The BRWP RiverWatch Program

A retrospective synthesis of water chemistry along the Bonnechere River, 1999-2013

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"Helping Ourselves to a Healthy Environment"

Introduction

A watershed is an entire geographical area drained by a river and its tributaries (BRWP 2010). The Bonnechere River Watershed encompasses an area of 2400 km^2 and the Bonnechere River stretches 145km from its headwaters in Algonquin Park to Castleford where it empties into the Ottawa River (BRWP 2010). When trying to determine the health of the river, it is essential to not only consider the river itself, but rather the entire watershed as everything within it is interconnected (BRWP). A problem originating in one area can have an impact further down the river. Problems include water flow, invasive species, and pollution.

There are two forms of pollution that can have measurable impacts on the quality of the water within a watershed. Point source pollution is one form and is limited to types of pollution that have an identifiable source (Gardner 2006). Point source pollution within the Bonnechere River Watershed is primarily associated with inadequate sewage treatment facilities (Gardner 2006). The other form of pollution is non-point source pollution. Unlike point source pollution that has an identifiable source, non-point source pollution comes from a diffuse source (Gardner 2006). Common types of non-point source pollution include run-off from roadways, pesticides or herbicides washed into waterways from agriculture areas, storm drains, and inadequate or failing septic systems (Gardner 2006). Regardless of a source being point or non-point, all can result in an adverse impact on the quality of the water.

The goal of the water quality monitoring conducted by the Bonnechere River Watershed Project (BRWP) Riverwatch team is to identify areas of concern along the main channel of the river and using this data to develop an appropriate action plan for future improvement of water quality (Gardner 2006). The Riverwatch team monitors a number of chemical as well as physical parameters that are compared to a set of Canadian Water Quality Guidelines (CWQG) for both drinking and recreational water uses (Gardner 2006).

Methods

Water quality monitoring has been conducted along the Bonnechere River by the BRWP since 1999 when the project began until present day. While testing has occurred over an almost 15 year span, the data has been collected intermittently over the years and by different individuals. The intent of this report is obtaining a better understanding of the data that has been collected by observing temporal changes in water quality. While most of the data was collected along the main stem of the Bonnechere River, the Carleton University dataset was collected at the mouth of tributaries entering the Bonnechere and so may deviate slightly from the other datasets. In order to accurately compare all datasets, only data collected from mid-July to August was used for this report. Data collected in July was chosen, as the water quality during this time is generally the poorest. All data collected was done so by use of either a Sonde YSI or Vernier Probe or with the Ottawa Riverkeeper Testing Kit. All graphing and analysis was completed using Microsoft Excel 2011.

Results

In general, the seasonal results exhibit a pattern that would be expected. For all parameters except dissolved oxygen, which experiences a decrease, the observed trend is an increase in levels along the length of the river. While the seasonal data does exhibit an expected pattern, this report only focuses on data collected in July and August. This is justifiable by the fact that late summer tends to have the poorest water quality. Of all the months, July and August are generally found to be one of the highest in all parameters and the lowest for dissolved oxygen. Another reason for focusing on July was to obtain an accurate reading of the data collected. The average seasonal data is less accurate and allows for a greater chance of error or a false depiction of the results, due to incomplete data collection in other months.

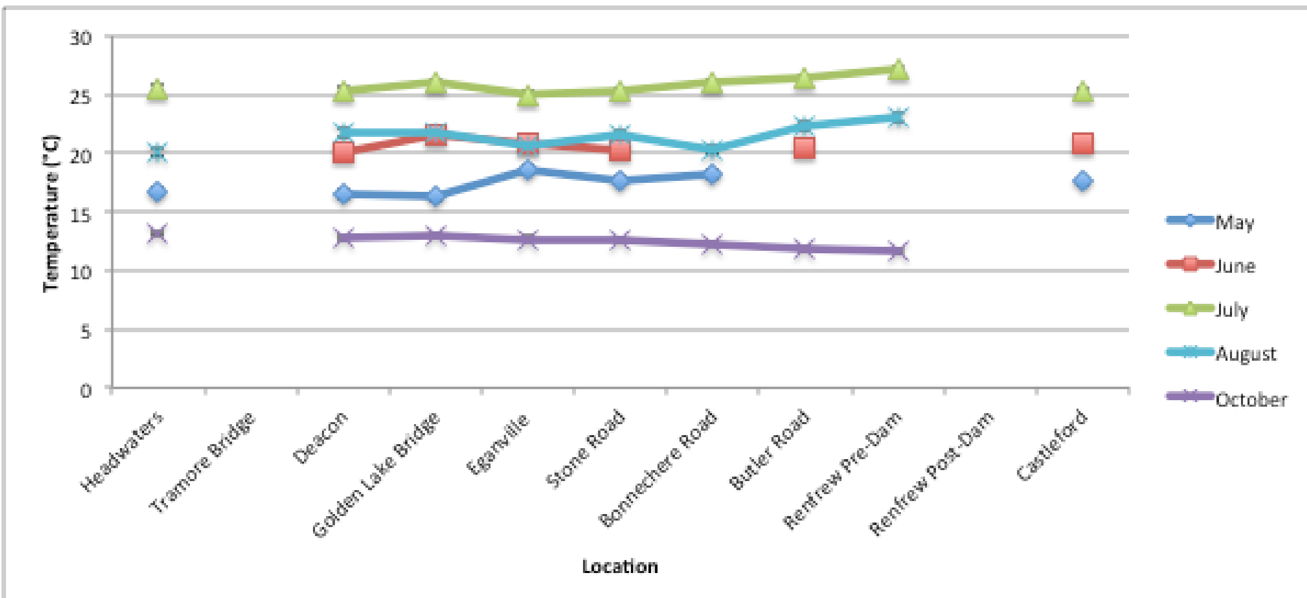

Figure 1 Average seasonal temperature (+/- standard error) along the Bonnechere River from 2009-2013

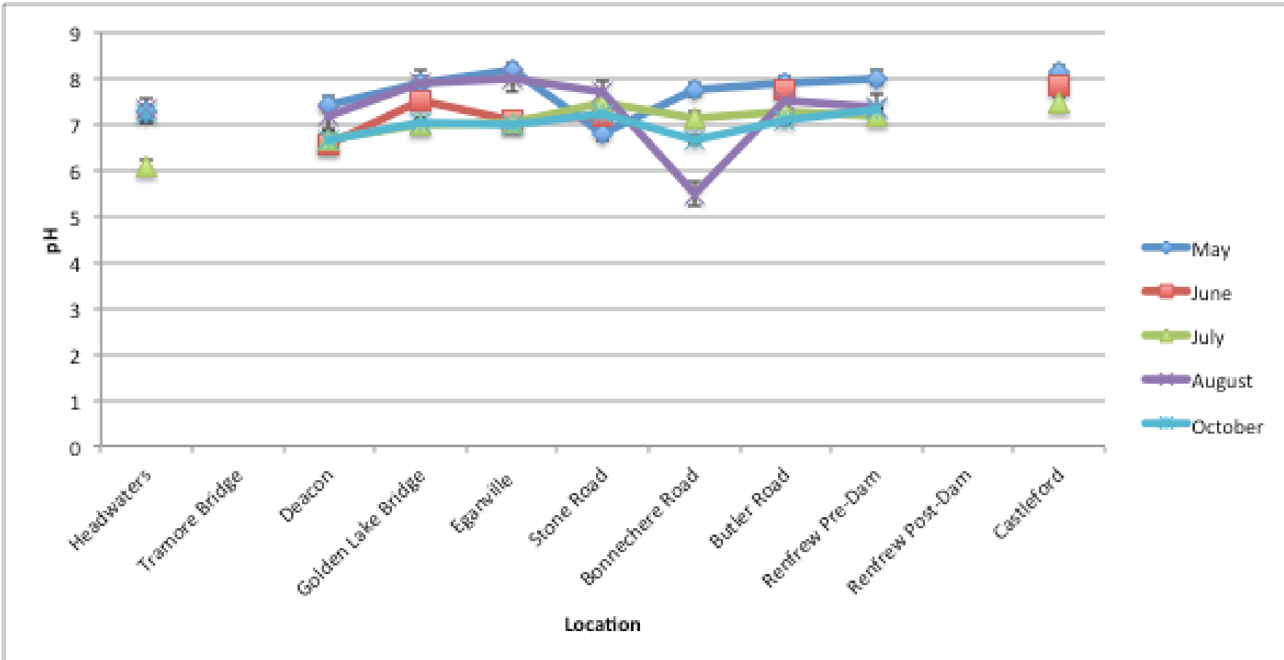

Figure 2 Average seasonal pH (+/- standard error) along the Bonnechere River from 2009-2013

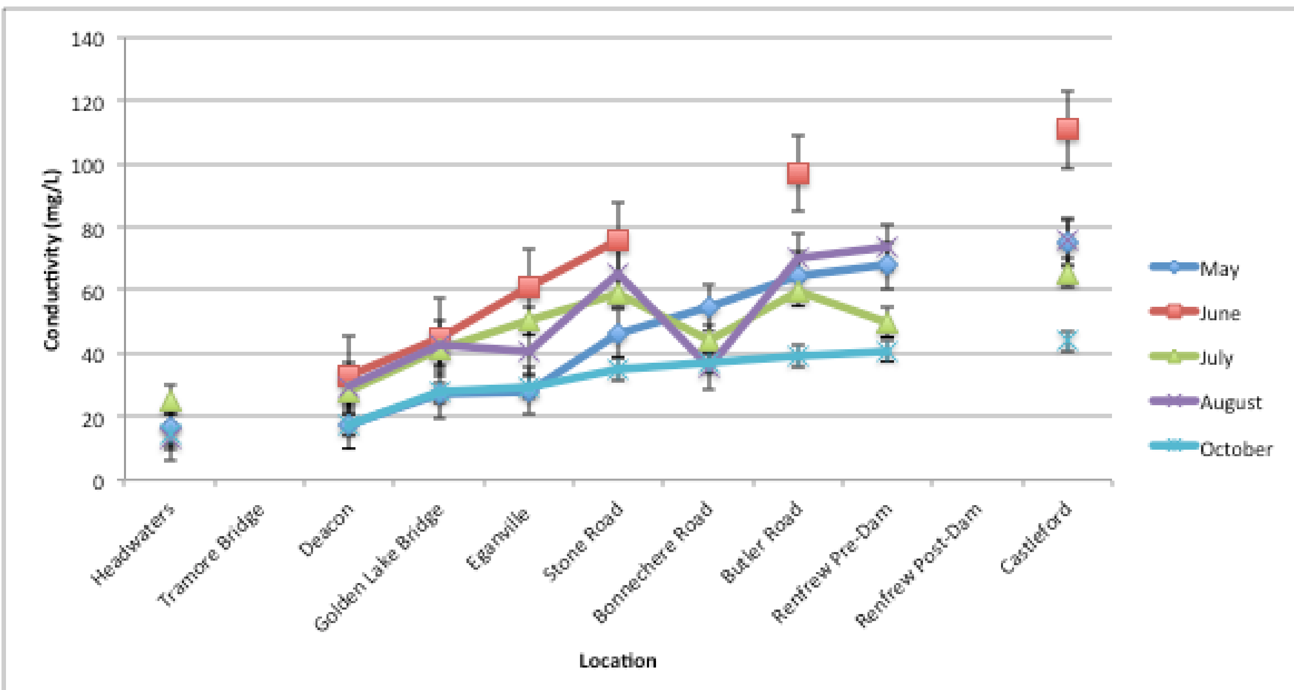

Figure 3 Average seasonal conductivity (+/- standard error) along the Bonnechere River from 2009-2013

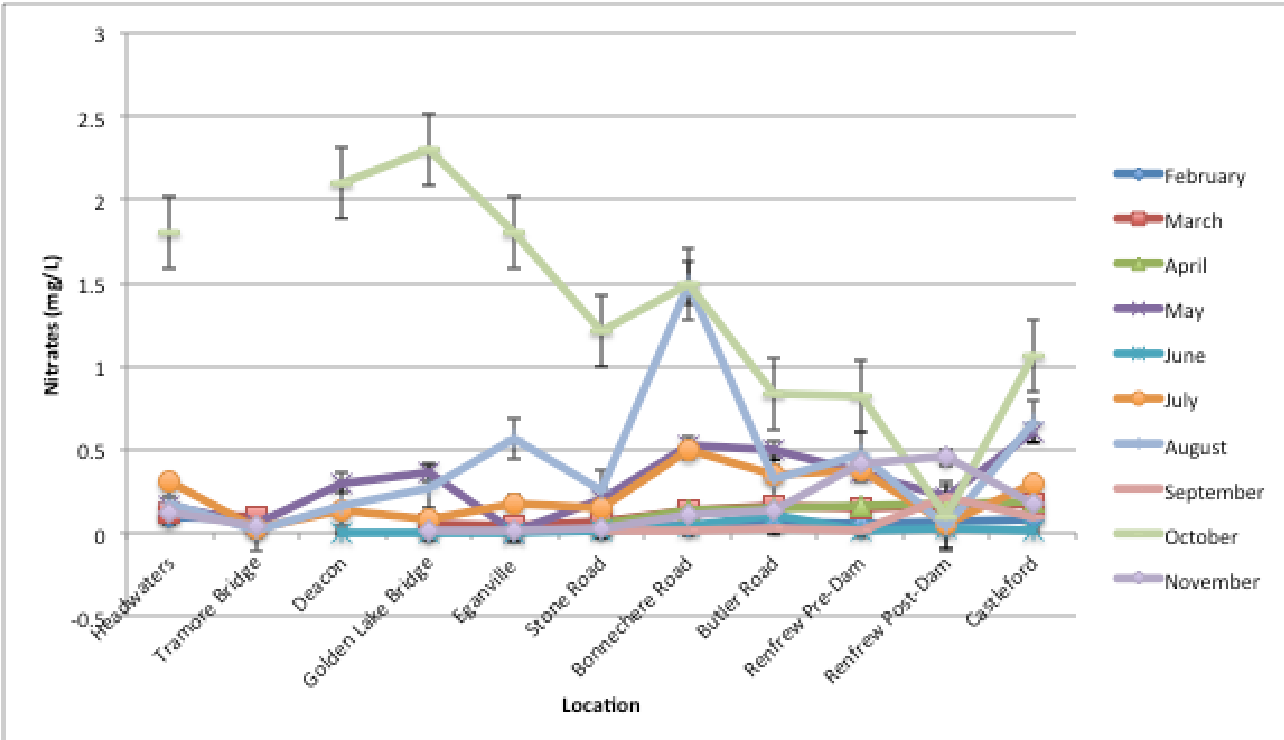

Figure 4 Average seasonal nitrates (+/- standard error) along the Bonnechere River from 1999-2013

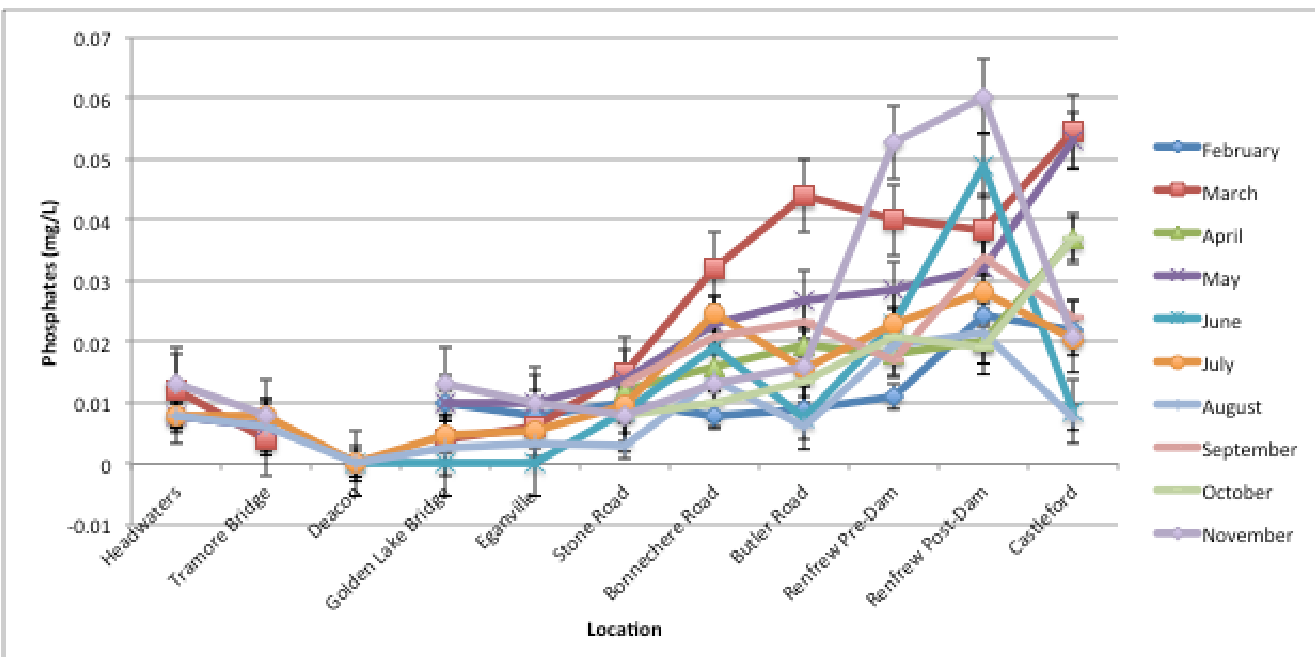

Figure 5 Average seasonal phosphates (+/- standard error) along the Bonnechere River from 1999-2013

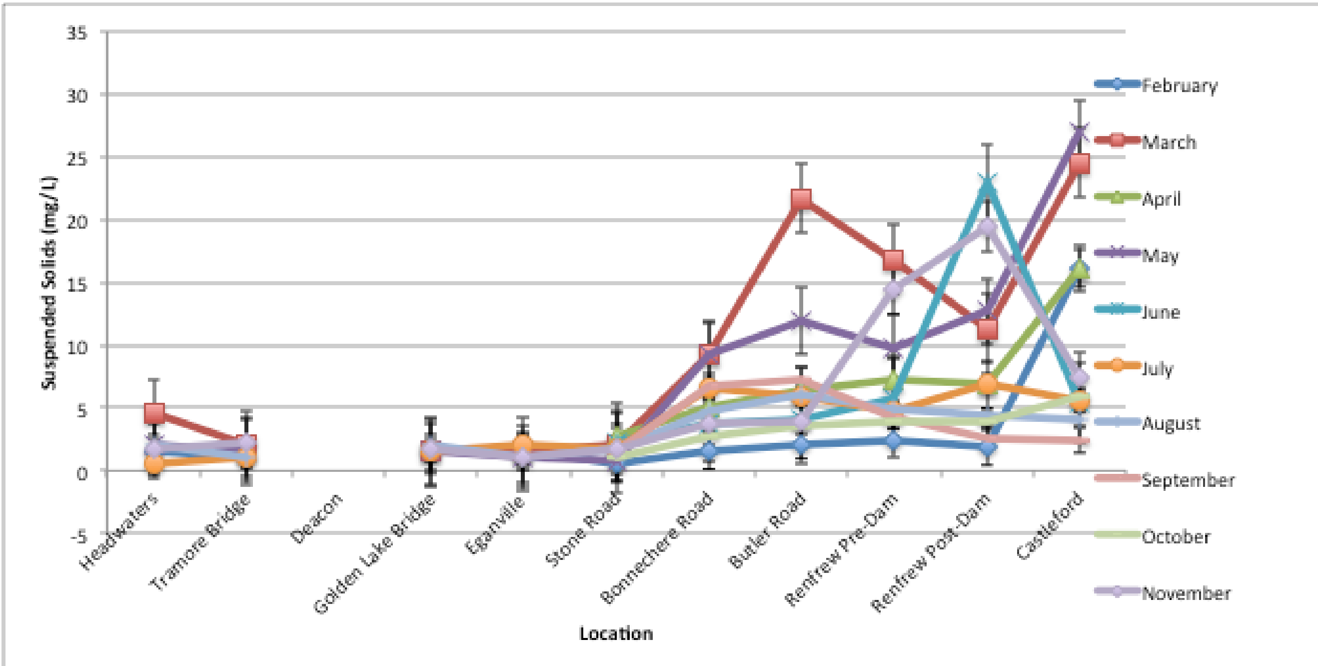

Figure 6 Average seasonal suspended solids (+/- standard error) along the Bonnechere River from 1999-2004

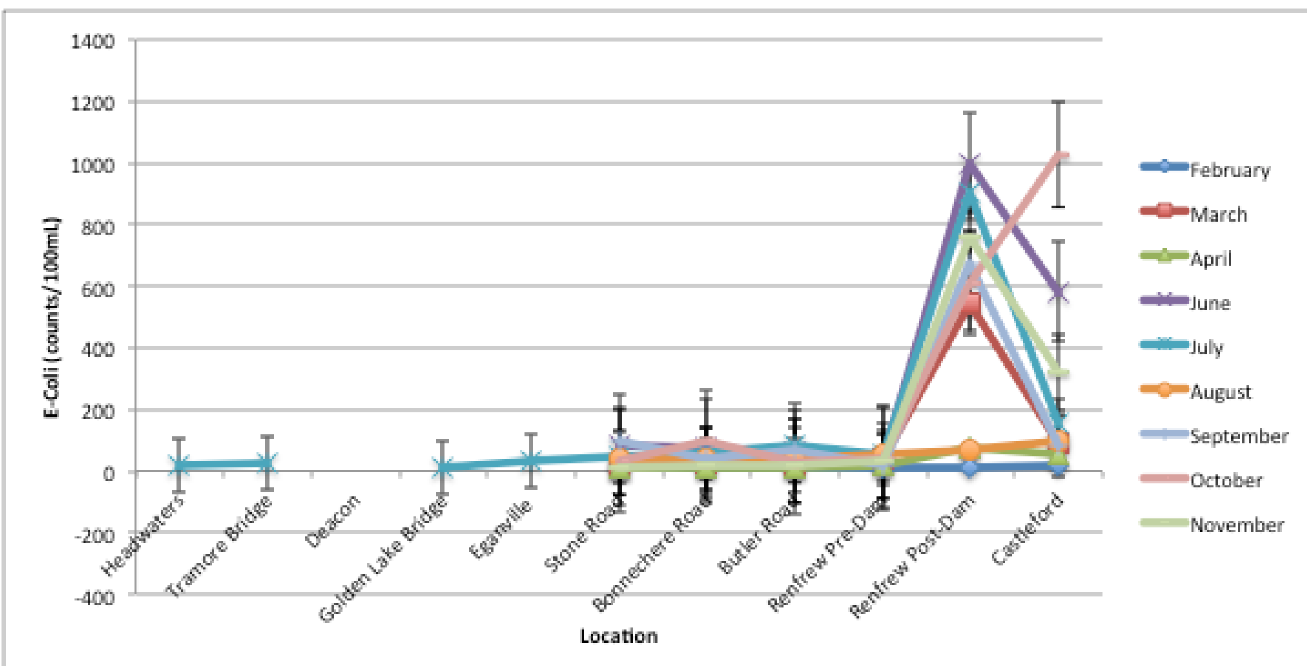

Figure 7 Average seasonal E-Coli (+/- standard error) along the Bonnechere River from 1999-2004

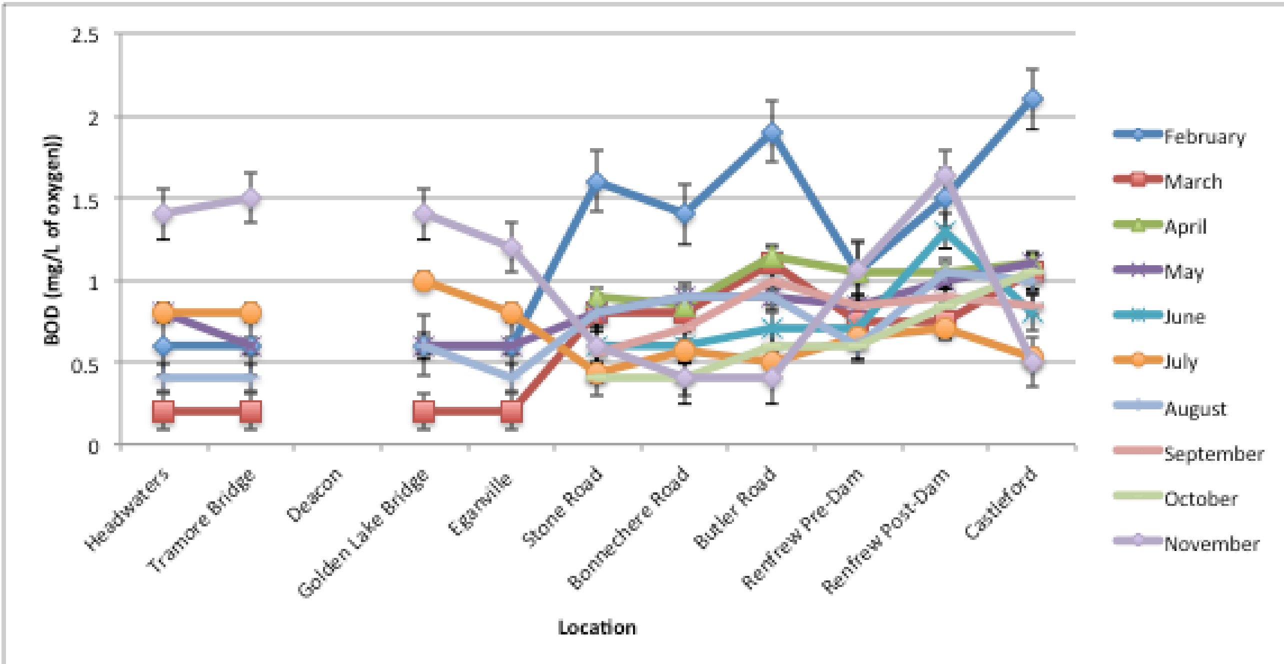

Figure 8 Average seasonal BOD (+/- standard error) along the Bonnechere River from 1999-2004

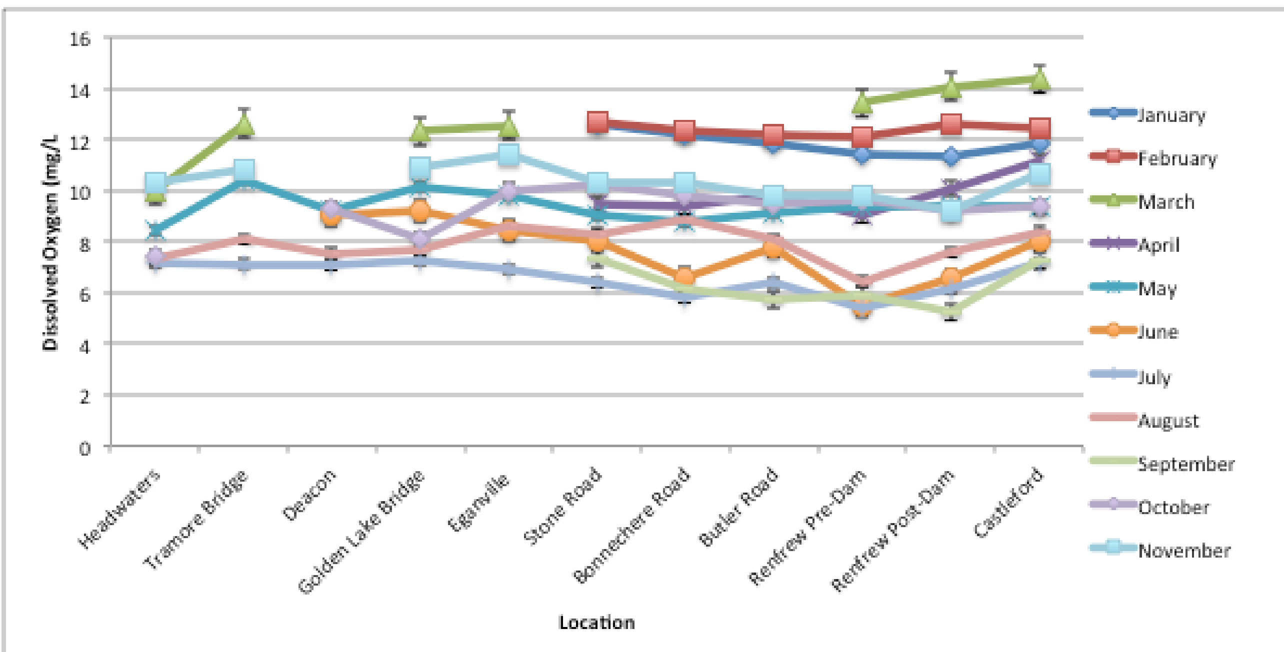

Figure 9 Average seasonal dissolved oxygen (+/- standard error) along the Bonnechere River from 1999-2013

Temperature

Sources and Impact

Water temperature is a key parameter that directly impacts many of the chemical, physical, and biological factors influencing aquatic organisms (Environment Canada 2013). Temperature can be influenced by a number of factors including weather, removal of riparian vegetation, turbidity, and dams (Environment Canada 2013). If the temperature is outside of the tolerance range of an organism for an extended period of time, they can become stressed and die resulting in a change of organisms inhabiting the water body (Environment Canada 2013).

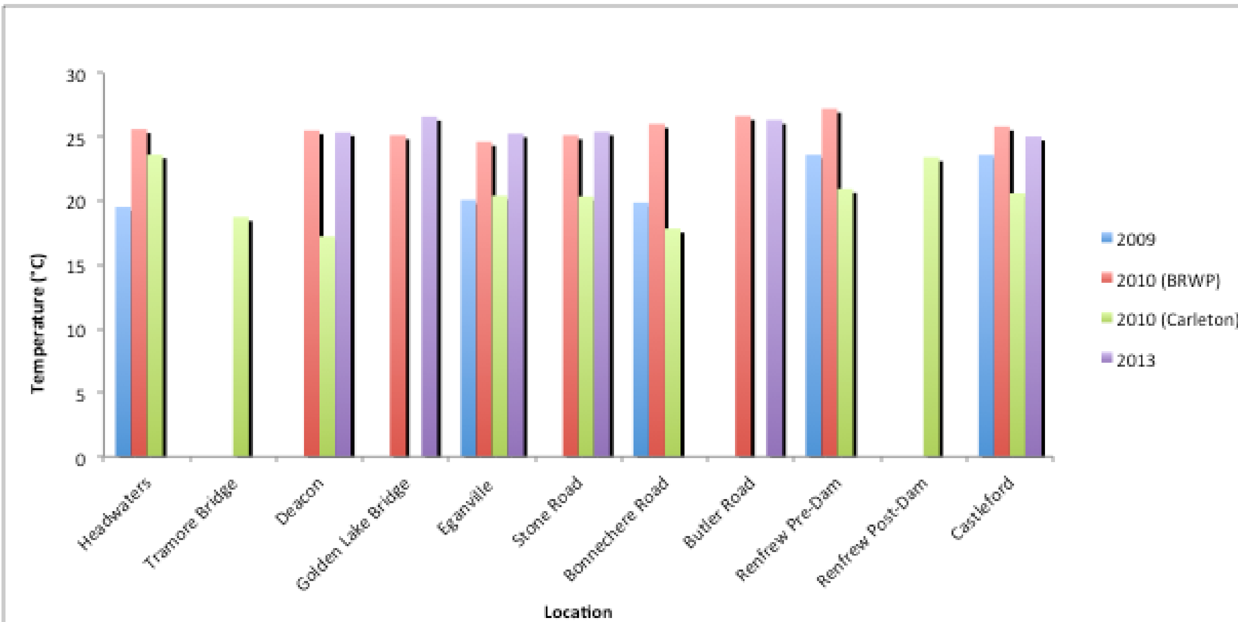

Figure 10 Water temperature sampled along the Bonnechere River in July from 2009-2013

In general the water temperature remains relatively constant along the length of the Bonnechere for each year with a slight increase in temperature towards the mouth of the river. As well the water temperature ranges from cool water (18-23°C) to warm water (26-31°C) (BRWP 2011). There is also an evident difference in water temperature between years and this is likely due to the difference in times when samples were collected.

pH

Sources and Impact

The relative acidity of water is based on a pH scale with a range of 0-14 (Environment Canada 2013). Young fish and aquatic insects are especially sensitive to pH values outside the optimum range (Environment Canada 2013). The pH of a waterbody is usually determined by the surrounding geological make-up, but is also influenced by acid rain, wastewater discharges, and drainage from coniferous forests (acidic) (Environment Canada 2013). The pH can also influence the forms of metals and therefore the toxicity to different aquatic species (Environment Canada 2013).

Safe Limits

Water with pH 6.5-9 is suitable for the greatest diversity of aquatic organisms (Environment Canada 2013).

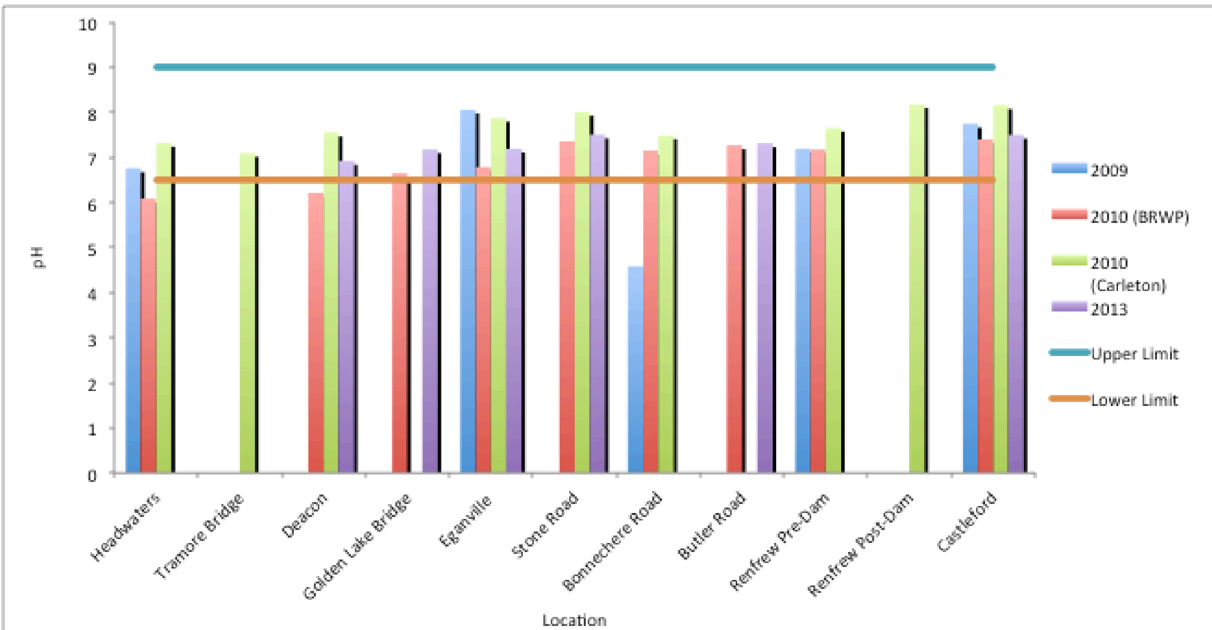

Figure 11 pH sampled along the Bonnechere River in July from 2000-2013

The results found display a similar pattern throughout every year. In general the pH increased slightly going down river. This would be expected as pH is influenced by the surrounding geological make-up. As the river morphology changes from mainly a limestone bed to the clay belt, an increase in pH would be expected to occur. For the most part the pH remained within the range for greatest biodiversity of 6.5-9, however the Bonnechere Road site for 2009 was found to have a pH 4.58. This could be attributed to a weather event having an impact on the water quality or this finding may indicate the presence of point source pollution such as wastewater discharge.

Conductivity/Total Dissolved Solids (TDS)

Sources and Impact

Conductivity is the ability of a solution to conduct an electrical current (Environment Canada 2013). This is dependent upon the total concentrations of ionized substances dissolved in the water and is also affected by temperature (Environment

Canada 2013). Conductivity is a useful tracer of point source pollution as sudden increases along a water body can indicate a point source (Environment Canada 2013).

Safe Limits

TDS values in lakes and streams are typically found to be in the range of 50 and 250 mg/L.

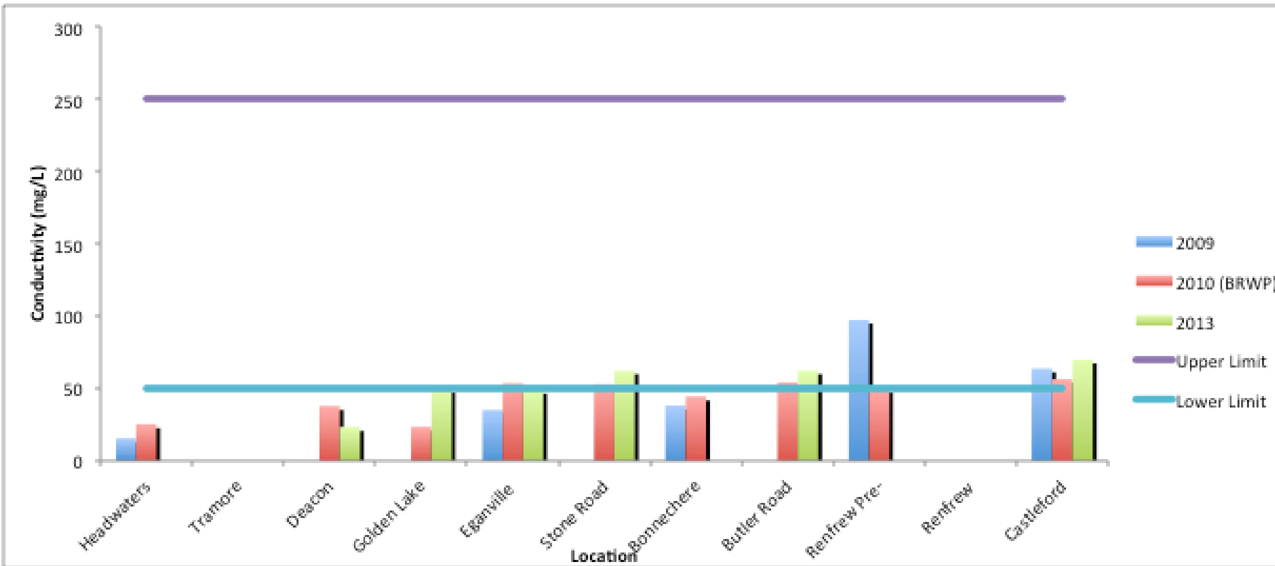

Figure 12 Conductivity/TDS sampled along the Bonnechere River in July from 2009-2013

In general the TDS values found are within the typical range of 50-250 mg/L with some lower values in the upper reaches. Figure 3 clearly displays an increase in conductivity as distance from the headwaters increases for all years.

Nitrates

Sources and Impact

There are many forms of nitrogen found within the environment (Gardner 2006). The form depends heavily on a number of parameters within the water including temperature, pH, and oxygen availability (Gardner 2006). Nitrate is the most dominant form of nitrogen found in the environment and can be found both naturally and released into the environment by sources such as agricultural and industrial operations (Gardner 2006). Once within the environment, nitrates can move very easily through soil into groundwater supplies or into surface water systems (Gardner 2006).

When there is an abundance of oxygen, nitrates are taken up readily by plants and will promote growth (Gardner 2006). When found in high concentrations within surface water systems, plant growth will be excessive which can have a number of potential impacts (Gardner 2006). Algal blooms can reduce oxygen levels, thereby putting stress on aquatic organisms and in some cases toxins are released that adversely affects aquatic life (Gardner 2006). Further, nitrates can also affect animals and invertebrates by influencing their growth rate, maturity, reproductive abilities, and in extreme levels can be lethal (Gardner 2006).

Safe Limits

The limit set for nitrate levels within the environment are tentative as impacts are influenced by other factors such as dissolved oxygen levels (Gardner 2006). Therefore, the CWQG limit should be treated as a guideline as impacts will not always be expressed (Gardner 2006). The CWQG to protect freshwater life should not exceed 13 mg/L (Gardner 2006). As well the average nitrate concentration for Canadian lakes and rivers studied do not exceed 4 mg/L (Gardner 2006).

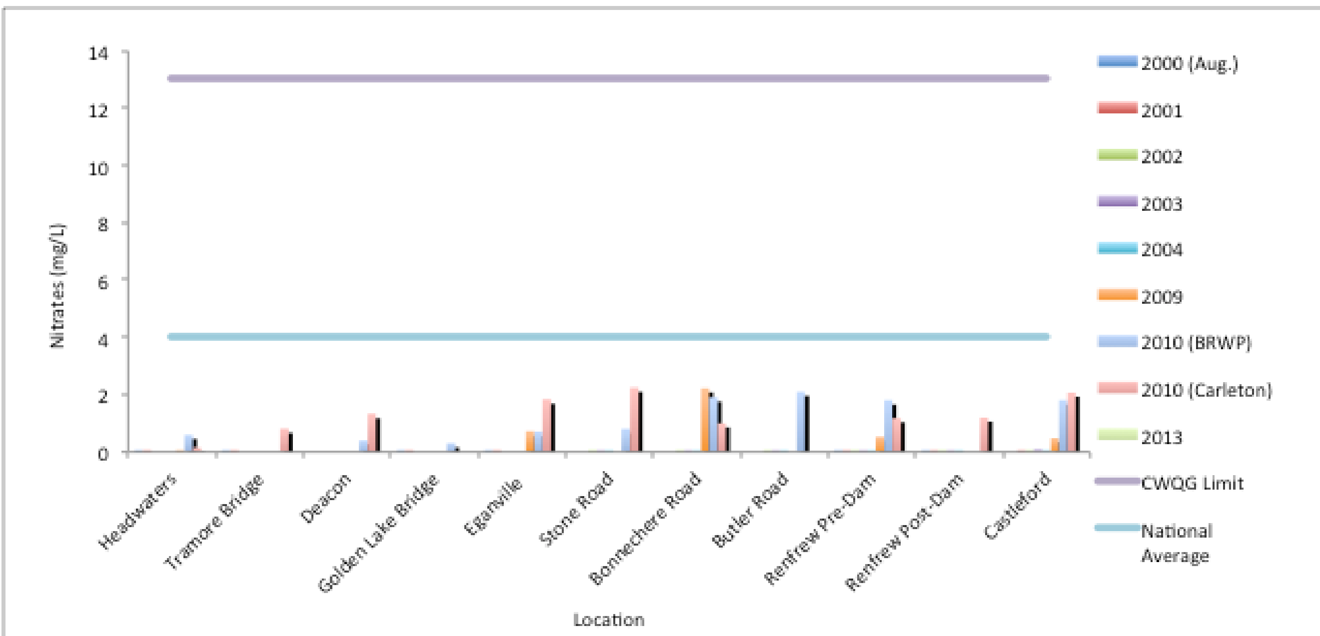

Figure 13 Nitrates sampled along the Bonnechere River in July from 2000-2013

As expressed in Figure 4, the nitrate concentrations for each year are well below the CWQG limit of 13 mg/L and the majority well below the national average of 4 mg/L. For the years with measurable concentrations of nitrates, an increase in concentration is evident from Stone Road to Butler Road and at Castleford. The increase in concentration between Stone and Butler Road is likely due to the surrounding landscape being heavily agricultural, which would account for higher nutrient levels from non-point sources such as field run-off.

A notable difference is also evident in the concentrations found before 2009 and after. The sampled values from 2009 onward are considerably higher than those before 2009. This is suggestive of a degradation of the water quality in more recent years, however the 2013 results for nitrates were found to be 0 mg/L at every site tested. For this reason, further sampling would be necessary to determine the accuracy of these findings. The use of one standard test method would be advised in order to determine if the differences noted are due to change in levels or testing methods.

Phosphates

Sources and Impact

Phosphorus is a naturally occurring nutrient found in rocks and is released when they erode (Gardner 2006). Phosphorus can enter a ground water system by means of the atmosphere, from sewage treatment plants and industrial waste, and from storm water run-off (Gardner 2006). Inorganic phosphorus is consumed by aquatic plants for nutrition (Gardner 2006).

Excessive amounts of phosphorus leads to increased plant growth (Gardner 2006). This will result in a variety of impacts including changes to plant and animal diversity, additional organic matter as a result of dead plants and animals, and decreased oxygen levels (Gardner 2006). Low oxygen supplies can lead to fish kills and in some cases blue-green algae (cyanobacteria), an algae that proliferates in high phosphorus levels, may occur and result in fish kills, decreased drinking water quality, and can prove to be fatal to livestock and other wildlife (Gardner 2006).

Safe Limits (Gardner 2006)

Ultra-oligotrophic: < 0.004 mg/L or 4.0 ug/L
Oligotrophic: 0.004-0.01 mg/L or 4.0 - 10 ug/L
Mesotrophic: 0.01-0.02 mg/L or 10 – 20 ug/L
Meso-eutrophic: 0.02-0.035 mg/L or 20.0 – 35.0 ug/L
Eutrophic: 0.035-0.1 mg/L or 35.0 – 100.0 ug/L
Hyper-eutrophic: >0.1 mg/L or >100 ug/L

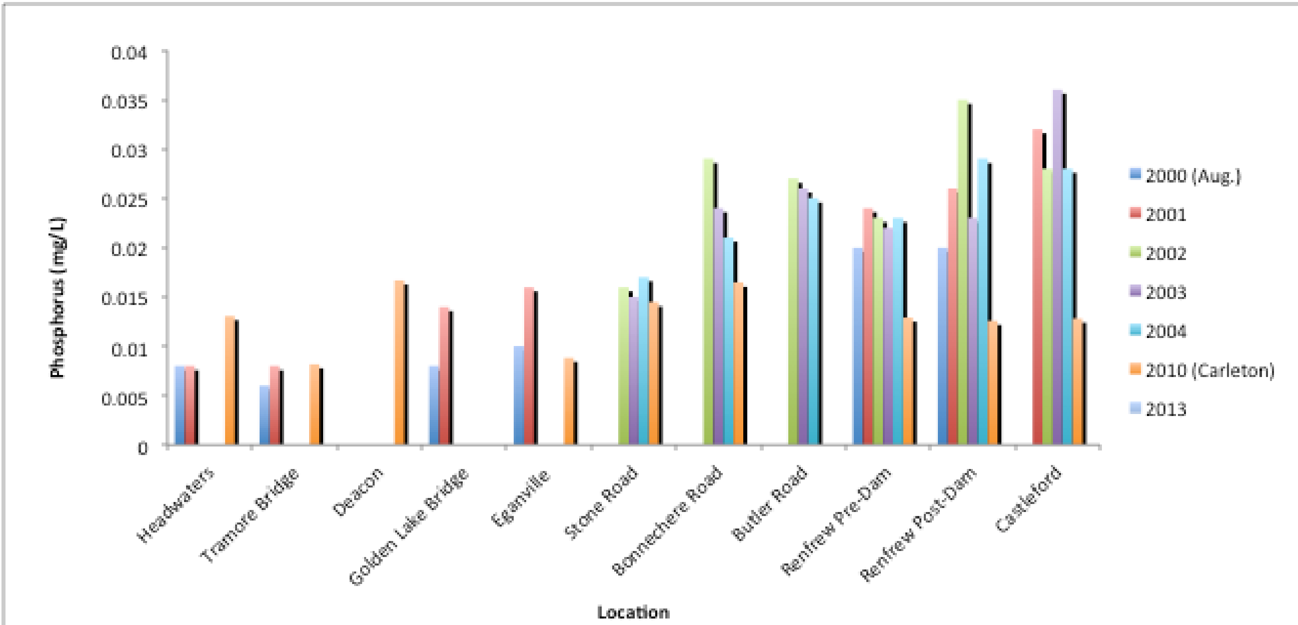

Figure 14 Phosphates sampled along the Bonnechere River in July from 2000-2013

Overall the sampled values of phosphorus concentrations were quite low. When considering the trophic status of the river, the upper reaches ranged from oligotrophic to mesotrophic, while the lower reaches ranged from mesotrophic to meso-eutrophic. In general, all years displayed an increase in phosphorus levels as distance from the headwaters increased. This would be expected from the geologic change of purely bedrock to clay belt. As well further increases in phosphorus levels further down river would be expected from higher impact from anthropogenic sources such as sewage and agricultural run-off.

Similar to nitrates, the phosphate levels found in 2013 were 0 for all sites. The form of phosphates sampled in 2013 was orthophosphates, though the form tested in other years is not known. It is possible that the differences are due to the form of phosphate tested and therefore a standardized test is necessary.

Suspended Solids

Sources and Impact

Suspended solids are an indicator of the particulate matter found floating in water (Gardner 2006). This includes substances such as silt, sand, decomposing leaves, and pieces of wood (Gardner 2006). The amount of suspended solids found within a system is dependent on the flow rate (Gardner 2006). An increased flow rate can result in erosion of banks and shorelines and also inhibits suspended solids from settling to the bottom of the water system (Gardner 2006).

Suspended solids play an important role in water quality, as they will diminish the amount of sunlight able to penetrate the water thereby decreasing plant growth (Gardner

2006). Suspended solids also actively transport chemicals such as pesticides and bacteria through a water system (Gardner 2006). Moreover, as the flow rate decreases or reaches a pooling area, suspended solids are able to settle to the bottom (Gardner 2006). This can smother life found in the substrate of the water system due to a decrease in oxygen availability (Gardner 2006).

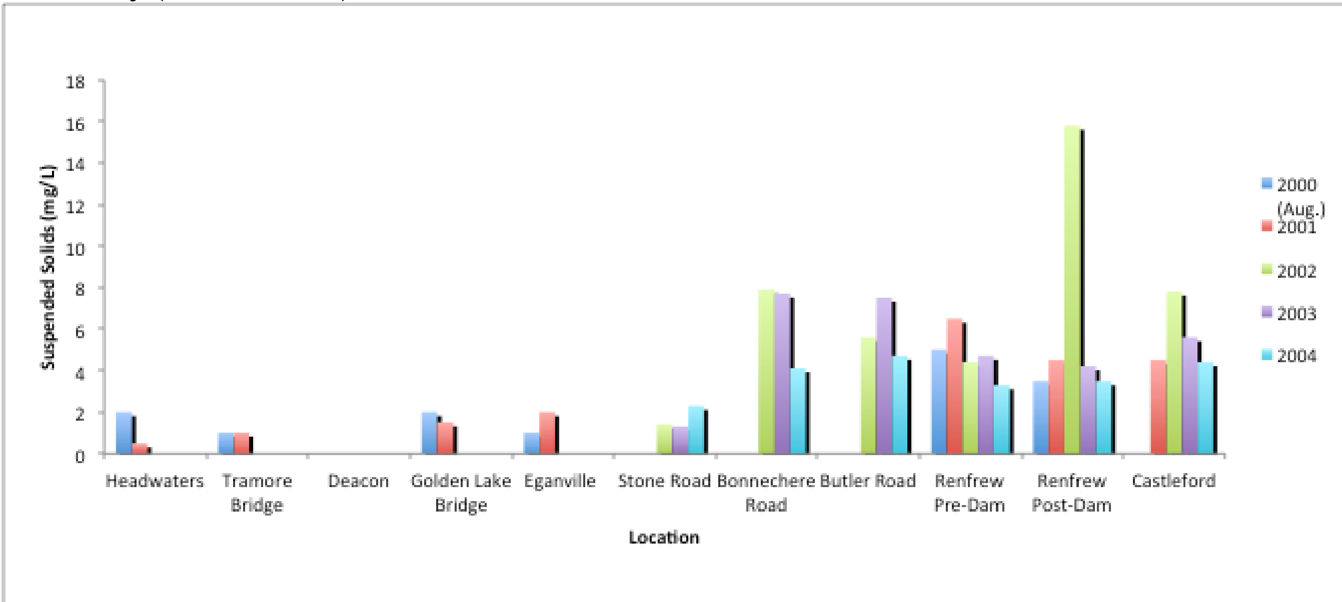

Figure 15 Suspended Solids sampled along the Bonnechere River in July from 2000-2003

As exhibited in Figure 6, suspended solids sampled in the upper reaches was found to be between 0-2 mg/L, while all years experienced an increase beginning at Bonnechere Road. This increase is consistent with the change from bedrock to clay belt in the lower reaches of the river. Increased flow rate is another reason for higher suspended solids in a water system. This accounts for the high value observed at the Renfrew Post-Dam site, as the flow rate would experience an increase after passing through a structure such as a dam.

E-Coli

Sources and Impact

Sources of e-coli are not identified during standard testing, but may include humans, livestock, and other warm-blooded animal's fecal matter (Gardner 2006). E-Coli are associated with many exposure-related illnesses, including gastro-intestinal illnesses that can be introduced by consuming contaminated water or participating in recreational activities at a contaminated site (Gardner 2006).

Safe Limits (Gardner 2006)

Drinking water – 0 counts per 100 mL
Recreational water – 100 counts per 100 mL

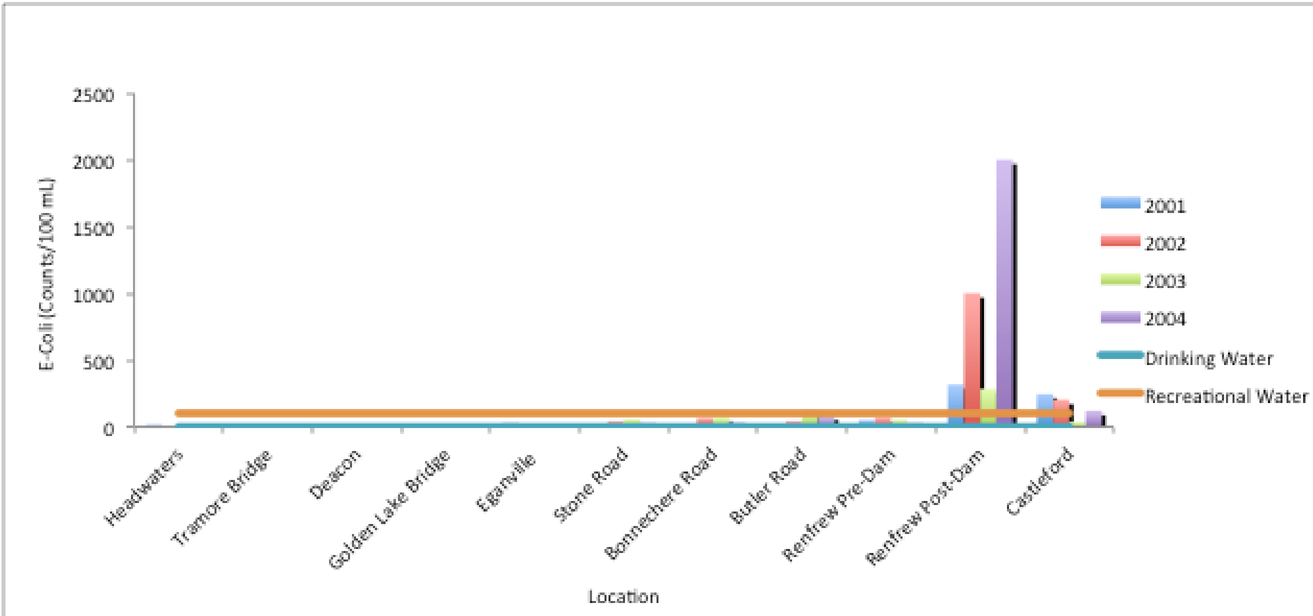

Figure 16 E-Coli sampled along the Bonnechere River in July from 2001-2004

The results displayed in Figure 7 show that traces of e-coli were found in every site test. The counts were below 100 counts per 100 mL of water safe for recreational water use up to and including the Renfrew Pre-Dam site. The last two sample sites were found to have extremely high counts of e-coli, exceeding 100 counts per 100 mL and in some cases reaching 1000 counts or greater. These high counts can likely be attributed to the fecal matter discharge from the Renfrew area.

Biological Oxygen Demand

Sources and Impact

Biological Oxygen Demand (BOD) refers to the amount of oxygen that would be consumed if all the organics in one liter of water were oxidized by bacteria and protozoa (Gardner 2006). The test measures the oxygen utilized during a specified incubation period for the biochemical degradation of organic materials (Gardner 2006). Maintaining adequate levels of oxygen to sustain aerobic organisms is vital to a healthy watershed (Gardner 2006). When oxygen levels reach an inadequate level it results in fish and other aquatic organism mortality (Gardner 2006).

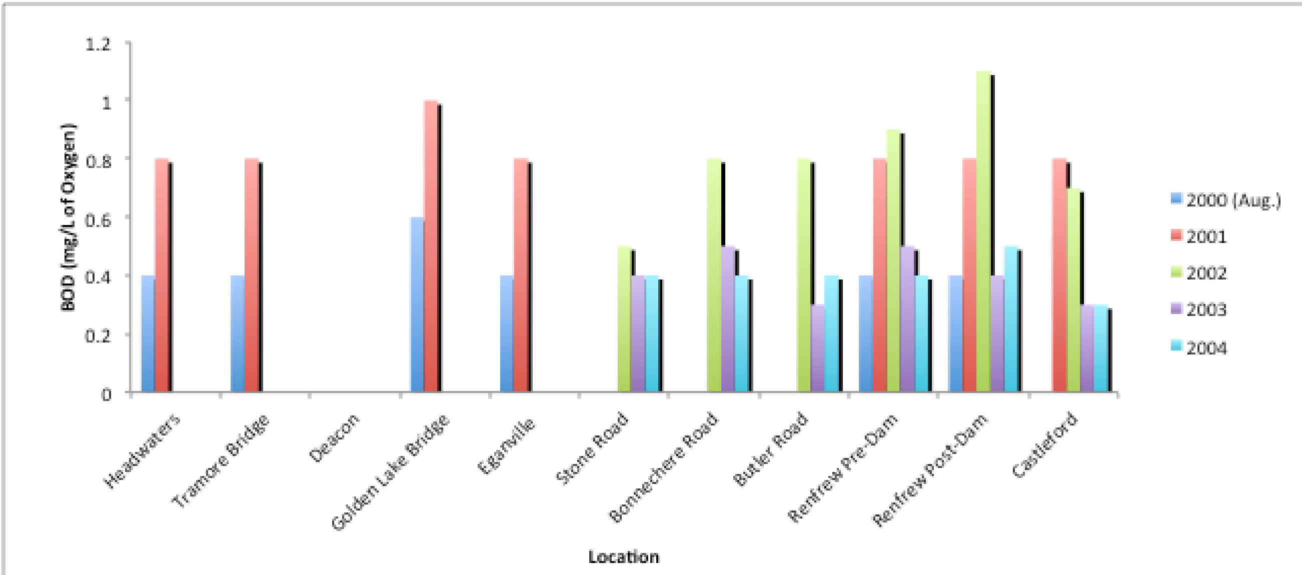

Figure 17 BOD sampled along the Bonnechere River in July from 2000-2004

The results found show that the biological oxygen demand remained relatively constant over the length of the river for each year with a slight increase in the lower reaches of the river. This would be attributed to the greater oxygen demand for the degradation of organic matter (Gardner 2006).

Dissolved Oxygen

Sources and Impact

Dissolved Oxygen is the measurement of the amount of oxygen freely available in the water sampled (Gardner 2006). Dissolved Oxygen is inversely related to temperature; therefore dissolves more readily in cold water than warm water (Gardner 2006). Adequate levels of dissolved oxygen are required for maintaining a healthy aquatic ecosystem, which vary depending on the type of biological community (Gardner 2006). When the dissolved oxygen concentration falls below the required levels, it will result in suffocation of the animals within that habitat (Gardner 2006).

Safe Limits (Gardner 2006)

6.0 mg/L protection of early life stages of warm water biota
5.0 mg/L protection of other life stages of warm water biota
9.5 mg/L protection of early life stages of cold water biota
6.5 mg/L protection of other life stages of cold water biota

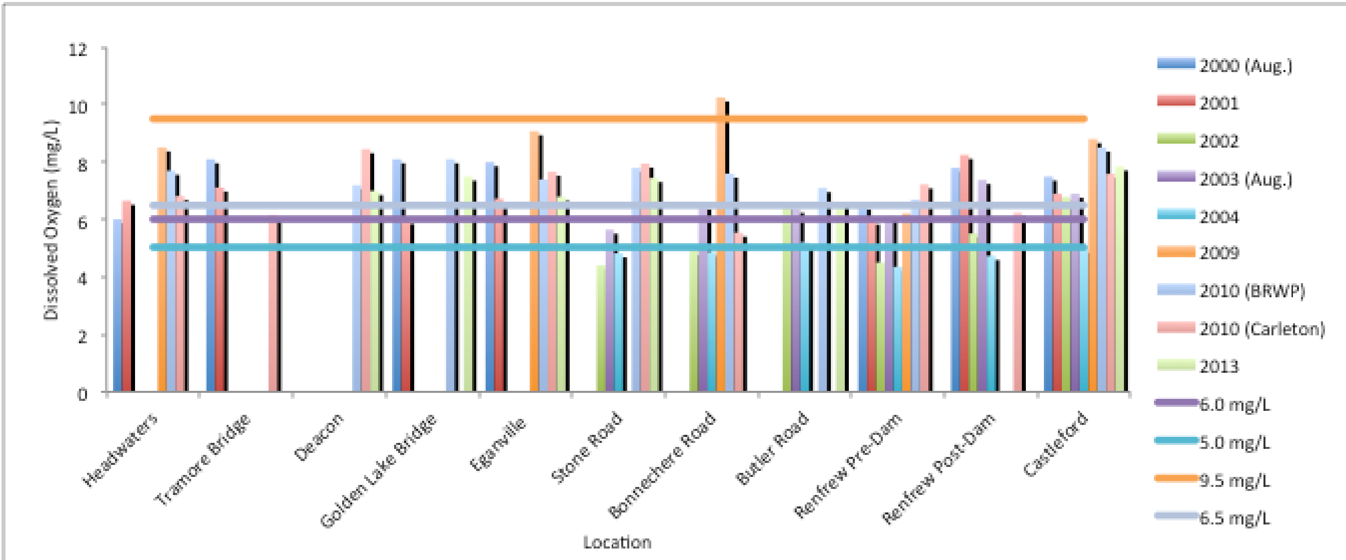

Figure 10 Dissolved Oxygen sampled along the Bonnechere River in July from 2000-2013

The results found show that the sites sampled had a dissolved oxygen level ranging from 4-10 mg/L with the majority having a reading around 6-8 mg/L. While these low oxygen levels obviously would not support any stage of cold-water biota, it must be considered that for the purpose of this report only samples from mid-July to August were used and so lower levels of dissolved oxygen would be expected with lower solubility of oxygen in warm water.

Conclusion

In general the water chemistry data collected over the past 14 years has been consistent with expectations. As expected the quality of water decreased from the headwaters of the Bonnechere to the mouth, which has been attributed to both anthropogenic and geographical influences. While the water quality does appear to decrease along the length of the river, most values are well within the safe limits set by the Canadian Water Quality Guidelines with the exceptions of dissolved oxygen and e-coli; however some these poor conditions can be attributed to natural degradation of water quality that occurs over the summer months. On the whole the water quality along the Bonnechere River appears to remain healthy and within safe standards, although it is necessary to continue to monitor the river with standardized testing in order to maintain the health and beauty of a river, and more importantly a watershed, that provides so much for all that rely on it.

Works Cited

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