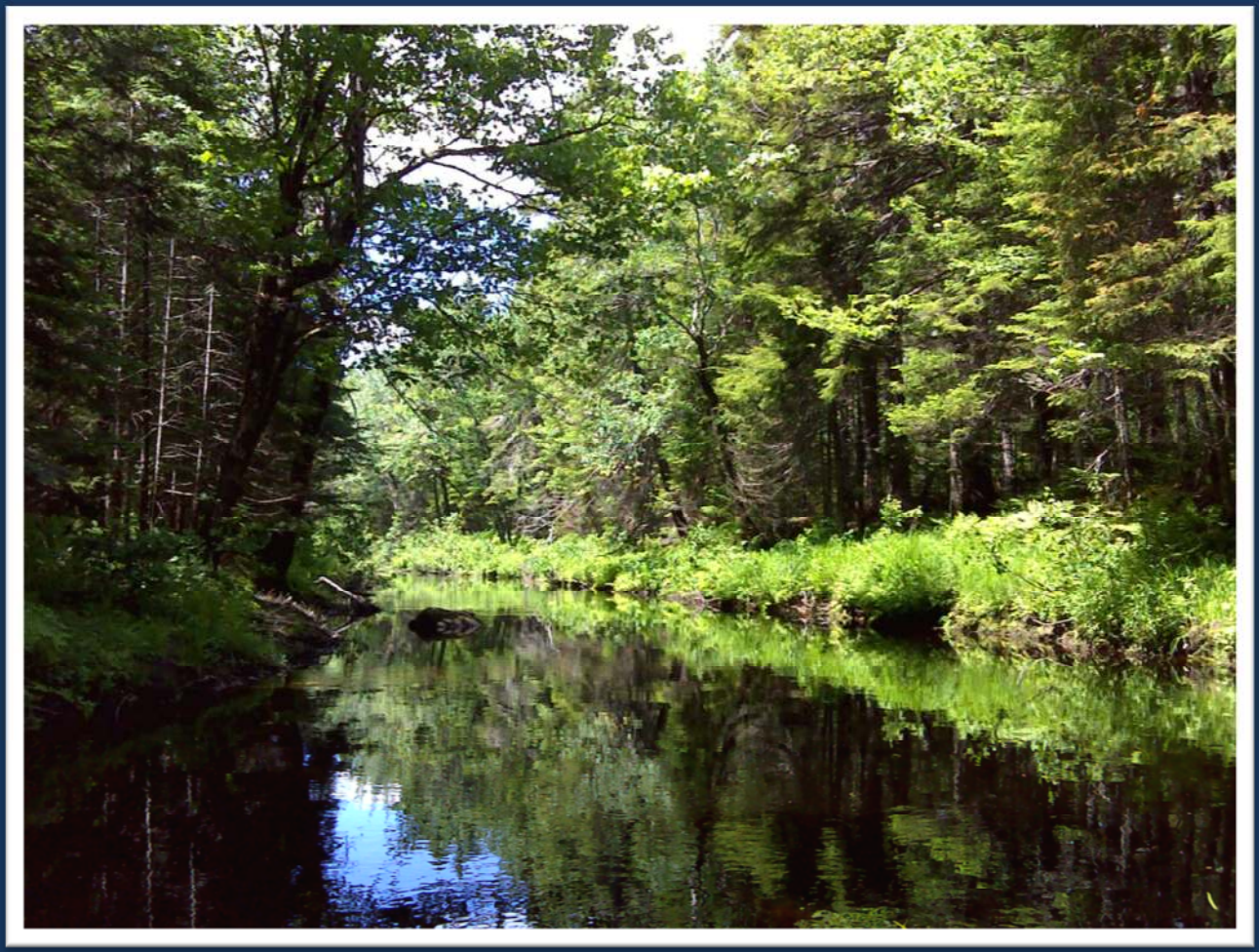
MREAC
MIRAMICHI RIVER ENVIRONMENTAL ASSESSMENT COMMITTEE

Atlantic Salmon Habitat Assessment

Barnaby River Drainage Basin

2015



The Atlantic Salmon Conservation Foundation
La fondation pour la conservation du saumon atlantique

MREAC

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Executive Summary

The Miramichi River Environmental Assessment Committee (MREAC) engaged in an Atlantic salmon habitat assessment on the Barnaby River drainage basin in the spring and summer of 2015 in order to determine if the drainage basin maintains habitat requirements that sufficiently provide an important contribution to regional stocks of Atlantic salmon (*Salmo salar*).

Three representative river reaches were surveyed using the DNR&E / DFO – New Brunswick Stream Habitat Inventory field form. The three reaches (Barnaby @ HWY 126, Barnaby @ Semiwagan Road, and Semiwagan Stream @ Semiwagan Road) had a combined linear distance of 3000 meters. Of the 51.5 kilometer Barnaby River meander length, 30 kilometers were travelled by canoe. Visual observations were noted and points of interest were recorded for further investigation.

Three sites were also monitored for water temperature via data loggers (HOBO U20 and TidbiT v2) which were deployed early in the field monitoring season and extracted late in the season. Understanding the thermal regime was important since cooler water temperatures are important to maintain a healthy environment for salmonids.

A set of water quality samples were collected near the three data logger sites and analyzed for various parameters (*B package and E.coli) at the Department of Environment and Local Government's (DELG) laboratory in Fredericton, New Brunswick. Land-use and available historical data and events were taken into consideration during the assessment process.

Based on the collected data, analytical results, visual observations, and with guidance from expert advisers, the Barnaby River and major tributaries, do not appear to maintain habitat requirements that sufficiently provides an important contribution to regional stocks of Atlantic salmon. Elevated stream temperatures in the heat of summer and relatively few deep cool-water pools to serve as refugia for salmonids appear to be significant factors. As with other rivers of similar type and comparable size on this New Brunswick Eastern Lowlands eco-region, the "fall run" of Atlantic salmon is important to maintain the resident salmon population. Additional work on this run and spawning success/density of Atlantic salmon is worthy of consideration.

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Tables:

1.0 Introduction

The Miramichi River system is a critical refuge for Atlantic salmon (*Salmo salar*) in New Brunswick and internationally renowned as a premier river for recreational salmon fishing. The Barnaby River, as part of the larger Miramichi drainage basin can be considered part of this system. The Miramichi River Environmental Assessment Committee (MREAC) undertook an assessment of the Atlantic salmon habitat potential of the Barnaby River and her main tributaries in the spring and summer of 2015 with support from the Atlantic Salmon Conservation Foundation (ASCF).

No formal Atlantic Salmon Habitat Assessment studies were available or previously completed according to the staff from the New Brunswick Department of Natural Resources (DNR) and Fisheries and Oceans Canada (DFO).

2.0 Background

The Barnaby River has a drainage area of 490.26 km² and an approximate 51.5 kilometer meander length. The drainage basin's major tributaries include:

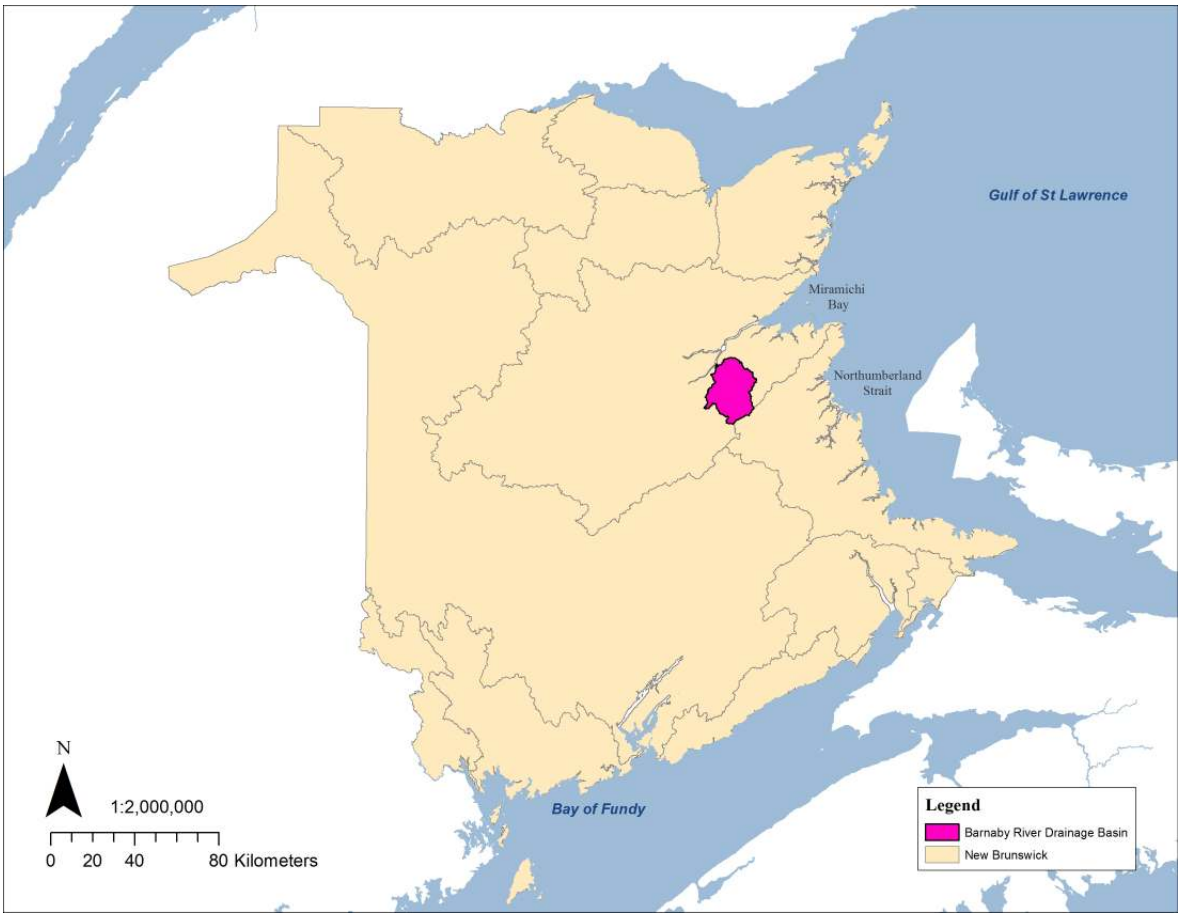
- Middle Branch Barnaby River
- Right Hand Branch Barnaby River
- East Branch Barnaby River
- Semiwagan Stream

It is a tributary of the Southwest Miramichi River. The Southwest Miramichi is tributary to the Miramichi River which flows into the Miramichi Inner Bay, and then into the Gulf of St. Lawrence.

2.1: Location

The Barnaby River drainage basin lies in northeastern New Brunswick (Figure 2.1.1). The basin drains into the Southwest Miramichi River near the city of Miramichi. The entire Miramichi watershed, which includes the Barnaby River, ultimately drains into the Gulf of St. Lawrence.

Figure 2.1.1: The Geographical Location of the Barnaby River Drainage Basin within New Brunswick

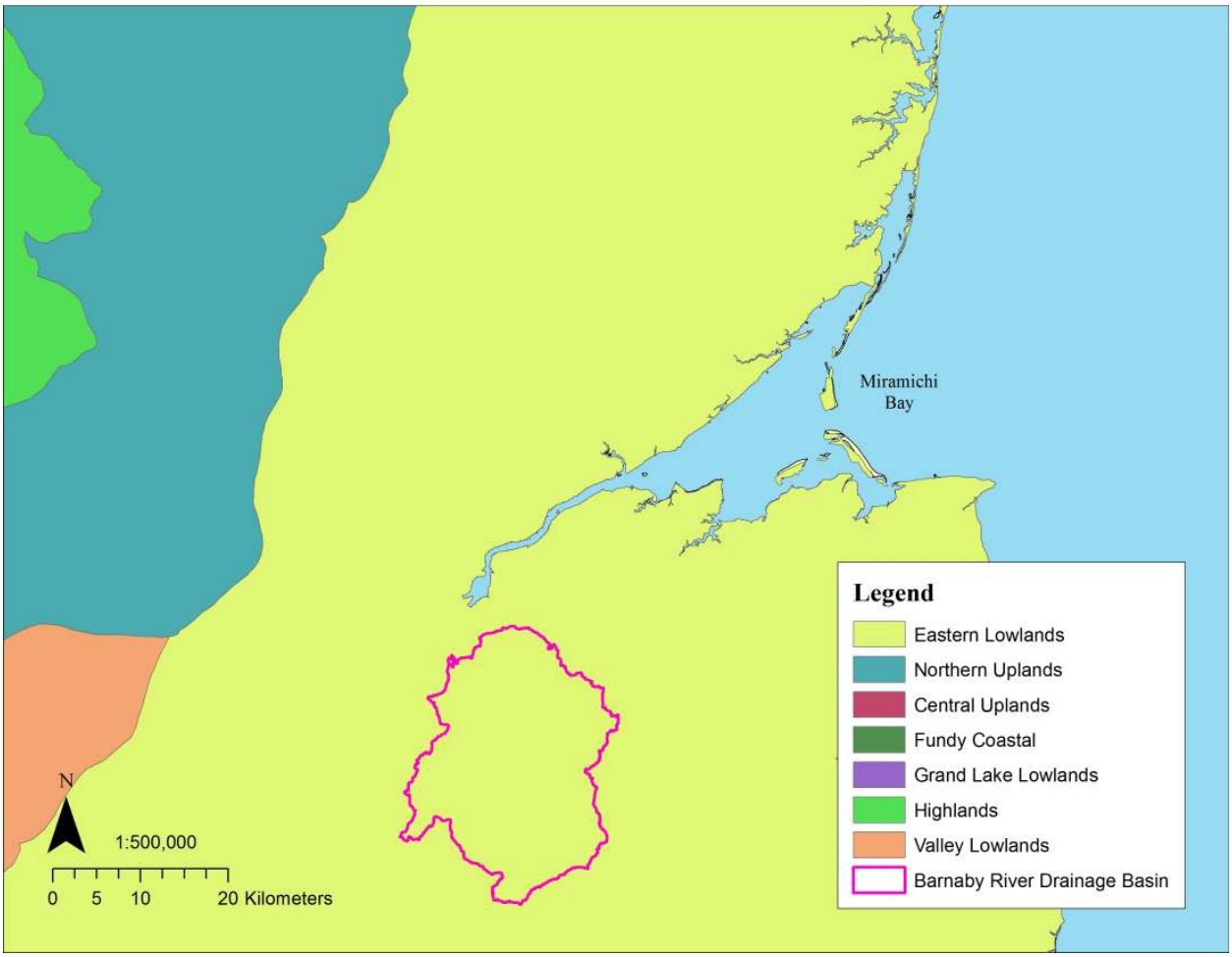


2.2: Physical Setting and Climate

The Barnaby River drainage basin lies in the Eastern Lowlands ecoregion (Figure 2.2.1). The drainage basin and surrounding area have a mean July temperature of 19.2°C and a mean January temperature of -10.7°C. The mean annual precipitation is 1115 mm and the drainage basin receives an annual 1993.4 total hours of sunshine (Environment Canada, 2013).

Note: The historical data was obtained from Environment Canada, Canadian Climate Normal 1971-2000 Station Data, for the city of Miramichi. It is assumed that given the basins close proximity to the city their climate would be relatively similar.

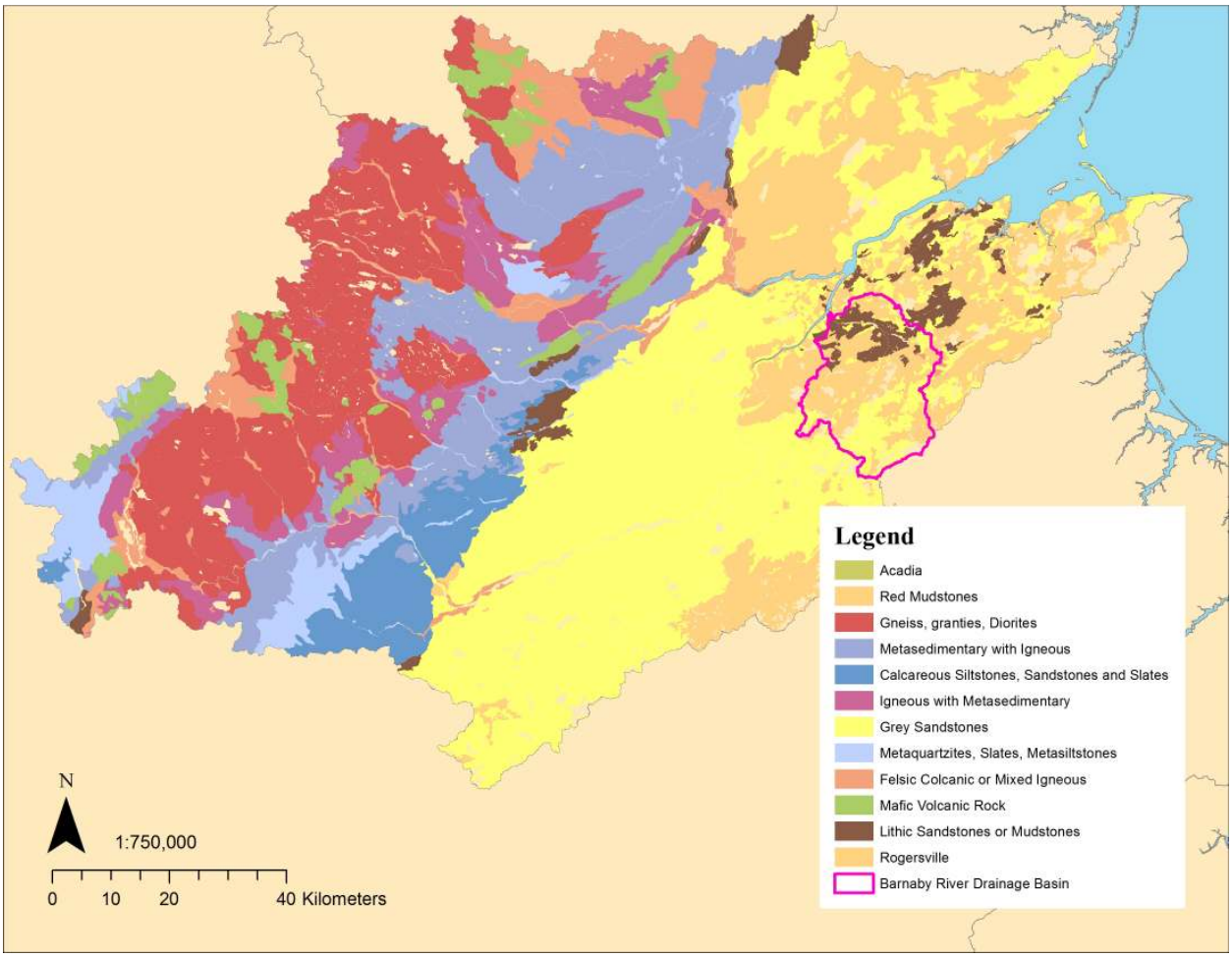
Figure 2.2.1: The Barnaby River Drainage Basin Ecoregion



2.3: Bedrock Geology

The bedrock geology of the Barnaby River drainage basin is typical to that of the eastern lowlands ecoregion which is generally composed of grey sandstone and red mudstone, although there is presence of lithic sandstone or mudstone within the northern section of the watershed (Figure 2.3.1). The predominant mudstone and sandstone stratum dates back to the Carboniferous (Pennsylvanian) geologic time period, (NBDNR, 2000; 2009).

Figure 2.3.1: The Barnaby River Drainage Basin Bedrock Geology



2.4: Surficial Geology

The surficial geology of the Barnaby River drainage basin is primarily composed of silt, sand, minor clay, gravel, rubble, loamy lodgement till, and minor ablation till. This blanket (veneer) that covers the bedrock varies from 0.5 meters to 3 meters in thickness. Organic sediments such as peat, muck, minor silt, and fine sand were deposited in shallow basins and on poorly drained surfaces such as bogs, fens, and swamps. These organic sediments are typically 1 to 5 meters thick. Most of the depositions occurred during the Quaternary (Holocene, Late Wisconsinan and/or Early Holocene, Late Wisconsinan) geologic time period (Figure 2.4.1), (Rampton, 1984).

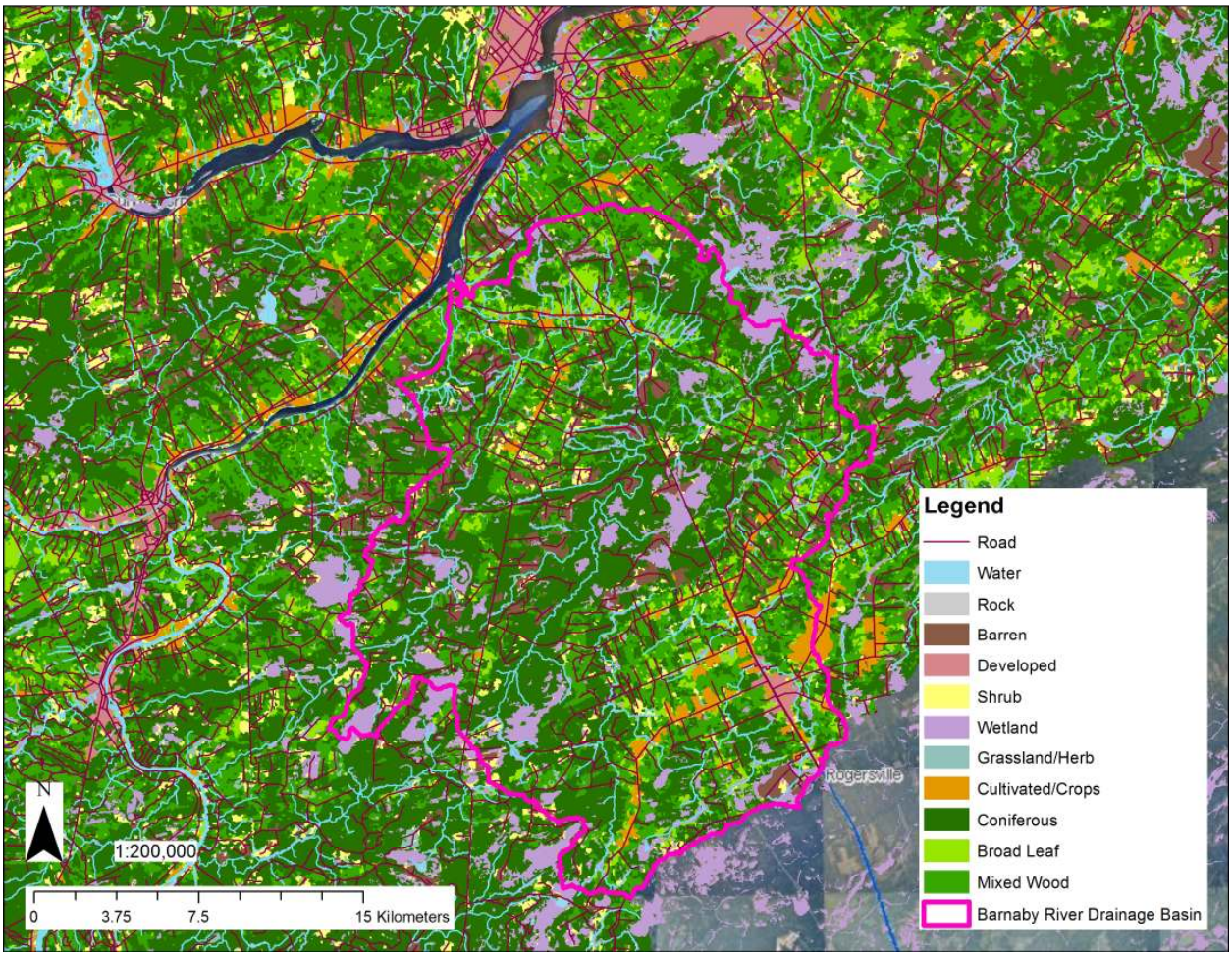
Figure 2.4.1: Typical Barnaby River Substrate

2.5: Land Cover and Use

The predominant land cover within the Barnaby River drainage basin is Acadian forest. This is followed by wetlands and then cultivated/crops (Figure 2.5.1), (NBDNR, 2009). Forest harvesting is the predominant land-use activity.

The Barnaby River drainage basin lies south of the City of Miramichi there. The village of Rogersville lies on the Southeastern boarder of the watershed. There are significant numbers of rural residences along local roadways, including Hwy 126, the North Barnaby Road and the South Barnaby Road. A number of camps are also located along some reaches of the Barnaby River.

Figure 2.5.1: The Barnaby River Drainage Basin Land Cover and Use



3.0 Methodology

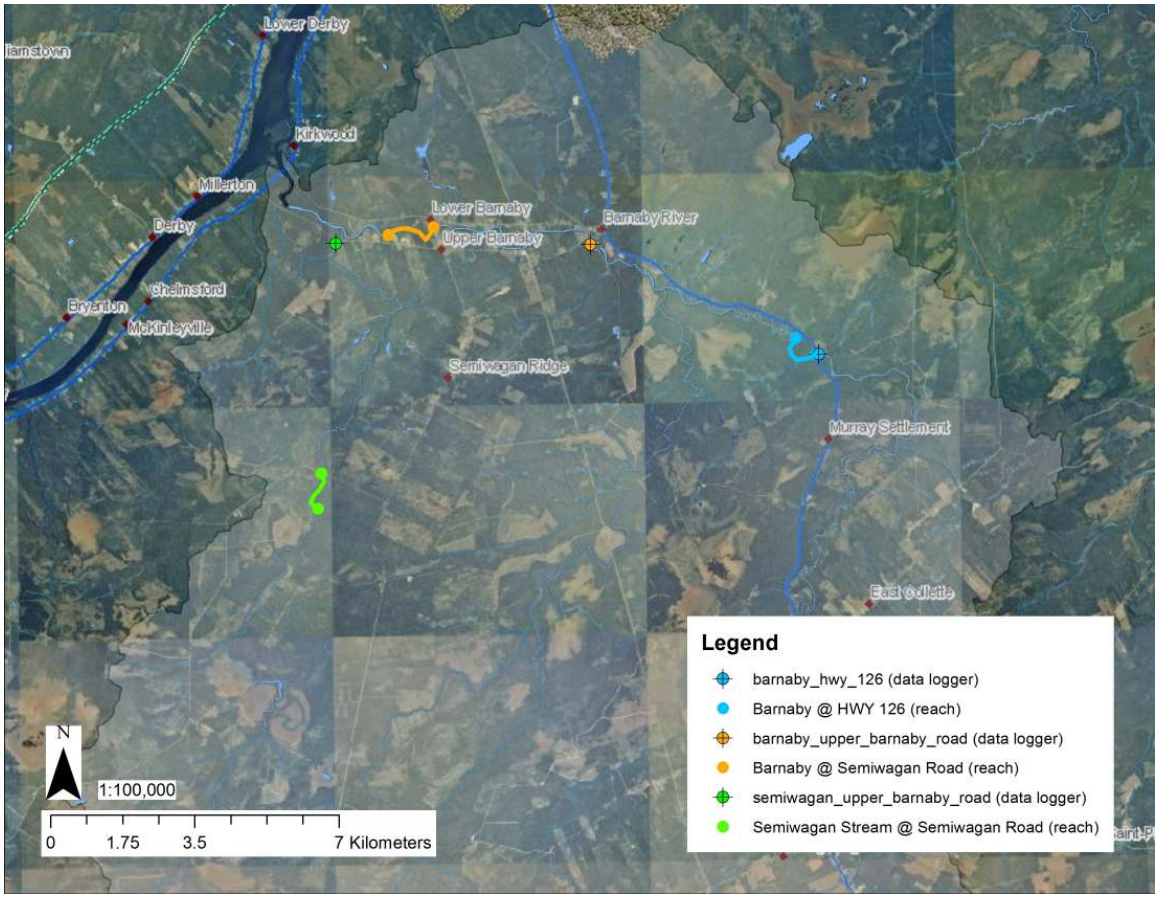
The Barnaby River drainage basin Atlantic salmon habitat assessment was performed by MREAC staff with support from students and volunteers. The DNR&E/DFO-New Brunswick Stream Habitat Inventory field survey was adopted for the three habitat assessment reaches. The analytical work on water quality was purchased through the New Brunswick Department of Environment and Local Government's (DELG) provincial laboratory in Fredericton. The results were provided to MREAC via email.

3.1: Habitat Assessment Reaches and Data Logger Sites

The detailed stream habitat survey was completed in the field along three reaches, two on the main branch of the Barnaby and one on Semiwagan Brook. These were chosen based on their access and distribution along the river corridor, and felt to be representative of local conditions. Each of the three reaches covered approximately one kilometer. The left and right banks were considered up to the treeline. The three reaches were generally able to be waded in therefore it allowed in-stream work. A canoe was used to contain and transport the field equipment and occasionally to cross the deeper sections of the river.

Three sites were also monitored for water temperature via data loggers (HOBO U20 and TidbiT v2) which were deployed early in the field monitoring season and extracted late in the season (Figure 3.1.1).

Figure 3.1.1: The Barnaby River Drainage Basin Reaches and Data Logger Sites



3.2: Water Quality Monitoring

The water quality monitoring for the Barnaby River drainage basin habitat assessment was performed using the following equipment:

- Yellow Spring Incorporated (YSI) Pro 2030 – Handheld Conductivity, Dissolved Oxygen, Salinity, and Temperature Meter
    - The YSI Pro 2030 was air calibrated at the start of each field monitoring day
- Onset Computer Corporation TidbiT v2 Water Temperature Data Logger
    - TidbiT (UTBI-001, LGR S/N: 10190363) deployed on June 2, 2015 and extracted October 26, 2015 (barnaby_highway_126 site)
    - TidbiT (UTBI-001, LGR S/N: 10723345) deployed on June 12, 2015 and extracted October 26, 2015 (semiwagan_upper_barnaby_road site)
- Onset Computer Corporation HOBO U20 Water Level and Temperature Data Logger
    - HOBO U20 (U20-001-04, LGR S/N: 10156536) deployed on June 2, 2015 and extracted October 26, 2015 (barnaby_upper_barnaby_road site)

Water quality monitoring was performed for the following parameters:

- Dissolved Oxygen (mg/L)
- Salinity (ppt)
- Specific Conductance (µS/cm)
- Temperature (°C)

The parameter data was recorded in a field book and/or on the DNR&E/DFO-New Brunswick Stream Habitat Inventory survey field form.

3.3: Water Quality Sampling

The water quality sampling protocol for the Barnaby River drainage basin habitat assessment was modeled after the Water Classification program protocol which involved the collection of

surface water for analytical work (Table 3.3.1). The surface water was collected from the three data logger sites on June 9, 2015.

Table 3.3.1: Water Classification Protocol Analyses, Container Type, and Quantity

Analyses	Container	Volume **(ml)**	Preservative	*Quantity
Bacteria	Plastic Bottle	200	Sodium Thiosulphate	1
General Chemistry	Plastic Bottle	500	No	1
Metals	Plastic Bottle	125	No	1
Nitrate	Plastic Bottle	125	No	1
Nutrients	Plastic Bottle	500	No	1

* quantity required for each site

The appropriate plastic containers were labelled, filled, placed in a cooler, and then mailed the same day to DELG analytical services laboratory, Fredericton. The samples were kept at ~ 4°C, and DELG's laboratory was notified of the shipments arrival within 24 hours.

Water quality analyses were performed for various parameters (Table 3.3.2).

Table 3.3.2: Inorganic Package *B Analytical Parameters

Inorganic Package **(*B)**				
Alkalinity	Alk		Total Ammonia	NH_3T
Aluminum	Al		Nickel	Ni
Arsenic	As		Nitrite	NO_2D
Calcium	Ca		Nitrogen Oxides	NOx
Cadmium	Cd		Lead	Pb
Chlorine	Cl		Potential Hydrogen	pH
Colour	Clra		Antimony	Sb
Conductivity	Cond		Sulfate	SO_4
Chromium	Cr		Suspended Solids	SS
Copper	Cu		Total Kjeldahl Nitrogen	TKN
Fluorine	F		Total Organic Compounds	TOC
Iron	Fe		Total Phosphorus Low	TP-L
Potassium	K		Turbidity	Turb.
Magnesium	Mg		Zinc	Zn
Manganese	Mn		Nitrate	NO_3
Sodium	Na		Hardness	Hardness

* inorganic package referred to as "Asterisk B"

Bacteriological analysis was also performed on surface water samples testing for the presence of *Escherichia coli (E. coli)*.

3.4: Water Quality Guidelines

The water quality analytical results that were obtained from DELG's laboratory were compared to the Canadian Council of Ministers of the Environment's (CCME) Water Quality Guidelines for the Protection of Aquatic Life (Table 3.4.1). This provided a snapshot of the overall water quality at the Barnaby River drainage basin at that point in time and at the site sampled.

Table 3.4.1: The CCME Water Quality Guidelines for the Protection of Aquatic Life

Water Quality Parameter	Non-compliance if:	Value1	Value 2	Unit	Hardness >	Hardness <=
Pb (Lead)	hardness	1		µg/L	0	60
Pb (Lead)	hardness	2		µg/L	60	120
Pb (Lead)	hardness	4		µg/L	120	180
Pb (Lead)	hardness	7		µg/L	180	
Ag (Silver)	>	0.1		µg/L		
Al (Aluminum)	pH dependant	0.005	0.1	mg/L		
Ammonia	compute	0.0152		mg/L as N		
As (Arsenic)	>	5		µg/L		
Chloride	>	150		mg/L		
Chlorophyll	>			mg/L		
Cd (Cadmium)	CdHardness			µg/L		
Cr-III (Chromium III)	>	8.9		µg/L		
Cr-VI (Chromium VI)	>	1		µg/L		
Cu (Copper)	CuHardness			µg/L		
DO (Dissolved Oxygen)	<	6.5		mg/L		
Fe (Iron)	>	0.3		mg/L		
Hg (Inorganic Mercury)	>	0.026		µg/L		
MeHg (Methyl Mercury)	>	0.004		µg/L		
Mo (Molybdenum)	>	73		µg/L		
Ni (Nickel)	NiHardness			µg/L		
Nitrogen	>			mg/L		
Nitrate (NO3)	>	2.9		mg/L		
pH	<>	6.5	9			
Phosphorous	>	0.03		mg/L		
Se (Selenium)	>	1		µg/L		
Th (Thallium)	>	0.8		µg/L		
Zn (Zinc)	>	30		µg/L		
Turbidity	>	10		NTU		

The Escherichia coli (E. coli) parameter was compared to Health Canada's (HC) Guidelines for Canadian Recreational Water Quality that suggests that an acceptable level of *E. coli* should not exceed 200 MPN/100ml.

4.0 Results

The DNR&E / DFO – New Brunswick Stream Habitat Inventory field form data results for the three reaches on the Barnaby River can be obtained upon request from the MREAC office.

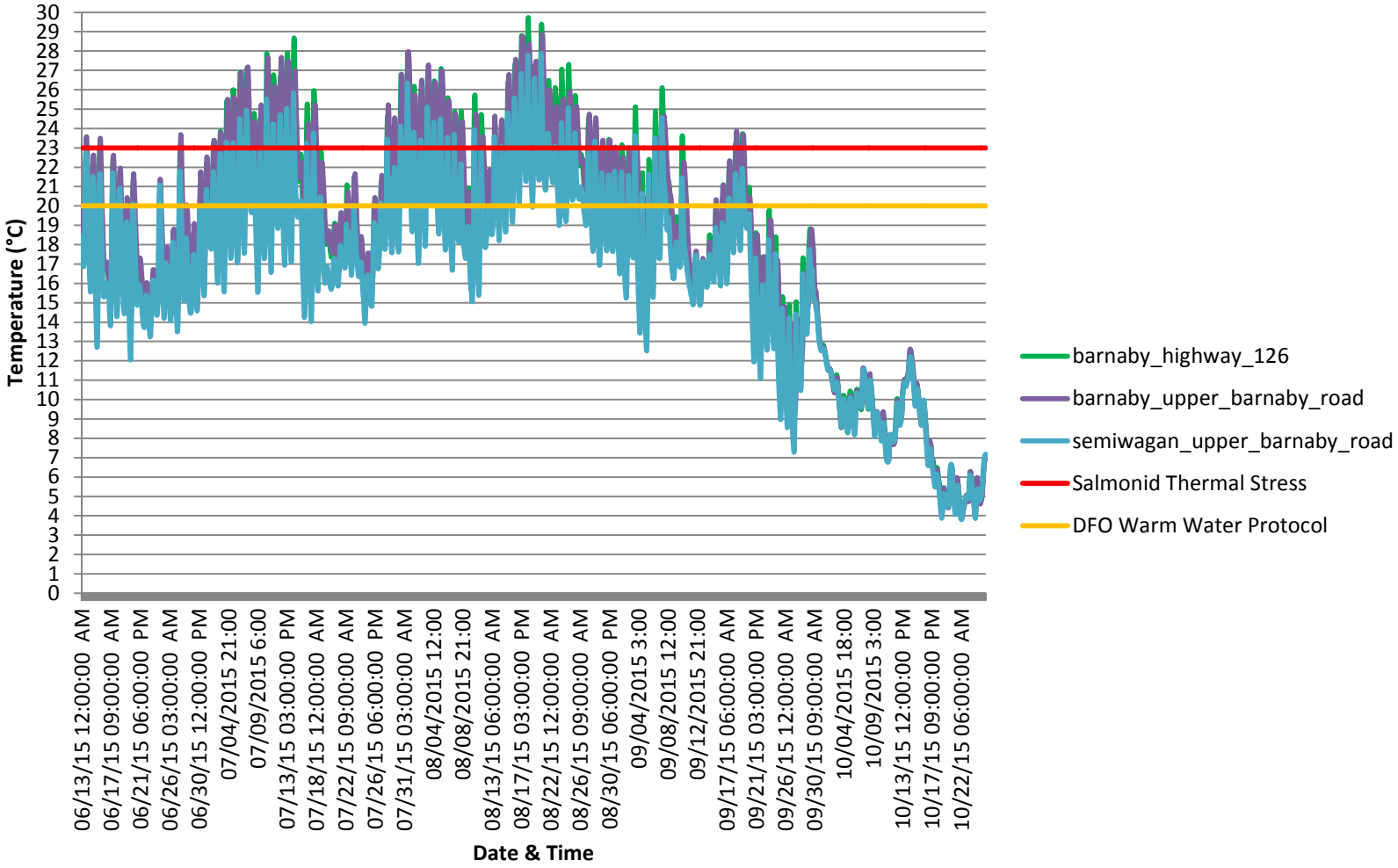
The water quality results, for the four DELG key water quality indicators, were compared to the appropriate guidelines as specified in section 3.0: Methodologies (Table 4.1).

Table 4.1: Four DELG Key Water Quality Indicators

Parameter	Non Compliance if	Barnaby highway_126	Barnaby upper_barnaby_road	Semiwagan upper_barnaby_road
DO	< 6.5 mg/L	11.10	10.85	11.10
E. coli	> 200 MPN/100 ml	50	40	20
NO3	> 2.9 mg/L	< 0.05	< 0.05	< 0.05
pH	< 6.5 and > 9.0	7.47	7.41	7.04

The following figure represents the water temperature at the three data logger sites vs. thermal stress for salmonids and the DFO warm water protocol (Figure 4.1).

Figure 4.1: Water Temperature vs. Salmonid Thermal Stress and DFO Warm Water Protocol for the Barnaby River Drainage Basin



5.0 Discussion

The DNR&E / DFO – New Brunswick Stream Habitat Inventory field form data for the three Barnaby River drainage basin reaches appear to show that the overall characteristics are: good bank stability, vegetation along banks, good canopy coverage in the headwaters (Barnaby River and Semiwagan Stream), and some large woody debris. However there is a lack of deep cool water pools which are considered essential for good Atlantic salmon habitat.

The land cover and use figure for the Barnaby River drainage basin illustrates that a large percentage of the watershed is covered by forest. The major economic activity appears to be lumber harvesting which does not appear to be a significant threat to fish habitat at this time.

The water quality data received from DELG's analytical laboratory suggests that the water quality at the sampling locations and at the time of sampling falls well within acceptable guidelines.

The water temperature at the three data logger sites indicates that the 23°C salmonid thermal stress threshold was exceeded three times, and for a prolonged period of time. The month of August saw the highest temperatures with a maximum of ~ 30°C.

6.0 Conclusion

Based on all collected data, analytical results, visual observations, and assistance from expert advisers, it can be concluded that the Barnaby River and major tributaries, such as the Semiwagan Stream do not appear to maintain a habitat requirement that sufficiently provides an important contribution to regional stocks of Atlantic salmon (*Salmo salar*). The combination of relatively few deeper cool-water pools and elevated water temperatures over considerable periods during the heat of summer is felt to be limiting salmonid habitat and production. As with other waterways of this scale on the Eastern Lowlands ecoregion, the Barnaby may have a significant fall-run of Atlantic salmon that has not been adequately assessed to date. It would be of value to assess the juvenile abundance of salmonids to get a better picture of the actual productivity of this waterway.

References

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