The BRWP RiverWatch Program

Smith's Creek
Catchment Report

October 2013
Revised: April 2014

Report by: Lisa Kelly
Assisted by: Paul O'Brien
Reviewed/Revised by: Dr. Kathryn Lindsay

Bonnechere River Watershed Project

P.O. Box 234
Renfrew, ON
K7V 4A3
info@bonnechereriver.ca
www.BonnechereRiver.ca

"Helping Ourselves to a Healthy Environment"

Introduction

Smith's Creek is one of 29 tributaries in the Bonnechere River watershed that the BRWP has been monitoring from time to time since the early 2000s. Smith's Creek is approximately 14 km long and begins at Hurds Lake and flows into the Bonnechere River in the Town of Renfrew. There is a water control structure on the outflow from Hurds Lake that is managed by a local resident.

The Smith's Creek catchment is found in the lower (eastern) portion of the Bonnechere River watershed (Figure 1) and spans multiple municipalities (Townships of Admaston/Bromley, Horton, Greater Madawaska and Town of Renfrew). The catchment area draining in to Smith's Creek encompasses 48.4 km^2 and has varying land uses; 77% is comprised of forested, 12.2% is agricultural (hay), 3.5% of the watershed is wetland, and 1.3% is developed (BRWP 2012). The Smith's Creek catchment is one of the most developed stream catchments that has been studied by the BRWP in the Bonnechere River watershed.

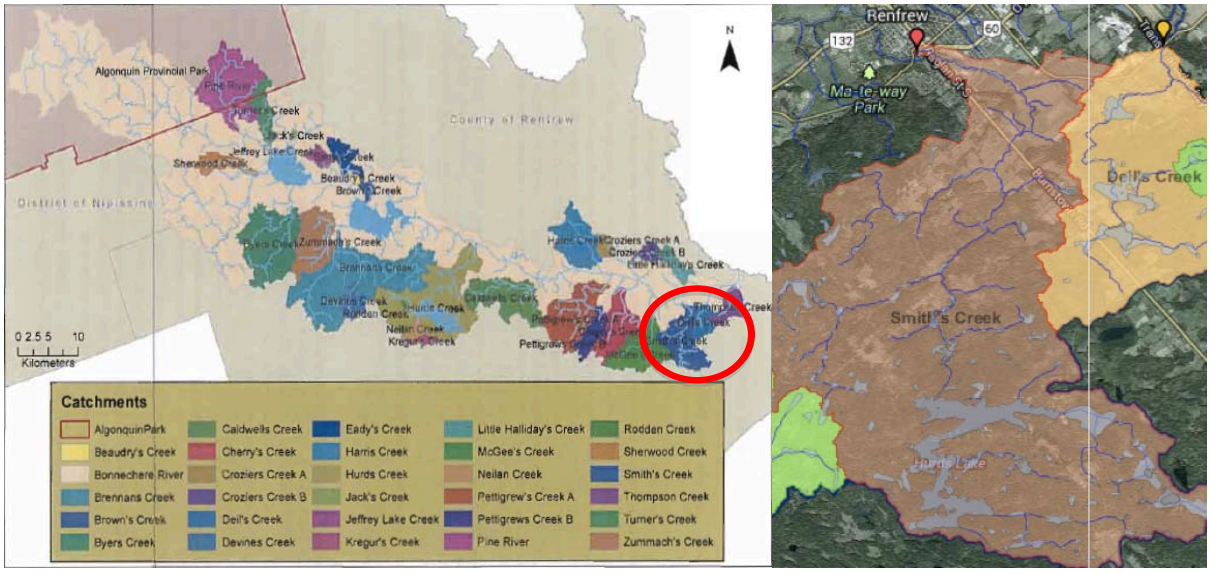

Figure 1. a) Map of the Bonnechere River watershed and all stream catchments. Smith's Creek is circled. b) Map of Smith's Creek with catchment boundaries.

The BRWP has assessed stream condition in Smith's Creek at Stewart Park in Renfrew based on the composition and abundance of instream macroinvertebrates 9 times over 5 years from 2003 to 2008 (BRWP 2008). Once in each of two years (2004 and 2007; 22% of survey effort) stream condition was rated as FAIR (potentially impaired); otherwise it rated as GOOD (unimpaired). However, there was a concern of proximity of a site historically used as snow dump to Smith's Creek and the increased levels of silt north and west of the sampling location. At that time, the BRWP recommended further monitoring of the creek and possibly remediation to rectify silt situations.

The BRWP RiverWatch program assessed the condition of Smith's Creek using benthic macroinvertebrates as GOOD in 2009, FAIR in 2010 (BRWP 2011) and POOR in 2011 (BRWP 2012a). It is important to note that the sampling site in 2011

was flooded extensively on both banks, and the water quality was turbid, with little movement. This was not the case in other years.

The catchment survey on Smith's Creek was done by the Bonnechere River Watershed Project (BRWP) RiverWatch team in June 2013 used a modified macro-stream assessment protocol adapted from the CityStream Watch protocol (2011) used by Rideau Valley Conservation Authority. Eight, 100m surveys were conducted throughout the 14km long creek. These surveys documented stream, streambed and bank characteristics as well as land use up to 100m on each side of the surveyed bank. The objectives of this study were to provide a detailed overview of the stream and bank characteristics of Smith's Creek. These surveys will act to provide insight into stream conditions and potential land issues affecting water quality that could be potentially mitigated.

The max wetted width, which is the maximum distance from the edge of the water level on one bank to the other, was measured at 5.08 meters (averaged over the 8 surveys). The max bankfull width, which is the maximum distance from the high water mark on one bank to the other was measured at 5.9 meters (averaged). This tells us that the water level was not at peak heights, and the max wetted depth (maximum depth of present water levels) was an average of 0.53 meters. These factors indicate that this stream contains a permanent flow and water is present year-round.

Anthropogenic Alterations

Figure 2 demonstrates that 88% of the creek portion surveyed was in a natural state, with minor human alterations. 13% was considered altered, with considerable human impact but significant natural portions. The altered sections were agricultural and developed lands related.

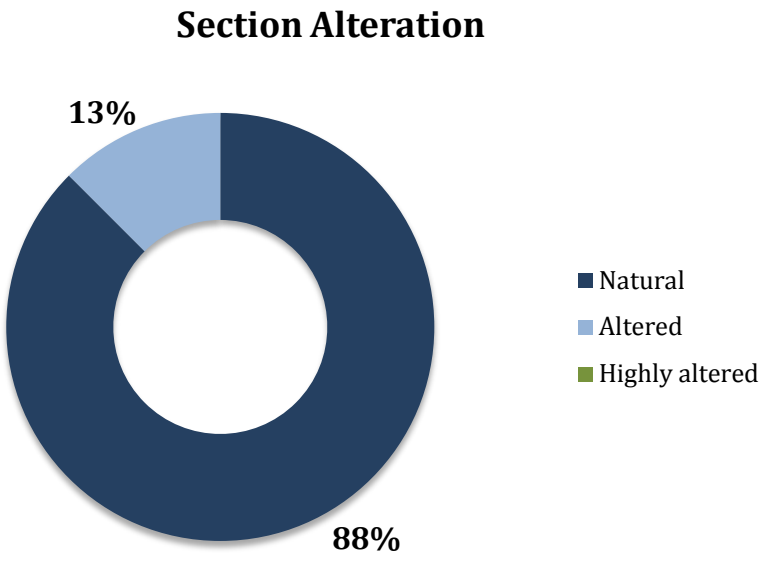

Figure 2. Section alterations to Smith's Creek.

Adjacent Land Use

The land use adjacent to the creek varied, and there were eight different types of land use identified in Figure 3. Land use was largely agricultural, with 58% pastured land, and 6% active agriculture. Wetland areas were found within 8% of the areas surveyed and are an important natural component of stream habitat, filtering toxins from the water and providing important wildlife habitat. Forest and scrubland accounted for 4% and 3%, respectively. This vegetated buffer adjacent to the stream banks is important for filtering out excess nutrients, absorbing rainwater, and providing habitat for wildlife (CityStream Watch 2011). There was also a large portion (19%) that was considered recreational, where the creek ran adjacent to parks or pathways within the town of Renfrew. Also, 1% was considered residential. However, an increase in the number of surveys would most likely provide a more accurate representation of these land classes, as the stream does go through a portion of the town of Renfrew, however the survey entry points were within recreational parks and so, slightly biased. The surveys captured land use within the 100m transect, and up to 100m on either side of the stream.

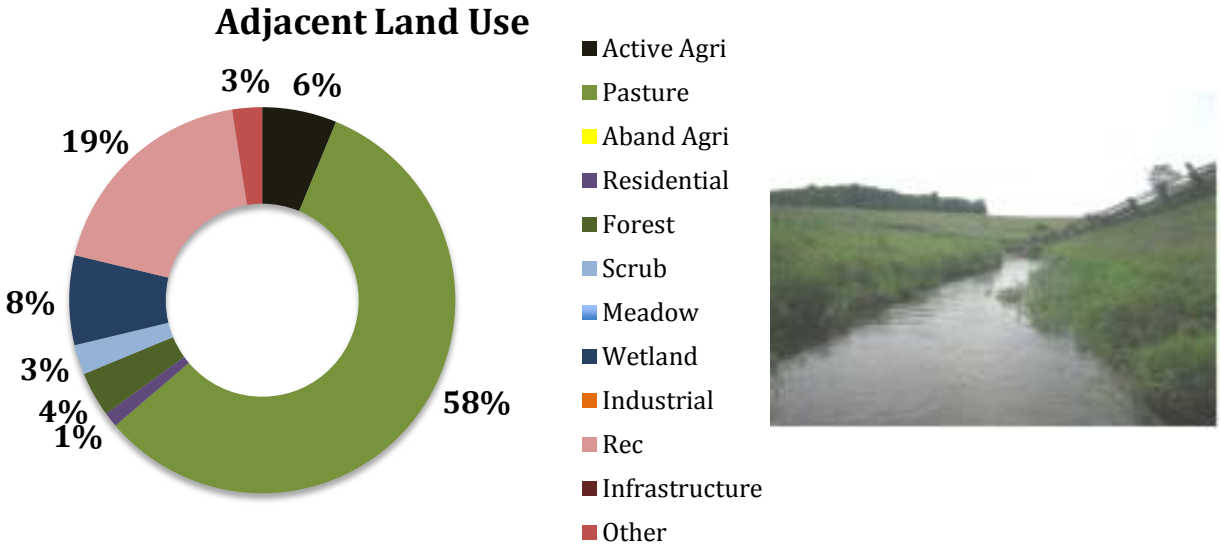

Figure 3. Classes of land use occurring along Smith's Creek. Photo on right depicts adjacent agricultural land use along Smith's Creek. Photo taken in June 2013.

Channel Type

Figure 4 demonstrates that Smith's Creek was 100% natural, containing pools, riffles and runs with unaltered stream banks. The creek meandered through the landscaped unaltered, and maintained a natural sinuosity, with no alteration to form any kind of straightened channel, ditch or drain.

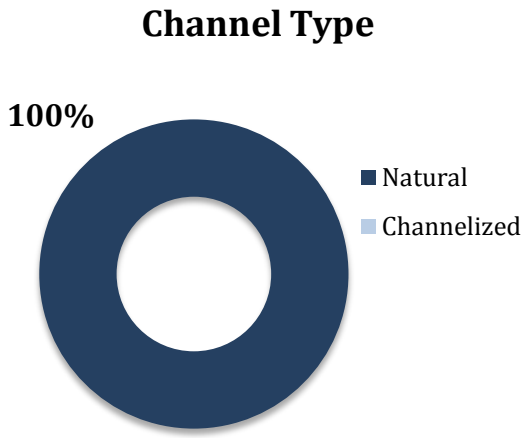

Figure 4. Channel type observed on Smith's Creek.

Instream Morphology

The types of features found in a stream are dependent on the stream substrate and depth. Figure 5 shows that 89% of the surveyed areas of Smith's Creek were characterized by runs; areas of moderately shallow unagited water, where the thalweg (deepest part of the channel) is found in the center of the stream. 9% of the surveyed stream was characterized by pools; areas where deeper pockets of water are found, typically between riffles. Pools are important shelter area for stream wildlife, providing refuge if stream levels decrease, as well as over-wintering areas. Riffles were only found in 2% of the surveyed stream. Riffles are areas with agitated water surface, with moderate to rapid current velocity and are important for oxygenating the water (CityStream Watch 2011).

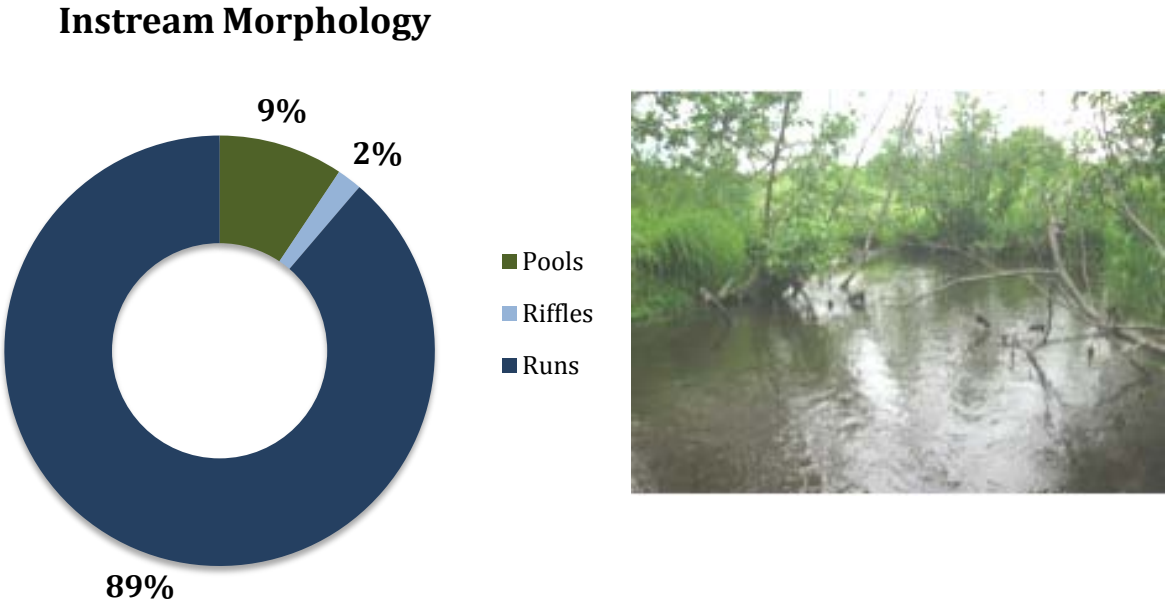

Figure 5. Instream morphology of Smith's Creek. Photo taken in June 2013.

Instream Substrate

Diverse instream substrate types will allow for a greater diversity of instream wildlife, as different species will secure different habitat niches. There was a variety of substrate types found in Smith's Creek, however there was a propensity for finer-particle substrates such as muck (31%), sand (26%), clay (14%) and gravel (9%) (Figure 6). Larger-particle substrate such as cobble (9%) are important over wintering and/or spawning habitat for small and juvenile fish, and boulders (12%) provide back eddies for larger fish to hide and rest out of the current (CityStream Watch 2011).

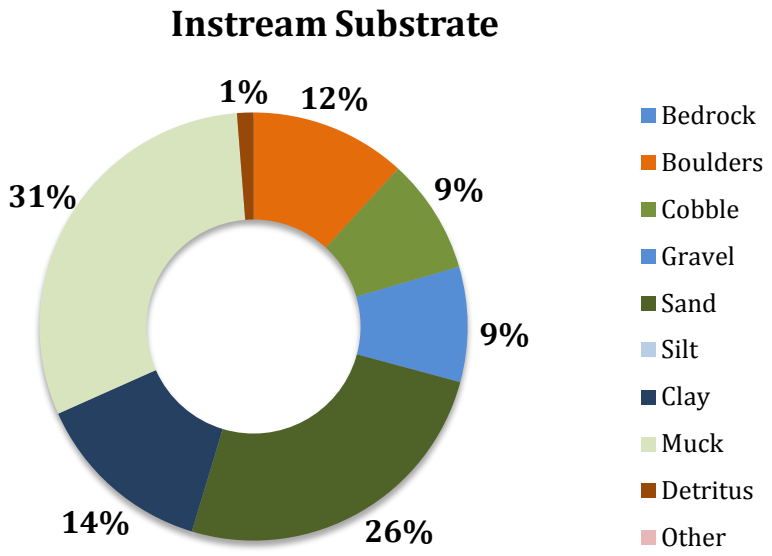

Figure 6. Types and percentage of instream substrate along Smith's Creek.

Both photos depict boulder and cobble substrate along a portion of Smith's Creek. Photos taken in June 2013.

Instream Habitat

The percentage of the left and right sides of the surveyed stream areas containing boulders or cobble did not differ much (Figure 7); boulder habitat (20% left, 14% right), cobble habitat (13% both). Again, these types of instream habitats are important for fish refuge and provide spawning habitat (CityStream Watch 2011). Figure 7 shows that a large percentage of the stream surveyed did not contain these critical habitats (68% Left, 74% Right). As we surveyed more downstream, the instream substrate changed from more rocky, to more clay and

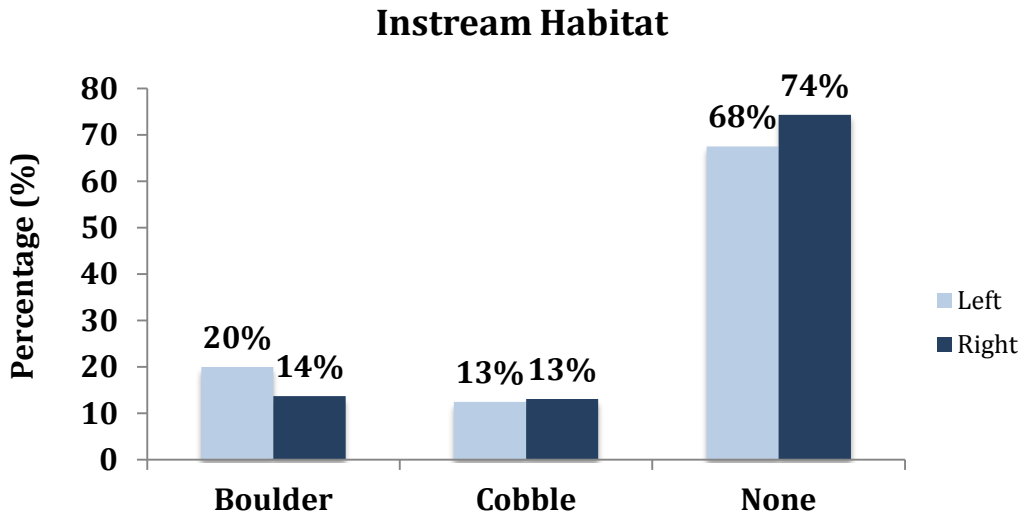

Figure 7. Percentage of instream habitat found on the left and right side of Smith's Creek.

Woody Debris

Trees along the banks of streams are important components of the stream habitat. They provide shade over the stream, which helps to moderate the water temperature. As well, their root systems help to stabilize stream banks. Trees and/or branches that have fallen into the stream provide refuge and feeding areas for fish and benthic wildlife (CityStream Watch 2011). Figure 8 shows that there was no difference in the amount of large trees and branches between sides of the stream. 19% of the stream surveyed contained woody debris instream, 28% of the stream surveyed had woody material overhanging the stream offering shade, and 53% of the stream did not contain any woody debris.

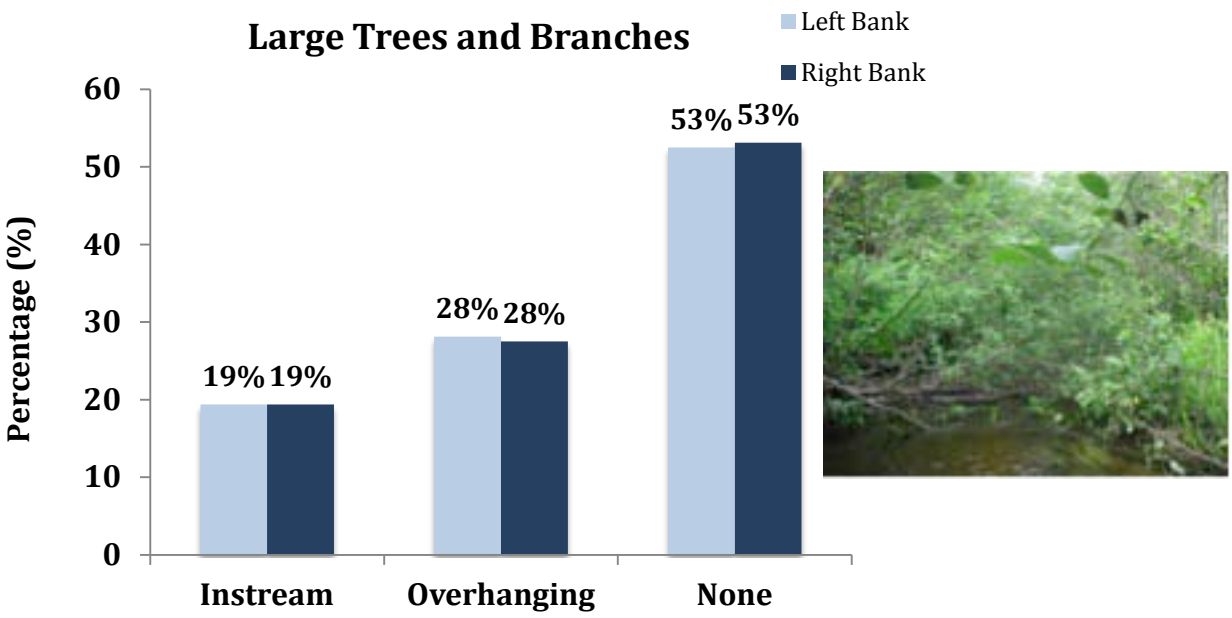

Figure 8. Percentage of woody debris found on the left and right banks of Smith's Creek. Photo on right depicts an example of branches overhanging Smith's Creek. Photo taken in June 2013

Vascular Plants

Vascular plants are important to stream habitat because they can help to stabilize banks with their root systems, and they provide shelter, protection and habitat for macroinvertebrates (CityStream Watch 2011). There was no difference found in the percent of plants found on the left bank versus right bank of Smiths Creek (Figure 9);. 51% of the creek surveyed contained vascular plants instream, 3% of the surveyed stream had plants overhanging, and 47% of the stream surveyed did not contain vascular plants.

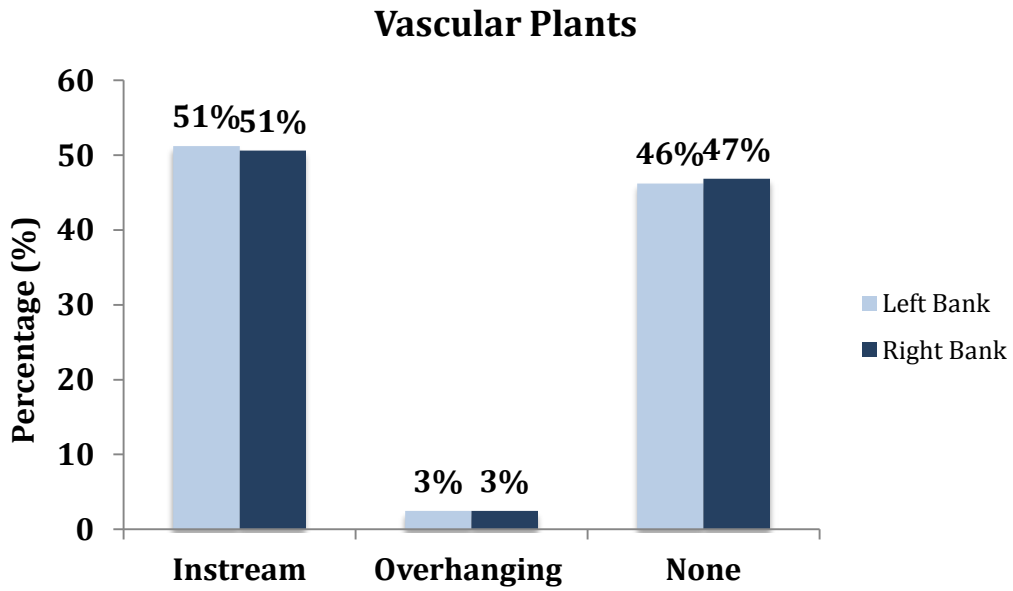

Figure 9. Percentage of vascular plants found on the left and right bank of Smith's Creek.

Undercut Banks

The percentage of undercut banks was approximately equal on both sides of Smith's Creek and accounted for 15-16% of the stream surveyed (Figure 10). Undercut banks are part of a normal stream ecosystem and provide refuge areas for fish.

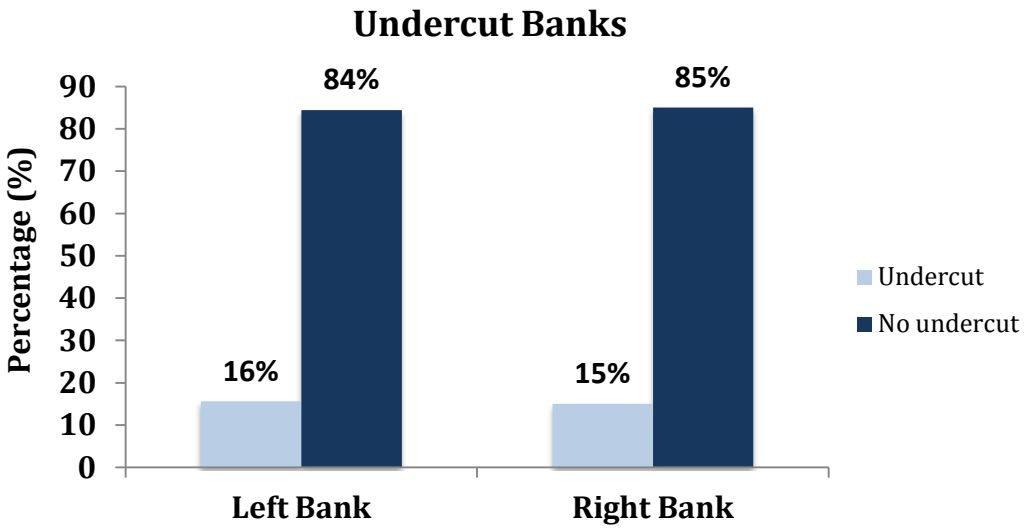

Figure 10. Percentage of undercut banks on the left and right banks of Smith's Creek.

Shad

Shade is an important component to a stream ecosystem as it moderates the temperature of the stream. Shade is typically provided by an assortment of grasses, shrubs and trees and so this also contributes to other factors of stream health, such as providing a food supply (CityStream Watch 2011). Smith Creek is a fairly open stream, with 67% of the stream open (Figure 11). However, there may be a slight sampling bias, as more woody portions of the creek at the headwaters were not surveyed due to difficulty in accessing those portions of the creek.

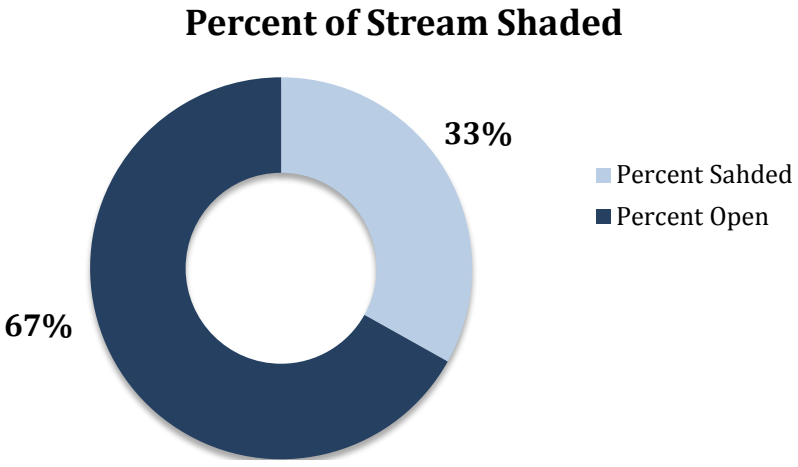

Figure 11. Percentage of Smith's Creek that is shaded versus open.

Instream Vegetation

Instream vegetation plays an important role in maintaining a healthy stream ecosystem. Plant processes help maintain clean and oxygenated water through the removal of contaminants and production of oxygen through photosynthesis (CityStream Watch 2011). However, vegetation is only beneficial within a normal range, as too much vegetation (or the wrong kind of vegetation) can be detrimental to stream health and an indicator of poor water quality. Instream vegetation in Smith's Creek was within an appropriate range. Figure 12 shows that the surveyed portion of the stream showed that 99% of the vegetation was considered to be either common or normal levels. While the remaining 1% was classed as low instream vegetation.

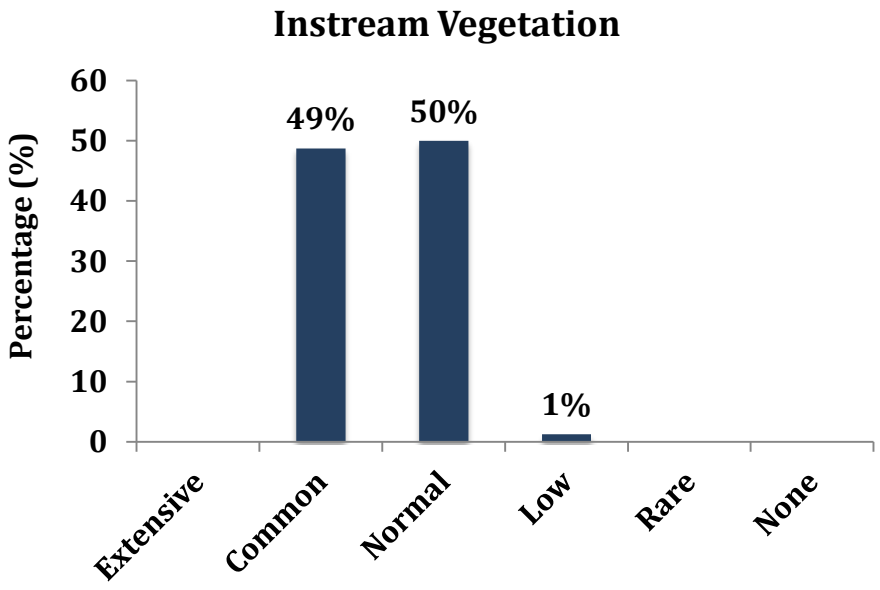

Figure 12. Percentage of instream vegetation separated into classes (extensive: choked with vegetation, common: >50% vegetation, normal: 25-50% vegetation, low: <25% vegetation, rare: few vegetation, none: zero vegetation) found within Smith's Creek.

Vegetation Types

It is also important to determine the types of instream vegetation, as different substrate types or varying water quality may lead to different types of vegetation proliferating. For instance, poor water quality may lead to a proliferation of algae, which can be detrimental to instream health if it becomes extensive. Also, a wide variety of vegetation types will allow a greater diversity of wildlife to coexist. There were a few different vegetation types observed in Smith's Creek. Figure 13 shoes that narrow-leaved emergents dominated the surveyed portions of the stream (59%), while broad-leaved emergents accounted for only 7% and robust emergent 2%. Submerged plants were the next most dominant; accounting for 27%, and algae was fairly low at 5%.

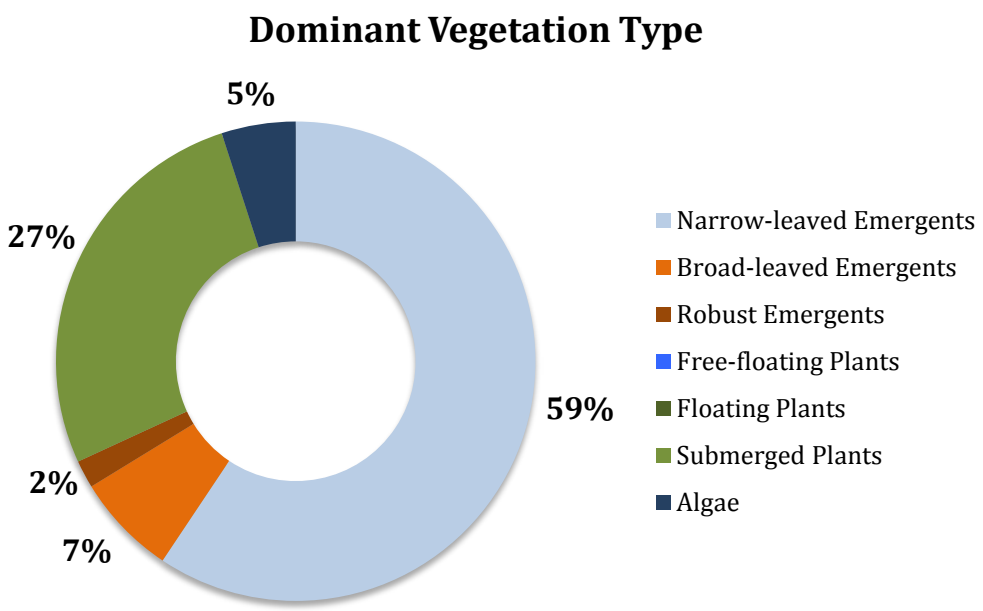

Figure 13. Percentage of the dominant vegetation types found in Smith's Creek.

Bank Erosion

Bank erosion is part of the normal process within a stream ecosystem, however if it becomes extensive it can lead to sedimentation within the stream, which can affect fish and wildlife habitat. Erosional tendencies within a stream will be largely dependent on the stability of the banks. A stable bank will resist erosional processes and will likely have a higher level of bank vegetation that will help to stabilize the soils. An unstable bank does not have the support system to retain the soil, and will lead to greater sedimentation and even bank failure if erosional processes are great enough (CityStream Watch 2011). The surveyed portions of Smiths Creek indicate that the majority of the banks are stable (88% left bank, 86% right bank), and there was not a significant difference in stability between the left and right bank (Figure 14).

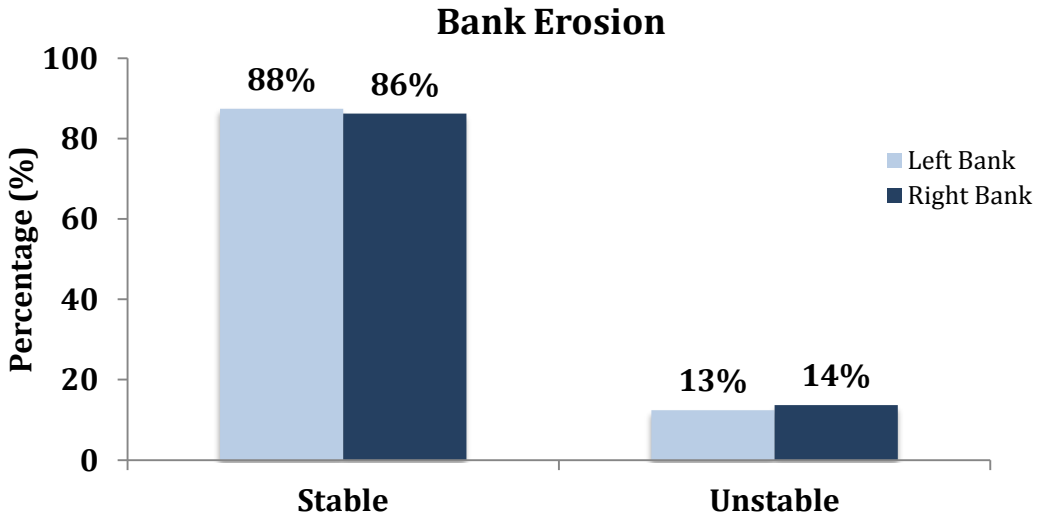

Figure 14. Percentage of bank erosion found on the left and right banks of Smith's Creek.

Bank Vegetation Types

A large percentage of vegetation types along the banks of Smith's Creek were grasses (Figure 15); tall grasses (56% left bank, 53% right bank), and short grasses (4% both banks). This is not surprising as a large portion of the surveys were done near agricultural areas. There was also a significant wetland area along the banks (20% left bank, 22% right bank). Wetlands are vital to healthy ecosystems as they remove pollutants, protect against flooding and erosion and provide habitat for wildlife (Cappiella and Frely-McNeal 2007). Forest also covered a portion of the surveyed banks, with deciduous trees (16% left bank, 18% right bank) and coniferous trees (1% both banks). Trees are important to steam health as their root systems help to stabilize the banks and prevent erosion and sedimentation, as well leaf litter contributes nutrients into the stream (CityStream Watch 2011).

Photo on left depicts tall grasses that are growing adjacent to Smith's Creek. This type of bank vegetation was most prevalent on Smith's Creek, accounting for 56% of vegetation on the left bank and 53% on the right bank. Photo taken in June 2013

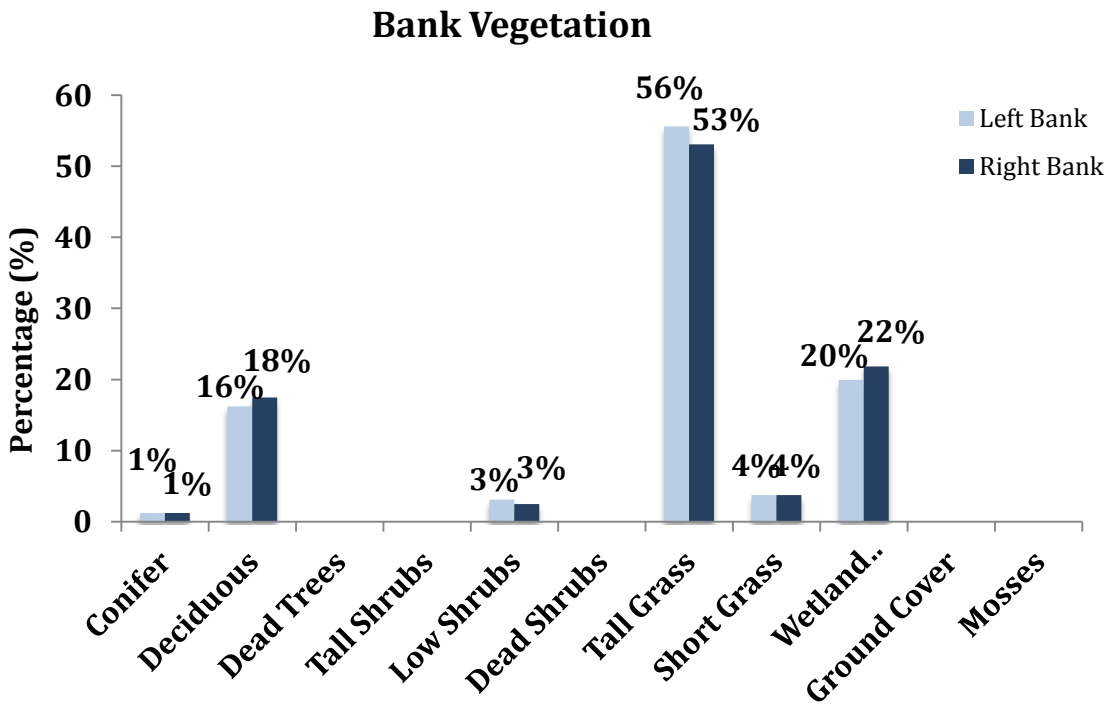

Figure 15. Percentage of vegetation types found on the left and right banks of Smith's Creek.

Shoreline Classification

About half of the shoreline surveyed on Smith's Creek (Figure 16) was classified as either natural (26% left-41% right), or regenerative (54% left-58% right). A natural shoreline class refers to no significant human disruption and that the shoreline is in a natural state with a thick riparian zone. Regenerative refers to less than 20-25% of the shoreline disturbed, with an effort to regenerate and naturalize the shoreline (CityStream Watch 2011). Portions of Smith's Creek surveyed closer to the headwaters typically had this type of shoreline class, whereas as we surveyed closer to the town of Renfrew there was an increase in the ornamental class as manicured lawns stretched down to the stream banks. However, this was typically only observed on the left bank (20%), as the right bank was typically in a woody area (1%).

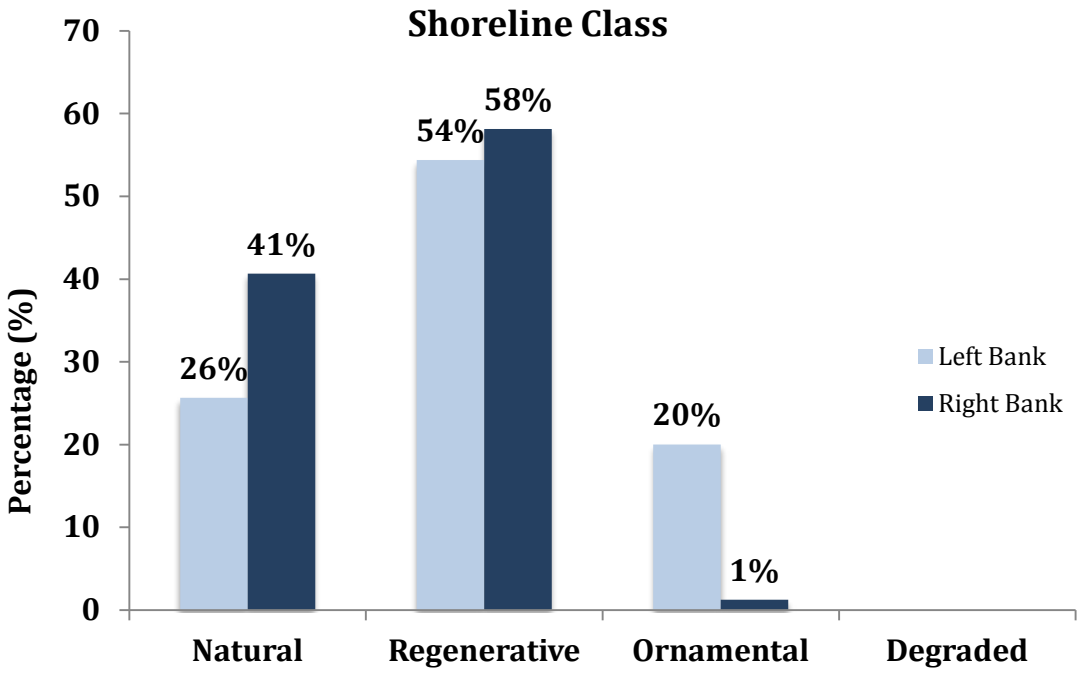

Figure 16. Percentage of shoreline classes (natural, regenerative, ornamental and degraded) found along the left and right banks of Smith's Creek.

The photo on the left depicts a regenerative shoreline classification. The left bank was largely wetland grasses and natural vegetation, while the right bank was part of a park in the town of Renfrew that had been re-vegetated with native shrub, tree and wildflower species. There was also some disturbed shoreline on the right side, where mowed grass reached almost to the stream's bank. Photo taken in June 2013.

Riparian Buffer Zones

Buffer zones containing vegetated areas between the stream and any sort of human activity are important features of a healthy stream ecosystem. These natural buffers are able to filter excess nutrients that may be dispensed from urban, rural (sewage) or agricultural (fertilizer) areas, and will also help to dampen any flooding or erosional processes by absorbing rainwater (CityStream Watch 2011). The recommended buffer width for a stream is 30m or more (Environment Canada, 2004). Figure 17 shows that the percentage of buffer width varied along the surveyed areas of Smith's Creek. The left bank of Smith's Creek tended to have a lower percentage of buffer area, and this was particularly evident once we entered the town of Renfrew (13% 0-5m, 3% 5-15m), however in the less developed areas there was a more substantial buffer area observed on the left bank (33% 15-30m and 33% 30+m). The right hand bank had a much great buffer zone (33% between 15-30m, and 67% 30+m). This was largely due to the fact that the areas surveyed within the town, the right hand side of the stream had not been developed and consisted of either wetland areas, or a steep vegetated undeveloped incline).

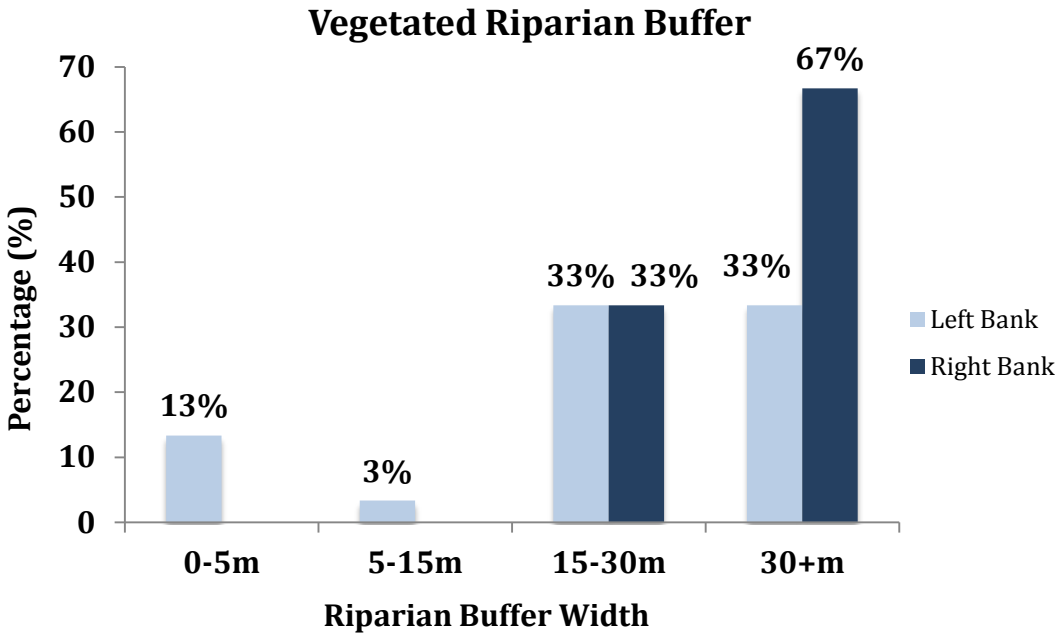

Figure 17. Percentage of vegetated buffer width classes found on the left and right banks of Smith's Creek.

Prospective Enhancement Opportunities

One important aspect of this pilot study done on Smith's Creek was the assessment of any potential enhancement projects that would help to mitigate current issues involving the creek. These assessments varied along the length of the creek, corresponding to different land use types and other factors that were identified through the transect surveys. Figure 18 demonstrates that 62.5% of the survey sites would benefit from riparian planting, i.e. planting of native vegetation

along stream banks to produce an adequate riparian buffer zone. This was particularly an issue along the left bank of Smith's Creek, as manicured lawns within the town of Renfrew often went quite close to the stream. Garbage cleanup was identified as a need at 25% of the surveyed sites. Again, this was particularly relevant once the stream entered the town of Renfrew, particularly within the recreational areas (parks and pathways). Invasive species control was identified as an enhancement opportunity at 12.5% of surveyed sites. One of the more common invasive species identified was the rusty crayfish, which competes with the native crayfish species. Cattle restriction was identified as a major issue within the Smith's Creek catchment, with restriction measures needed at 50% of the surveyed sites. Cattle were often found meandering right down to the creek banks, with no restriction to the water source. Cattle in the creek can be a problem as they destabilize the banks (Figure 19), and contribute excess nutrients to the stream system through their feces.

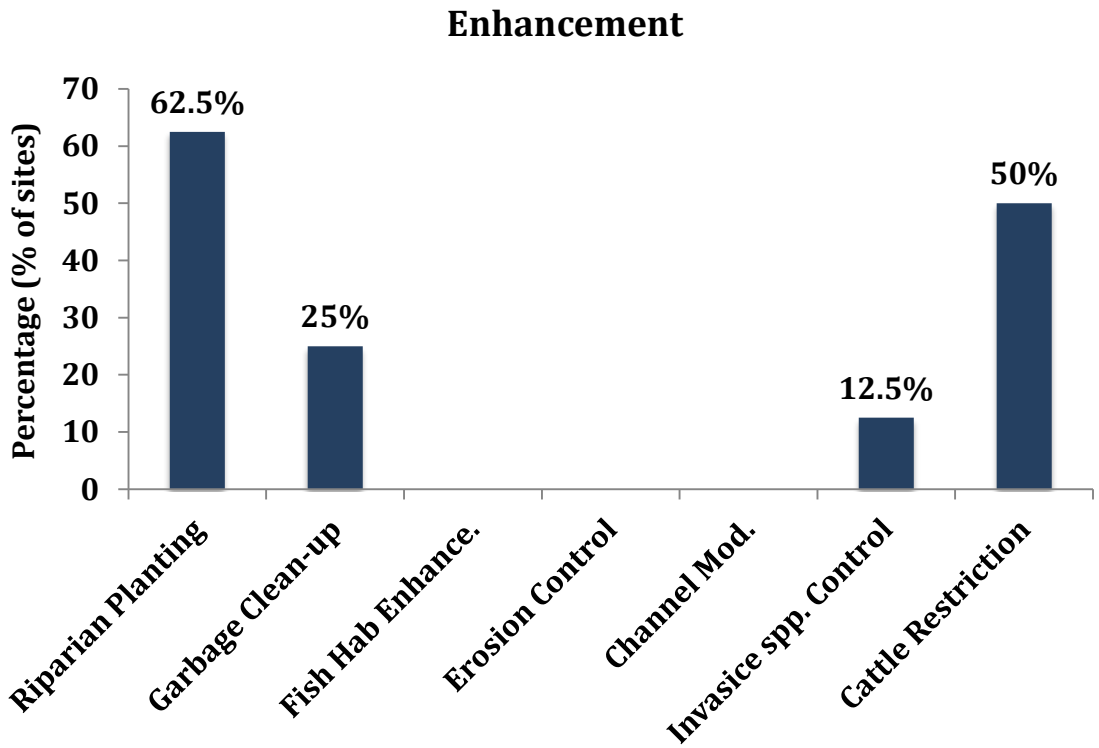

Figure 18. Enhancement opportunities based on percent of sites affected with listed issues within Smith's Creek catchment.

Figure 19. Example of destabilized banks due to cattle activity along Smith's Creek. Photo taken in June 2013.

Water Quality

Water quality measurements were taken at Smith's Creek from June to September in 2011 (BRWP 2013) as well as certain parameters were measured as part of the BRWP RiverWatch catchment survey in July 2013. Temperature is a key parameter in creek ecosystems and can influence aquatic organisms within the creek when it is outside of their tolerance range (Environment Canada 2013). Factors such as the removal of riparian vegetation along stream banks may affect temperature as there is less shade provided over the stream. Figure 20 shows that there was a small difference in temperature observed in the 2011 (20.9) versus 2013 (21.4) measurements, however the difference is quite small. This may be due to the month or even time of day the temperatures were taken.

Specific conductance (SpC) is the ability of water to conduct an electrical current. This is largely dependent on the amount of dissolved ionic constituents in the water sample (BRWP 2013). SpC was found to be low at 0.4 us/cm in the samples from Smiths Creek (Figure 20).

Dissovled oxygen (DO) is the amount of oxygen that is freely available in the measured water sample (BRWP 2006). DO is inversely related to temperature, and becomes more soluble as temperatures decreases (BRWP 2006). DO is required by the wildlife inhabiting the stream and there may be detrimental effects if the levels of DO drop below what the CCREM has determined as "safe limits" (CCREM, 2005). DO levels above 5.0mg/L will protect other life stages of warm water biota, while levels above 6.0mg/L will protect early life stages of warm water biota. Figure 20 demonstrates that DO levels in Smiths Creek were found to be above these safe limit ranges at 7.2mg/L and hence are adequate for the protection of the biological community residing in the stream.

The pH scale gives a range of the relative acidity of water, with 0-6 being more acidic (H^+ ions), 7 being neutral acidity, and 8-14 being more alkaline (OH^- ions) (Environment Canada 2013). Water bodies with a pH between 6.5-9 will allow the greatest diversity of aquatic organisms, however young fish and aquatic insects are most sensitive to fluctuating pH levels outside the normal range (Environment Canada 2013). The pH levels at Smiths Creek were within the normal range for both years sampled (7.7 in 2011 and 8.1 in 2013; Figure 20).

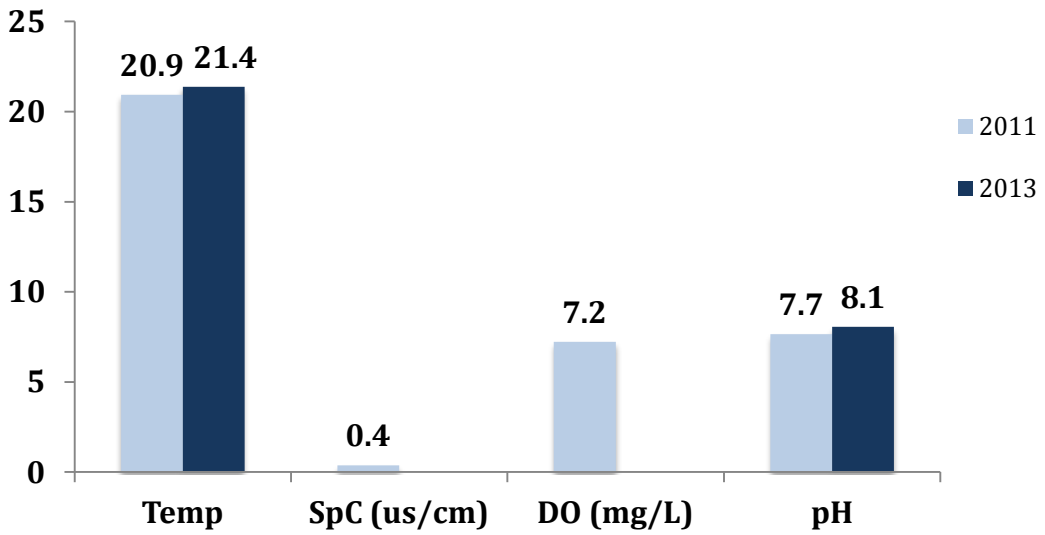

Figure 20. Measurements of water quality parameters in 2011 and 2013 for Smith's Creek.

Concentrations of major ions

Previous water quality studies done on the Bonnechere watershed have found that water chemistry data are strongly influenced by the location and type of land use (BRWP 2013). There is a west-east hydrogeological gradient with a predominance of Leda clays to the east in this watershed, which would affect the major ions found in the eastern portions. However, there is also a change in land-use in the eastern portion of the watershed, with increasingly agricultural areas, which could also affect the relative concentrations of the major ions (BRWP 2013). Smiths Creek is found in the eastern portion of the Bonnechere watershed and the concentrations of the major ions (in mg/L) can be observed in Figure 21.

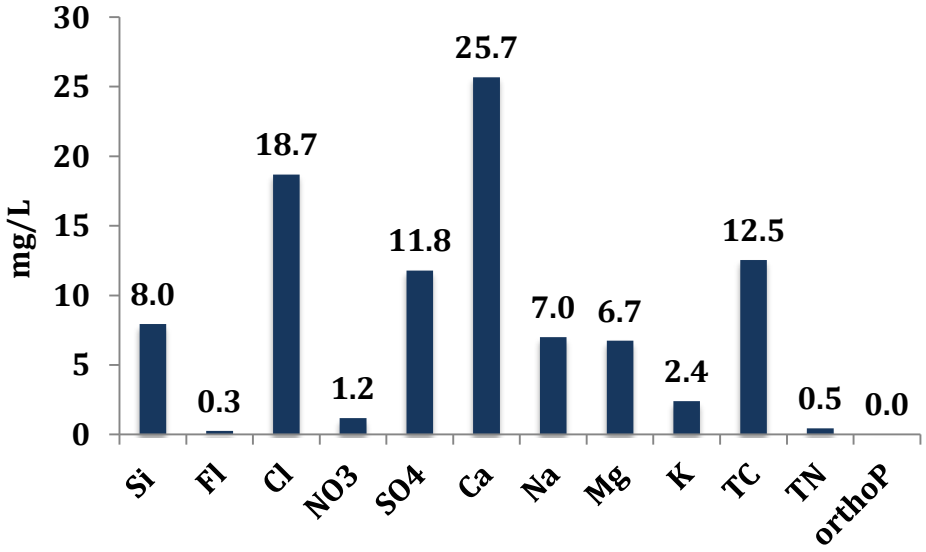

Figure 21. Concentrations of major ions (mg/L) measured in Smith's Creek water samples from 2011.

Conclusions

The results of this pilot study indicate that Smith's Creek is in FAIR to GOOD condition. The majority of the stream surveyed remained in a natural state, with no alteration to stream dynamics. Stream substrate was largely made of fine-grain particles such as muck, clay and sand, which does not provide ideal habitat for stream inhabitants, however there was some instream woody debris and vascular plants that provided refuge, feeding and habitat areas for fish and macro-invertebrates. Vegetation instream was made up largely of narrow-leaved emergent and submerged plants that were within the common or normal classification. It is a sign of good health that the stream was not overpopulated by vegetation, especially algae, which may indicate issues with degraded water quality. The majority of the stream banks were not undercut, nor where they eroded. Where unstable banks were found, this was largely due to the traverse of cattle down to the stream edge, which have destabilized the banks in discrete locations. Cattle access to the stream was one of the big areas of potential enhancement projects, as there were many farms that had cattle access along Smith's Creek. This could also adversely affect water quality as there may be an increase in nutrients such as nitrogen and phosphorus from cattle feces that may degrade water quality and promote algal growth. Nutrient concentrations were not measured during the 2013 surveys, however 2011 water quality measurements indicate the nitrogen and phosphorus species (N03-, orthophosphate) were in fairly low concentrations. Other potential important enhancement projects include riparian planting along the stream banks as well as garbage cleanup. The issue of garbage was largely concentrated within the city limits of Renfrew, and was particularly found within park and recreational areas. An adopt-a-stream program or stream cleanup day, as well as public education on garbage impacts to stream health would likely help to mitigate this problem. Riparian planting along stream banks would be hugely beneficial to overall stream health, as this would help to stabilize banks, as well as absorb some of the runoff from snow and rain that would be coming off the lands.

This new method of surveying streams within the Bonnechere Watershed has many merits as it looks at many sections of the stream, rather than a single survey site, which may not be representative of overall stream health. The macro-invertebrate sampling done in 2011 was done at a single site within a low-lying wetland area during a period of flooding. The results of this survey indicated that Smith's Creek was in poor health due to the presence of certain genera of macro-invertebrates, however this may have been slightly biased as it has no temporal or spatial perspective. It is very important for the BWRP in future to standardize their sampling method, so that comparisons can be made between years about the condition of stream health. This modified stream protocol from the CityStream Watch is fairly easy to replicate and requires little training (unlike the macro-invertebrate species identification). This method could provide adequate baseline information upon which to build a database of stream health over the years to come using a standardized method.

References

BRWP. 2006. Bonnechere River Watershed Water Quality: A guide to water quality monitoring along the Bonnechere River for use by rural and urban community groups. A report prepared by Holly Gardner for the Bonnechere River Watershed Project. Available on-line at BonnechereRiver.ca/RiverWatch.

BRWP. 2008. Smith's Creek Water Quality Report. Available on-line at BonnechereRiver.ca/RiverWatch.

BRWP. 2011 RiverWatch 2010: The Status of the Bonnechere River and its Tributaries. A report by the Bonnechere River Watershed Project. Available on-line at BonnechereRiver.ca/RiverWatch.

BRWP. 2012a. RiverWatch 2011: An Update on the Status of the Bonnechere River Tributaries. A report by the Bonnechere River Watershed Project. Available on-line at BonnechereRiver.ca/RiverWatch.

BRWP. 2012b. Geospatial Characterization of the Bonnechere Watershed. Prepared by Alex MacIntosh for the Bonnechere River Watershed Project. Available on-line at BonnechereRiver.ca/RiverWatch.

BRWP. 2013. The Bonnechere River Watershed Stream Water Quality Monitoring in 2011. A report prepared by Sarah Anderson and Dr. Murray Richardson, Department of Geography & Environmental Studies, Carleton University, Ottawa, ON, for the Bonnechere River Watershed Project. Available on-line at BonnechereRiver.ca/RiverWatch.

Canadian Wildlife Service (CWS), Environment Canada. 2004. How Much Habitat Is Enough? Available on-line at http://www.ec.gc.ca/EnviroZine/english/issues/64/feature2_e.cfm.

Cappiella, K. and Fraley-McNeal, L. 2007. The Importance of Protecting Vulnerable Streams and Wetlands at the Local Level. Wetlands and Watersheds Article #6, Center for Watershed Protection, Ellicott City, MD.

CCREM (Canadian Council of Ministers of the Environment). 2005. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Excerpt from publication No. 1299. ISBN 1-896997-34-1

CityStream Watch 2011. Becketts Creek 2011 Summary Report. Rideau Valley Conservation Authority, Ottawa, ON.

Environment Canada. 2013. Water Chemistry. Canadian Aquatic Biomonitoring Network: Wadeable Streams Field Manual. Available on-line at http://www.ec.gc.ca/rcba-cabin/default.asp?lang=En&n=D7DEA90B-1&offset=6&toc=show.