Northwest Miramichi
Sub-Watershed Monitoring
2007

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Your Environmental Trust Fund At Work

1.0. – Introduction:

The Miramichi River watershed covers approximately 14,000 km^2 of the province of New Brunswick. Within the Miramichi River watershed, the area is divided into sub-watersheds based on major rivers that branch off of the main Miramichi River. One of those rivers, which is the focus river for this study, is the Northwest Miramichi River.

Figure 1.1. – Map of Miramichi Watershed highlighting the location of the Northwest Miramichi Sub-watershed.

The Miramichi River watershed is found mostly in the Northumberland County of New Brunswick and has two major branches, the Northwest and the Southwest Miramichi River. The Northwest Miramichi River is second to the Southwest Miramichi in overall size with an area of approximately 2,400 km^2. This river begins in a low impacted, uninhabited mountainous area where the highest mountain, Big Bald Mountain, is 672 m above sea level. Numerous brooks and streams flowing eastward converge - to form the Northwest Miramichi River and its major branches, the North and South Sevogle River. The Northwest Miramichi River flows eastward and turns southward where the Tomogonops River and the Portage River joins the main branch. The Sevogle River converges with the Northwest Miramichi River as it flows eastward to where it joins with its counterpart the Southwest Miramichi branch, and thus forming the Miramichi River.

Apart from impacts from mining, forestry and some ribbon housing along major access roads, the Northwest Miramichi sub-watershed has minimal anthropological development. The sub-watershed is far from Miramichi City, very mountainous in areas and much of the land is crown land, regulating anthropogenic activity in the area. The province has leased much of the land to industry for forest products. Lumbering is currently the most significant economic activity in the sub-watershed. The Heath Steele mining site was decommissioned in 1999 after operating for 56 years, mining copper, lead and zinc. The mine site was situated principally on the Tomogonops River, a tributary of the Northwest Miramichi River. With the limited land use and minimum human impact in this sub-watershed, the water quality is expected to be good with underlying rock geology being the biggest water chemistry factor.

Water quality monitoring has always been important on this river and it continues to be monitored today after the mine`s closure. Following the decommissioning of the site, it was necessary for the owner (currently Xstrata Inc.) to collect and treat runoff from the site to avoid acid mine drainage and metals from impacting downstream water quality. Renewed intent in base metal mining has resulted in an increased amount of prospecting for mineral resources. The potential impacts of this interest had promoted, in part, MREAC's interest in studying this sub-watershed.

The Northwest Miramichi River is also world renown for its Atlantic salmon fishing. Due to its clean water, low impacted land use, and efforts from various science groups, the Miramichi River remains the largest active salmon spawning habitat in North America. "Crown reserve" salmon pools are bid on annually by "sports" fly fishing enthusiasts from around the world. A lower, tidal influenced section of this river is also the only site for Striped bass spawning in the Gulf of St. Lawrence. Therefore, good water quality is very important for the survival of salmon and Striped bass at all stages in life. Impacts from mining and lumbering can compromise the required conditions.

Environment Canada has been monitoring the water levels of the Northwest Miramichi River for the past 45 years. Recently, they have upgrading their monitoring system to a Real-Time Hydrometer and data is available online (Environment Canada).

2.0. – Materials and Methods:

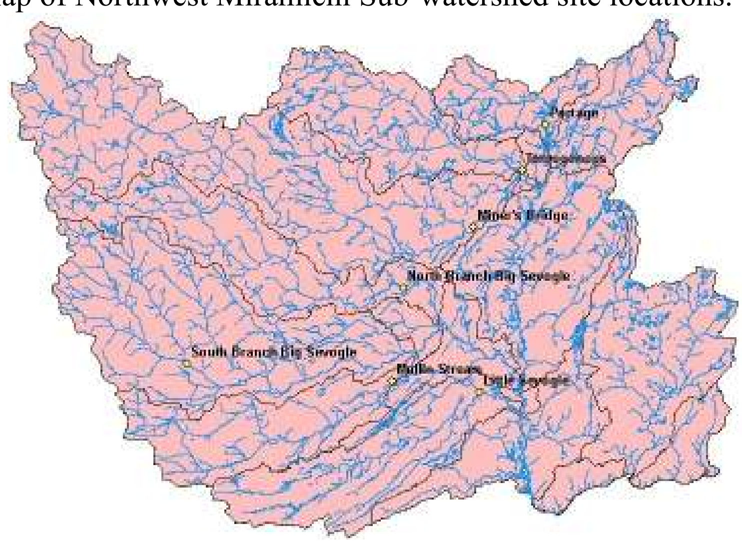
Seven sites were selected of the sub-watershed, targeting different branches of the Northwest Miramichi River and where access for sample collection was readily available. Water samples were collected at the seven sites twice during the year of 2007, once in September during low water conditions and again in November during high water conditions. These seven sites were: Little Sevogle River, Mullin Stream, South Branch of Big Sevogle River, North Branch of Big Sevogle River, Miner's Bridge on the Northwest Miramichi River, Tomogonops River and Portage River (See site coordinates in Table 2.1 and site locations in Figure 2.1).

Table 2.1. – Northwest Miramichi River sample site coordinates.

Location Name	N	W
Little Sevogle	47^{o}02.535'	65^{o}53.308'
Mullin Stream	47^{o}03.156'	65^{o}59.907'
South Big Branch Sevogle	47^{o}04.119'	66^{o}15.487'
North Big Branch Sevogle	47^{o}08.026'	65^{o}58.970'
Miner's Bridge	47^{o}11.145'	65^{o}53.664'
Tomogonops	47^{o}14.066'	65^{o}49.908'
Portage	47^{o}16.428'	65^{o}48.075'

Water samples were collected by grab samples using sterile water bottles for *Escherichia coli*, suspended solids, nutrients, metals and general chemistry tests. They remained in a cooler during the field collection and were then sent to the New Brunswick Department of Environment laboratory in Fredericton, New Brunswick on the day of sampling. The results from these tests were then returned to MREAC for follow up analysis.

Figure 2.1. – Map of Northwest Miramichi Sub-watershed site locations.



3.0. – Results:

The water quality results were analyzed and the two sample runs during the low and high water seasons were compared. The test results were also compared with the *Canadian Water Quality Guidelines for the Protection of Aquatic Life, 2002*. This document was used to compare the sample results with the allowed limit for sustainable aquatic life, the Limit of Quantitation (LOQ).

The *E. coli* results for the seven sites during the two sample runs, were presented as the number of *E. coli* colony forming units (cfu) per 100ml of water, are demonstrated in the table below, Table 3.1. This table illustrates that all of the water samples collected for this Northwest Sub-watershed study are relatively low and are considered acceptable for aquatic life. The only sample that exceeded 50 cfu/100 ml is the Portage River sample acquired during the low water run was (120 cfu/100 ml).

Table 3.1. – Bacteriological results for Northwest sub-watershed monitoring, 2007

	E. coli (cfu/100ml)	
Location Name	**10-Sep-07**	**19-Nov-07**
Little Sevogle	20	50
Mullin Stream	20	20
South Big Branch Sevogle	30	20
North Big Branch Sevogle	<10	<10
Miner's Bridge	10	30
Tomogonops	<10	<10
Portage	120	40

There were several chemical parameters that exceeded the *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. Most of the parameters that exceeded the limit in the low water run were different in the high water run, and when the limit was exceeded it was only exceeded by a small margin. (See Appendix A for the chemical water quality results).

During the low water sample run conducted in September, 2007, Mullin Stream, South and the North Branch of Big Sevogle Rivers exceeded the 0.017 µg/L limit for cadmium as all three results were 0.1 µg/L. Chromium exceeded the 0.001 mg/L limit at three sites as well. The Little Sevogle River, North Big Branch Sevogle River and Tomogonops River had results slightly above the limit with their results being 0.0016, 0.0011 and 0.0015 mg/L respectively. The Tomogonops River sample at low water was the only sample during this project that indicated a presence of fluoride, and the sample slightly passed the LOQ of 0.12 mg/100ml as the result was 0.122 mg/100ml. The final exceeded parameter during the low water run was iron found in both the Little Sevogle River and the Portage River. The water quality limit is 0.3 mg/L and the results for the samples were 0.347 and 0.688 mg/L respectively.

The high water sample run conducted in November, 2007 had different results as more sites and other parameters exceeded the *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. High levels of aluminum were found in three samples, Little Sevogle River, Mullin Stream and Portage River. With a limit of 0.1 mg/L, the results for these sites were 0.20, 0.28 and 0.15 mg/L respectively. Iron was also found slightly exceeding its limit at these same three sites, with the limit being 0.3 mg/L and results indicating 0.316, 0.312 and 0.384 mg/L respectively. In regarded to pH, the Mullin Stream site result was below the acceptable limit range. The desired level of pH for aquatic life is between 6.5-9.0, but the pH found at this site was 6.01.

4.0. – Discussion

The parameters that exceeded the Canadian *Water Quality Guidelines for Protection of Aquatic Life* during the low water sample run were cadmium at three sites, chromium at three sites and iron at two sites. During the high water sample run, aluminum exceeded the limit at three sites and iron at three sites. The site locations that exceeded the parameter limit varied, and the degree that the samples exceeded was relatively small.

Cadmium is naturally found in northern New Brunswick bedrock, and resides in the Northwest Miramichi (Natural Resources). It is used in nickel cadmium batteries, coatings, television picture tubes, automobile radiators, motor oil, plastics and synthetic products, etc. While it is mainly recovered during the smelting of zinc and other mined metals, its pathway into the environment is normally by effluent or industrial atmospheric fallout. Once in the environment, cadmium will most likely end up in the sediment or suspended solids in the water column. In water, mixed hydroxides, oxides, silicates and sulphates may be present, which will react and form complexes with cadmium. Environmental changes such as redox status, reduced pH or biological or chemical oxidation of the organic matter may cause cadmium to be released and re-enter the ecosystem (*Cadmium*, 1999).

Having cadmium levels in the environment above the *Canadian Water Quality Guideline for Protection of Aquatic Life* limit (LOQ 0.017 µg/L in freshwater) does poses problems, and water hardness can have an influence on the toxicity level. Aquatic plants are affected by cadmium exposure by reducing their growth and inhibiting photosynthesis. Acute toxicity of cadmium has been found with 24 freshwater invertebrate species, 21 showing chronic toxicity affects, with reproductive impairment being the most significant. For acute toxicity for freshwater fish, 23 fish species have been identified, with salmonids being the most sensitive family. For chronic exposure, reductions in body weight and fork length have been found in Atlantic salmon whereas the survival rate of other fish species is also reduced. Survivability in Striped bass has been shown to be reduced by 12.5% (*Cadmium*, 1999).

Primary industrial uses of chromium in Canada are metal plating and finishing, leather tanning, wood preservation, corrosion inhibition, as well small quantities are used when producing cosmetics, toners for coping machines, fertilizers, rubber products, plastics and soaps. Primary sources of chromium entering the environment are from cooling towers, tanneries, steal foundries, metal finishing and planting operations, oil drilling and recovery rigs and even pulp and paper mills, etc. There are also some natural sources of chromium such as forest fires, volcanic emissions, vegetative debris, and marine aerosols. Road dust can have a small amount of chromium due to wear and tear of tires and brakes, and urban runoff and industrial storm waters can also contribute to environmental sources of chromium (*Chromium*, 1999).

Chromium has two forms, chromium III and VI. Both forms are naturally found in the environment, however, chromium III is slightly water soluble and therefore hard to find in large concentrations in the environment. Some organisms require chromium III in their diets and therefore it is not considered a threat to aquatic life if found in water, unlike its counterpart. Chromium VI is a more stable molecule with high oxidizing potential and an effortless ability to penetrate through biological membranes, making this form of chromium very toxic to flora and fauna. Salmon are the most sensitive fish species studied for freshwater affects from chromium VI, but invertebrates are even more sensitive. Chromium can inhibit the growth of some plants. In order for chromium III to possess toxic effects, high concentrations are required (LOQ 8.9 µg/L in freshwater), affecting fish the most, then invertebrates and then plants. Chromium VI follows the same pattern of species toxicity affects but at a lower concentration (LOQ 1.0 µg/L in freshwater) (Lenntech*; Chromium*, 1999).

Iron is naturally found in rock and soil, and is the fourth most abundant element that makes up the earth's crust by weight, and it is also a major component of clay materials. In the environment, iron also can be found in two forms, soluble ferrous iron and insoluble ferric iron (The Iowa Department of Natural Resources, 2005). There currently is no Canadian Water Quality Guideline Fact Sheet for iron as iron is an essential nutrient for plants and animals. However, there is a LOQ for iron which is 0.3 mg/L for freshwater.

Fluoride was found in one sample out of the 14 samples collected during this project. The Tomogonops River sample indicates a presence of fluoride during the low water run which marginally surpassed the LOQ for freshwater for aquatic life by 0.002 mg. Inorganic fluoride is most commonly found in the environment in bedrock which will then leach into the groundwater and appear in the surface water and seawater. There are four main types of inorganic fluorides with various uses. One type, sodium fluoride, is used for fluoridation of drinking water, as a preservative in glues, glass and enamel production, and also wood preservation in Canada. The other three types of fluoride have a variety of purposes primarily in the industrial world (*Inorganic Fluorides*, 1999).

Inorganic fluorides remain dissolved in water if under acidic conditions, low hardness, and in the presence of ion-exchange material and calcium or aluminum ions (Inorganic Fluorides, 1999). For the Tomogonops River sample during the low water sample run, total hardness, calcium, sulphate and conductivity stand out as they were much higher than all of the other samples. These parameters do not have an LOQ from the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* and therefore not of great concern on their own, however their affect on inorganic fluorides may have created inadequate conditions for naturally occurring fluoride to dissolve in the water. The levels of hardness, sulphate and conductivity continued to be high during the high water sample run of the Tomogonops, but not as high as during the low water run. Fluoride was not found during high flow conditions.

5.0. – Conclusion

The biological and chemical results for the Northwest Miramichi sub-watershed collected during the low water (September) and high water (November) conditions during the year 2007 were collected, analyzed and compared with the *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. The water quality for this river is suitable for sustaining aquatic life. Some samples exceeded the LOQ but only marginally and this was not repeated in the second sample run.

MREAC's current interest in the Northwest Miramichi watershed stems from the current world demand for base metals and the intensive exploration activity underway in this watershed. The results of this study show that several parameters are at or exceed the national guidelines for sustaining aquatic life. This would suggest that there is a limited margin of error for increasing levels of toxic materials in the freshwater system. As such MREAC will remain alert to opportunities to monitor these existing sample sites and other areas where prospecting and/or mining activities are carried out. At the same time provincial jurisdictional agencies, especially the Department of Natural Resource and the Department of Environment are encouraged to take note of the results and the recommendations associated with this study.

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