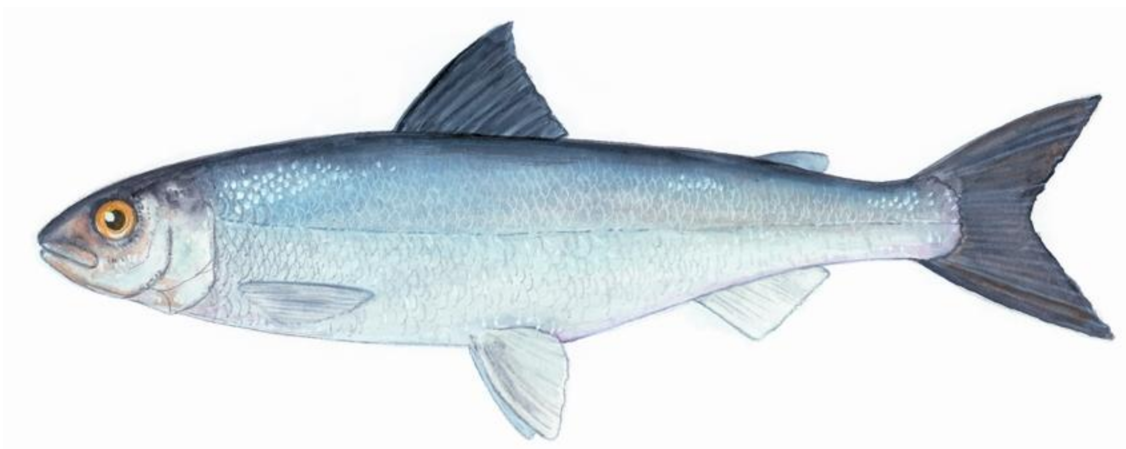
The Atlantic Whitefish Recovery Project

2011 Final Report



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INTRODUCTION

Bluenose Coastal Action Foundation

The Bluenose Coastal Action Foundation (BCAF) is a non-profit community-based charitable organization that addresses the environmental concerns within Lunenburg County, Nova Scotia. BCAF's goal is to promote the restoration, enhancement, and conservation of our ecosystem through research, education, and action. BCAF has been an established member of the Lunenburg County community since their inception in 1993. As part of the Atlantic Coastal Action Program (ACAP), BCAF was initially created to respond to the urgent need to restore human-impacted coastal environments, so that they could continue to sustain coastal communities.

Over the past 18 years, BCAF has lead several ecosystem-related projects throughout Lunenburg County. In 2011, BCAF was involved in the Roseate Tern Recovery Project, East River, Chester Elver Abundance Study, Gold River Watershed & Salmon Research Project, Mushamush River Restoration Project, LaHave River Watershed Project, American Eel Habitat Assessment Study, Environmental Home Assessment Program, and Atlantic Whitefish Recovery Project.

The Atlantic Whitefish

The Atlantic whitefish (*Coregonus huntsmani*) is a naturally anadromous, endangered fish species, which is endemic to eastern Canada. Currently, it is only found within the Petite Rivière watershed in Lunenburg County, Nova Scotia. Although it is possible that the species' range had already been reduced prior to its identification in 1922 (Huntsman, 1922; DFO, 2004a), the only known population is presently land-locked and restricted to an area of 16km^2 within three inter-connected lakes (Minamkeak, Milipsigate, and Hebb). In 1984, the Atlantic whitefish became the first Canadian fish species to be classified as "endangered" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Its "endangered" status was reconfirmed by COSEWIC in 2000, and more recently in 2010. The Atlantic whitefish was also recognized as being threatened with imminent extinction and listed as "endangered" on Schedule 1 of the federal *Species at Risk Act* (SARA) in 2003. It is protected under the *Maritime Fishery Regulations*, the federal *Species at Risk Act*, and the Nova Scotia *Endangered Species Act*. Extinction of the Atlantic whitefish would have a significant effect on the local aquatic biodiversity (COSEWIC, 2010). Therefore, with an aim to help conserve and recover the current population, BCAF has been dedicated to raising public awareness and researching the Atlantic whitefish since 2004.

The Atlantic whitefish is a coregonid species, which is classified as a subfamily within the salmonids. It was previously known as the Acadian whitefish, Sault whitefish, Round whitefish, and Common whitefish (Edge and Gilhen, 2001). Its physical resemblance to the more common Lake whitefish originally delayed its identification (COSEWIC, 2010); however, anatomical comparisons and genetic analyses have confirmed the Atlantic whitefish as a distinct species (Bernatchez et al., 1991; Murray, 2005; COSEWIC, 2010). The Atlantic whitefish has silver sides, a white belly, and a black, dark blue, or dark green back (Figure 1). It can be further identified by its deeply forked tail and the presence of a fleshy adipose fin, which lies along its back, between its dorsal and caudal fin (Scott and Scott, 1988). Land-locked individuals reach an average length of 20 to 25cm, significantly smaller than anadromous individuals, which reach an average length of 38cm (Bradford, 2000). Anatomical comparisons conducted by Hasselman et al. (2009), showed three species-specific characteristics that consistently distinguished the Atlantic whitefish from the Lake whitefish. The Atlantic whitefish was found to have shorter pectoral fin lengths, a greater number of lateral line scales (Atlantic whitefish: mean = 94; Lake whitefish: mean = 77), and a more terminal mouth position.

Figure 1: An Atlantic whitefish (*Coregonus huntsmani*).

Although the remaining Atlantic whitefish population is now only found within the Petite Rivière watershed, historically, an anadromous population was also known to inhabit the Tusket-Annis watershed in Yarmouth County, Nova Scotia. However, this population is believed to be extirpated as there have been no reported sightings since 1982 (Bradford et al., 2010). Occasional, isolated sightings have been reported in other coastal areas around Nova Scotia, including the Sissiboo River (in 1909) (Scott and Scott, 1988), Halls Harbour (in 1958) (Edge and Gilhen, 2001), the Lahave Estuary (in 1995 and 1997) (Edge and Gilhen, 2001), the Medway River (DFO 2011 Pers. Comm.), and the lower reaches of the Petite Rivière system, including Fancy Lake (DFO, 2006). It is likely that these individuals were remnant members of the Petite Rivière and/or Tusket-Annis populations (DFO, 2006).

Threats

A number of factors have been identified as threats to the survival of the Atlantic whitefish, although, it is uncertain which of the current threats played a significant role in the decline of the species in earlier years (Bradford et al., 2010). The following threats, identified by COSEWIC, are thought to have either lead to the decline of the population, and/or are currently threatening the survival of the Atlantic whitefish: habitat degradation, fishery-related bycatch, the introduction of non-native invasive species, and barriers to fish passage.

Habitat Degradation

Acidification caused by acid rain has been identified as a major cause of habitat loss and degradation. Many of the rivers in southwest Nova Scotia are naturally acidic but have become more acidic in recent years. Acidification likely played a significant role in the extirpation of the Tusket-Annis population, and it has also been identified as major factor in the decline of wild Atlantic salmon throughout the region (DFO, 2000). Fortunately, the Atlantic whitefish is considered to be relatively tolerant to acidic conditions (Cook et al., 2010), and due to its buffering capacity, the Petite Rivière tends to maintain a slightly higher pH than other rivers in the area (COSEWIC, 2010).

Fishery-Related Bycatch

Historically, unregulated fishing practices and poaching may have had a significant impact on the decline of the species (Bradford et al, 2004b). The once abundant Atlantic whitefish was targeted as a food and sport fish, and was also a common bycatch product in the gaspereau gillnet fishery (Bradford, 2004a). It has also been suggested that the Atlantic whitefish may have been harvested in large quantities for use as lobster bait and fertilizer (Cited in DFO, 2006; Scott and Scott, 1988; P. Longue, DFO, 2001 Pers. Comm.). Legal harvesting of the Atlantic whitefish and harmful bycatch fisheries ceased in the Petite Rivière prior to 1980, and Section 6 of the *Maritime Provinces Fishery Regulations*, which came into effect in 1993, specifically banned the catch, retention, and possession of the Atlantic whitefish (DFO, 2006). Presently, incidental catch by recreational anglers may have a small impact on the current population (COSEWIC, 2010).

Non-Native Invasive Species

The introduction of non-native invasive species into Nova Scotia's lakes and rivers with the purpose to enhance recreational angling activities continues to pose a threat, not only to the Atlantic whitefish, but also to other native fish species. The introduction of chain pickerel (*Esox niger*) into the Tusket-Annis watershed has been linked to the decline of several species, as well as the extirpation of the Atlantic whitefish (Bradford et al., 2004b). Another illegally introduced species, the smallmouth bass (*Micropterus dolomieu*), has been identified as a potential threat to the remaining Atlantic whitefish population in the Petite Rivière. The effect of smallmouth bass on native fish populations in other watersheds has been well documented (COSEWIC, 2010) and potential impacts include direct predation, trophic disruption, and habitat competition (Jackson, 2002).

Smallmouth bass are a member of the sunfish family, *Centrarchidae*, and due to their ability to fight when hooked, they are considered to be a great angling fish. The increased popularity in smallmouth bass angling has lead to the illegal introduction of this species throughout Canada. Smallmouth bass were first introduced to Nova Scotia in 1908 and were first recorded in the Petite Rivière in 1994 (Bradford et al., 2004b). Angling and nesting surveys have shown that that smallmouth bass are becoming well established in the Petite Rivière watershed.

Barriers to Fish Passage

Southwest Nova Scotia's rivers have had an extensive damming history. The Atlantic whitefish population, which is believed to be naturally anadromous, has been land-locked for at least several decades, and perhaps for well over a century, due to a series of dams constructed along the Petite Rivière since the late 1700s (Sodero, 1994; DFO, 2006). At least 48 known mills, producing lumber, flour, laths, and shingles, were operated on the Petite Rivière between 1783 and 1973 (Sodero, 1994). Present barriers include: structures at Crousetown, Conquerrall Mills, Hebbville, Milipsigate Lake, and Minamkeak Lake.

Table 1: Descriptions of barriers to fish passage in the Petite Rivière [DFO, 2004b; DFO, 2006 (adapted from Conrad, 2005); Fielding, 2011].

DAM	DESCRIPTION	CONSTRUCTION DATES
Crousetown	A 2.4m high timber dam located at a former sawmill site. The dam includes a run-around channel fishway constructed from loose stone. Considered to be inefficient for fish passage.	Current structure built in 1889; fishway repaired in 1945 (previous dam may have been constructed as early as 1802).
Conquerrall Mills	The dam at the former Conquerrall Mills hydroelectric site was partially dismantled, allowing a 9m space between the remaining concrete abutments. The resulting series of rapids constitutes a 1.2m drop, which may present a velocity barrier to Atlantic whitefish travelling upstream.	Installed in 1939; operation ceased in 1971; dam was breached in 1979.
Hebbville	A hydroelectric facility, which operated between 1939 and 1971. It currently serves as a storage dam at the base of Hebb Lake for the Town of Bridgewater's source water supply. It consists of a concrete flow-control structure and a long rock and earth filled berm. This dam was upgraded in 2011 to include a fish passage facility, which should be operational in 2012.	Initial construction could have been as early as 1901; new dam constructed between 1971-1974; upgraded in 2011.
Milipsigate	A concrete dam structure operated by the Town of Bridgewater for flow regulation and water storage purposes. Other than the spillway, no fish passage is provided at this dam.	1939 (approx.); upgraded in 2011.
Minamkeak	The uppermost storage dam for the Town of Bridgewater for flow regulation and water storage purposes. Other than the spillway, no fish passage is provided at this dam.	1939 (approx.); upgraded in 2011.

The Hebbville Dam has been the main barrier blocking upstream fish passage into Hebb Lake since the early 1900's (DFO, 2006). During the summer and fall of 2011, upgrades were made to the Hebbville Dam and a fish passage facility, including a fishway and fish trap, was constructed (Figure 2). The new structure will facilitate monitoring and sampling activities, and will also allow fish that have fallen over the dam to return to their present habitat and spawning grounds. A recent study showed that juvenile Atlantic whitefish are tolerant to, and even have a preference for, seawater (Cook et al., 2010). Ultimately, the newly constructed fish passage facility could potentially reintroduce and establish anadromy among the land-locked Atlantic whitefish population.

Figure 2: The Hebbville Dam showing part of the newly constructed fishway.

Recovery Strategy

Recovery of the Atlantic whitefish is considered to be both biologically and technically possible (DFO, 2006). It is believed that a minimum population size of 550 to 2000 mature adults is required to maintain genetic diversity (DFO, 2006; DFO, 2009). Although current abundance is considered to be critically low, an accurate population estimate is not available. The remaining Atlantic whitefish population could be undergoing or recovering from a genetic bottleneck, which puts the species at risk of imminent extinction, should a catastrophic event occur (DFO, 2009). Therefore, in accordance with SARA section 37, a recovery strategy (DFO, 2006) has been developed for protection and conservation the Atlantic whitefish. The ultimate goal of the Recovery Strategy is *"to achieve stability in the current population of Atlantic whitefish in Nova Scotia, reestablishment of the anadromous form, and expansion beyond its current range"* through the following strategic objectives (DFO, 2006):

1. *Conserve, protect, and manage the species and its habitat;*
2. *Increase the number and range of viable populations;*
3. *Increase understanding of the species and its habitat, and;*
4. *Increase public involvement and acceptance.*

Goals and Objectives

Compared to other salmonid species, little is known of the biology, life-history, habitat requirements, or abundance of the Atlantic whitefish. BCAF's Atlantic Whitefish Recovery Project (AWRP) team has been working together with federal, provincial, and municipal governments, local universities, anglers, and environmentally-focused community organizations in researching the Atlantic whitefish. The potential impacts of recent upgrades to the Hebbville Dam, particularly the construction and future operation of the fishway, initiated many of the research activities conducted during the 2011 spring and summer field season. This study focused on the following four objectives:

1. To increase Atlantic whitefish awareness within the community;
2. To monitor the presence of smallmouth bass in Milipsigate Lake and the spread of smallmouth bass into Hebb Lake;
3. To ensure suitable Atlantic whitefish habitat below the Hebbville Dam; and
4. To monitor water quality throughout the Petite Rivière watershed.

Methods

Study Area

All sampling took place within the Petite Rivière watershed (Figure 3) between May and August 2011. Data were collected from two lakes, Milipsigate and Hebb, as well as the main branch of Petite Rivière below the Hebbville Dam, and several tributaries feeding into the river.

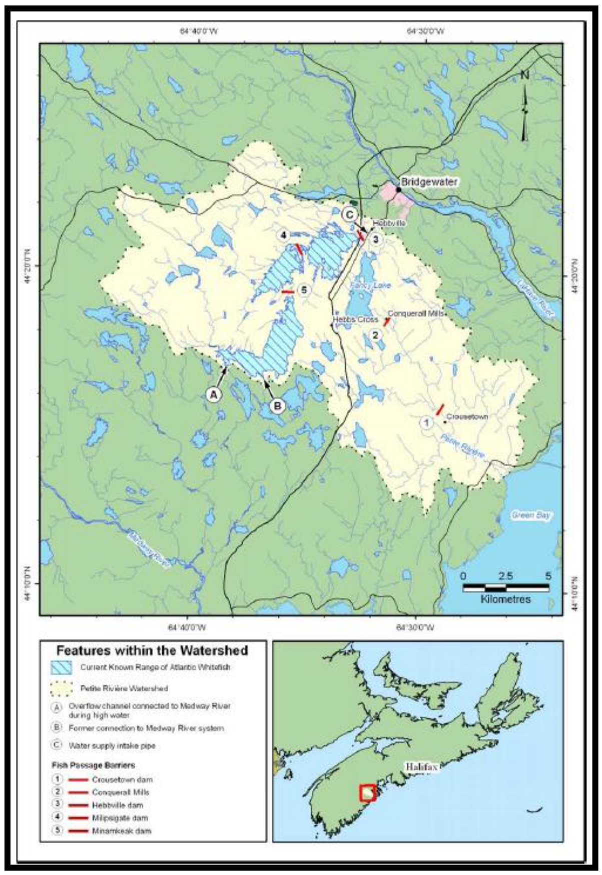

Figure 3: Map of the Petite Rivière watershed showing the three lakes (Minamkeak, Milipsigate, and Hebb), which contain the remaining Atlantic whitefish population, and the dams that currently impede fish passage.

Outreach and Education

Educating local youth in Atlantic whitefish identification and the importance of releasing and reporting Atlantic whitefish captures was the main focus of this summer's outreach campaign. The AWRP team delivered Atlantic whitefish presentations at local schools (Grades three to five) and at Camp Mushamush. BCAF employees also set up a display board and participated in local farmers markets, festivals and events, including a children's fishing derby, the Kejimkujik Mi'kmaw Celebration and Park Days, the Bridgewater Sustainability Festival, the Bridgewater Big Exhibition Parade, and the Mahone Bay Regatta and Pirate Festival. Educational materials such as Atlantic whitefish brochures, activity books, fish identification cards, tattoos, and postcards were distributed at these events to promote public awareness.

Fish Assemblage Surveys

Angling Surveys

Angling trials commenced in Milipsigate Lake in May 2011. Using a 14-foot aluminum boat and a four-stroke motor, a range of habitats were fished including shallow rocky shores, grassy patches, deep sections (>10m), and areas with flowing water (including inputs and outputs). In accordance with DFO Licence # 332017 only unbaited lures were used.

The focus of the fish assemblage survey shifted to determine the establishment of a smallmouth bass population below the Milipsigate Dam and in Hebb Lake, as the angling trials in Milipsigate Lake showed an abundance of smallmouth bass. Ten sites within the outlet between Milipsigate and Hebb Lakes, and four sites within Hebb Lake (near the input) were fished between late morning and afternoon for a minimum of 30 minutes per site. Each fish angled was photographed and safely released back into the water. The GPS coordinates as well as the following data were recorded:

- Weather conditions
- Sampling time at each site
- Habitat description
- Average water depth at each site
- Catch data: species, total length, life stage, water depth, type of lure used, and time of catch

Minnow Traps

Three minnow trap trials were completed this season. The first bait trial was completed in Milipsigate Lake (44°20'28.50"N 64°35'27.30"W). Ten black minnow pots were baited with ten different types of bait: corn, white bread, sardines, salmon, three types of wet cat food, one type of wet dog food, beef liver, and tuna. The baits were placed in cheese cloth and tied to the inside of each trap. The traps were set in a shallow grassy cove and were retrieved after 24 hours to determine an optimal bait type.

Following an unsuccessful first trial, a second bait trial was completed in the outlet between Hebb Lake and Milipsigate Lake. Five types of bait (corn, white bread, beef liver, sardines, and cat food) were tested in duplicate in two different habitat locations. Five traps were set in Location 1 (44°20'43.09"N

64°35'7.42"W), which was a shallow beach area, and the remaining five traps were set in Location 2 (44°20'43.91"N 64°35'7.18"W), which was a rocky cove with a steep drop. All traps were set in less than 35cm of water and the follow data were recorded:

- Weather conditions
- Amount of time the traps were set
- Habitat description
- Water quality parameters (measured using a YSI Sonde): temperature (°C), dissolved oxygen (% saturation and mg/L), conductivity (mS/cm), TDS (g/L), salinity, and pH
- Estimated water depth
- Catch data: species, total length, life stage, water depth, and type of bait used

The traps were retrieved after 24 hours. All captured fish were transferred to a holding bucket and identified using the “Small Fish Identification Guide” created by UNB’s Canadian Rivers Institute.

Following the same protocol as above, minnow traps were set for a third time using only white bread as bait. The previous bait trial showed that the traps baited with white bread were the most successful. The ten traps were again set within Location 1 (44°20'43.09"N 64°35'7.42"W) and Location 2 (44°20'43.91"N 64°35'7.18"W). The traps were retrieved after 22 hours, the catch data were recorded, and each fish was photographed and safely released back into the water.

Smallmouth Bass Nesting Surveys

Smallmouth bass nesting surveys were conducted in Milipsigate Lake between late-June and early-July 2011. Surveys took place on calm sunny days when nests were more clearly visible from above the water. All surveyors wore polarized sun glasses to reduce water glare. Initially, a 14-foot aluminum boat was rowed along shore and nests were examined using a “viewfinder”. To improve nest identification, surveyors began snorkelling along the edge of the shoreline to view nests more clearly. Masks, snorkels, wetsuits, and fins were used while snorkelling. Visible nests were marked with flagging tape and classified as:

- A – newly excavated
- B – eggs present
- C – fry present
- D – fry dispersed

Water Quality Monitoring

Water quality monitoring took place between May 4, 2011 and September 23, 2011 on a biweekly basis. A YSI Sonde was used to monitor 18 sites throughout the Petite Rivière watershed. The Sonde was calibrated prior to each monitoring activity to ensure accurate field readings. At each site, the Sonde was submerged in the water for two to five minutes or until stabilized. Once stabilized, the following water quality parameters were recorded:

- Temperature (°C)
- Dissolved oxygen (% saturation and mg/L)
- Conductivity (mS/cm)
- Total Dissolved Solids (TDS) (g/L)
- Salinity
- pH

Petite Rivière Temperature Monitoring

As part of the NSLC Adopt-a-Stream Temperature Monitoring Program, four temperature loggers (one stationary air temperature logger, one stationary main branch water temperature logger, one stationary tributary water temperature logger, and one mobile water temperature logger) were place within the Petite Rivière watershed. The stationary air temperature logger was fastened to a tree at Wallace Brook (44°16'19.90"N 64°31'30.20"W). The water temperature loggers were encased in PVC tubing for protection, then attached to a large rock with string, and submerged in the water. A stationary water temperature logger was placed in the main branch of the Petite Rivière (44°14'37.00"N 64°28'24.70"W). A second stationary water temperature logger was placed in Wallace Brook (44°16'19.90"N 64°31'30.20"W). All temperature loggers were set on June 15, 2011 and retrieved on September 7, 2011; however, a third water temperature logger, which was designated as a mobile logger was moved to a different tributary every two weeks. Temperature readings were taken every hour and the following data were recorded at each site:

- Date, time, GPS coordinates
- Stream name
- Stream depth
- Stream width
- Riparian zone characteristics

Habitat Assessments

Habitat assessments were conducted between the Hebbville Dam and the Petite Rivière Bridge from May 27, 2011 to September 12, 2011. Assessment protocols were in accordance with the NSLC Adopt-A-Stream Program. The river was divided into 27 sections based on physical barriers or changes in habitat. A minimum of two AWRP members walked the length of each section. The following parameters were either measured or noted:

- GPS coordinates - start and finish of each section
- Weather conditions - current and recent (past two days)
- Water level - high, medium, or low
- Water appearance - clear, foamy, tea-brown, milky, muddy
- Water quality (measured using a YSI Sonde) - temperature (°C), dissolved oxygen (% saturation and mg/L), conductivity (mS/cm), TDS (g/L), salinity, and pH
- Channel width - average width measured using a 30m measuring tape
- Water movement - shallow/fast, shallow/slow, deep/fast, deep/slow
- Velocity - estimated by measuring the average amount of time taken for a fishing bobber to travel 5 meters
- Substrate type and size - percentage of boulder, cobble, gravel, pebble, sand, and silt
- Substrate embeddedness
- Physical habitat description
- Riffle, run, pool sequence
- Pool size - measured using a 30 meter measuring tape
- The presence of obstructions or barriers
- Bank conditions
- Streamside vegetation - percentage of hardwood trees, softwood trees, alders, shrubs, grasses, manicured grasses, farm fields, and wetland along the banks
- Evidence of invertebrates - rocks were overturned and examine for the presence of invertebrates
- Wildlife - evidence of fish, birds, and animals were noted
- Human impacts and adjacent land uses
- Issues that need to be addressed

The habitat assessment data will be used to determine the suitability of the Petite Rivière as Atlantic whitefish habitat and to address any habitat restoration issues.

RESULTS

Fish Assemblage Surveys

Angling Surveys

Angling surveys confirmed the establishment of smallmouth bass in the outlet section between Milipsigate and Hebb Lakes (Table 2). Within this area, ten sites were fished and smallmouth bass were the only species caught. The majority of bass were angled from shallow water (~1m or less) and ranged in size from 10 to 35cm in total length.

No smallmouth bass were angled from Hebb Lake. Six yellow perch (*Perca flavescens*), ranging in size from 10 to 17cm were caught in near shore, shallow water. Habitat type varied slightly between the two areas fished. The outlet consisted of several shallow, rocky coves and ledges, whereas Hebb Lake appeared to have higher levels of silt and slightly more vegetation.

Table 2: Data obtained from angling in the outlet and in Hebb Lake between July 18, 2011 and August 3, 2011.

Site	Habitat description	Species	Total Length	Depth
Millipsigate to Hebb Lake Outlet				
Site 1 44°20'45.9"N 64°35'02.2"W	Deep channel with shallow rocky banks	Smallmouth Bass Smallmouth Bass	14cm 20cm	~1m ~1m
Site 2 44°20'43.69"N 64°35'7.79"W	Rocky point with a shallow beach to the right and a rocky shore with a deep drop to the left	Smallmouth Bass Smallmouth Bass Smallmouth Bass Smallmouth Bass Smallmouth Bass Smallmouth Bass Smallmouth Bass Smallmouth Bass Smallmouth Bass	16cm 20cm 21cm 22cm 25cm 25cm 26cm 28cm 35cm	Surface ~1m <1m ~1m >1m ~1m <1m <1m <1m
Site 3 44°20'44.23"N 64°35'13.89"W	Steep rocky drop with flowing water on the right	Smallmouth Bass Smallmouth Bass	11cm 16cm	<1m Surface
Site 4 44°20'43.22"N 64°35'14.97"W	Shallow rocky cove with little vegetation	Smallmouth Bass	19cm	<1m
Site 5 44°20'44.74"N 64°35'14.95"W	Shallow stream with fast running water and a deep drop	Smallmouth Bass Smallmouth Bass Smallmouth Bass Smallmouth Bass	12cm 12cm 23.5cm 25cm	<1m <1m N/A N/A

Site 6 44°20'44.40"N 64°35'16.20"W	Small cove with a steep rocky drop	Smallmouth Bass Smallmouth Bass	22cm 22cm	N/A N/A
Site 7 44°20'40.87"N 64°35'14.28"W	Cove with a deep drop, cobble/rocky bottom, and little vegetation	Smallmouth Bass Smallmouth Bass Smallmouth Bass	10cm 10cm 29cm	<1m <1m ~1m
Site 8 44°20'44.80"N 64°35'17.40"W	Rocky shore with several large exposed rocks, the presence of lily pads and grass, and a shallow silty bottom	Smallmouth Bass Smallmouth Bass	11cm 24cm	<1m >1m
Site 9 44°20'41.23"N 64°35'18.93"W	Narrow, rocky channel with fast flowing water	Smallmouth Bass Smallmouth Bass	10.5cm 20cm	Surface Surface
Site 10 44°20'42.09"N 64°35'20.47"W	Rocky shore with a deep drop	Smallmouth Bass Smallmouth Bass	11cm 12cm	>1m Surface
Hebb Lake				
Site 11 44°20'40.61"N 64°34'59.80"W	Rock/cobble, silty bottom with small patches of vegetation, adjacent to the inflow into Hebb Lake	Yellow Perch Yellow Perch	15.5cm 17cm	<1m <1m
Site 12 44°20'40.10"N 64°34'51.90"W	Rocky island with a shallow cobble shore, deep drop, silty bottom, and small patches of vegetation	Yellow Perch Yellow Perch	11cm 11.5cm	<1m <1m
Site 13 44°20'38.40"N 64°34'59.51"W	Shallow cobble shore, silty bottom with small patches of vegetation, adjacent to inflow	Yellow Perch	13.5cm	<1m
Site 14 44°20'20.68"N 64°34'51.06"W	Rocky outcrop with patches of vegetation	Yellow Perch	10cm	Shallow

Minnow Traps

Three banded killifish (*Fundulus diaphanous*) and one juvenile smallmouth bass were caught in the minnow traps (Table 3). The catch data provided in Table 3 includes: site location, habitat description, species type, total length, trap depth, and the type of bait used. A water quality sample was also taken from Site 1 on July 21, 2011: Temperature = 25.91; Conductivity = 28; Salinity = 0.01; TDS = 0.018; pH = 6.47; DO% = 100.5; DO mg/L = 8.18.

Table 3: Data obtained from minnow traps set in the Milipsigate to Hebb Lake outlet. Traps were set July 20-21, 2011 and July 28-29, 2011.

Site	Habitat Description	Species	Total Length	Depth	Bait Used
Millipsigate to Hebb Lake Outlet					
Site 1 44°20'43.09"N 64°35'7.42"W	Shallow beach area with pebble, sand, silt, and eel grass	Banded Killifish Banded Killifish Banded Killifish	8.2cm 7.5cm 8.5cm	33cm 35cm 35cm	White Bread White Bread White Bread
Site 2 44°20'43.99"N 64°35'7.09"W	Small rocky cove with a deep drop, no grass present	Smallmouth Bass	11cm	30cm	Corn

Each fish caught during the fish assemblage surveys was photographed and safely released back into the water (Figures 4, 5, and 6).

Figure 4: Juvenile smallmouth bass angled from the outlet between Milipsigate and Hebb Lakes.

Figure 5: Juvenile yellow perch angled from Hebb Lake.

Figure 6: Banded killifish caught in a minnow trap that was set in the outlet between Milipsigate and Hebb Lakes.

Smallmouth Bass Nest Surveys

Although smallmouth bass nest surveys were attempted, a delayed start in the survey resulted in insufficient data.

Water Quality Monitoring

The following sites were monitored for water quality on a biweekly basis from May 12, 2011 to September 23, 2011 (Table 4):

Table 4: The water quality sites monitored throughout the Petite Rivière watershed.

	Site	GPS Coordinates
1	Milipsigate Lake (above the Milipsigate Dam)	**44°20'40.02"N 64°35'27.14"W**
2	Hebb Lake (below Milipsigate Dam)	**44°20'40.31"N 64°35'26.39"W**
3	Birch Brook	**44°19'57.95"N 64°38'6.16"W**
4	Minamkeak Lake	**44°17'0.40"N 64°38'27.59"W**
5	Minamkeak Dam	**44°19'11.32"N 64°35'55.59"W**
6	Fancy Lake	**44°18'15.84"N 64°33'41.42"W**
7	Hebb Lake outlet (Cranberry farm)	**44°21'1.90"N 64°32'23.37"W**
8	Hebbville dam	**44°21'6.88"N 64°32'43.34"W**
9	Fancy Lake Picnic Park	**44°19'42.13"N 64°31'57.01"W**
10	Fancy Lake Outlet	**44°18'45.68"N 64°31'57.83"W**
11	Conquerrall Mills	**44°18'29.11"N 64°31'32.06"W**
12	Hebb Mill Brook	**44°17'28.16"N 64°30'52.52"W**
13	Italy Cross Intersection (Wallace Brook)	**44°15'43.03"N 64°29'19.27"W**
14	Crousetown Dam	**44°15'42.52"N 64°29'5.62"W**

15	Brown Branch Brook Bridge	**44°14'52.35"N 64°28'37.95"W**
16	Tannery Road Bridge	**44°14'16.73"N 64°27'35.12"W**
17	Wamback Mill Brook	**44°14'19.61"N 64°27'22.02"W**
18	Petite Rivière Bridge	**44°14'3.02"N 64°26'46.33"W**

Due to road construction, the Tannery Road Bridge and Wamback Mill Brook sites were inaccessible between June 15, 2011 and July 11, 2011. Water quality readings were not taken at the Fancy Lake outlet on May 12, 2011, August 8, 2011, or September 23, 2011 due to restricted access.

The temperature at all sites, except Birch Brook, Wamback Mill Brook, and the Petite Rivière Bridge, exceeded 22°C during the peak summer period (Figure 7). The highest temperature readings were recorded at Conquerrall Mills (26.20°C), Hebb Mill Brook (26.02°C), Fancy Lake outlet (25.94°C), Hebb Lake outlet (25.49°C), Fancy Lake Picnic Park (25.43°C), and the Hebbville Dam (25.07°C) on July 25, 2011.

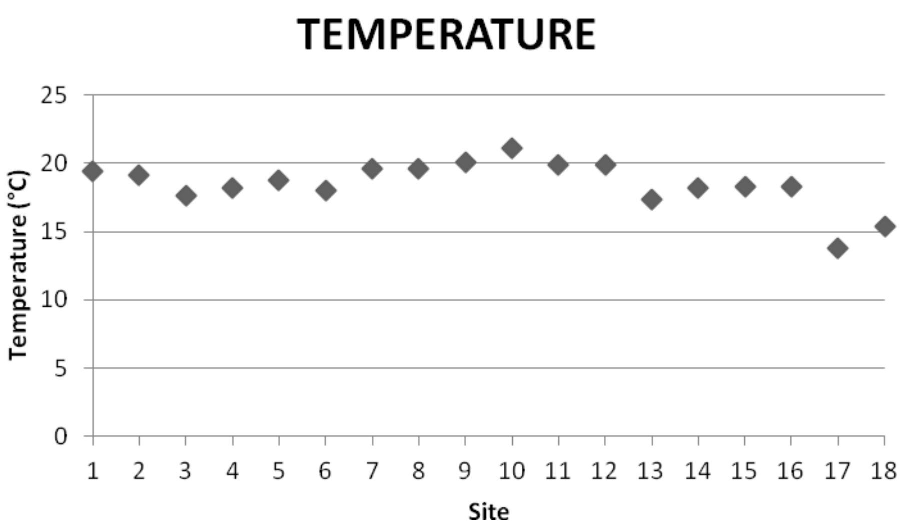

Figure 7: Average temperature readings at each of the 18 sites monitored.

For the most part, the pH readings within the watershed remained above 5.0 (Figure 8). pH levels were at their lowest during the spring months and peaked in the summer when water temperatures were at their highest. Average readings over the monitoring period remained between 5.0 and 7.0 at all sites. Milipsigate Lake, Hebb Lake, Conquerrall Mills, and the Petite Rivière Estuary had the highest average pH readings, which were all above 6.10. Sites along the main branch of the river below the Hebbville Dam, maintained average pH readings between 5.44 and 5.89. A few tributary streams had, on average, consistently lower pH readings, including Birch Brook (Average = 5.11; Low = 4.47), Wamback Mill Brook

(Average = 5.26; Low = 4.43); Hebb Mill Brook (Average = 5.19; Low = 4.44); and the Italy Cross Intersection (Wallace Brook) (Average = 5.44; Low = 4.94).

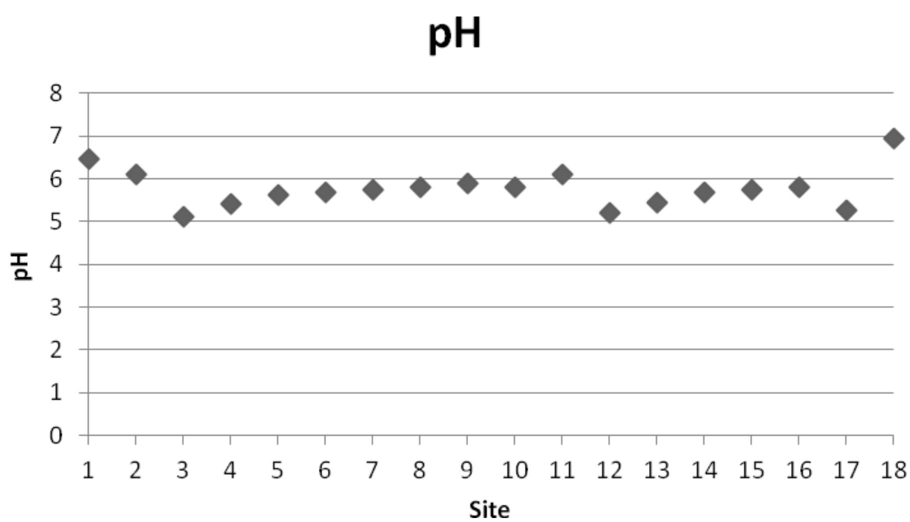

Figure 8: Average pH readings at each of the 18 sites monitored.

On average, dissolved oxygen levels were lowest at Birch Brook, Fancy Lake, and Hebb Mill Brook (Figure 9). Occasionally, the dissolved oxygen levels dipped below acceptable levels [7mg/l at temperatures <15°C; and 9mg/l at temperatures ≥15°C (Raleigh, 1982)] at all sites during warmer temperatures. However, there may have been inaccuracies in the readings due to difficulties in calibrating the dissolved oxygen probe. Despite the possible inaccuracies, the Fancy Lake and Hebb Mill Brook sites consistently had the lowest dissolved oxygen readings. At these two sites, some readings fell below 5mg/l, which is considered to be the minimum tolerable dissolved oxygen concentration for salmonids (Raleigh, 1982).

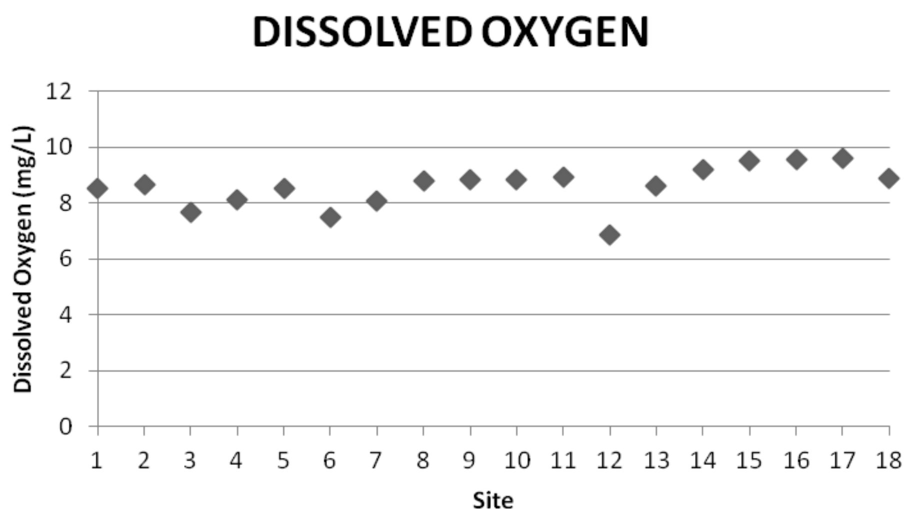

Figure 9: Average dissolved oxygen readings (mg/L) at each of the 18 sites monitored.

Salinity measurements were relatively consistent among sites and averaged between 0.01 and 0.025ppt outside the tidal zone (Figure 10). Salinity increased slightly, averaging 0.05ppt at the Fancy Lake site, which sits adjacent to a culvert and the Highway 103 intersection.

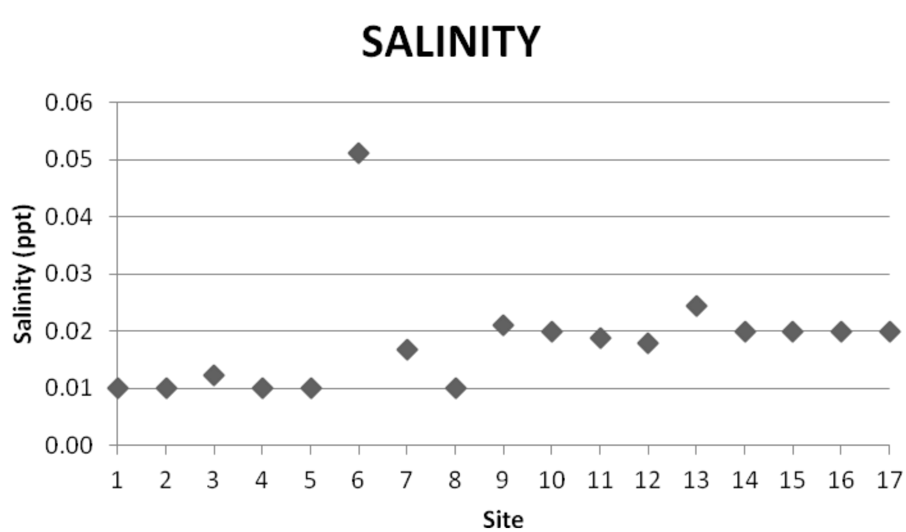

Figure 10: Average salinity reading at each of the 17 (non-tidal) sites monitored.

Average total dissolved solids (TDS) remained consistent between 0.02 and 0.03 g/L for all non-tidal sites except Fancy Lake (average TDS=0.07 g/L) (Figure 11). The increased TDS at this particular site may be due to the elevated salinity, or road and storm water runoff.

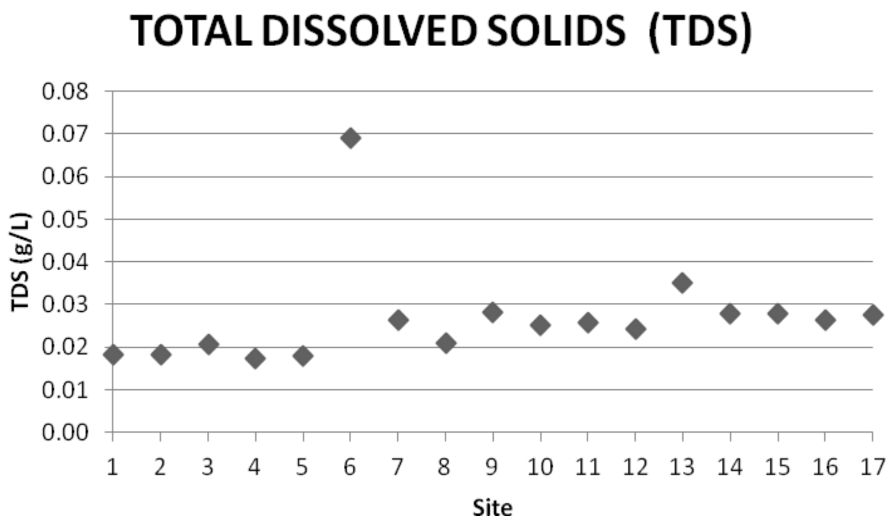

Figure 11: Average total dissolved solids (TDS) reading at each of the 17 (non-tidal) sites monitored.

Conductivity remained slightly lower in the upper reaches of the watershed (Sites 1 – 5) (Figure 12). Conductivity was slightly higher at the Italy Cross Intersection site, where Wallace Brook flows into the main branch of the river, and it was significantly higher at the Fancy Lake site. The increased conductivity at these two sites may also be due to the elevated salinity, or road and storm water runoff.

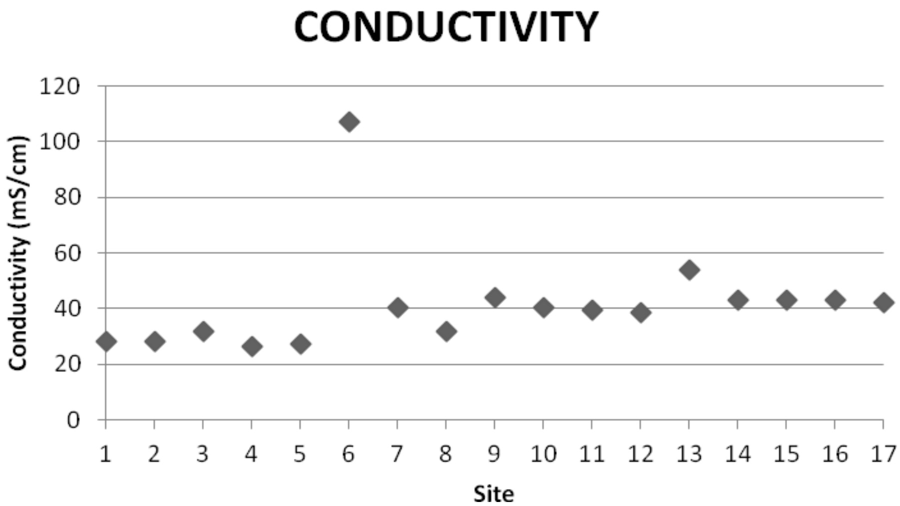

Figure 12: Average conductivity readings at each of the 18 sites monitored.

Petite Rivière Temperature Monitoring

Site information relating to the NSLC Adopt-a-Stream Temperature Monitoring Study is shown in Table 5. The data is currently being analyzed by Nova Scotia Department of Fisheries and Aquaculture as part of a broader temperature monitoring study involving several rivers systems throughout Nova Scotia. The raw data shows that temperatures peaked in Wallace Brook at 29.8°C on July 22, 2011 and in Hebb Mill Brook at 28.7°C on July 25, 2011. The temperature in the main branch of Petite Rivière peaked on July 7, 2011, reading 25.2°C.

Table 5: Temperature logger site information.

Logger	Site	GPS coordinates	Date deployed	Date removed	Stream width (m)	Average depth (cm)	Right buffer	Left buffer
Stationary Main Branch	Petite Rivière	44°14’37.0”N 64°28’24.7”W	June 15	Sept 7	17	80	18m mixed hardwood / softwood; 5m grass, then a main road	30m mixed hardwood / softwood
Stationary Tributary	Wallace Brook	44°16’19.9”N 64°31’30.2”W	June 15	Sept 7	6.3	44	30m+ hardwood (95%), softwood (5%)	30m+ hardwood (95%), softwood (5%)
Stationary Air Logger	Wallace Brook	44°16’19.9”N 64°31’30.2”W	June 15	Sept 7	-	-	30m+ hardwood (95%), softwood (5%)	30m+ hardwood (95%), softwood (5%)
Mobile Tributary	Location 1 (Brown Lake Brook)	44°16’27.3”N 64°27’25.2”W	June 15	July 12	2	40	30m+ mixed hardwood / softwood	30m+ mixed hardwood / softwood
Mobile	Location 2	44°14’52.6”N	July 12	July 25	6	30	6m grass and	0.5m grass and

Tributary	(Brown Branch Brook)	64°28’37.3”W					bush; 30m+ mixed hardwood / softwood	bush; 30m+ mixed hardwood / softwood
Mobile Tributary	Location 3 (Hebb Mill Brook)	44°17’27.8”N 64°30’81.8”W	July 25	Aug 18	4	22	Grass; 10m hardwood; driveway	Long grass; 20m hardwood; driveway.
Mobile Tributary	Location 4 (Birch Brook)	44°19’54.22”N 64°38’7.93”W	Aug 18	Sept 1	2	25	30m+ mixed hardwood / softwood	30m+ mixed hardwood / softwood
Mobile Tributary	Location 5 (Wildcat Brook)	44°22’0.03”N 64°35’0.05”W	Sept 1	Sept 7	5	26	30m+ mixed hardwood / softwood	30m+ mixed hardwood / softwood

Habitat Assessments

Hebbville Dam to Fancy Lake

The river section between the Hebbville Dam and Fancy Lake has been highly modified. The presence of the Hebbville Dam, the Highway 103 overpass, cranberry farm flood gates, irrigation pumps, and adjacent farm properties could have an impact on fish habitat. There are several rock shelves that could be potential barriers in extreme low water conditions and the riparian zone has been cleared in certain areas. However, at the time of assessment (May 27, 2011) the in-stream habitat appeared good. This section has two large pools, and there was adequate water flow, sufficient in-stream cover, and the presence of invertebrates. Potential concerns include road runoff, nutrient input from farms, water withdrawal for irrigation, loss of riparian zone, and potential barriers (dam, food gates, rock shelves) in extreme low water conditions.

Fancy Lake to Conquerrall Mills Dam

The section of the river between Fancy Lake and the old Conquerrall Mills Hydroelectric Power Plant is less developed, although, there are a few river-side residential properties and a mature red pine plantation in behind the old dam site. At the time of assessment (June 17, 2011 to July 4, 2011), the in-stream habitat appeared to be good. There was adequate water flow, sufficient in-stream fish cover, the presence of invertebrates, a healthy riparian zone, and evidence of aquatic wildlife. One large pool, which appeared to be a popular fishing site, had an abundance of fish. A smallmouth bass and a white perch were angled from this pool. The main concerns in this area are potential property development, forestry activities related to the tree plantation, and a long riffle/run section with no real pools (923m).

Conquerrall Mills to Stewart’s Bridge Road

Although this section is mostly undeveloped, it begins at the former Conquerrall Mills Dam site, where two concrete abutments remain (Figure 13). The concrete structure creates a fast flowing drop that could be a potential velocity barrier for upstream migrating fish. Throughout the section, the in-stream habitat appeared to be good. At the time of assessment (August 2, 2011 to September 1, 2011), there was adequate flow, sufficient in-stream fish cover, a healthy riparian zone, and the presence of invertebrates. There appeared to be a man-made pool formed from a digger log near the middle of the section, which held several fish. Visible species included several (10+) smallmouth bass and three white suckers. As the river runs through a large stillwater, the water colour changes from clear to tea-brown. Potential concerns include large quantities of algae, which might indicate a nutrient input source, long straight river sections with no well defined pools, ATV tracks through the river, signs of garbage (an old oil can), potential logging activities, and possible signs of erosion along some of the banks.

Figure 13: The current structure remaining at the old Conquerrall Mills Dam site.

Stewart's Bridge Road to Crousetown Dam

There is little residential development along the river between Stewart's Bridge Road and the Crousetown Dam. This section contains a variety of habitats including a long stillwater and several fast flowing sections. The current Crousetown Dam holds back a significant amount of water creating a large pool above the dam that meanders around the bend at the Italy Cross Intersection. Throughout this section, the in-stream habitat appeared to be good. At the time of assessment (August 23, 2011 to August 24, 2011), there was adequate flow, sufficient in-stream fish cover, and the presence of invertebrates. Potential concerns include long stretches of riffles and runs with no well defined pools (1400m), property development, cleared banks in front of the properties and along the roadside, and road runoff at the Italy Cross Intersection. The structural condition of the Crousetown Dam and the efficiency of fish passage through the existing fishway are major concerns. The dam structure is old and the run-around style fishway could present a velocity barrier (Figures 14 and 15).

Figure 14: The old mill and dam at Crousetown.

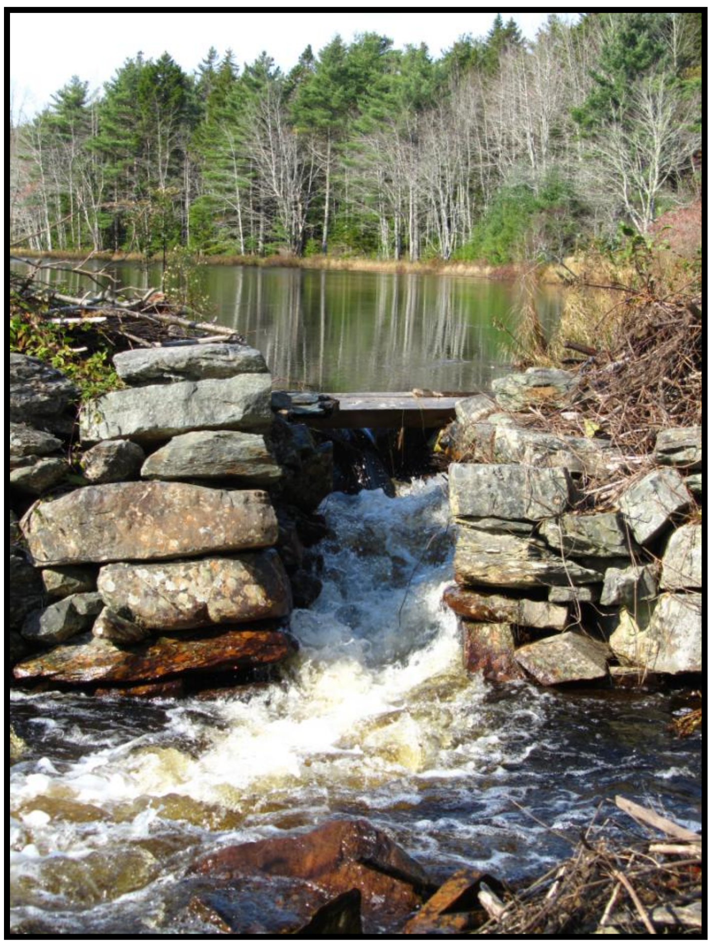

Figure 15: Fishway at Crousetown Dam.

Crousetown Dam to Brown Branch Brook

Residential development increases near the end of this section where the Petite Rivière Road meets the river. There is one large property in the middle of the section and a few smaller river-side properties closer to the Brown Branch Brook input. Throughout this section, the in-stream habitat appeared to be good. There are several pools, large boulders, and fast flowing sections. At the time of assessment (August 23, 2011), there was adequate flow, sufficient in-stream fish cover, the presence of invertebrates, and several well defined pools. Potential concerns include road runoff and a loss of riparian zone in front of the properties and along the roadside.

Brown Brook Bridge and Petite Rivière Bridge

The river has been highly modified between Brown Branch Brook and the Petite Rivière Bridge. The entire section follows adjacent to the Petite Rivière Road and flows into the Petite Estuary. During the summer (2011) the road was resurfaced, new culverts were installed, and the banks were cleared. Over the years, several rock walls have been constructed to improve salmon pool habitat. Many of these pools have lost their original form due to weather events that have shifted the rocks. A pond formed from a flooded gravel excavation site that sits adjacent to the river and is currently used as a fire pond. During the summer 2011, BCAF and NSLC Adopt-A-Stream employees, along with community members, cleared debris from one of the channels, which was blocking flow back into the main branch of the river.

There is a wide variety of habitat throughout this section, including a series of fast-flowing riffles and runs, several pools, and a long stillwater. At the time of assessment (September 12, 2011), the in-stream habitat appeared to be good. There was adequate flow, sufficient in-stream fish cover, several large boulders, and the presence of invertebrates. Potential concerns include bank erosion, flooding, stream-side development, riparian zone clearing, algae, road runoff, garbage, and fishing debris.

DISCUSSION

Outreach

Educating local residents, community groups, anglers, and school children is an important aspect in raising awareness about the plight of the Atlantic whitefish. The elementary school presentations, which focused on the Atlantic whitefish, local species at risk, and environmental stewardship, were very well received by both the children and their teachers. By targeting local youths, BCAF has helped:

- Create a greater appreciation for the natural environment and local species at risk;
- Create a better understanding of the effects of negative and positive impacts on the environment;
- Share valuable knowledge with the children that can be passed on to their friends and families within the community; and
- Generate an interest in reporting and recording species at risk sightings.

BCAF's attendance at local festivals, events, and farmer's markets provided interested individuals with the opportunity to voice their concerns, ask questions, and to learn more about the Atlantic whitefish. Educational and outreach materials, such as boaters cards, fish identification cards, activity books, and pamphlets were distributed at these events to help promote public awareness and stewardship opportunities.

BCAF and the South Shore Naturalists Club hosted a community angler's meeting at the Petite Rivière Fire Hall on March 3, 2011. In total, 53 individuals attended the meeting, including local residents, active anglers, interested community groups, and representatives from Fisheries and Oceans Canada (DFO) and the Nova Scotia Department of Fisheries and Aquaculture (NSDFA). Presentation topics included:

- Species at risk management and DFO's Atlantic Whitefish Recovery Strategy
- The difference between the Atlantic whitefish and the Lake whitefish
- Stocking (Andersen Lake) and tagged releases (Petite Rivière)
- Captive breeding at the Mersey Biodiversity Facility
- Conservation and protection
- Ecosystem management
- BCAF's Atlantic Whitefish Recovery Project plans
- The potential impacts of smallmouth bass on the Atlantic whitefish population
- Fish passage improvements on the Petite Rivière

The meeting also provided community members with an opportunity to view a live Atlantic whitefish (transported from the Mersey Biodiversity Facility by John Whitelaw, DFO) and to voice any concerns. Although future meetings have not yet been organized, it is expected that the community angler's meetings will be held on an annual or bi-annual basis.

Outreach activities for 2012 will include elementary school presentations and additional environmental education programs, which are currently being explored. BCAF will continue to attend local festivals and events in Bridgewater, Mahone Bay, and Lunenburg. Additional events in the Petite Rivière and LaHave River communities will also be considered (i.e., the Petite Rivière Winery, the Petite Rivière Fire Hall, or Fort Point Museum). Due to poor attendance in 2010, presentations were not delivered at the Provincial Parks in 2011. However, with improved advertising, community presentations at Risser's Beach Provincial Park will be considered in 2012.

Fish Assemblage Surveys

Determining the composition and distribution of the fish community in Milipsigate and Hebb Lakes was an initial focus of the research conducted in 2011. However, with limited resources and time, an accurate fish assemblage survey proved to be difficult. Smallmouth bass nest surveys conducted in 2009 and 2010 showed that smallmouth bass were successfully reproducing in Minamkeak and Milipsigate Lakes, but were not yet established in Hebb Lake. Consequently, the focus of research shifted to determine whether or not a smallmouth bass population was established in the outlet between Milipsigate and Hebb Lakes, as well as in Hebb Lake itself.

Smallmouth bass were angled in abundance within the outlet, but were not caught in Hebb Lake. Yellow perch were the only species angled from Hebb Lake. It is believed that the smallmouth bass population initially established itself in Minamkeak Lake, and then spread into Milipsigate Lake. The lack of angled smallmouth bass in Hebb Lake could be further indication that the smallmouth bass population has not yet spread this far; although, only a small portion of the lake was fished. This result could also be a reflection of the differences in habitat characteristics between the two lakes. Hebb Lake is more shallow, with more silt and vegetation than Milipsigate Lake. Smallmouth bass prefer rocky shoals with little silt and vegetation (Edwards et al., 1983), whereas yellow perch often occupy moderately vegetated areas with sandy, mucky bottoms (Krieger et al., 1983).

Although other species including trout, salmon, and Atlantic whitefish have been known to inhabit Milipsigate and Hebb Lake, only smallmouth bass and yellow perch were angled during this study. This is likely due to the time of year, the types of habitat fished, and the type of angling gear used (spinner lures and rubber worms). Both smallmouth bass and yellow perch are most active during the warm summer months when temperatures exceed 20°C (Edwards et al., 1983; Krieger et al., 1983). Most of the areas fished were relatively shallow and close to the shoreline with adequate cover. These areas tend to be occupied by smallmouth bass and yellow perch during the summer months. Aside from one juvenile smallmouth bass, three banded killifish were also caught in the baited minnow traps. While the traps were set in two distinct types of habitats, the three killifish were all captured from a vegetated, shallow beach area with a sandy, silty bottom. This type of habitat is typically preferred by banded killifish (COSEWIC, 2003).

The inherent biases associated with minnow traps (Layman and Smith, 2001) and with angling during the summer months make fish assemblage surveys particularly difficult to conduct over a large area. Future angling efforts should focus on the establishment of smallmouth bass in Hebb Lake during the summer, and should also include fishing during the spring and fall when water temperatures are cooler, and other species (i.e., salmonids) are more active. Fishing in the deep sections of the lakes and the tributary streams should also be explored. The combination of angling, beach seining, electrofishing, and the use of traps (i.e., eel pots) may help provide a more accurate representation of the fish community within Milipsigate and Hebb Lakes. As the Atlantic whitefish is particularly sensitive to handling, non-invasive sampling methods including the use of baited underwater cameras or hydroacoustic surveys could also be useful tools for measuring fish abundance and distribution in future years.

Over the past 3 years, BCAF has worked together with Jason LeBlanc from the Nova Scotia Department of Fisheries and Aquaculture to conduct smallmouth bass nest surveys. Initially, the AWRP team planned to continue the nest surveys in 2011 by creating an index of nests located in Milipsigate Lake, and by surveying Hebb Lake for new nest sites. However, the surveys did not start until fairly late into the spawning season, when the nests were still visible but the fry were mostly dispersed. Smallmouth bass begin building nests around the end of May when water temperatures reach 16°C, and the fry are generally dispersed and the nests abandoned by early-July (McNeill, 1995). During the spring of 2012, the AWRP team is planning to work with Jason LeBlanc to conduct follow-up nest surveys with an aim to determine the spread and establishment of a reproducing smallmouth bass population in Hebb Lake.

Water quality

Compared to other rivers of Southwest Nova Scotia, the water quality within the Petite Rivière watershed is generally considered to be good. Temperature is one of the most important water quality parameters for fish, as it has a direct effect on their growth rate, reproduction, feeding capacity, metabolism, and it also triggers migration patterns (Brett, 1979; NSSA, 2005). The habitat preferences and upper tolerable limits outlined in the Habitat Suitability Index Model for Brook Trout are occasionally used as guidelines for evaluating salmonid habitats in Nova Scotia. These guidelines suggest that the upper tolerable temperature limits for brook trout fall between 22 - 25°C (Raleigh, 1982; NSSA, 2005).

To explore the thermal tolerance specifically for Atlantic whitefish, Cooke et al. (2010) used captive-bred fish to evaluate their ability to resist changes in temperature, and to determine an optimum and a maximum temperature for growth. They discovered that optimal growth occurred at 16.5°C and that growth ceased when water temperatures exceeded 24.6°C. Atlantic whitefish were found to have similar temperature thresholds to Atlantic salmon, which are able to tolerate temperatures between 22-28°C over extended periods of time (i.e., days to weeks); however, temperatures exceeding 30°C can be lethal (Elliott, 1991; Elliott and Elliott, 2010). Temperatures within the main branch of the Petite Rivière reached critically high levels for brook trout, although, Atlantic whitefish should be able to tolerate these temperatures. The temperatures recorded by the loggers used in the NSLC Adopt-A-Stream Temperature Monitoring Study peaked at 29.8°C in Wallace Brook. However, temperatures fluctuated throughout the day, and extremely warm temperatures were generally short-lived. During periods of high temperatures, fish often take refuge in cooler, shaded areas or deep pools. Since temperatures in the watershed approached, and at times exceeded, the upper tolerable limits for native brook trout, monitoring should continue throughout the year and temperature loggers should be placed in the main branch of the river, as well as, the tributaries during the warmer months.

Many of the rivers in Southwest Nova Scotia are prone to acidification, which has been a major factor in the decline of many salmonid species throughout the region. As with most species, pH tolerance is life-stage dependant for Atlantic whitefish (Cook et al., 2010). Egg survival deceases significantly when the pH falls below 5.0, and larval and juvenile survival decreases when the pH falls below 4.5 (Cook et al., 2010). Fortunately, the buffering capacity in the Petite Rivière helps maintain a relatively healthy pH throughout the river system. The water quality monitoring showed that the sites within the three lakes (Minamkeak, Milipsigate, and Hebb) and along the main branch of the river maintained pH levels well above 5.0. However, the pH dropped below 5.0 in several tributary streams. As the study conducted by Cook et al. (2010) also showed that thermal sensitivity in Atlantic whitefish decreased significantly in acidic conditions, the pH levels in these tributary streams are of particular concern when water temperatures are high. Consequently, pH should continue to be monitored, along with temperature, throughout the year.

Dissolved oxygen is also an important water quality parameter for salmonids, which require high levels of oxygen in the water. Cool, fast moving water holds more oxygen than warmer water; however, the demand for oxygen increases in warmer water as the fish's metabolism increases (NSSA, 2005). As no studies have explored the dissolved oxygen requirement for Atlantic whitefish specifically, the Habitat Suitability Index Model for Brook Trout suggests that dissolved oxygen levels should not fall below 5mg/l, and that the ideal levels should remain above 7mg/l at temperatures <15°C; and above 9mg/l at temperatures ≥15°C (Raleigh, 1982). Although readings at some sites dipped below acceptable levels, the accuracy of these readings is uncertain due to difficulties in calibrating the dissolved oxygen probe. However, the sites at Fancy Lake, Hebb Mill Brook, and Birch Brook were consistently lower than the other sites. The Fancy Lake site is a stagnant water site, susceptible to storm water and road runoff, which could lead to reduced dissolved oxygen concentrations in the water. The lower dissolved oxygen concentrations in the two streams, Birch Brook and Hebb Mill Brook, could be associated with runoff from an upstream quarry (adjacent to Birch Brook), nutrient input from agricultural areas, or inflow from relatively stagnant lakes and marshes.

Salinity, TDS, and conductivity were also monitored at all sites. Aside from slightly elevated levels of all three of these parameters at Fancy Lake and at the Italy Cross Intersection (Wallace Brook), there was little variation among the remaining non-tidal sites. The elevated levels at Fancy Lake and the Italy Cross Intersection are likely due to storm water and road runoff. Overall, the in-stream water quality at most sites within the Petite Rivière system is considered to be acceptable for Atlantic whitefish.

Habitat Assessments

The habitat assessments conducted within the main branch of the Petite Rivière revealed a few areas of concern. Major areas of concern are the potential barriers blocking fish passage at Crousetown, Conquerrall Mills, Hebb Lake, Milipsigate Lake, and Minamkeak Lake. Although the Hebbville Dam has been the main barrier blocking upstream passage into the three lakes, the newly installed fish passage facility will allow upstream passage into Hebb Lake in 2012. However, within the lakes, upstream passage is still blocked between Hebb Lake and Milipsigate Lake, as well as, between Milipsigate Lake and Minamkeak Lake. Although fish may be able to return to Hebb Lake, any fish passing over the Minamkeak and Milipsigate Dams are still unable to return to theses lakes. Additionally, upstream passage is questionable in the lower part of the river at both Conquerrall Mills and the Crousetown Dam. A potential velocity barrier at Conquerrall Mills may impede fish passage at certain times of the year, and the efficiency of the fishway around the Crousetown Dam should be re-evaluated (DFO, 2004b).

Possible habitat restoration projects within the Petite Rivière could include pool creation within the long, straight, fast-flowing sections of the river; bank reinforcement and deflection where erosion is occurring; and riparian zone planting. Any impacts related to stream-side development, riparian zone clearing, nutrient input, and irrigation withdrawal should be monitored in future years.

Future AWRP Project Plans

Future ARWP research activities will focus on gaining additional knowledge about the biology, life-history, and habitat use of the Atlantic whitefish. The newly constructed fish passage facility will facilitate monitoring and sampling activities, and will potentially reintroduce anadromy to the population. Monitoring and sampling activities will contribute valuable information related to the biology of the Atlantic whitefish, as well as other species inhabiting the river system. Sampling activities will likely involve physical measurements (lengths and weights), scale extraction for aging, tissue sampling for genetic analyses, and tagging or marking. In addition to the research activities occurring at the Hebbville Dam Fish Passage Facility, BCAF is planning to install a rotary screw trap just below to the Hebbville Dam to capture any Atlantic whitefish passing over the dam and migrating to sea (Figure 16). The trap is expected to be in place between mid-April 2012 and the end of June 2012 (or until water levels become too low). It is anticipated that this trap will provide information on the downstream migration patterns for Atlantic whitefish. To compliment this data, monitoring activities at the Hebbville Dam Fish Passage Facility during the fall and winter of 2012, will help establish an upstream migration pattern and an estimated wild spawning time for Atlantic whitefish.

Figure 16: A rotary screw trap (photo provided by EG Solutions).

An electrofishing study is also being explored for the 2012 spring season. BCAF staff are planning to electrofish in the tributary streams feeding into the main branch of the river and into Hebb, Milipsigate, and Minamkeak Lakes. The focus of the study will be to determine whether there are any Atlantic whitefish present in the lower branches of the Petite Rivière, and if any of the tributaries are potentially being used as habitat. This information will also be used to help determine any downstream migration patterns.

The interaction between smallmouth bass and Atlantic whitefish, and the establishment of a reproducing smallmouth bass population in Hebb Lake, will also be investigated during the 2012 spring and summer season. Smallmouth bass nest surveys will continue in Hebb Lake, and the possibility of conducting stomach analyses on angled smallmouth bass is being explored. Stomach content analyses will help provide additional information on the interaction between smallmouth bass and Atlantic whitefish, and will also help indicate whether or not smallmouth bass directly prey on Atlantic whitefish.

Conclusion

Currently, there are significant gaps in Atlantic whitefish knowledge. There are no accurate estimates of population size and little is known of the species biology, life history, habitat preference, wild spawning time, migration patterns, or interspecific interactions. BCAF's AWRP team will continue to work together with members of the AWC&RT to collect valuable information to help with efforts directed towards the conservation and recovery of this rare and unique species.

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