Appendix A.

The protocol and materials list for the e-DNA sampling can be found in Annex 1.

2.2 Material

The equipment used to conduct the Freshwater Mussel Inventory are listed below:

- Underwater viewers
- Chest Waders
- Polarized sunglasses and hat
- Field data sheets, maps and clipboards
- GPS
- Digital Camera
- Stopwatch
- Water resistant notepads + pencils
- Water-condition instrument (YSI)
- Survey measuring tape (50m) and metre stick (1m)
- Reference documents (identification key)

3. Results and Observations

3.1 Surveys for 2018

During the spring, summer and fall 2018, 9.6 km of habitat was surveyed or searched for the presence of the rare brook floater mussel within the boundaries of the Shediac Bay watershed. Environmental DNA sampling was conducted in the highest priority locations as part of a partnership with the Department of Fisheries and Oceans. The results of the eDNA sampling can be found in section 4.

The sites surveyed and searched in the summer 2018 are based on the knowledge acquired during the freshwater mussel inventories between 2014 and 2017. The information and observations obtained in those previous years helped prioritize which sections of the Shediac and Scoudouc Rivers should be the focus of the visits in 2018.

In order to focus as much time as possible to finding the rare brook floater, the SBWA field team conducted habitat searches only in 2018. These were done by walking various accessible parts of the watershed looking for brook floater mussels in suitable habitats. Those areas were visually scanned for the mussels, and underwater viewers were used as a visual aid tool when needed. Observations and measurements of the habitats were taken: water quality data (temp., DO, pH, salinity); substrate characterization; depths/width/flow speed; signs of erosion; land uses; algae or other vegetation; etc. All habitat data, GPS coordinates, and other information noted on the field sheets can be found in Appendix A. As requested by the NB Museum, freshwater mussel specimens were collected and submitted to the museum as vouchers. A freshwater mussel collection permit was acquired under Section 52 of the Fishery Regulations for scientific purposes (Licence No. SG-RHQ-18-086).

Determining site ID codes has been based on historical water quality monitoring sites in the Shediac Bay watershed, plus the addition of a numerical or alphabetical value depending on the direction of the survey from the access point. For example, the site ShdG is accessed from the St-Philippe road. If a survey or search is conducted upstream of the bridge, the site will be identified by an alphabetical value; ShdG-A. If the team goes downstream of the access point, the code is given a numerical value; ShdG-1. Subsequent surveys or searches will be identified with the next numerical or alphabetical values.

Figure 2: Map of total freshwater mussel surveys in the Shediac River for 2018

Figure 3 Map of total freshwater mussel surveys in the Scoudouc River for 2018

Table 1: Results of Habitat-Search freshwater mussels' surveys in the Shediac and Scoudouc Rivers, 2018 with GPS coordinates

Site ID		Start		End	
	Distance (m)	Latitude	Longitude	Latitude	Longitude
ShdE-A	211	N46°14'42.59"	W64°39'53.17"	N46°14'40.7"	W64°40'02.1"
ShdE-B	305	N46°14'40.7"	W64°40'02.1"	N46°14'40.7"	W64°40'15.9"
ShdI-A	348	N46°14'42.00"	W64°39'16.40"	N46°14'31.20"	W64°39'18.50"
ShdI-B & C	577	N46°14'33.17"	W64°39'17.76"	N46°14'29.84"	W64°39'36.33"
ShdE-1 & 2	366	N46°14'40.55"	W64°39'43.29"	N46°14'29.87"	W64°39'36.33"
ShdG-1	1276	N46°12'53.98"	W64°40'29.42"	N46°13'29.29"	W64°40'16.05"
ShdL-A	808	N46°12'32.71"	W64°41'37.57"	N46°12'18.50"	W64°41'55.10"
ShdD-1	315	N46°14'25.6"	W64°41'27.00"	N46°14'25.6"	W64°41'13.6"
ShdD-2	647	N46°14'25.6"	W64°41'13.6"	N46°14'23.3"	W64°40'56.3"
ShdD-A	1115	N46°14'12.83"	W64°41'59.48"	N46°14'15.85"	W64°41'22.41"
ShdM-A	196	N46°12'27.49"	W64°40'21.05"	N46°12'21.53"	W64°40'18.82"
ShdN-A	1115	N46°14'12.82"	W64°41'58.44"	N46°14'13.44"	W64°42'43.33"
ShdE-2A	247	N46°14'30.07"	W64°39'36.97"	N46°14'24.55"	W64°39'45.68"
ShdG-A	830	N46°12'51.37"	W64°40'29.96"	N46°12'28.17"	W64°40'21.33"
ShdE-2B	669	N46°14'24.84"	W64°39'45.57"	N46°14'10.37"	W64°40'4.48"
Total Shediac	**9025**				
ScdD-A	266	N46°11'38.67"	W64°31'23.29"	N46°11'37.7"	W64°31'11.4"
ScdD-B	336	N46°11'39.08"	W64°31'24.72"	N46°11'37.6"	W64°31'09.7"
Total Scoudouc	**602**				
Total distance surveyed	**9627**				

3.2 Freshwater Mussel Inventory in Shediac River 2018- Site Description

In the Shediac River, a total of 19 sites were searched for the Brook Floater in 2018. A total of 9.0 km of the river and its tributaries were scanned for habitats containing freshwater mussels, and these habitats were thoroughly searched for Brook Floater mussels. Site descriptions and information are described below.

Given that the Shediac River is the most important river where Brook Floaters were reported in the 2006 report[1], the majority of the work was done within the main branch and the tributaries of the Shediac River. All areas where the Brook Floater was reported to have been found, at six sites in the Shediac River, are considered high priority sites.

3.2.1 Shd D

This site was accessed by walking down a trail located behind a private property (986 Shediac River Road), for which we received land owner permission to use. This area can also be accessed via an ATV trail connected to the Shediac River Rd. (N46°13'49.12" W64°41'48.19"), further upstream. ShdD is located upstream from site ShdE; the area searched here connects down to the end point of ShdE-C.

The habitat upstream from the access of the private property (ShdD-A), is a beautiful site for freshwater mussels; a mix of mostly rubble, gravel and sand. Water levels ranged from 25-50 cm in depth, and is perfectly clear giving great visibility of the riverbed. There are multiple sand bars along ShdD-A, and they were carefully inspected for visible valves of burrowed mussels. The habitat is rich in common freshwater mussels; count surveys were done in previous years but not in 2017. This area was of high priority; 30 brook floater mussels were reported to have been found in this area in the 2006 report[1]. This area was visited twice in the season.

The habitat downstream (ShdD-1&2) had long stretches of bare bedrock. Therefore, there was a lot of walking involved in order to reach habitat that contained a more favourable substrate. However, the habitats that were searched contained larger cobble and rocks, and did not have many freshwater mussels. No counts were taken, the purpose of this sweep was a search for freshwater mussel habitat and for the Brook Floater mussel. This area was visited once in the season and 3 eDNA samples were collected.

The total area searched for ShdD is 2,077 m, with average stream width of 10 metres gives a total of 20,770 m^2. For more information on freshwater mussel surveys refer to Appendix A.

Figure 4: Site photos of ShdD-A survey site, upstream view (left), downstream view (right)

Figure 5: Site photos of ShdD-1 survey site, upstream view (left), downstream view (right)

Figure 6: Site photos of ShdD-2 survey site, upstream view (left), downstream view (right)

Figure 7: Map of site of the total search area for ShdD, 2018

3.2.1 Shd E

This site is also in the main branch of the Shediac River, located at the covered bridge on Shediac River Rd. This area is a priority because of the substrate/habitat type, and that it is located in the lower reaches of the freshwater habitat of the Shediac River, even though no brook floaters were reported here in the 2006 report[1].

The habitat at the covered bridge going upstream (ShdE-A,B) is excellent for freshwater mussels; rubble, gravel and sandy substrate; clear water of an average depth of 35 cm; low water velocity and very wide (average width of 12 m). The riverbanks were also searched for Brook Floater shells during the return trips back to the covered bridge.

The substrate downstream of the covered bridge towards the Shediac River rd. bridge is mainly bedrock and boulders. Therefore, in 2016-2018, the site ShdE-1 begins downstream of the Shediac River Road's bridge. The substrate at the beginning of ShdE-1 is mostly large flat rocks, and doesn't contain more than a few freshwater mussels. The habitat begins to transform approximately halfway through this site, to more favourable substrate; rubble, gravel and sand. Two eDNA samples were collected in this area.

Along the section of ShdE-2, there is the convergence of the Weisner brook to the Shediac River. This section at the lowest point of the Weisner Brook was identified as ShdE-2A, as the site ShdE-2 is used as an access point. This area is densely forested and has great canopy coverage. The water of this brook is significantly cooler, even in the heights of the summer months. This area is an

excellent source of cold water, creating an important habitat for fish looking to migrate to avoid thermal stress. The riparian zones have healthy buffer zone but have some areas with high bank erosion. The substrate along ShdE-2A&B consists of rock, rubble, gravel and sand, which are suitable characteristics for freshwater mussels. No count was taken but there were possibly thousands of Eastern Pearlshells.

The total area searched for ShdE (A, B, 1, 2) is 882 m with an average stream width of 12 metres gives a total of 10,584 m^2. The total area searched for ShdE-2A&B is 916 m, with an average stream width of 8 metres gives a total of 7,328 m^2. For more information on freshwater mussel surveys refer to Appendix A.

Figure 8: Site photos of ShdE-A survey site, upstream view (left), downstream view (right)

Figure 9: Site photos of ShdE-B survey site, upstream view (left), downstream view (right)

Figure 10: Site photos of ShdE-C survey site, upstream view (left), downstream view (right)

Figure 11: Site photos of ShdE-1 survey site, upstream view (left), downstream view (right)

Figure 12: Site photos of ShdE-2 survey site, upstream view (left), downstream view (right)

Figure 13: Site photos of ShdE-2A survey site, upstream view (left), downstream view (right)

Figure 14: Site photos of ShdE-2B survey site, upstream view (left), downstream view (right)

Figure 15: Map of site of the total search area for ShdE-A & B, 2018

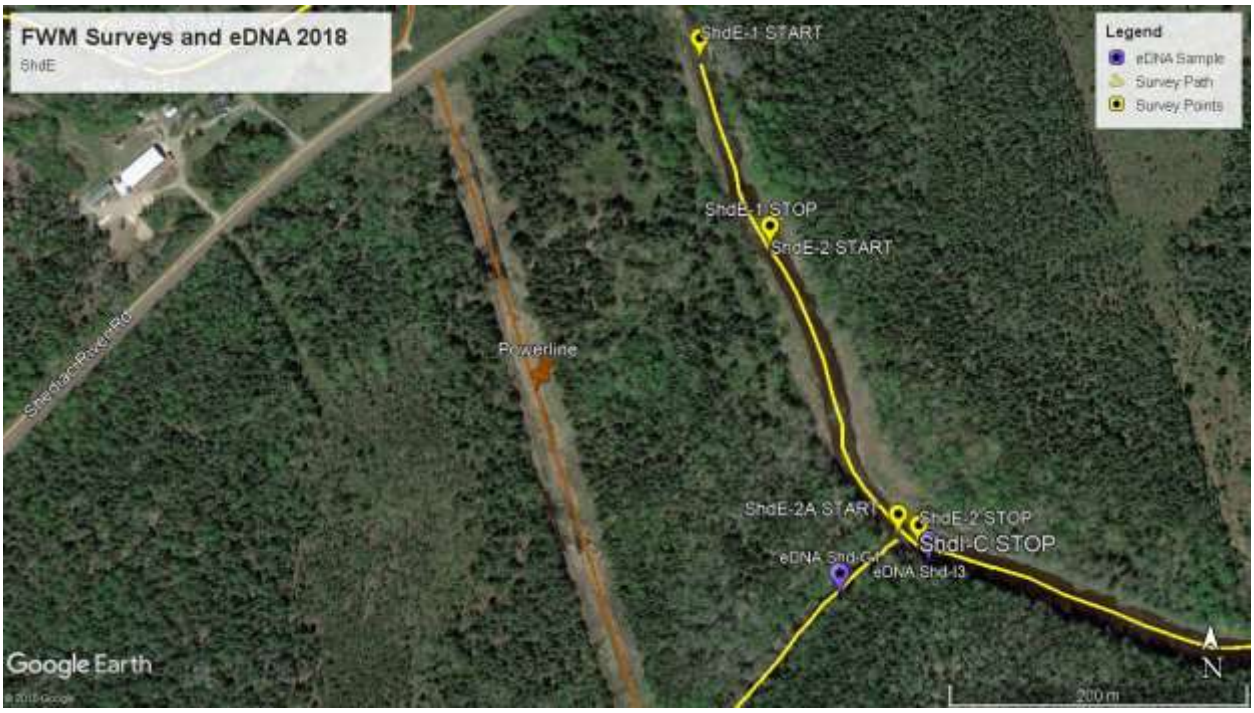

Figure 16: Map of site of the total search area for ShdE-1 & 2, 2018

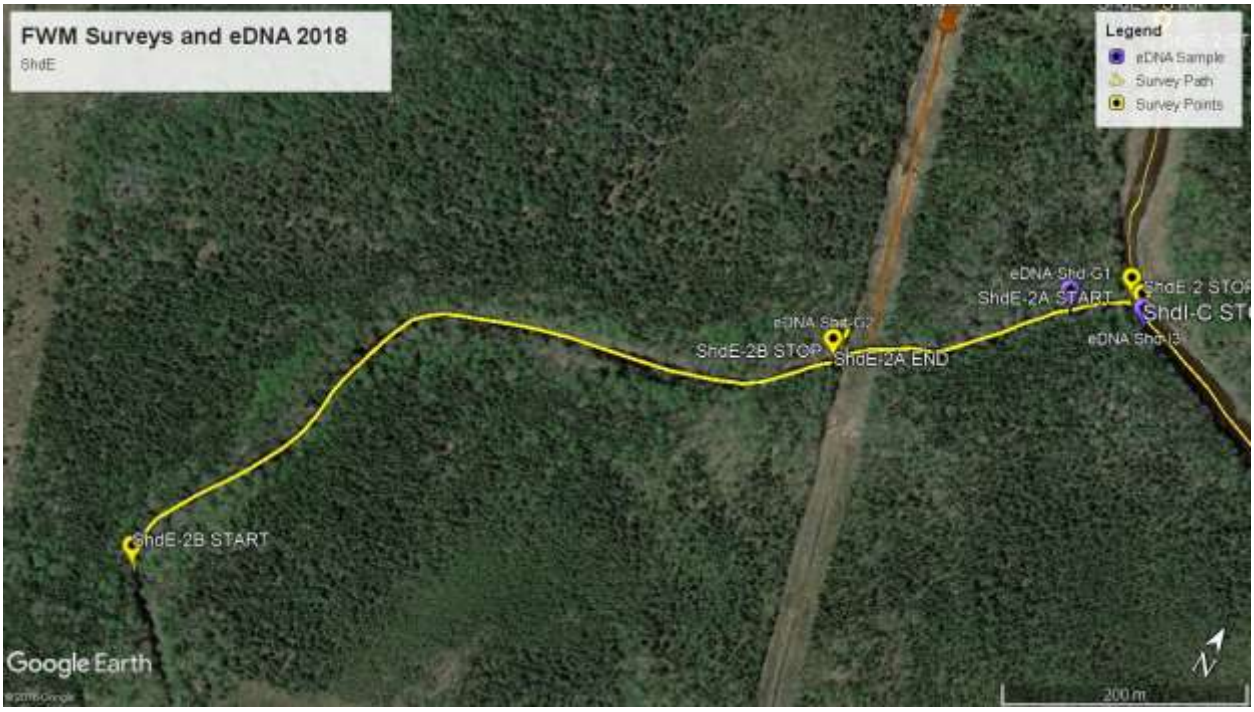

Figure 17: Map of site of the total search area for ShdE-2A, 2018

3.2.2 ShdG

This site is located at the bridge on St-Philippe Road, in the Weisner Brook. An extensive search was conducted upstream and downstream.

The habitat upstream (ShdG-A) has been modified by the presence of a beaver dam, which is located directly underneath the bridge. The habitat upstream has higher water levels and the substrate contains fine sediments over the substrate, with some rocks. The entire section of the Weisner Brook (830 m) upstream from the St-Philippe road up to the next bridge on Bateman Mill Rd (ShdG-A to ShdM-1), was searched for mussel habitat. There are 6 beaver dams along this brook, making the majority of the stream modified with high water levels and sediment. The substrate in the remaining sections is mostly bedrock, with some rubble and gravel. Only one area contained enough of a gravel substrate to be suitable for Brook Floater mussels. This area was inspected but only Eastern pearlshell mussels were seen. Two eDNA samples were collected in this area.

An extensive search was also done downstream of the Weisner Road Bridge (ShdG-1); as it has better substrate conditions and more freshwater mussel habitat. A total 1,276 m was searched.

The total area searched for ShdG is 2,106 m, with average stream width of 4.5 metres (9,477 m^2). For more information on freshwater mussel surveys refer to Appendix A.

Figure 18: Site photos of ShdG-A survey site, upstream view (left), downstream view (right)

Figure 19: Site photos of ShdG-1 survey site, upstream view (left), downstream view (right)

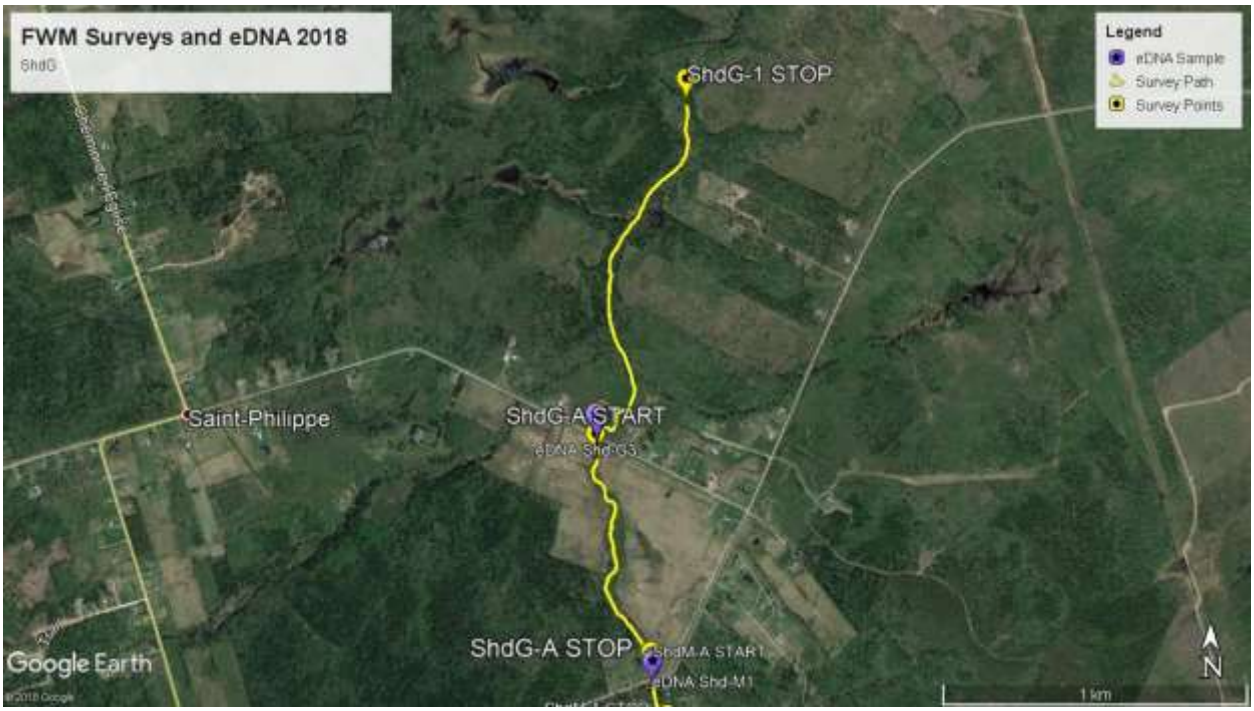

Figure 20: Map of site of the total search area for ShdG, 2018

3.2.1 Shd I

Located directly in the Shediac River, this site used to be accessed by walking down an ATV trail connecting to the Shediac River Rd, but this property has been purchased and a new home was built. An attempt was made to contact the landowners but they were not home at during those attempts. The next property was approached and the landowners gave the SBWA permission to park in their driveway and access the river.

This section of the Shediac River, a short distance from the highest tidal zone, has excellent habitat for freshwater mussels: medium to low water levels, and the substrate consists of rocks, rubble, gravel and sand. This site begins where the habitat transforms from brackish waters to freshwater habitat, and where the common *margaritifera* mussels begin to appear.

This site is the beginning of the high priority area, being the lowest reach of the Shediac River's freshwater habitat. This priority area extends from ShdI to the Covered Bridge and beyond, to ShdD. The site ShdI-A was reported to have 4 brook floaters mussels in the 2005 surveys[1]. Three eDNA samples were collected in this area.

The total area searched for ShdI is 925 m, with average stream width of 12 metres (11,110 m^2). For more information on freshwater mussel surveys refer to Appendix A.

Figure 21: Site photos of ShdI-A survey site, upstream view (left), downstream view (right)

Figure 22: Map of site of the total search area for ShdI, 2018

3.2.2 Shd J

This site is located at the bridge on Lemenager Road, off Shediac River Road. It is located in the lower reach of the Shediac River, and the habitat is tidal and brackish water. The habitat here is not suitable for freshwater mussels; it is an eDNA sampling site only. The Department of Fisheries and Oceans requested a saltwater site for one of the samples to test their protocol. One eDNA sample was collected below the bridge.

Figure 23: eDNA sample location for ShdJ, 2018

3.2.1 Shd L

This site is situated in the Calhoun Brook, accessed on Weisner Rd., at the bridge that is nearest to St-Philippe Rd. This site was of low priority because no Brook Floaters was found here, but the stream was searched upstream due to the habitat characteristics.

Upstream of the bridge (ShdL-A), the beginning of the habitat is in a residential area with very little vegetation in the buffer zone due to lawn mowing close to the stream. There is fine sediment covering the substrate in this area, and sediment loads impacting the area immediately downstream of the bridge. Once past the residential area upstream, the habitat becomes healthier and more favourable to freshwater mussels; a substrate containing rocks, rubble, gravel, and sand, with some sections of bare bedrock. The average width of the stream was approximately 5 metres, with water depths ranging from 20-50 cm. There were some areas where erosion was noted, and also some areas that had significant green algae growth. Two eDNA samples were collected in this area.

The total area searched for ShdL is 808 m, with average stream width of 5 metres gives a total of 4,040 m^2. For more information on freshwater mussel surveys refer to Appendix A.

Figure 24: Site photos for ShdL-A, upstream view (left), downstream view (right)

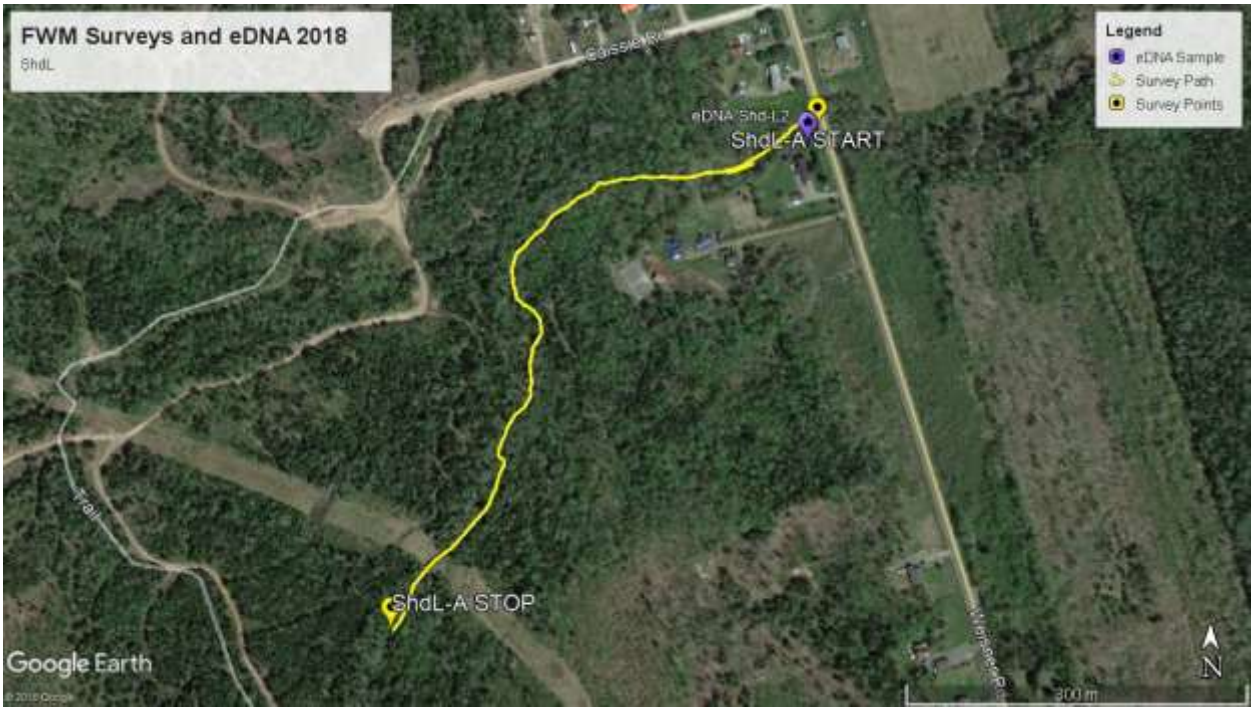

Figure 25: Map of site of the total search area for ShdL, 2018

3.2.2 Shd M

Located on Bateman Mill Rd., at the bridge where the Weisner Brook crosses the road. This area upstream of the bridge (ShdM-A), was high priority as there was 27 Brook Floaters reported in the 2006 report[1] (ShdM-A). The site was thoroughly searched in 2014, 2015, 2016, 2017, and 2018, but no signs of Brook Floater mussels were found.

The habitat upstream (ShdM-A) is in good condition, the substrate composed of mostly rocks and sand with good vegetation cover along the banks. However, there is some erosion nearby on a riverfront property owner's land, due to a lack of vegetation. That area would be a good place to create stewardship with the landowner for erosion control. There are a lot of common mussels here. Two eDNA samples were collected in this area.

The total area searched for ShdM is 196 m, with average stream width of 7 metres gives a total of 1,372 m^2. For more information on freshwater mussel surveys refer to Appendix A.

Figure 26: Site photos of ShdM-A survey site, upstream view (left), downstream view (right)

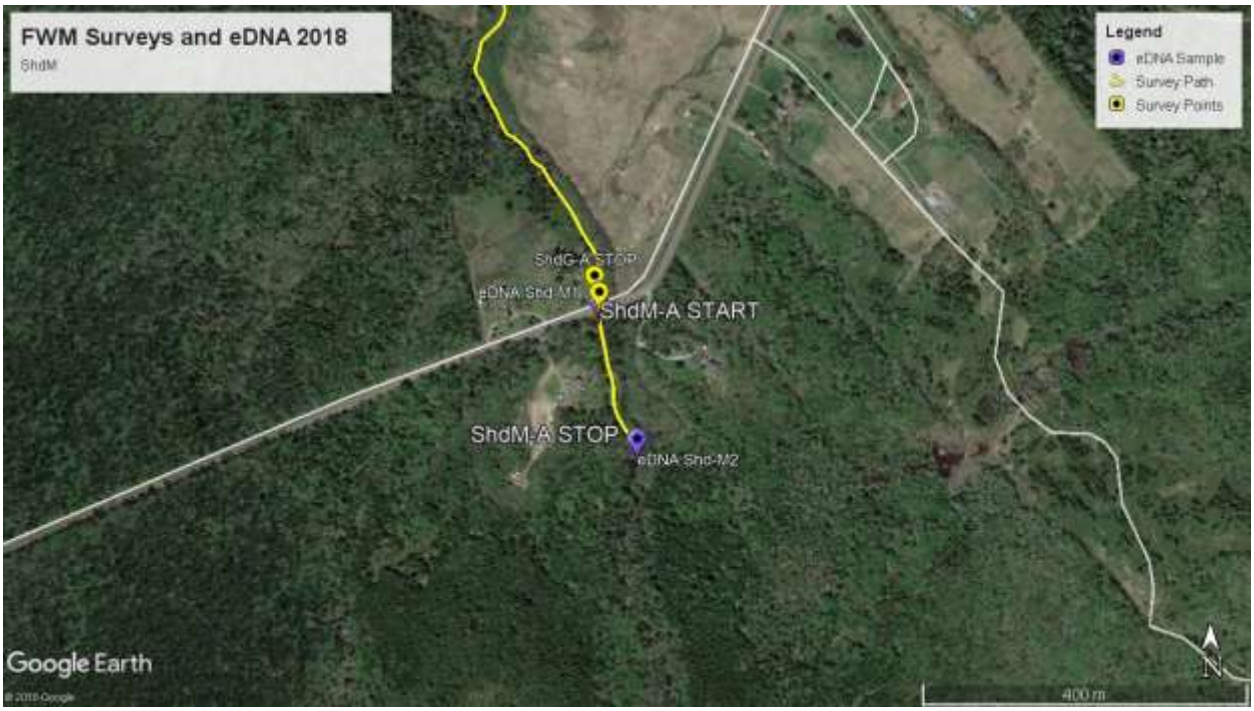

Figure 27: Map of site of the total search area for ShdM, 2018

3.2.3 Shd N

This site is further upstream of site Shd D, and it is a more difficult place to access due to the lack of roads nearby. There are two access points; a public ATV trail accessed off Shediac River Road (N46°13'49.21" W64°41'48.17"), and a private path (N46°13'57.24" W64°42'19.58"), behind the house at 846 Shediac River rd. depicted on the site map. The landowners were very nice to let us park in their driveway and use the path to the river in 2016. This year, the ATV trail was used, and the team walked to the private trail and began the survey from there, making their way back to the ATV trail.

The site ShdN-A has is comprised of rocks, rubble, gravel and sand. There is good habitat for freshwater mussels. The area around the private path (where it meets the river) has severe erosion along the meandering bank, in addition to more erosion along the site. Water levels were quite low, on average 10-20 cm, with moderate flow. Three eDNA samples were collected in this area.

The total area searched for ShdN is 1,115 m, with average stream width of 8 metres gives a total of 5,280 m^2. For more information on freshwater mussel surveys refer to Appendix A.

Figure 28: Site photos of ShdN-1 survey site, upstream view (left), downstream view (right)

Figure 29: Site photos of ShdN-2 survey site, upstream view (left), downstream view (right)

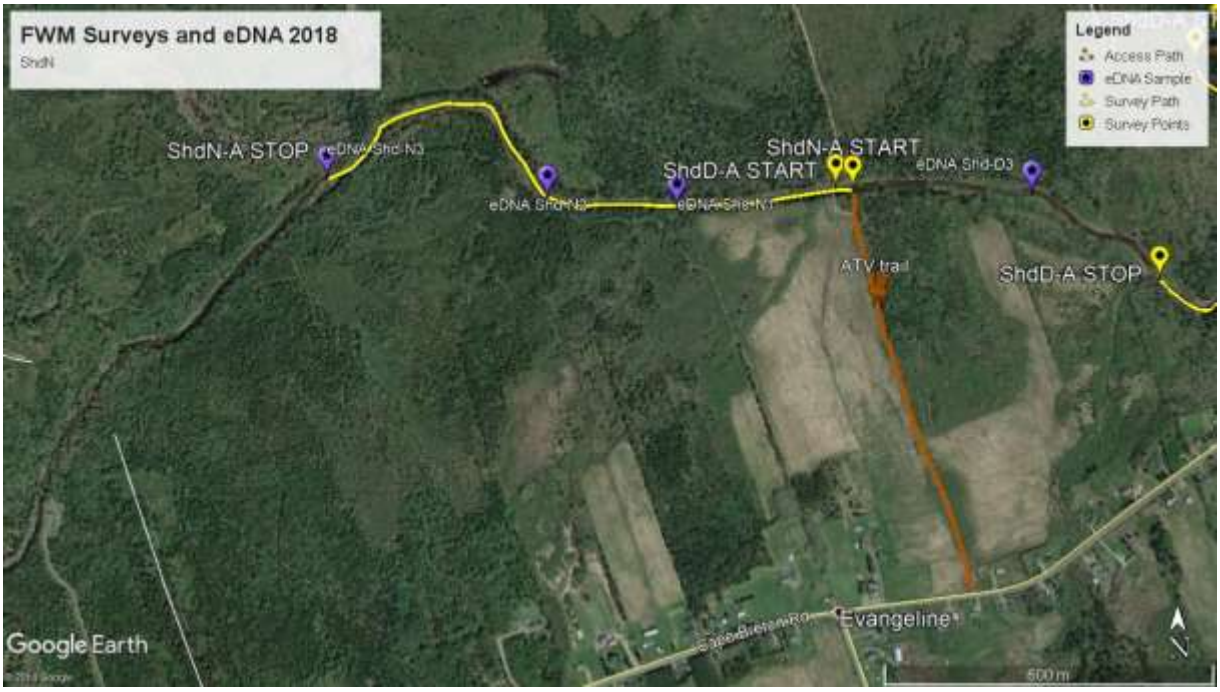

Figure 30: Map of site of the total search area for ShdN, 2018

3.3 Freshwater Mussel Inventory in Scoudouc River 2018 – Site Description

In the Scoudouc River, only one area was searched for the Brook Floater mussel in 2018. Environmental DNA samples were collected in 2 areas to help determine priority areas to search in the future.

The Scoudouc River is of lower priority for the Brook Floater mussel; only 19 brook floaters were reported to have been found in 2005, in a higher section of the river (ScdI=1 BF and ScdA=18 BF). Those sites are difficult to access, requiring an ATV to get there. In 2014 and 2015, the site ScdI was thoroughly searched, and the site ScdA, a small tributary adjacent to ScdI, was discovered to be very difficult to survey. It was determined that the site was modified by beaver activity; beaver dams were observed and the habitat was compared with the site photos and the habitat descriptions from the 2006 report[1]. The team attempted to search the brook for freshwater mussels, but had great difficulty. The water was concentrated in red tannins making the visibility of the riverbed extremely poor. Fine sediments covered the substrate, creating clouds of sediment obstructing the visibility with every step. Also, the brook had an abundance of large aquatic plants that were hiding freshwater mussels. It is possible that in 2005, the brook was in much better condition for freshwater mussels surveying, and they were able to discover the 18 Brook Floaters. Due to the current conditions of the habitat, the team did not attempt to return.

Another problem with the Scoudouc River is a lack of access points to suitable freshwater mussel habitat. Therefore, the team focused their efforts in the lower reaches of the river, where there are some access points to freshwater mussel habitat, and may have better luck finding brook floaters that would have moved downstream.

Figure 31: Photos of Eastern Elliptio (*Elliptio complanata*) mussels found in the Scoudouc River

3.3.1 Scd D

This site is located where freshwater habitat begins in the Scoudouc River. It was accessed by Red Bridge Road off Route NB-132 (Scoudouc Road). Once at the end of the paved road, it transitions to a dirt road that follows the power lines down to the river.

The habitat suitable for freshwater mussels begins a short distance away from the access point. The substrate is comprised of a mix of rocks, rubble, and sand, with some sections of bedrock. The riparian zone is healthy without any sign of severe erosion (mild natural erosion), and has good mixed forest vegetation on both sides. In addition to the common Eastern Pearlshell mussel (*Maragaritifera margaritifera*), there is a second species commonly found in the Scoudouc River; the Eastern Elliptio mussel (*Elliptio complanata*).

The river is very wide here, and is very rich with 2 species of freshwater mussels. Therefore, a lot of time is needed to conduct a survey when a species count is needed, as each mussel needs to be examined so that they were properly identified. The two species looks very similar and require training to note the differences the characteristics of the shells.

The site ScdD was visited twice in 2018; the first survey was a training session for the summer students, and the second was a focused habitat search. Despite having these two species prominently found in the Scoudouc River, no other species have been found during the surveys of 2014, 2015, 2016, 2017 or 2018.

The total area searched for ScdD is 602 m, with average stream width of 16 metres gives a total of 9,632 m^2. For more information on freshwater mussel surveys refer to Appendix A.

Figure 32: Site photos of ScdD-A survey site, upstream view (left), downstream view (right)

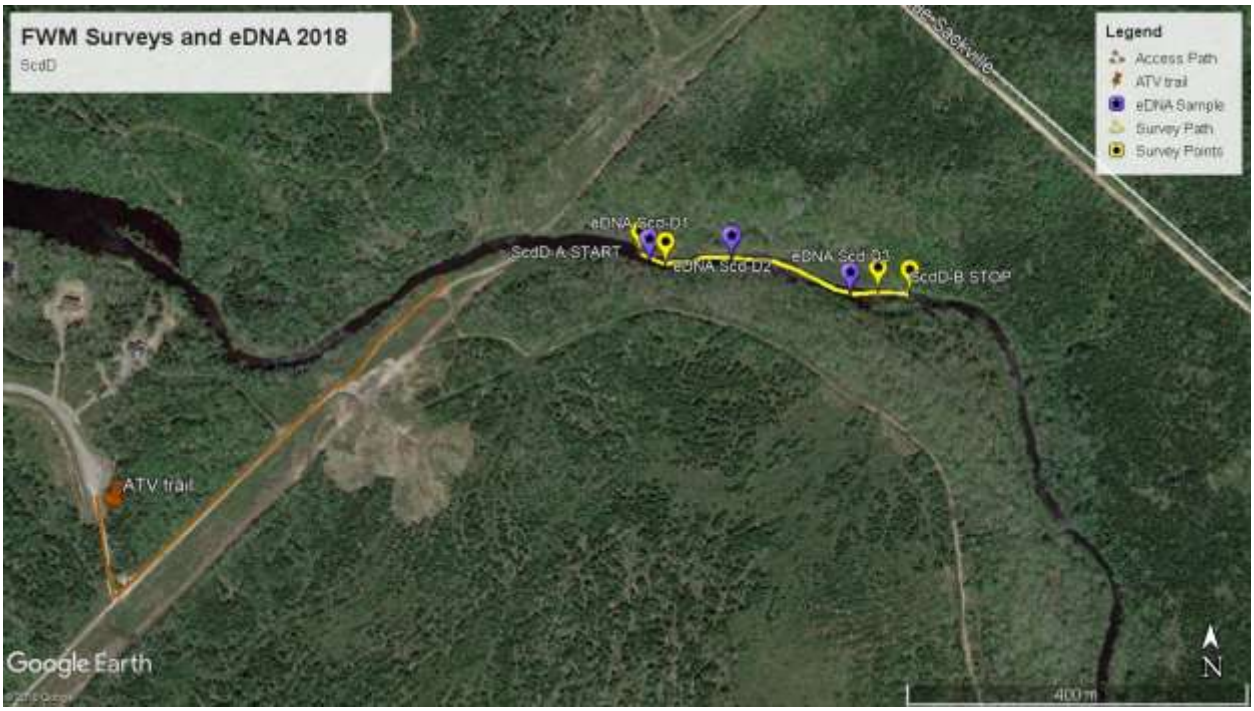

Figure 33: Map of site of the total search area and eDNA sampling for ScdD, 2018

3.3.2 ScdF

This site is located upstream of ScdD in the main branch of the Scoudouc River. It was accessed by taking Pellerin Rd., a dirt road off Lino rd. in Shediac. On Google maps, this road is labelled as Sackville rd. Approximately 15 min down this road, there is an ATV trail (N46°11'5.02" W64°30'27.83") that goes down to the river, which is about a 5 min walk.

The habitat here, going downstream (ScdF-1) was surveyed in 2016 and was found not to be suitable for freshwater mussels; the substrate is comprised mostly of large flat rocks and boulders. There were no mussels seen during that survey, and at the time, the water was too deep for wading upstream (ScdF-A). In September of 2017, water levels were low enough to allow the team to walk upstream and observed freshwater mussels with underwater viewers. The water was still too deep to be able to pick up and identify the freshwater mussels. In 2018, eDNA samples were collected at this location in the hopes that it would detect a positive signal from Brook Floater mussels upstream. No additional searches were done considering the difficulties and safety conditions from previous years. This area is still a good access point to freshwater mussel habitat in the Scoudouc River.

Figure 34: Site photos of access site ScdF-A survey site, upstream view (left), downstream view (right)

Figure 35: Map of site of the eDNA sampling for ScdF, 2018

4. eDNA Results

In partnership with the *Department of Fisheries and Oceans Canada*, the sampling to detect Brook Floater with *Environmental DNA* sampling eDNA was continued. The purpose of this sampling is to attempt to detect the species at risk by traces of its DNA in the river systems, coming from its reproductive materials (sperm, glochidia), excrements, etc. Five sites were sampled on two occasions; the first sampling was done on June 16, and the second on August 25. The protocol can be found in Annex 1.

Ten sites were sampled between August 13th and August 24th with two to three samples taken per site. A control blank was used on 5 sites to measure the effectiveness of the decontamination process. A sample was also taken on a salt water site (Shd J) for testing purpose.

The site Shd-N had a trace of the Brook Floater mussel detected during this study. The signal is considered inconclusive but is comparable to other sites that have confirmed Brook Floater presence. This site is not easily accessible and has not been extensively surveyed. The area will be identified as a priority zone for 2019 surveys.

The following tables give the coordinates for the eDNA sampling and the results that were sent by DFO.

Table 2: eDNA site information for the Shediac Bay watershed, 2018

Collection Date	Sample Info	Waterbody	Latitude	Longitude
08/13/2018	Scd D-1	Scoudouc River	N 46°11'38.78"	W64°31'24.19"
08/13/2018	Scd D-2	Scoudouc River	N 46°11'38.92"	W64°31'19.60"
08/13/2018	Scd D-3	Scoudouc River	N 46°11'37.51"	W64°31'12.97"
08/13/2018	Scd D-Blank	Control Blank	N 46°11'39.01"	W64°31'24.21"
08/14/2018	Shd D-1	Shediac River	N 46°14'15.85"	W64°41'22.41"
08/14/2018	Shd D-2	Shediac River	N 46°14'7.86"	W64°41'25.69"
08/14/2018	Shd D-3	Shediac River	N 46°14'12.56"	W64°41'43.02"
08/14/2018	Shd D-Blank	Control Blank	N 46°14'12.38"	W64°41'42.87"
08/15/2018	Shd M-1	Weisner Brook	N 46°12'27.22"	W64°40'21.11"
08/15/2018	Shd M-2	Weisner Brook	N 46°12'21.53"	W64°40'18.82"
08/15/2018	Shd M-Blank	Control Blank	N 46°12'27.03"	W64°40'20.87"
08/17/2018	Shd N-1	Shediac River	N 46°14'11.74"	W64°42'13.41"
08/17/2018	Shd N-2	Shediac River	N 46°14'12.25"	W64°42'24.47"
08/17/2018	Shd N-3	Shediac River	N 46°14'13.44"	W64°42'43.33"
08/17/2018	Shd N-Blank	Control Blank	N 46°14'11.74"	W64°42'13.41"
08/21/2018	Shd E-1	Shediac River	N 46°14'42.22"	W64°39'53.23"
08/21/2018	Shd E-2	Shediac River	N 46°14'40.14"	W64°40'0.98"
08/21/2018	Shd E-Blank	Control Blank	N 46°14'42.24"	W64°39'53.31"
08/21/2018	Shd G-1	Weisner Brook	N 46°14'28.85"	W64°39'38.95"
08/21/2018	Shd G-2	Weisner Brook	n 46°14'24.55"	w64°39'45.68"
08/21/2018	Shd I-3	Shediac River	N 46°14'29.51"	W64°39'36.05"
08/21/2018	Shd G -Blank	Control Blank	N 46°12'53.03"	W64°40'29.71"
08/21/2018	Shd I-1	Shediac River	N 46°14'42.26"	W64°39'16.61"
08/21/2018	Shd I-2	Shediac River	N 46°14'33.79"	W64°39'17.53"
08/23/2018	Shd L-1	Shediac River	N 46°12'57.32"	W64°40'41.67"
08/23/2018	Shd L-2	Shediac River	N 46°12'32.30"	W64°41'37.95"
08/23/2018	Shd J-1	Calhoun Brook	N 46°15'44.20"	W64°38'37.98"
08/23/2018	Shd G-3	Weisner Brook	N 46°12'52.93"	W64°40'29.71"
08/24/2018	Scd F-1	Scoudouc River	N 46°11'1.24"	W64°30'37.87"
08/24/2018	Scd F-2	Scoudouc River	N 46°10'57.52"	W64°30'40.68"

Table 3: e-DNA sampling results 2018, *Department of Fisheries and Oceans Canada*

Collection Date	DFO ID	Tube ID	Sample Info	qPCR Brook Floater (A. varicosa)	qPCR Eastern pearlshell (M.margaritifera)
2018-08-13	r18D:2863	2018-39	Scd D-1	Not detected	32.39
2018-08-13	r18D:2864	2018-40	Scd D-3	Not detected	29.81
2018-08-13	r18D:2865	2018-41	Scd D-Blank	Not detected	33.96
2018-08-14	r18D:2866	2018-42	Shd D-1	Not detected	27.68
2018-08-14	r18D:2867	2018-43	Shd D-2	Not detected	28.89
2018-08-14	r18D:2868	2018-44	Shd D-3	Not detected	28.81
2018-08-14	r18D:2869	2018-45	Shd D-Blank	Not detected	34.29
2018-08-15	r18D:2870	2018-46	Shd M-1	Not detected	27.01
2018-08-15	r18D:2871	2018-47	Shd M-2	Not detected	25.59
2018-08-15	r18D:2872	2018-48	Shd M-Blank	Not detected	32.16
2018-08-17	r18D:2873	2018-49	Shd N-1	Not detected	28.62
2018-08-17	r18D:2874	2018-50	Shd N-2	38.23	27.43
2018-08-17	r18D:2875	2018-51	Shd N-3	Not detected	27.67
2018-08-17	r18D:2876	2018-52	Shd N-Blank	Not detected	Not detected
2018-08-21	r18D:2877	2018-53	Shd E-1	Not detected	27.55
2018-08-21	r18D:2878	2018-54	Shd E-2	Not detected	26.92
2018-08-21	r18D:2879	2018-55	Shd E-Blank	Not detected	Not detected
2018-08-21	r18D:2880	2018-56	Shd G-1	Not detected	26.43
2018-08-21	r18D:2881	2018-57	Shd G-2	Not detected	26.84
2018-08-21	r18D:2882	2018-58	Shd I-3	Not detected	27.18
2018-08-21	r18D:2884	2018-59	Shd G -Blank	Not detected	Not detected
2018-08-21	r18D:2885	2018-60	Shd I-1	Not detected	26.76
2018-08-21	r18D:2886	2018-61	Shd I-2	Not detected	26.04
2018-08-23	r18D:2887	2018-62	Shd L-1	Not detected	28.19
2018-08-13	r18D:2888	2018-63	Scd D-2	Not detected	28.84
2018-08-23	r18D:2889	2018-64	Shd L-2	Not detected	27.53
2018-08-23	r18D:2890	2018-65	Shd J-1	Not detected	30.93
2018-08-23	r18D:2891	2018-66	Shd G-3	Not detected	26.73
2018-08-24	r18D:2892	2018-67	Scd F-1	Not detected	29.16
2018-08-24	r18D:2893	2018-68	Scd F-2	Not detected	30.13

* Filtrations done using 1000 mL of water and 0.8 uM nylon filters
* Brook Floater LOD = 36.97
* Eastern pearlshell LOD = 36.83

4.1 Project Summary

The following table summarizes the total distances searched for the brook floater mussel and its habitat over the 2018 field sessions, adding up to approximately 9.6 km. All of those locations have been visited several times over the past 4 years since the beginning of this project. A total of 24 eDNA samples were collected for DFO.

Table 4: Total search distances and surface area, # of eDNA samples collected for the Shediac and Scoudouc River in 2018

Site ID	Distances Searched (m)	Total Surface Area (m^2)	# eDNA samples collected
Shd D	2,077	20,770	3
Shd E	882	10,584	2
ShdE-2	916	7,328	2
Shd G	2,106	9,477	1
Shd I	925	11,110	3
Shd J	-	-	1
Shd L	808	4,040	2
Shd M	196	1,372	2
Shd N	1,115	8,920	3
ScdD	602	9632	3
ScdF	-	-	2
Total	**9, 627 m**	**83,233 m^2**	**24**

4.2 Discussion

As previously mentioned, the purpose of this project was to re-confirm the presence of Brook Floater (*Alasmidonta varicosa*) in the Shediac Bay watershed, based on the finding of the report *Freshwater Mussel Inventory in the Shediac and Scoudouc Rivers, New Brunswick* (Caissie C., and D. Audet 2006). After thoroughly searching all sites where the rare brook floater mussel was reported to be found in 2005, on multiple occasion during these past 4 years of reproducing the project, no brook floater mussels nor shells of the species were found in the Shediac Bay Watershed.

When adding up the distances searched from all the sites in the Shediac and Scoudouc Rivers in 2018, we get an approximate of 10 km of watercourse habitat that was scanned for the species at risk. All high priority areas, which are based on habitat characteristics and whether or not the brook floater was reported there in the 2006 report[1], were visited multiple times during different seasons in the past 4 years. These visits during the changing seasons are to account for varying factors that may cause burrowed mussels to rise to the surface of the substrate, where they could finally be spotted. According to recent studies, as much as 30-80% of freshwater mussels may be buried (*COSEWIC* 2009). Schwalb and Pusch (2007) found that up to 75% of a mussel population that is buried varies with discharge volumes of the river, day length, water temperature and possibly the mussel's reproductive cycle. This is also the reason why the SBWA has been encouraged to embark on a multi-year project to confirm the presence of the brook floater mussel in our watershed. The timeline for undertaking presence/absence surveys is 2-5 years (*Management Plan for the Brook Floater in Canada, SARA 2016*).

Most of the work in the past 5 years was conducted in the Shediac River for two main reasons: the large majority of the Brook Floater mussels in the 2006 report[1] were found in the Shediac River; there is more suitable freshwater mussel habitat and more access points to those suitable habitats than in the Scoudouc River. The Scoudouc River proved to be difficult to access, requiring the use of an ATV or landowner's permission of access through their properties. The Shediac River had a total 103 brook floater mussels found during the 2005 surveys[1], in the mid to lower reaches of the river. The Scoudouc River has a total of 19 individuals found in the higher reaches of the river.

In the Assessment and Status Report on the Brook Floater in Canada (COSEWIC 2009), the population assessment of the Brook Floater in the Shediac River was estimated at 6,100, based on the findings of these 103 mussels. This population estimate would classify the Shediac River as one of the most important rivers for the species in New Brunswick. However, the same report describes the sources of errors of the population estimates. One source of error is that the populations are being *overestimated*, because the assumption was made that the brook floater would be continuously distributed throughout the occupied reaches of the river, when in fact they are patchily distributed in suitable habitats of sand or sandy gravel in areas of moderate flow. Although, another source of error describes that populations may be *underestimated* because surveys rely primarily on visual searches for mussels occurring at the surface of the substrate, when as mentioned above, as much as 30-80% of mussels may be buried. Another reason why populations may be *underestimated* is because the Time-Search protocol, which is commonly used in freshwater mussel surveys, does not locate all mussels present in a site or suitable habitat, they

only locate those found during the allotted amount of search time. That being said, it is extremely difficult to determine the population dynamics of the brook floater in the Shediac Bay Watershed.

Another cause for concern is regarding whether or not the Brook Floater mussels reported in the 2006 report[1] were properly identified as *Alasmidonta varicosa*. No vouchers specimens were ever submitted to the NB Museum for positive identification. Very few photos from 2005 were found in the archives of the SBWA, and the only photos on a disk named "Brook Floater 2005" that were not blurry were sent to two experts (Dwayne Sabine of DFO and Dr. Donald McAlpine, curator of the NB Museum). The two photos, showing frontal and lateral view of the mussel, were inspected by Dr. McAlpine and M. Sabine. Although identification of freshwater mussels cannot be definitive by analyzing them through photographs, both their opinions were that the lateral view of the mussel confirmed that it was not a Brook Floater, but resemble the Triangle floater (*Alasmidonta undulata*).

In addition, the only other known survey in the Shediac River that reports Brook Floaters being found is in 2002 by Kate Bredin, as cited in the report, "Assessment and status report on the Brook Floater (*Alasmidonta varicosa*) in Canada, COSEWIC. 2009." The information in this report saying that Bredin found 2 brook floaters in the Shediac River in 2002 is also likely a mistake. The ACCDC (Atlantic Canada Conservation Data Centre) was contacted during the winter 2014-2015 for the raw data of this 2002 survey. The data received indicated that 2 mussels *resembling* the brook floater were found, and they were noted as "Unidentified floaters". Yet those two *unidentified floaters* were taken as proof of the existence of the Brook Floater population in the Shediac River. Not only is there the possibility of misidentification of Brook Floater mussels in the 2006 report[1], it is also likely that the mention of Eastern Elliptio (*Elliptio complanata*) in the Shediac River is wrong. The Eastern Pearlshell and Eastern Elliptio are two very similar looking mussels, frequently described as confusing species. During the surveys from 2014 to 2017, only the Scoudouc River was found to contain a population of Elliptio. The only species found in the Shediac River during those years are: the Eastern Pearshell (*Margaritifera margaritifera*), the Creeper mussel (*Strophitus undulatus*), and one other unidentified mussels, a possible Triangle Floater (*Alasmidonta undulata*) or a shell variation of a Creeper mussel.

The possible detection of Brook Floater by eDNA is however encouraging. More surveys will be done in the vicinity of the site with the detection.

5. Habitat and Water Quality Enhancement

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

Blockage to fish migration are both naturally occurring and man-made, like debris jams, hanging culverts, and man-made dams. When these barriers occur in lower areas of a watershed, it can close off a large amount of suitable spawning grounds for important migratory fish species like the Atlantic salmon. Because freshwater mussels rely on host fish in their reproductive cycle, fish migration is an important element in assessing the watershed for threats to rare species like the Brook Floater.

Two sites were selected for habitat enhancement. The habitat enhancements involved repairs of last year`s restoration work at "Edna`s pond" along the Scoudouc River, and enhancement of the buffer zone at the water quality monitoring site ScdF. In addition, an old ATV crossing along the Shediac River was blocked off to help protect the habitat, due to the fact that it is located in a high priority area for the Brook Floater as stated in the 2006 Freshwater Mussel in 2018.

5.1 Edna's Pond Restoration Site

An area in the Scoudouc River was selected for remediation due to erosion and sedimentation problems in 2017. This year, the restoration of this site was continued. There was a bit of damage from the spring`s canoe and ATV run. The fourth log, at the bottom of the hill, had been taken off and thrown to the side of the trail. This summer, the log was retrieved and reinstalled at the same location as well as a new piece of geotextile. The restoration also involved in the maintenance of the channel stabilizers, by digging trenches towards the woods, where fine sediments had accumulated on the logs over the winter and spring. Fall rye was planted all over the restoration site again this year due to the destruction made by this year`s ATV run. It is important to establish a good amount of fall rye on the trail to further stabilize the soil that was disturbed by the creation of this project.

Figure 36: Signage at Edna's Pond

Figure 37: Map showing where restoration work was done at the Scoudouc River in 2017-2018

Additional native trees were planted. Some of the trees planted in 2017 didn`t survive the winter, and others were damaged by ATVs. Approximately 15 native trees were planted in the fall of 2018 to help replace the ones that died. It was important to replace the trees that didn't survive by the river. These will help to stabilize the eroding river bank. Large trees were selected to help ATV drivers to see them more clearly and not trample over them. The trees used were provided by the wood lot of "*Vert l'Avenir*" farm.

The tree planting was done with the help of grades 7-8 students from Shediac Cape School, as part of the Adopt-A-River program. This project involves taking students at the river and sampling for benthic macro-invertebrates. They can learn the processes of sampling and how to measure habitat attributes. After the activity, some of the students crossed the river to the restoration site and helped plant the 15 native trees. Planting trees is a good activity for young minds; it informs them of the benefits of trees for water quality and the overall aquatic habitats.

One more sign was installed at the Edna`s pond restoration site to add to the other 5 that was installed in 2017. This sign contains information on the functions and purpose of the channel stabilizers. It was installed on the side of the trail where it is easily visible next to a channel stabilizer.

A new handout was designed and printed for distribution to the ATV community, in an attempt to raise awareness about the impacts of motor vehicles crossing aquatic habitats.

5.2 Buffer Zone Restoration on unnamed tributary of the Scoudouc River

The water quality monitoring station ScdF is located on a tributary of the Scoudouc River. This tributary may be an important habitat for Atlantic salmon. The surrounding banks around this site is being subject to severe erosion due to the lack of vegetation. This site was selected for a buffer zone enhancement and bank stabilization by the planting of native trees. A Water and Wetland Alteration Permit (WAWA) was acquired.

Figure 38: Map of tree planting area along the unnamed tributary of the Scoudouc River

A total of 224 native trees were planted on October 31st and November 1st. The native trees include; 158 White Spruces, 3 Balsam Firs, 1 White Pine, 2 Red Oaks, 2 Mountain Ash, 32 Red Maples, 7 Grey Birches, 2 willows, 1 Trembling Aspen, 1 rose bush, 2 meadowsweet and 13 Tamaracks. The trees were transplanted from *Vert l'Avenir* Farm woodlot.

The native trees were planted on both sides of the stream. The erosion was more severe on the southern bank of the stream, thus a thicker layer of trees was planted there. Mostly coniferous trees, such as white spruce, was selected for this buffer zone enhancement due to the history of beaver activity in the region.

Two signs were installed to prevent the new trees from being mowed during the usual maintenance of the fields on both sides of the watercourse.

Figure 39: Signage for tree planting zone installed on both sides of the stream

5.3 ATV Crossing Blockage on the Shediac River

An area along the Shediac River had traditionally allowed for ATV vehicles to cross a sensitive habitat for freshwater mussels and other aquatic species. The area was identified as an important section of the Shediac River for the Brook Floater. A bridge was built in recent years by the Kent ATV Club. However, the original crossing through the river remained accessible and showed signs on ongoing use.

In the fall of 2018, the SBWA initiated talks with the local ATV club, who were most receptive to the idea of putting up a barrier to discourage crossing through the river, thus encouraging the use of their bridge. They donated and installed the 4 large posts. The Shediac Bay Watershed Association bought the cables and clamps, and subsequently designed and installed signage.

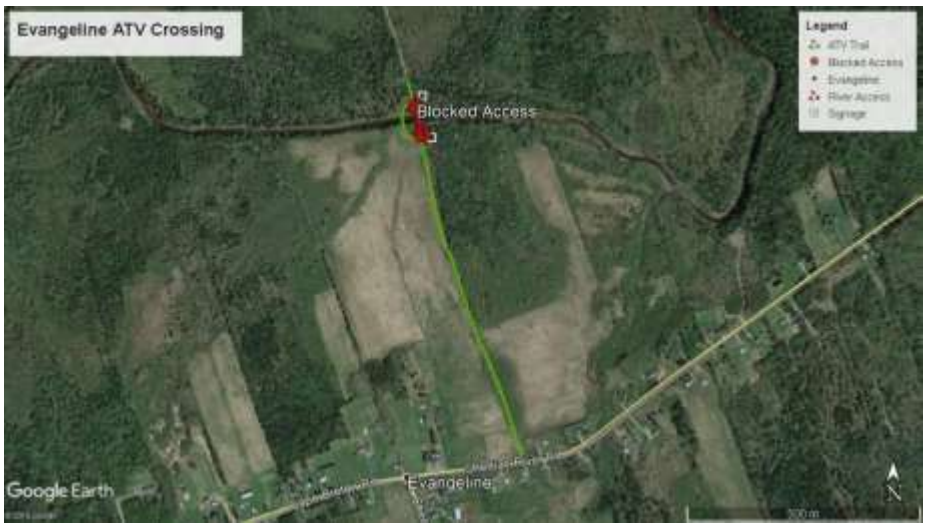

Figure 40: Location of Evangeline ATV Crossing

Figure 41: Images of the old crossing and new bridge

The same signs and cables were placed on both sides of the river. The cable gate has a lock so the cable can be unhooked to allow passage of the trail groomer in the winter. This was a great partnership to help protect river habitat from unwanted access by all-terrain and other off-road vehicles. The Kent ATV club was super supportive of our initiative and provided lots of in-kind and monetary partnership assistance.

Figure 42: Images of the signage and trail closure

5.4 Culvert Assessment

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

Aquatic connectivity is very important for the biodiversity of a watershed. Culverts modify the morphology and the hydrology of a stream, and can sometimes hinder that connectivity by creating barriers. The presence of an outflow drop, steep culvert slopes, deteriorating culverts, and the presence of beaver dams or debris blockages within the culvert, can all negatively influence fish passage. Problematic culverts in terms of passage prevent fish to access upstream habitats. These fish are potential hosts for Brook Floater glochidia

In 2016, the *Petitcodiac Watershed Alliance* (PWA) developed the Atlantic Canada Culvert Assessment Toolkit (ACCAT), a rapid assessment version of the protocol developed by NSLC Adopt-A-Stream. The goal was to standardize a protocol for culvert assessments, and to allow other watershed groups to easily and effectively assess their water crossings. The toolkit included; data sheets, field equipment checklist, informative videos, data calculation, classification instructions, and remedial guidelines.

During the summer of 2018, 20 culverts of concerns were assessed within the Shediac Bay watershed. The assessments consisted of using surveying equipment to measure specific elevation points; the inlet and outlet of the culvert, and the first and second riffle downstream of the crossing. The culvert`s dimensions (height, width and length) were measured using a tape measure. The culvert slope, the outflow drop and the downstream slope were calculated with the formulas provided by the protocol. Information such as the presence of beaver dams, debris blockages, culvert condition, and evidence of erosion were noted. Four photographs were taken for each culvert assessed; the upstream habitat, the inlet of the culvert, the downstream habitat, and the outlet of the culvert. Photos of assessed culverts are included in Appendix B. The results are summarized in Table 10 and 11.

Seven culverts that were assessed are located in areas impacted by tides. The protocol did not include information on how to assess tidal sites. Some of the parameters could not be measured due to the nature of tidal streams, such as outflow drops and downstream slope. The morphology of tidal streams often lack riffles that are used as a guide for measurements. Three tidal sites were classified as full barriers as they were visited at both low and high tide, and a significant drop was present during those conditions. The other four culverts could not be classified under the ACCAT protocol. In addition, 15 other culverts were visited, of which 7 were located in seasonal streams. A full assessment was not conducted for these culverts, only a rapid assessment was done for fish passage classification.

Table 5: Culvert Assessment Summary Results for 2018

Culvert ID	Stream	Stream Type	Available habitats (km)	Culvert slope (%)	Outflow drop (m)	Classification
DFO-16901	McQuade Brook	**Non-tidal**	**2.78**	**1.21 and 0.93**	**0.05 and 0.02**	**Both Partial barrier**
DFO-17616	Shediac tributary	**Non-tidal**	**3.15**	**0.30**	**0.6**	**Full barrier**
DFO-16886	McQuade Brook tributary	**Non-tidal**	**1.05**	**1.06**	**-0.18**	**Partial barrier**
DFO-16884	McQuade Brook tributary	**Non-tidal**	**1.85**	**-4.76 and -4.80**	**-**	**Both Partial barrier**
DFO-16866	Shediac tributary	**Non-tidal**	**1.11**	**1.55**	**0.1**	**Partial barrier**
DFO-16860	Calhoun Brook	**Non-tidal**	**10**	**-0.19**	**-0.36**	**Passable**
DFO-15974	Weisner Brook	**Non-tidal**	**3.22**	**-1.19 and -0.86**	**-**	**Passable**
DFO-15937	Scoudouc tributary	**Non-tidal**	**3.24**	**-0.2**	**-0.13**	**Passable**
DFO-15939	Scoudouc tributary	**Non-tidal**	**2.47**	**0.4**	**0.02**	**Partial barrier**
DFO-16868	Weisner Brook tributary	**Non-tidal**	**2.88**	**0.33**	**-0.16**	**Passable**
DFO-16858	Weisner Brook	**Non-tidal**	**0.86**	**-0.94**	**-0.13**	**Partial barrier**
DFO-16865	Calhoun Brook	**Non-tidal**	**1.68**	**1.71**	**-0.74**	**Partial barrier**
DFO-15980	Weisner Brook	**Non-tidal**	**5.86**	**-0.49, 0.20- and -0.83**	**0.19, -0.01 and 0.16**	**Full, Passable, Full**
DFO-17597	Shediac tributary	**Tidal**	**0.75**	**0.99**	**0**	**Unknown***
DFO-17605	Shediac tributary	**Tidal**	**2.23**	**0.27**	**0**	**Unknown***
DFO-17593	Shediac tributary	**Tidal**	**3.08**	**-0.26**	**0.30**	**Full barrier**
DFO-17601	Shediac tributary	**Tidal**	**1.48**	**1.51**	**0.72**	**Full barrier**
DFO-17600	Shediac tributary	**Tidal**	**0.79**	**6.23**	**0.30**	**Full barrier**
DFO-17589	Shediac tributary	**Tidal**	**1.97**	**2.85**	**0.08**	**Unknown***
DFO-16853	Bateman Brook	**Tidal**	**18.96**	**0.19**	**-0.8**	**Unknown***
***Protocol not adapted for tidal sites, to be reassessed**						

Table 6: Rapid Assessment Summary Results for 2018

Culvert ID	Stream	Stream Type	Classification
DFO-17580	Ruisseau Albert-Gallant	Non-tidal	Passable
DFO-17582	Ruisseau Albert-Gallant	Tidal	Unknown
DFO-17581	Ruisseau Albert-Gallant	Seasonal	Dry
DFO-16870	Weisner Brook tributary	Seasonal	Dry
DFO-16875	McQuade Brook tributary	Non-tidal	Full barrier
DFO-16864	Batemans Brook tributary	Seasonal	Dry
DFO-16855	Batemans Brook tributary	Non-tidal	Passable
DFO-16862	Batemans Brook tributary	Seasonal	Dry
DFO-16903	Shediac River tributary	Seasonal	Dry
DFO-16904	Shediac River tributary	Seasonal	Dry
DFO-16906	Shediac River tributary	Seasonal	Passable
DFO-16889	Shediac River main branch	Non-tidal	Passable
DFO-16854	Batemans Brook tributary	Non-tidal	Passable
DFO-15934	Scoudouc River tributary	Non-tidal	Dry
DFO-15946	Scoudouc River tributary	Non-tidal	Passable

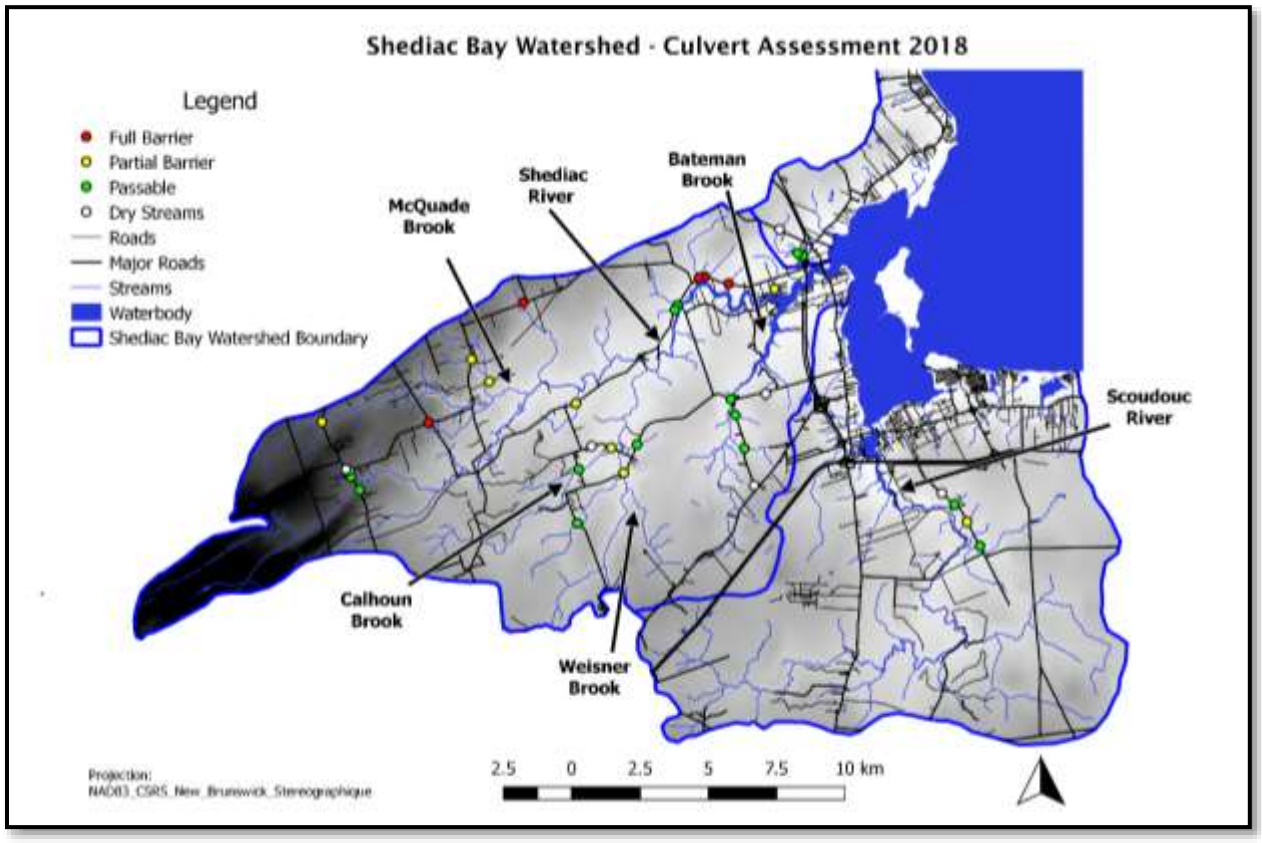

Figure 43: Culvert classification for the Shediac Bay Watershed, 2018

5.4.1 Results for Scoudouc River

Four culverts were evaluated in the lower Scoudouc River watershed, as they have the most potential to block large areas of upstream habitat. The Scoudouc River's surrounding land uses is mostly forested land, and has relatively low number of stream culvert crossings. Two culverts were identified as passable, and one culvert was considered a partial barrier. The last culvert crosses a seasonal stream that was dry.

Figure 45 : Culvert classification for the Scoudouc River, 2018

DFO-15937

This culvert was assessed on August 20th and is located on Pellerin Rd., where it crosses a tributary of the Scoudouc River (N46°10'51.2" W64°30'16.8"). This is the location of one of SBWA`s water quality monitoring stations (ScdF). This culvert is old, but it is still in excellent condition, and consist of corrugated metal. There was no evidence of erosion around the culvert. This culvert has been classified as passable and has 3.2 km of upstream habitat available.

DFO -15939

This culvert was assessed on July 30th and is located on Pellerin Rd., where it crosses a tributary of the Scoudouc River (N46°11'19.9" W64°30'37.3"). This deteriorating infrastructure consists of a rusted and collapsing corrugated metal pipe. This site has got an extensive amount of erosion at

both ends of the culvert. The estimated area of active erosion at the inlet of the culvert is 7.82 m^2 (left bank, right bank and fill slope) and 8.05 m^2 at the outlet. This culvert has been classified as a partial barrier due to the presence of an outflow drop less than 10 cm. There is 2.5 km of potential upstream habitat for the aquatic fauna that can make it through the crossing.

Rapid Assessments: DFO – 15934 & 15946

These two culverts were rapidly assessed on August 27th, and are both located on Pellerin Rd. The DFO-15934 culvert crosses a tributary of the Scoudouc River (N46°11'54.40" W64°31'19.30"). The stream was dry at the time of the inspection and the culvert could not be classified appropriately. The DFO-15946 culvert also crosses a tributary of the Scoudouc River (N 46°11'41.20" and W 64°30'57.70"). This crossing was classified as passable.

5.4.2 Results for the Main Branch of the Shediac River

The lower Shediac River is mostly crossed by bridges. The culvert assessments were mostly conducted on smaller tributaries as they join the main branch. Of the 12 culverts assessed, 5 were determined to have full barriers, one was a partial barrier and 4 were passable. Two culverts crossed streams that were dry during the site visits.

Figure 46: Culvert classification for the Shediac River, 2018

DFO-17616
This culvert was assessed on July 23rd and is located on MacDougall Rd., where it crosses a tributary of the Shediac River (N46°15'51.8" W64°43'6.00"). This is a collapsing culvert that consists of a corrugated metal pipe. There is an estimated area of 4 m² of erosion on the right bank at the inlet of the culvert, and an extensive 24 m² of erosion of both the left and right banks at the outlet. This culvert has been classified as a full barrier due to the presence of a high outflow drop (0.6 m). The crossing prevents aquatic fauna the access to 3.1 km of upstream habitat.

DFO-16866
This culvert was assessed on July 31st and is located on Shediac River Rd., where it crosses a tributary of the Shediac River (N46°13'51.15" W64°41'39.73"). This is a concrete culvert and is beginning to collapse. There is an estimated area of 2.5 m² of erosion (left bank, right bank and fill slope) at the inlet of the culvert, and 12.3 m² of erosion on both the left and right banks at the outlet. This culvert has been classified as a partial barrier due to the presence of an outflow drop equal to 10 cm and a slope percentage greater than 0.5%. There is 1.1 km of upstream habitat available for aquatic fauna capable of crossing the culvert.

DFO -17597
This culvert was assessed on July 31st and is located on Shediac River Rd., where it crosses a tributary of the Shediac River (N46°15'39.38" W64°38'46.90"). This corrugated metal pipe is old, but it is still in good condition. There was no evidence of erosion at this site. This site was visited at high tide and did not show signs of being a fish passage barrier. However, the ACCAT protocol does not provide a classification for tidal sites. The site was not visited at low tide. This small brook contains approximately 0.75 km of aquatic habitat upstream of the culvert.

DFO -17605
This culvert was assessed on July 31st and is located on Shediac River Rd., where it crosses a tributary of the Shediac River (N46°15'44.85" W64°38'42.45"). This corrugated metal pipe is old, but it is still in good condition. There is no evidence of erosion, however, the presence of large rocks was noted inside the culvert that might cause fish passage issues in the future. This site is tidal, and cannot be classified for fish passage under the ACCAT protocol. This site has approximately 2.2 km of upstream habitat.

DFO -17593
This culvert was assessed on July 26th and is located on Shediac River Rd., where it crosses a tributary of the Shediac River (N46°16'16.7" W64°38'4.6"). The condition of this corrugated metal pipe is old, eroding at the bottom and rusted. There is approximately 8 m² of active erosion at the inlet (left and right bank) and 6 m² at the outlet (Left and right bank). There is a bit of wood debris inside the culvert. This site is tidal, and cannot be classified for fish passage under the ACCAT protocol. However, the site was revisited at high tide and still had an outflow drop of more than

10 cm. Therefore, the crossing can be seen as a full barrier, but more information is needed in order to classify the culvert properly under a different protocol. This culvert prevents aquatic fauna to access 3.1 km of upstream habitat.

DFO -17601

This culvert was assessed on August 20th and is located on Shediac River Rd., where it crosses a tributary of the Shediac River (N46°16'17.3" W64°37'54.6"). This corrugated metal pipe is old, eroding at the bottom of the outlet and the top of the culvert is beginning to collapse. There is 4 m² of active erosion on the fill slope of the inlet. This site is tidal, and cannot be classified for fish passage under the ACCAT protocol. However, the site was revisited at high tide and still had an outflow drop of more than 10 cm. Therefore, the crossing can be seen as a full barrier, but more information is needed in order to classify the culvert properly under a different protocol. This culvert may prevent aquatic fauna to access 1.5 km of upstream habitat.

DFO -17600

This culvert was assessed on July 26th and is located on Shediac River Rd., where it crosses a tributary of the Shediac River (N46°16'8.63" W64°37'14.31"). This corrugated metal pipe is old, a bit rusted and collapsing. There is approximately 5.9 m² of active erosion at the inlet (left and right bank) and 3 m² at the outlet (left and right bank). This site is tidal, and cannot be classified for fish passage under the ACCAT protocol. However, the site was revisited at high tide and still had an outflow drop of more than 10 cm. Therefore, the crossing can be seen as a full barrier, but more information is needed in order to classify the culvert properly under a different protocol. This culvert may prevent aquatic fauna to access approximately 0.8 km of upstream habitat.

DFO -17589

This culvert was assessed on July 26th and is located on Aurèle Poirier Rd., where it crosses a tributary of the Shediac River (N46°16'1.10" W64°35'56.6"). The condition of this corrugated metal pipe is old, eroding at the bottom and rusted. There is approximately 3.7 m² of active erosion at the inlet (left and right bank) and 6.6 m² at the outlet (Left bank, right bank and fill slope). This site is tidal, and cannot be classified for fish passage under the ACCAT protocol. There is approximately 1.9 km of upstream habitat available for aquatic fauna capable of crossing the culvert.

Rapid assessments: DFO – 16903, 16904, 16906 & 16889

The following 4 culverts were rapidly assessed on August 27th.

The culverts DFO-16903 and DFO-16904 are located on Scotch Settlement Rd. (N46°12'38.25" W64°48'9.44") and Route NB-115 (N46°12'39.03" W64°48'14.63"), respectively. They both cross the same seasonal tributary of the Shediac River. The stream was dry at the time of the inspection and the culverts could not be classified.

The culverts DFO-16906 and DFO-16889 are both located on Route NB-115 (N46°12'30.17" W64°48'6.30") and (N46°12'39.03" W64°48'14.63") respectively. The culvert DFO-16889 crosses the higher reaches of the main branch of the Shediac River. The culvert DFO-16906 crosses a smaller tributary of Shediac River. Both of these culverts were classified as passable.

5.4.3 Results for Weisner Brook

The Weisner Brook is an important tributary of the Shediac River in terms of salmonid habitat. Five culverts were assessed: 3 were passable culverts, one was a partial barrier, and the fifth one crossed a seasonal stream that was dry.

Figure 457: Culvert classification for the Weisner Brook, 2018

DFO-16868

This culvert was assessed on July 31st and is located on Bateman Mill Rd., where it crosses a tributary of Weisner Brook (N46°13'1.0" W64°39'56.9"). This corrugated metal pipe was in very poor condition, it is old, eroding, rusted and collapsing. There is also evidence of erosion on both ends of the culvert. There is an estimated area of 3 m² of erosion at the inlet (left bank, right bank and fill slope) and 4.14 m² of erosion at the outlet (left bank, right bank and fill slope). There is a beaver dam directly at the inlet of the culvert and a debris blockage of branches and rocks inside the culvert. Although the culvert is in poor condition and there is the presence of obstacles for fish

passage, the culvert has been classified as passable. A simple debris cleanup would optimize the potential of this crossing and allow access to 2.9 km of upstream habitat for aquatic fauna.

DFO-15974

This culvert was assessed on June 29th and is located on Weisner Rd., where it crosses the Weisner Brook (N46°10'34.6" W64°41'5.30"). This double culvert is made of corrugated metal and is old, rusted and collapsing. The water level of this site was very high and did not reveal any riffles, therefore the outflow drop and the downstream slope could not be calculated. The slopes of the two culverts are facing the wrong way and is greater than 0.5%. Considering the high-water level at this site, it was decided to classify these culverts as passable. There is 3.2 km of upstream habitat available.

DFO-16858

This culvert was assessed on June 29th and is located on Bateman Mill Rd., where it crosses Weisner Brook (N46°12'27.9" W64°40'20.8"). The condition of this culvert is new and made of corrugated metal. Although the culvert is in excellent condition, there is unfortunately a large amount of active erosion (19 m^2) on the right bank and fill slope at the outlet. At the time of the assessment, there was no evidence of beaver activity. A site inspection in October revealed the presence of a beaver dam downstream of the culvert. The crossing has been classified as a partial barrier due to the slope percentage exceeding 0.5%. There is 0.9 km of upstream habitat available for aquatic fauna able to cross this culvert.

DFO-15980

This culvert was assessed on July 12th and is located on Weisner Rd., where it crosses Weisner Brook (N46°11'29.70" W64°41'39.73"). This triple corrugated metal culvert is new and in excellent condition. However, there is approximately 5.34 m^2 of active erosion on the left and right banks at the inlet of the culverts. There is also the presence of a debris blockage inside the middle culvert, consisting of branches and twigs. The middle culvert has been classified as a partial barrier due to the slope percentage exceeding 0.5% and the debris. The other two were classified as full barriers due to the presence of outflow drops more than 10 cm. This crossing can allow the access of 5.9 km of upstream habitat aquatic fauna capable of crossing.

Rapid assessment: DFO-16870

The DFO-16870 culvert was rapidly assessed on August 27th and is located on St Philippe Rd., where it crosses a tributary of the Weisner Brook (N46°13'0.00" W64°41'14.50"). The stream was dry at the time of the inspection and the culvert could not be classified.

5.4.4 Results for Bateman Brook

Five culverts were assessed on the Bateman Brook. Two culverts were considered passable, two culverts crossed a dry stream and could not be classified, and the fifth is a tidal site and cannot be classified under the ACCAT protocol.

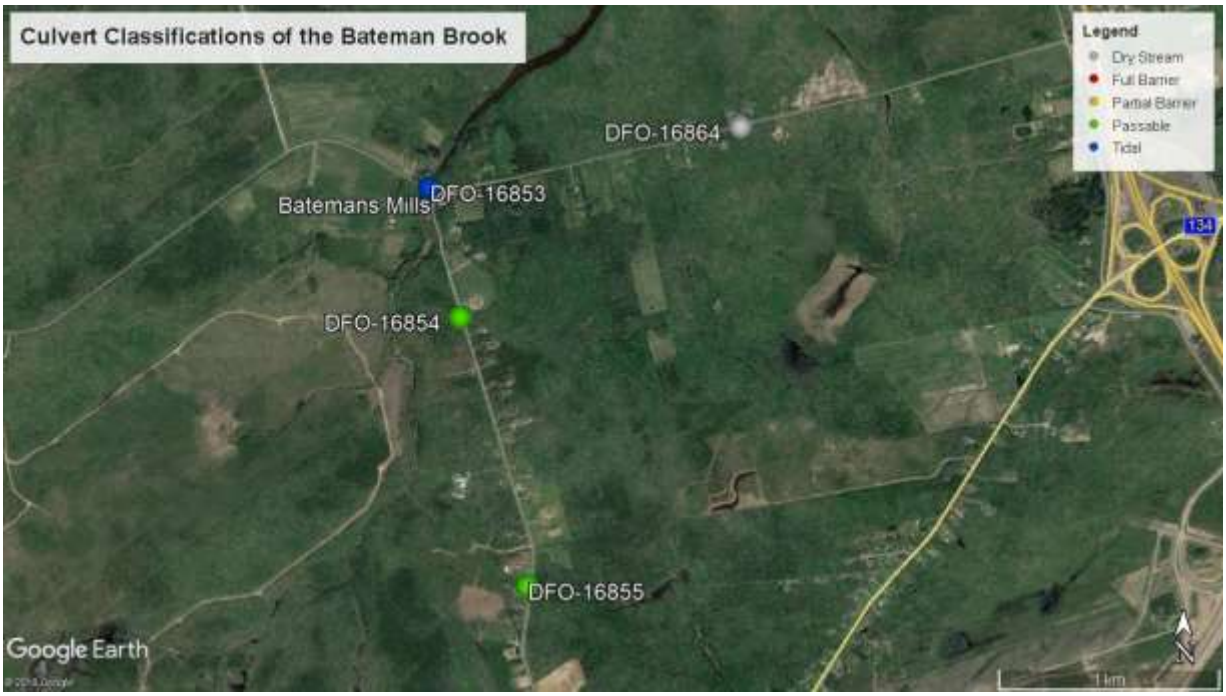

Figure 48: Culvert classification for the Bateman Brook, 2018

DFO-16853

This culvert was assessed on July 12th and is located on Bateman Mill Rd., where it crosses Bateman Brook (N46°13'52.0" W64°37'15.1"). This is the location of one of SBWA`s water quality monitoring stations (ShdH). This corrugated metal pipe is old, but it is still in excellent condition. There is approximately 5 m² of active erosion on the right bank and the presence of a beaver dam at the inlet of the culvert. This site is tidal, and cannot be classified for fish passage under the ACCAT protocol. There is approximately 19 km upstream habitat available to aquatic fauna able to cross the culvert.

Rapid assessment: DFO-16864 & 16862, DFO-16855-16854

The following 4 culverts were rapidly assessed on August 27th.

The culverts DFO-16864 and DFO-16862 are located on Bateman Mill Rd. (N46°14'1.00" W64°36'9.50") and Sawdust Rd. (N46°12'9.40" W64°36'38.50") respectively. They both cross small tributaries of the Bateman Brook. Both streams were dry at the time of the inspection and the culverts could not be classified appropriately.

The culverts DFO-16855 and DFO-16854 are both located on Sawdust Rd. (N46°12'53.40" W64°36'53.80") and (N46°13'33.50" W64°37'8.20") respectively. Both of these culverts were considered passable.

5.4.5 Results for the Calhoun Brook

Two Culverts were assessed on the Calhoun Brook, a tributary of the Weisner Brook. One was classified as a partial barrier and the other is classified as passable for fish.

Figure 49: Culvert classification for the Calhoun Brook, 2018

DFO-16860
This culvert was assessed on July 23rd and is located on Weisner Rd., where it crosses Calhoun Brook (N46°12'33.4" W64°41'37.31"). This newer culvert is still in excellent condition and it consists of corrugated metal. There is no evidence of erosion at this site. This crossing has been classified as passable and allows access to 10 km of available upstream habitat.

DFO-16865
This culvert was assessed on July 12th and is located on St Philippe Rd., where it crosses the Calhoun Brook (N46°12'57.9" W64°40'41.0"). This corrugated metal pipe is old and eroding at the bottom. There is evidence of erosion at the outlet of the culvert, approximately 6.16 m^2 on the right bank and fill slope. There is also the presence of a beaver dam directly at the inlet of the culvert. This culvert has been classified as a partial barrier due to the slope percentage being greater than 0.5%. There is 1.7 km of available upstream habitat for aquatic fauna capable of crossing this culvert.

5.4.6 Results for McQuade Brook

Four culverts were assessed on the McQuade Brook, an important tributary of the Shediac River in terms of salmonid habitat. One full barrier was identified and three culverts were classified as partial barriers.

Figure 50: Culvert classification for the McQuade Brook, 2018

DFO-16901

This site was assessed on July 30th and is located on Route NB-115 near Irish Town, where it crosses the McQuade Brook (N46°13'36.04" W64°48'53.8"). This is a double culvert, meaning that there are two corrugated metal pipes next to each other. This is precautionary for when high water levels over compensating the first culvert. These culverts are old, but they are still in excellent condition. The only evidence of erosion is a deep hole of around 1 m^2 at the fill slope on the outlet side of the culvert. Both culverts have been classified as partial barriers, since they have outflow drops of less than 10 cm and their slope percentages exceed 0.5%. A potential 2.8 km of upstream habitat is available for aquatic fauna that can cross the culverts.

DFO-16886

This culvert was assessed on July 23rd and is located on Scotch Settlement Rd., where it crosses a tributary of the McQuade Brook (N46°14'46.0" W64°44'36.2"). This corrugated metal pipe is old, eroding and collapsing. There is an extensive amount of active erosion on both ends of the culvert; 12.44 m^2 on the fill slope at the inlet and 6.69 m^2 (on both right and left banks) at the outlet. There is also a debris blockage present consisting of branches inside the culvert. This culvert has been classified as a partial barrier due to an outflow drop of less than 10 cm, and a slope percentage greater than 0.5%. There is approximately 1 km of potential upstream habitat.

DFO-16884

This culvert was assessed on August 20th and is located on Gilles Pie Lane, a farmer's road in Scotch Settlement, where it crosses a tributary of the McQuade Brook (N46°14'19.34" W64°44'6.76"). This double culvert consists of corrugated metal pipes that are old, rusted and collapsing. There was no evidence of erosion at this site, although there is a debris blockage present, consisting of branches and large rocks. There is also the presence of a beaver dam, downstream of the crossing. The high water levels created by the beaver dam didn`t allow for the measurements requiring the location of the riffles downstream, therefore the outflow drop and the downstream slope could not be calculated. This made the classification of this site difficult. However, the fact that the culvert slopes were 4.76 % and 4.80 % in the wrong direction, it is evident that this site is a partial barrier for fish passage. There is 1.9 km of upstream habitat available to aquatic fauna that can cross this culvert.

Rapid Assessment: DFO-16875

The culvert DFO-16875 was rapidly assessed on August 27th and is located on Scotch Settlement Rd. (N46°13'32.10" W64°45'52.00"). This culvert was classified as a full barrier due to the conditions of the crossing. The culvert is totally collapsed preventing flow and creating a stagnant pool upstream.

5.4.7 Results for Ruisseau Albert-Gallant

Three culverts were rapidly assessed on the Ruisseau Albert-Gallant, a tributary of the Shediac Bay. Two of those culverts were classified as passable and the third was a seasonal stream that was dry at the time.

Figure 51: Culvert classification for the Ruisseau Albert-Gallant, 2018

Rapid assessment: DFO-17580, 17582 & 17581

The culverts DFO-17580 and DFO-17582 were rapidly assessed on August 27th and are located on Babineau Access Rd. (N46°16'42.47" W64°35'14.65"), and on the exit ramp of highway 11 to Viaduc Rd. (N46°16'39.48" W64°35'6.58") respectively. These two culverts cross the Ruisseau Albert-Gallant. Both culverts were classified passable.

The culvert DFO-17581 was rapidly assessed on July 26th and is located on Babineau Rd. (N46°17'10.70" W64°35'44.80"). This stream was dry at the time of the inspection and could not be classified appropriately.

5.5 Recommendations for Culvert Restoration

Since the Brook Floater relies on fish populations for reproduction, any improvement of fish habitat is also an improvement for freshwater mussels. Fish passage blockages caused by culverts impede the ability of many fish species, especially smaller fish, from accessing habitat. These fish are potential hosts for the Brook Floater reproduce. Therefore improving fish passage can have a direct impact on the survival of the species. The other issue identified during the culvert surveys was erosion that can cause sedimentation. Fine sediments in the stream can negatively affect the filtration system of the mussels or even bury the mussels in extreme cases. By addressing these two issues the SBWA will ameliorate potential habitat for Brook Floater and other freshwater mussels.

Four culverts are identified for potential restoration projects. The field team of the SBWA will revisit the culverts in spring 2019 to verify the status of the culverts. If culverts are deemed suitable for restoration the association will contact the New Brunswick Department of Transportation and Infrastructure and the New Brunswick Department of Environment and Local Government to acquire approval for proposed work. A watercourse and wetland alteration permit will be necessary once the association receives approbation from the province. Detailed restoration plans will be prepared to be submitted with permit applications. The following paragraph gives potential restoration activities that will be confirmed and developed in the detailed plan.

The culvert DFO 16886 is a partial barrier that can easily be remediated by the removal of debris blocking the culvert. The removal of debris would allow the passage for 1km of habitat upstream. Erosion was observed at the outlet that can degrade the habitat for Brook Floater. Erosion issues can be reduced using the techniques described in the DFO guide Ecological Restoration of Degraded Habitats : a Watershed Approach 2006.

The culvert DFO – 15980 is located on the Weinser Brook and has issues with debris and outflow drops. The SBWA will remove the debris and may use rock weirs at the outfall to increase water depth therefore reducing the outflow drop. Remediation of this culvert would allow the passage of fish to 5.9 km of stream habitat upstream. A culvert with an elevated outflow drop is blocking access for fish to a tributary off the Shediac River.

The culvert DFO 17616 has a drop of 0.6 m. The SBWA will discuss with other groups to determine the best methods that can be applied to improve fish passage. If rock weirs are not sufficient, a small fish ladder could be a viable solution. The remediation of this culvert would open access to 3,1 km habitat. Severe erosion was also observed at this site. Even if the fish passage cannot be remediated to improve brook floater habitat the banks around the culvert can be stabilized to reduce fine sediment from entering the watercourse. Bank stabilization can be done by planting native shrubs or using stabilization techniques described in the guide produced by DFO.

On the Scoudouc river the culvert DFO-15939 is located on Pellerin road and is a partial barrier that can be remediated. There is an outflow drop of less than 10 cm that could be reduced with rock weirs. This culvert also has extensive erosion problems that could be remediated with stabilization techniques and planting native shrubs. The upstream habitat gain would be 2,5 km.

6. Communications and outreach

The absence of Brook Floaters during field surveys has delayed the outreach activity to specific landowners. The focus of the 2019 communications strategy was instead targeted to users of the rivers that have potential Brook Floater habitat.

Presentations were given to different groups on the activities of the SBWA. The presentation includes a section on freshwater mussels. The public are always surprised to learn about these fascinating creatures and the fact that there may be an endangered species in our watercourses.

A new poster was developed in 2017 on freshwater mussels, their life cycle and on the species at risk. The poster was professionally designed and will be used to complement presentations and communications with stakeholders. The poster was developed in French and English.

Figure 46: Freshwater Mussel Poster, 2017

An article on the Brook Floater project was included in our annual newsletter. A total of 250 copies were distributed.

A fact sheet on Freshwater mussels was prepared for our information kiosk and share on our Facebook page. The post on the factsheet share got 296 views.

Educational materials and reports on the Brook Floater can be found on our website – www.shediacbaywatershed.org

Presentations were made to the local ATV clubs to educate their members on the possible impacts of driving vehicles in the streams. From these meetings areas have been identified for restoration projects that will mitigate the impact of ATV's on freshwater mussel habitat. The description of activities can be found in section 6 of this report.

6.1 Landowner Database

A gap was discovered while planning the stewardship outreach program. The SBWA had no database of landowners for which to send the information. A new landowner database was created to improve communication between the SBWA employees and landowners in the watershed. The database is an excel spreadsheet that will contain all the landowner information that is collected by staff to carry out projects.

Basic contact information is recorded along with the PID number of their parcels. More information is then added to give background information on participation in past projects and possible future partnerships. The staff will then evaluate the potential for stewardship restoration by rating the type of land, the presence of water and the willingness of individuals to collaborate. These criteria are to serve as a guide and facilitate knowledge transfers when there's a change in staff. The following table shows the questions that are answered in the worksheet.

The spreadsheet will also describe any brochures or information that has been given by the SBWA. This will help monitor outreach activities and measure stewardship activities.

The staff has started to add current landowner information in the spreadsheet. The next step will be to identify landowners that have potential Brook Floater habitat on their parcel of land.

Table 7: Landowner assessment spreadsheet example

Landowner Engagement Level	Type of Lot / Land	Water Presence	Riparian Area Type and Condition	Stewardship Involvment	Access to Watercourse
1-Low involvment and Collaboration 2-Moderate Collaboration 3-Full Collaboration 4-Wants to Do More than Proposed	1-Small Home/Cottage Lot 2-Woodlot 3-Agriculture Farmer 4-Cattle farmer 5-Business 6-Industry 7-Municipal 8-Institutional	1-No Water 2-Large Wetland Area 3-Small Marsh 4-Small Stream 5-Riverfront, 6-Waterfront (Bay)	1-Streambank erosion 2-Lawn to edge 3-Good buffer zone 4-Presence of trees 5-Vegetation mix 6-Other (specify)	1-Habitat Observations 2-Habitat Protection 3-Access to Watercourse 4-Permission to Restore Riparian Area 5-Active Participation in Restoration Efforts 6-Other (Specify)	1-Contact before arriving on site 2-Parking space for on car only 3-Parking space for two to three cars

The SBWA has pamphlets on Brook Floater and information on restoration to distribute. During the 2019 field season we target landowners to receive information specific to the Shediac and Scoudouc rivers. The communication will serve as an invitation to participate in improving riparian zones by tree planting.

If Brook Floater is found during 2019 surveys the surrounding landowners will receive a notice and be encouraged to put actions on the ground to protect or restore habitat.

7. Conclusion

To conclude, after 5 years of field surveys and habitat searches, the SBWA has finally received a positive signal from the eDNA testing indicating that the species is still present in the Shediac River. According to the Department of Fisheries and Oceans, the positive signal was detected in the mid to higher reaches in the Shediac River, in a more remote location that is more difficult to access. In 2019, the SBWA will approach new landowners to request access to the river through their property, and conduct a search and additional eDNA tests to physically locate the rare Brook Floater. If found, the SBWA will work with these landowners to engage them in habitat stewardship and protection.

The fulfillment of this project is of great value, as it gives us much needed information on the state of the habitats and current freshwater mussel populations throughout the Shediac Bay watershed. This information will be used as part of future endeavours to physically find this species of special concern and to integrate our findings in the community awareness mission of the SBWA. Some great restoration work was done to enhance freshwater habitat and mitigate human impacts. The educational part of this project was successful, in that many residents were made aware of the existence of freshwater mussels. The subject comes as a surprise to many people, possibly due to the fact that freshwater mussels are not consumed like their saltwater cousins. Many riverfront property owners were also informed of the existence of a rare freshwater mussel that could possibly be found in their own backyard. The topic seemed to interest most property owners, and discussions were always in a positive note. If the search for this rare freshwater mussel can continue in future years, a stewardship program with riverfront property owners will be officially implemented.

The Shediac Bay Watershed Association is confident in the works performed throughout this project. The realization of this project has allowed us to better understand the composition of the freshwater mussel populations and the state of their habitats in the Shediac Bay watershed.

8. LITERATURE CITED

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APPENDIX A: Field Sheet Data 2018

Table 8: Site data for 2018 field season; watercourse name, access points and direction

Date	Site ID	River	Access	Upstream/ Downstream from Access
05/16/2018	ShdE-A	Shediac	Covered bridge	U/S
05/16/2018	ShdE-B	Shediac	Covered bridge	U/S
06/06/2018	ScdD-A	Scoudouc	End of Red Bridge Rd, ATV trail	U/S
06/20/2018	ShdI-A	Shediac	Private property w. landowner consent	D/S
06/21/2018	ShdI-B & C	Shediac	Private property w. landowner consent	U/S
06/21/2019	ShdE-1 & 2	Shediac	Private property w. landowner consent	U/S
06/27/2018	ShdG-1	Shediac	St Philippe Rd.	D/S
06/28/2018	ShdL-A	Shediac	Weisner Rd.	U/S
07/09/2018	ShdD-1	Shediac	Private property, 985 Shediac River Rd.	D/S
07/09/2018	ShdD-2	Shediac	Private property, 985 Shediac River Rd.	D/S
07/10/2018	ShdD-A	Shediac	ATV trail, Evangeline	U/S
08/13/2018	ScdD-B	Scoudouc	End of Red Bridge Rd, ATV trail	U/S
08/14/2018	ShdD-A	Shediac	ATV trail, Evangeline	D/S
08/15/2018	ShdM-A	Shediac	Batman Mill Rd	U/S
08/17/2018	ShdN-A	Shediac	ATV trail, Evangeline	U/S
08/21/2018	ShdE-A	Shediac	Covered bridge	U/S
08/21/2018	ShdE-2A	Shediac	Covered bridge powerline	D/S
08/31/2018	ShdG-A	Shediac	St Philippe Rd.	U/S
08/31/2018	ShdE-2B	Shediac	Powerline covered bridge	U/S

Table 9: Site data for 2018 field season; GPS coordinates of start and end points of each survey with distance (m)

		Start		End		
Date	Site ID	Latitude	Longitude	Latitude	Longitude	Distance (m)
05/16/2018	ShdE-A	N46°14'42.59"	W64°39'53.17"	N46°14'40.7"	W64°40'02.1"	211
05/16/2018	ShdE-B	N46°14'40.7"	W64°40'02.1"	N46°14'40.7"	W64°40'15.9"	305
06/06/2018	ScdD-A	N46°11'38.67"	W64°31'23.29"	N46°11'37.7"	W64°31'11.4"	266
06/20/2018	ShdI-A	N46°14'42.00"	W64°39'16.40"	N46°14'31.20"	W64°39'18.50"	348
06/21/2018	ShdI-B & C	N46°14'33.17"	W64°39'17.76"	N46°14'29.84"	W64°39'36.33"	577
06/21/2019	ShdE-1 & 2	N46°14'40.55"	W64°39'43.29"	N46°14'29.87"	W64°39'36.33"	366
06/27/2018	ShdG-1	N46°12'53.98"	W64°40'29.42"	N46°13'29.29"	W64°40'16.05"	1276
06/28/2018	ShdL-A	N46°12'32.71"	W64°41'37.57"	N46°12'18.50"	W64°41'55.10"	808
07/09/2018	ShdD-1	N46°14'25.6"	W64°41'27.00"	N46°14'25.6"	W64°41'13.6"	315
07/09/2018	ShdD-2	N46°14'25.6"	W64°41'13.6"	N46°14'23.3"	W64°40'56.3"	647
07/10/2018	ShdD-A	N46°14'20.40"	W64°41'29.05"	N46°14'7.50"	W64°41'32.10"	662
08/13/2018	ScdD-B	N46°11'39.08"	W64°31'24.72"	N46°11'37.6"	W64°31'09.7"	336
08/14/2018	ShdD-A	N46°14'12.83"	W64°41'59.48"	N46°14'15.85"	W64°41'22.41"	1115
08/15/2018	ShdM-A	N46°12'27.49"	W64°40'21.05"	N46°12'21.53"	W64°40'18.82"	196
08/17/2018	ShdN-A	N46°14'12.82"	W64°41'58.44"	N46°14'13.44"	W64°42'43.33"	1115
08/21/2018	ShdE-A	N46°14'42.22"	W64°39'53.23"	N46°14'40.14"	W64°40'0.98"	183
08/21/2018	ShdE-2A	N46°14'30.07"	W64°39'36.97"	N46°14'24.55"	W64°39'45.68"	247
08/31/2018	ShdG-A	N46°12'51.37"	W64°40'29.96"	N46°12'28.17"	W64°40'21.33"	830
08/31/2018	ShdE-2B	N46°14'24.84"	W64°39'45.57"	N46°14'10.37"	W64°40'4.48"	669

Table 10: Site data for 2018 field season; water quality data

Date	Site ID	Water Temp. (°C)	D.O. (mg/L)	pH	Salinity (ppm)	Depth (cm)	Width (m)	Flow
05/16/2018	ShdE-A	12.6	10.19	6.65	0.05	30-45	15.6	Fast
05/16/2018	ShdE-B	15	9.88	7.73	0.05	15	35-45	Fast
06/06/2018	ScdD-A	13.6	13.4	8.90	0.04	40	17.1	Moderate-fast
06/20/2018	ShdI-A	-	-	-	-	30-45	17-25	Fast
06/21/2018	ShdI-B & C	18.9	11.1	7.20	0.05	25	17.2	Fast
06/21/2019	ShdE-1 & 2	-	-	-	-	-	-	Slow
06/27/2018	ShdG-1	-	-	-	-	17	6.2	Moderate
06/28/2018	ShdL-A	-	-	-	-	32	5.6	Moderate
07/09/2018	ShdD-1	26.9	8.33	7.91	0.07	-	-	Moderate
07/09/2018	ShdD-2	-	-	-	-	-	-	Moderate
07/10/2018	ShdD-A	22.4	9.38	7.99	0.08	-	-	Slow
08/13/2018	ScdD-B	24.2	7.91	9.06	0.05	-	-	-
08/14/2018	ShdD-A	22.4	8.36	8.51	0.12	-	-	-
08/15/2018	ShdM-A	-	-	-	-	-	-	-
08/17/2018	ShdN-A	18.4	9.77	9.05	0.12	-	-	-
08/21/2018	ShdE-A	-	-	-	-	-	-	-
08/21/2018	ShdE-2A	-	-	-	-	-	-	-
08/31/2018	ShdG-A	-	-	-	-	-	-	-
08/31/2018	ShdE-2B	-	-	-	-	-	-	-

Table 11: Site data for 2018 field season; substrate characteristics

		Substrate type (100%)						
Date	Site ID	Bedrock (ledge)	Boulder (>460mm)	Rock (180 to 460mm)	Rubble (54 to 179mm)	Gravel (2.6 to 53mm)	Sand (0.06 to 2.5mm)	Fines (0.0005 to 0.05mm)
05/16/2018	ShdE-A	15	5	5	40	20	15	0
05/16/2018	ShdE-B	20	5	15	30	20	10	0
06/06/2018	ScdD-A	-	-	-	-	-	-	-
06/20/2018	ShdI-A	-	-	-	-	-	-	-
06/21/2018	ShdI-B & C	55	5	25	5	0	10	0
06/21/2019	ShdE-1 & 2	0	5	5	30	40	20	0
06/27/2018	ShdG-1	0	2	13	5	10	40	30
06/28/2018	ShdL-A	35	5	15	15	10	15	5
07/09/2018	ShdD-1	0	5	35	25	25	5	5
07/09/2018	ShdD-2	-	-	-	-	-	-	-
07/10/2018	ShdD-A	15	0	10	15	50	10	0
08/13/2018	ScdD-B	-	-	-	-	-	-	-
08/14/2018	ShdD-A	-	-	-	-	-	-	-
08/15/2018	ShdM-A	-	-	-	-	-	-	-
08/17/2018	ShdN-A	-	-	-	-	-	-	-
08/21/2018	ShdE-A	-	-	-	-	-	-	-
08/21/2018	ShdE-2A	-	-	-	-	-	-	-
08/31/2018	ShdG-A	-	-	-	-	-	-	-
08/31/2018	ShdE-2B	-	-	-	-	-	-	-

Table 12: Site data for 2018 field season; other general information

Date	Site ID	Bank Erosion?	Sand or Gravel Bars?	Surrounding Land Use	Fish (dead or alive?)	Algae?	Personnel	Comments
05/16 /2018	ShdE-A	Mild natural erosion	sand and gravel	Forest, houses/camps	3 dead fish, live macro-invertabrates	Slippery rocks, macrophytes	JH, RL	Found young creeper shell, spring water levels higher and faster currents, water is clear
05/16 /2018	ShdE-B	Mild natural erosion	No	Forest	1 dead fish, plenty alive	Slippery rocks	JH, RL	
06/06 /2018	ScdD-A	Mild natural erosion	Sand and gravel	Forest	2 dead fish, plenty alive	No	JH, RL, JC, IB, AM	
06/20 /2018	ShdI-A	Mild natural erosion	Sand bars	Forest, residential	Lots of live fish	Small amount of green and brown	JH, JC	Plenty of migrating/spawning gaspereau
06/21 /2018	ShdI-B & C	Yes, severe	Sand bars	Forest	1 dead fish, plenty alive	Green filamentous growth	JH, RL, JC, IB, AM	A previously sandy section is now bedrock
06/21 /2019	ShdE-1 & 2	Severe in 2 areas	Sand bars	Forest	3 dead fish, plenty alive	No	JH, RL, JC, IB, AM	
06/27 /2018	ShdG-1	Yes	No	Forest, residential	Lots of live fish	No	RL, AM	Makeshift bridge (wood pallets, foam, steel cables) fallen in the stream
06/28 /2018	ShdL-A	No	Sand bars	Forest, residential	Some live fish	Green filamentous	RL, IB, AM	
07/09 /2018	ShdD-1	Eroding bank at end point	No	Forest	No	Slippery rocks, macrophytes	JH, JC, IB, AM	Mild turbidity due to heavy rain 3 days earlier
07/09 /2018	ShdD-2	No	Sand and gravel	Forest	1 dead fish	No	JH, JC, IB, AM	
07/10 /2018	ShdD-A	Severe natural erosion	Gravel bars	Forest, ATV trails	Lots of live fish	Small amount of green algae	JH, JC, IB, AM	
08/13 /2018	ScdD-B	DND	DND	DND	DND	DND	RL, IB, JC, AM	
08/14 /2018	ShdD-A	DND	DND	DND	DND	DND	RL, IB, JC, AM	
08/15 /2018	ShdM-A	DND	DND	DND	DND	DND	RL, AM, IB	
08/17 /2018	ShdN-A	DND	DND	DND	DND	DND	RL, AM, IB	
08/21 /2018	ShdE-A	DND	DND	DND	DND	DND	RL, JC, AM, IB	
08/21 /2018	ShdE-2A	DND	DND	DND	DND	DND	RL, JC, AM, IB	
08/31 /2018	ShdG-A	No	No	Agricultural	Live fish	Dead filamentous	RL, AM	
08/31 /2018	ShdE-2B	No	Gravel bars	Forest	Live fish		RL, AM	

Appendix B - Culvert Assessment Photos

DFO-15937

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO -15939

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-16901

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-17616

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-16886

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-16884

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-16866

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-16860

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-15974

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-16853

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-16868

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-16858

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-16865

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO-15980

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO -17597

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO -17605

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO -17593

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO -17601

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO -17600

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

DFO -17589

Top: upstream of culvert and inlet

Bottom: downstream of culvert and outlet

ANNEX 1: e-DNA Protocol

DFO-GULF environmental DNA (eDNA) sampling protocol (Brook Floater survey 2017)

Version 1.00

Prepared by: Francis LeBlanc

The following document provides an overview of the procedure for the collection and preservation of environmental DNA (eDNA) samples for molecular testing. Kits with the required materials will be supplied to each field group and preserved filters should be returned to the MBU lab (DFO-GULF, Moncton) for lab analysis.

Materials needed:

1) Disposable 250 mL filter funnels
2) Vacuum flask 1L
3) Tubing L/S # 15
4) Hand operated pump
5) Rubber stopper
6) 2 L water collection bottle
7) 1.5 uM glass microfiber filters (GFC)
8) 2 mL labeled filter preservation tubes (contains 0.2mL of 100% ethanol)
9) Filter forceps
10) 50 mL tubes (1 for bleach and 1 for tap water/distilled water)
11) Latex gloves
12) Filter funnel adaptor
13) eDNA sampling protocol
14) eDNA sampling information collection form
15) Black plastic bags
16) Household bleach (not provided)
17) Tap water (not provided)

Figure 1: Materials included in the e-DNA water sampling kits.

General considerations

1) Water sampling should be done from the downstream to upstream waterflow direction to minimise surface water disturbance and contamination.

2) Sample collection should be done within the stream/river and in the middle of the water column in areas where the Brook Floater is at the highest probability of being present (i.e. suitable habitat). Collection from the bank is also acceptable if collection within the stream/river is not an option.

3) Gloves should be worn when handling field sampling materials that will come in contact with the water samples (i.e. sterile filter funnel assembly/interior of the funnel, filter paper) and forceps should be used to handle filter papers. A new pair of gloves should be used at each location within a site. No gloves are needed when handling materials that are below of the filter paper (i.e. vacuum flask, rubber stopper, vacuum pump, etc.).

4) Forceps used to handle the filter papers needs to be cleaned between samples by soaking them in a 50 % household bleach solution (1 part household bleach with 1 part tap water) for at least 2 minutes followed by rinsing them a few times in tap water. The provided 50 mL tubes should be used to perform this cleaning step.

5) Individual 2 L collection bottles should be used for each sample collected and not reused in more than one site without having been thoroughly cleaned. One filter funnel adapter should also be used per sample and not reused without having been thoroughly cleaned. The 250 mL filter funnels are disposable and can be thrown away after they've been used.

6) Non-disposable materials below the filter (i.e. vacuum flask, tubing, rubber stopper) do not need to be cleaned between samples from the same site.

7) Non-disposable materials should be thoroughly cleaned between sites or at the end of the day with a 10% bleach solution (1 part household bleach with 9 part tap water) (minimum 30 min) and rinsed 2-3 times in tap water (i.e. 2 L collection bottles, vacuum flask, forceps, rubber stopper, tubing, filter funnel adapters). After bleaching and rinsing, materials should be allowed to air dry and then stored. 2L bottles should be stored with lids on once dried.

8) If water samples (500 mL) in the collection bottles are not filtered immediately it is acceptable to store them temporarily in a cooler with ice for up to 6 hours.

9) In some streams/rivers, the filter may clog before the full water volume (500 mL) has been filtered. The filtering rate may slow to individual drips separated by several seconds. Consider setting a cutoff time or drip rate for ending filtering. Squeezing the lever of the manual hand pump repeatedly can also help filter the remaining water. For example, you might end filtering when the drip rate slows to 3 drips every 10 seconds. Just make sure to take notes of the approximate volume filtered.

Sampling procedure:

For each selected site, a total of 2 water samples will be collected as well as 1 control sample (tap water). The 2 water samples should be at different locations within the site during the survey period. For each sample collected record the sampling information in the provided sample collection form. An effort should be made to collect the water sample at the location where Brook Floaters are observed or close downstream. If Brook Floaters are observed after a water sample has been collected, please indicate the GPS location and distance from the water sampling location.

The following three scenarios should be considered for guidance purposes when planning the collection of the 2 samples on a site.

Scenario 1: If Brook Floaters are known to be present at that site and have been observed in 2016, sample water above or close downstream of where the individuals are located.

Scenario 2: If Brook Floaters were observed in previous years, but not in 2016, attempt to sample above or close downstream of where individuals have historically been detected.

Scenario 3: If Brook Floaters have never been detected on a site, collect a first water sample within the first hour of the search survey in an area where the species has a higher probability of being present (suitable habitat). If Brook Floater is not found towards the end of the time-search survey, collect the second water sample at the end of the search survey period.

Note: At each site, an effort should be made to sample above Brook Floaters if they are seen.

The control sample (500 mL of tap water) should be filtered first to ensure that the equipment is clean. The 2 water samples (500 mL collected in individual 2 L bottles) can then be filtered for that site.

The 500 mL water sample or tap water must be filtered in two steps of 250mL (maximum capacity of the filter funnel).

Step 1: Equipment assembly

1) Prepare the filtering assembly as seen in Figure 2.
2) The filter paper included in the sterile filter funnel package (0.45 uM nitrocellulose filter) must be replaced with the provided 1.5 uM glass microfiber filter (GFC). The 0.45 uM nitrocellulose filter can be disposed.
3) Remove the upper chamber of the filter funnel from the membrane collar (Figure 3) and replace the filter paper with the supplied 1.5 uM GFC filter (Figure 3).
4) Re-attach upper chamber to membrane collar.

Note: Make sure that gloves are worn when replacing the filter paper and use forceps to handle filters.

Figure 2: Water filtering equipment assembly: Taken from "eDNA protocol sample collection, Goldberg & Strickler, 2015, Washington State University".

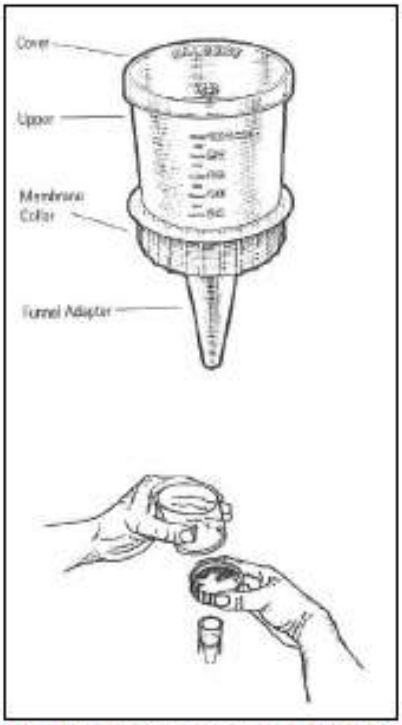

Figure 3: Filter funnel assembly and replacement/removal of filter paper.

Step 2: Water collection and filtration

1) Collect 500 mL of water from the stream/river using the provided 2 L collection bottles.

Note: Gloves do not need to be worn when collecting the water sample.

2) Pour the water sample slowly into the filter funnel up to the 250 mL mark.

Note: make sure that the filter paper has been replaced with the supplied 1.5um GFC filter.

3) Engage vacuum pump to begin filtration by squeezing the lever a few times.
4) Once the first 250mL of water has completely passed through the filter paper, slowly pour the second half (250mL) of the water sample into the funnel.

Note: The vacuum should not be to be stopped when adding the second half of the sample.

Note: Squeezing the lever of the manual hand pump a few more times can be done to help filter all the water.

5) Allow the vacuum to run for 1 min once all the water has passed through the filter to dry the filter as much as possible and keep the vacuum applied until the filter funnel has been removed from the filter funnel adapter.

Figure 4: Water filtration illustration: Taken from "eDNA protocol sample collection, Goldberg & Strickler, 2015, Washington State University".

Step 3: Filter paper removal and storage (make sure that gloves are worn for these steps)

1) Remove filter funnel from filter funnel adapter with the vacuum still applied to reduce chances of water droplets splashing from the filter funnel adaptor/vacuum flask onto the filter.
2) Remove upper chamber of the filter funnel.

Note: Some water might remain on the filter and in the membrane collar of the filter funnel once filtration is done. It is best to remove the filter from the membrane collar using the forceps,

dump the water remaining in the membrane collar and replace the filter in the membrane collar to proceed with the folding of the filter paper. Removal of as much water as possible will help with the ethanol preservation of the filter.

3) Fold filter in half once, a second time and then roll the filter so that it fits in the provided 2 mL collection tube using clean forceps (Figure 5).
4) Place filter in 2 mL collection tube containing 100% ethanol and inverse the tube a few times until the filter is completely soaked in ethanol.
5) Once at home, store the collection tubes with the ethanol preserved filters in a clean ziplock bag or box and store samples in a freezer if one is available.

Note: Ethanol preserved filters stored in a freezer can be kept for a prolonged period of time (up to 2 months).

Figure 5: Removal and folding of filter paper using forceps: Taken from "A protocol for collecting Environmental DNA Samples from Streams, Carim et al., 2016, Rocky Mountain Research Station, USDA."

Step 4: Log info in collection form and clean-up

1) Ensure that all the information requested has been captured in the provided collection form.
2) Place all non-disposable materials in the provided black plastic bag for thorough cleaning.
3) Contact Francis LeBlanc or Fabiola Akaishi to coordinate the pick-up/delivery of the samples for lab analysis.

For any question or concerns regarding this eDNA sampling protocol please contact:

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Email: francis.leblanc@dfo-mpo.gc.ca
Phone number: (506) 851-6222

Fabiola Akaishi
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