Kemptville Creek Subwatershed Report 2013
South Branch Catchment

RIDEAU VALLEY CONSERVATION AUTHORITY

The RVCA produces individual reports for six catchments in the Kemptville Creek Subwatershed. Using data collected and analysed by the RVCA through its watershed monitoring and land cover classification programs, surface water quality conditions are reported for the South Branch of Kemptville Creek along with a summary of environmental conditions for the surrounding countryside every six years.

This information is used to help better understand the effects of human activity on our water resources, allows us to better track environmental change over time and helps focus watershed management actions where they are needed the most.

The following pages of this report are a compilation of that work. For other Kemptville Creek catchments and the Kemptville Creek Subwatershed Report, please visit the RVCA website at www.rvca.ca.

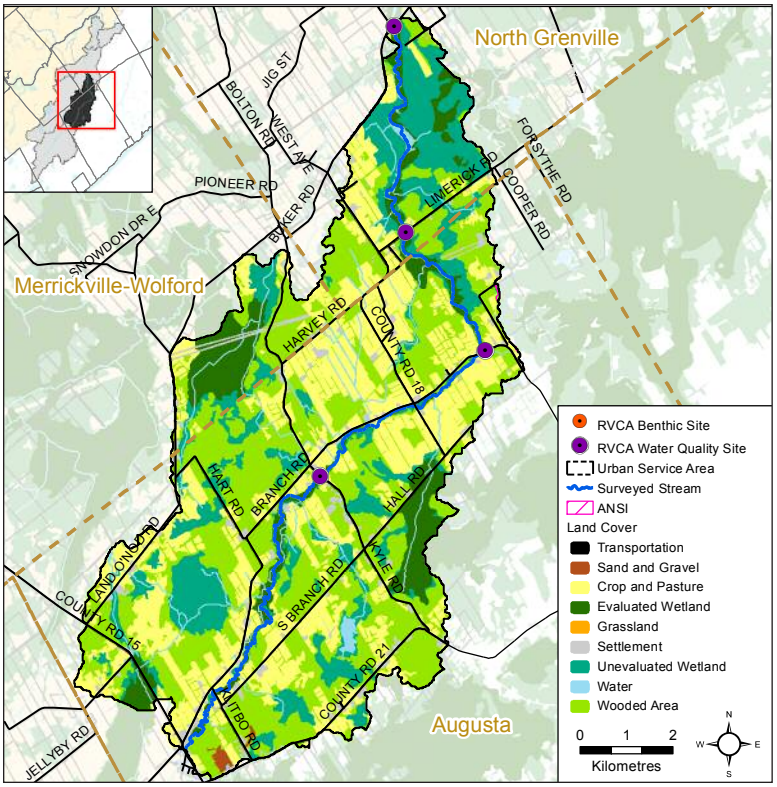
,

What's Inside

Catchment Facts

General Geography

- The catchment is predominantly rural in character with agriculture being the main land use
- Seventy-six percent of the catchment lies within Augusta Township, 15 percent within the Municipality of North Grenville and nine percent within the Village of Merrickville-Wolford



Physical Geography

- The lower half of the catchment (north end) is located within the Edwardsburg Sand Plain and is made up locally of sand, glacial till and clay plains. The upper half is within the Smith Falls Limestone Plain, which locally consists of dolostone, with thinner layers of shale and sandstone. This bedrock is generally overlain only by thin soils but more significant sand deposits lay on the boundary with the Mud Creek Catchment
- The drainage area of 80 square kilometres is about 17 percent of the Kemptville Creek Subwatershed, about two percent of the Rideau Valley Watershed and contains two municipal drains
- Dominant land cover is woodland (37 percent) followed by crop and pastureland (30 percent) and wetland (27 percent). Settlement areas (four percent) and transportation (two percent) occupy the rest of the landscape

Vulnerable Areas

- Flood plain mapping has been available along the South Branch of Kemptville Creek since 2009 and regulated since then.
- Shallow bedrock, especially in areas with very thin soils, is mapped as highly vulnerable to land use activities

Development Trends

- Very limited development activity has taken place in recent years

Conditions at a Glance

- Moving upstream to downstream, the water quality rating along the South Branch of Kemptville Creek is "Fair" at Kyle Road, "Good" in Garreton and at the Limerick Road and "Fair" at County Road 20; the Kyle Road site shows a decline in water quality over a 12 year reporting period (2001-2006 vs. 2007-2012), with no change observed at the other three sites over the same period
- Woodland cover proportion has decreased by two percent (184 hectares) from 2002 to 2008, due to a combination of changes in land cover and land use

- The riparian buffer (30 metres wide along both sides of Kemptville Creek and its tributaries) is made up of wetland (62 percent), crop and pastureland (19 percent), woodland (15 percent), settlement areas (two percent) and transportation (two percent)
- A warm/cool water baitfish and recreational fishery of 22 fish species is present
- Contains two municipal drains

Catchment Care

- Kemptville Creek Beaver Dam Management Pilot Project undertaken from 2003 to 2007 to address uncontrolled beaver activity along the North and South Branch of Kemptville Creek and its main stem to the Oxford Mills Dam. Subsequent work carried out by the RVCA, including beaver dam survey work and beaver and dam removal, has had a positive effect on the aquatic ecosystem and is an effective and welcome response to landowners concerns about high water levels and its effect on land drainage. Benefits include reduction in damage to woodlots and improved agricultural drainage adjacent to the creek, along with improved aquatic habitat
- Eleven stewardship projects (Rural Clean Water/Tree Planting) have been completed (2002 to 2012)
- Fish sampling conducted on Kemptville Creek (RVCA, 2011)
- Annual benthic macroinvertebrate sampling upstream of County Road 15 since 2004 (RVCA)
- RVCA macro stream surveys in 2011 on Kemptville Creek, taking measurements and recording observations on instream habitat, bank stability, other attributes and preparing a temperature profile
- MOE well records show there are about 300 water wells in the catchment (11 percent of all wells in the Kemptville Creek Subwatershed)
- Watershed model developed by the RVCA in 2009 was used to study the hydrological function of wetlands in the Rideau Valley Watershed, including those found in the South Branch catchment

1. South Branch Surface Water Quality Conditions

Assessment of streams in the Kemptville Creek watershed is based on 22 parameters including nutrients (total phosphorus, total Kjeldahl nitrogen, and ammonia), *E. coli*, metals (like aluminum and copper) and additional chemical/physical parameters (such as alkalinity, chlorides, pH and total suspended solids). Each parameter is evaluated against established guidelines to determine water quality conditions. Those parameters that frequently exceed guidelines are presented below.

The assessment of water quality throughout the Kemptville Creek Subwatershed also looks at water quality targets that are presented in the 2007 *Kemptville Creek Watershed Plan Update* (KCWP). The KCWP identifies nutrient and bacteria loading to be of concern as well as maintaining and/or improving water quality aesthetics throughout the Kemptville Creek watershed.

Surface water quality conditions in Kemptville Creek are monitored through the RVCA's Baseline Water Quality Monitoring Program. See Figure 1 and Table 2 for monitoring site locations.

The water quality rating for Kemptville Creek within the South Branch catchment ranges from "Good" to "Fair" (Table 2) as determined by the CCME Water Quality index (CCME WQI); analysis of the data has been broken into two periods 2001–2006 and 2007–2012, to examine if conditions have changed in this timeframe. Water quality scores are largely influenced by nutrient concentrations. For more information on the CCME WQI please see the Kemptville Creek Subwatershed Report.

Table 1 outlines the WQI scores and their corresponding ratings and Table 2 shows the overall rating for the four monitored sites on Kemptville Creek within the South Branch catchment.

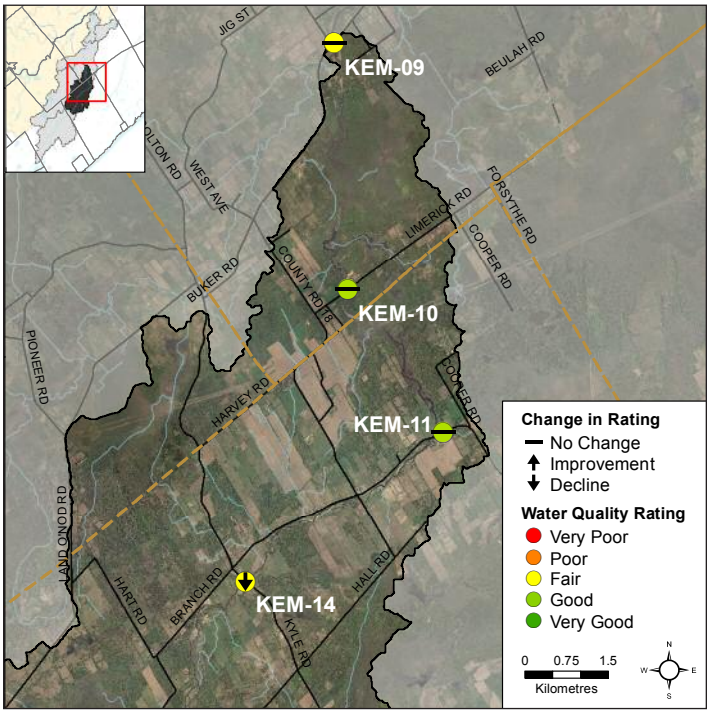


Figure 1 Water quality in South Branch. The rating shown on the map is for the 2007–2012 period. Arrows are used to show a change in the rating from the 2001–2006 period.

Table 1 WQI Ratings and corresponding index scores (RVCA terminology, original WQI category names in brackets)

Rating	Index Score
Very good (Excellent)	95-100
Good	80-94
Fair	65-79
Poor (Marginal)	45-64
Very poor (Poor)	0-44

Table 2 WQI Ratings for South Branch from 2001–2006 and 2007–2012

Sampling Site	Nearest interesction	2001-2006	Rating
KEM-14	Branch Rd. and Kyle Rd.	80	Good
KEM-11	West of Branch Rd and Cooper Rd.	81	Good
KEM-10	Limerick Rd. and Boomhouwer Rd.	81	Good
KEM-09	County Rd. 20 and County Rd. 18	78	Fair
Sampling Site	**Nearest interesction**	**2007-2012**	**Rating**
KEM-14	Branch Rd. and Kyle Rd.	69	Fair
KEM-11	West of Branch Rd and Cooper Rd.	82	Good
KEM-10	Limerick Rd. and Boomhouwer Rd.	82	Good
KEM-09	County Rd. 20 and County Rd. 18	73	Fair

South Branch Nutrients

Total phosphorus (TP) is used as a primary indicator of excessive nutrient loading and may contribute to abundant aquatic vegetation growth and depleted dissolved oxygen levels. The Provincial Water Quality Objective (PWQO) of 0.030 mg/l is used as the TP guideline. Concentrations greater than 0.030 mg/l indicate an excessive amount of TP.

Total Kjeldahl nitrogen (TKN) and ammonia (NH_3) are used as secondary indicators of nutrient loadings. RVCA uses a guideline of 0.500 mg/l to assess TKN[1] and the PWQO of 0.020 mg/l to assess NH_3 concentrations in Kemptville Creek.

Tables 3, 4 and 5 summarize average nutrient concentrations at monitored sites on Kemptville Creek and show the proportion of results that meet the guidelines. Highlighted values indicate average results that exceed the guidelines.

KEM-14

Site KEM-14 is the most upstream site within the South Branch catchment. Forty-seven percent of samples were below the guideline in the 2001–2006 period (Figure 2a) and improved to 54 percent of samples in the 2007–2012 period (Figure 2b). Average TP concentration increased from 0.037 mg/l (2001–2006) to 0.053 mg/l (2007–2012).

TKN results show that the bulk of results exceeded the guideline of 0.500 mg/l (Figures 3a and 3b), 20 percent of samples were below the guideline in the 2001–2006 period and declined to 10 percent in the 2007–2012 period. The average concentration increased from 0.784 mg/l to 0.936 mg/l. NH_3 results at this site were generally below the guideline (Figures 4a and 4b). The proportion of samples below the guideline declined from 93 percent (2001–2006) to 82 percent (2007–2012). An increase was also observed in the average concentration which increased from 0.008 mg/l (2001-2006) to 0.023 mg/l (2007-2012).

KEM-11

At site KEM-11 most results were below the TP guideline for both time periods; 55 percent of samples were below the guideline in the 2001-2006 period (Figure 2a); this improved to 62 percent of samples in the 2007-2012 period (Figure 2b). The average TP concentration also remained consistent, with only a slight increase from 0.031 mg/l (2001-2006) to 0.032 mg/l (2007-2012).

TKN results show that the majority exceeded the TKN guideline (Figures 3a and 3b); only 19 percent of samples were below the guideline in the 2001–2006 period; this decreased to eight percent of samples in the 2007–2012 period. The average concentration increased slightly from 0.788 mg/l to 0.824 mg/l, exceeding the guideline. NH_3 results at KEM-11 were generally below the guideline (Figures 4a and 4b). The proportion of samples below the guideline improved from 87 percent (2001–2006) percent to 92 percent (2007–2012). A small decline was also observed in the average concentration from 0.010 mg/l (2001-2006) to 0.008 mg/l (2007–2012).

KEM-10

The majority of samples at site KEM-10 were below the TP guideline for both time periods (Figures 2a and 2b), 65 percent of samples were below the guideline in the 2001–2006 period and declined to 56 percent of samples in the 2007–2012 periods. Average TP concentration increased from 0.031 mg/l (2001–2006) to 0.032 mg/l (2007–2012).

TKN results show that most exceeded the guideline (Figures 3a and 3b) 19 percent of samples were below the guideline in the 2001–2006 period, this declined to only 10 percent of samples in 2007–2012. The average concentration increased slightly from 0.829 mg/l to 0.846 mg/l. The majority of NH_3 results were below the guideline (Figures 4a and 4b) and the proportion of samples below the guideline increased from 87 percent (2001–2006) to 90 percent (2007–2012). A very slight change was also observed in the average concentration which increased from 0.010 mg/l (2001–2006) to 0.008 mg/l (2007–2012).

KEM-09

KEM-09 is the most downstream site within this catchment and results were comparable to upstream sites. Most sample results were below the TP guideline for both time periods (Figures 2a and 2b); 65 percent of samples were below the guideline in the 2001–2006 period; this declined to 62 percent of samples in the 2007–2012 period. There was little change in average TP concentration from 0.030 mg/l (2001–2006) to 0.029 mg/l (2007–2012).

Figures 3a and 3b show that the majority of results exceeded the TKN guideline, 13 percent of samples were below the guideline in 2001–2006 and this declined to five percent in the 2007–2012 period. The average concentration decreased from 0.835 mg/l to 0.811 mg/l, exceeding the guideline. The majority of NH_3 results were below the guideline (Figures 4a and 4b) and the proportion of samples below the guideline decreased marginally from 94 percent (2001–2006) to 92 percent (2007–2012). A slight increase was also observed in the average concentration from 0.006 mg/l (2001–2006) to 0.007 mg/l (2007–2012).

[1] No Ontario guideline for TKN is presently available however waters not influenced by excessive organic inputs typically range from 0.100 to 0.500 mg/l, Environment Canada (1979) *Water Quality Sourcebook, A Guide to Water Quality Parameters,* Inland Waters Directorate, Water Quality Branch, Ottawa, Canada

South Branch Nutrient Summary

The data shows that nutrient enrichment continues to be a problem in South Branch. Though elevated results do occur, water quality guidelines for TP and NH_3 are generally met at monitored sites or are approaching the guideline. However, TKN concentrations are elevated with frequent exceedances across all sites and may be influenced by the organic matter held by the large wetland areas found upstream of the catchment in the South Branch subwatershed, resulting in naturally high concentrations of organic nitrogen.

Table 3 Summary of total phosphorus results for South Branch from 2001–2006 and 2007–2012, highlighted values indicate that average concentrations exceed the guideline

Total Phosphorus 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-14	0.037	47%	30
KEM-11	0.031	55%	31
KEM-10	0.031	65%	31
KEM-09	0.030	65%	31
Total Phosphorus 2007–2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-14	0.053	54%	39
KEM-11	0.032	62%	39
KEM-10	0.032	56%	39
KEM-09	0.029	62%	39

Table 4 Summary of total Kjeldahl nitrogen results for South Branch from 2001–2006 and 2007–2012, highlighted values indicate that average concentrations exceed the guideline

Total Kjeldahl Nitrogen 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-14	0.784	20%	30
KEM-11	0.788	19%	31
KEM-10	0.829	19%	31
KEM-09	0.835	13%	31
Total Kjeldahl Nitrogen 2007–2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-14	0.936	10%	39
KEM-11	0.824	8%	39
KEM-10	0.846	10%	39
KEM-09	0.811	5%	39

Table 5 Summary of ammonia results for Kemptville Creek from 2001–2006 and 2007–2012, highlighted values indicate that average concentrations exceed the guideline

Ammonia 2001–2006			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-14	0.008	93%	30
KEM-11	0.010	87%	31
KEM-10	0.010	87%	31
KEM-09	0.006	94%	31
Ammonia 2007–2012			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
KEM-14	0.023	82%	39
KEM-11	0.007	92%	39
KEM-10	0.008	90%	39
KEM-09	0.007	92%	39

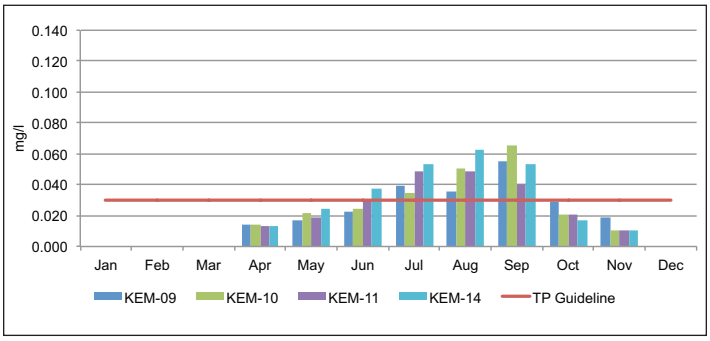


Figure 2a Total phosphorus concentrations in South Branch from 2001–2006

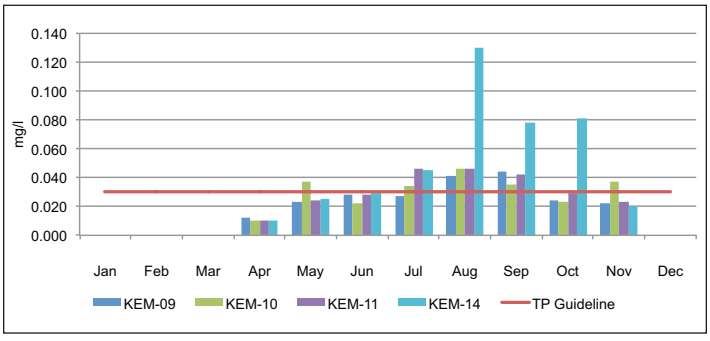


Figure 2b Total phosphorus concentrations in South Branch from 2007–2012

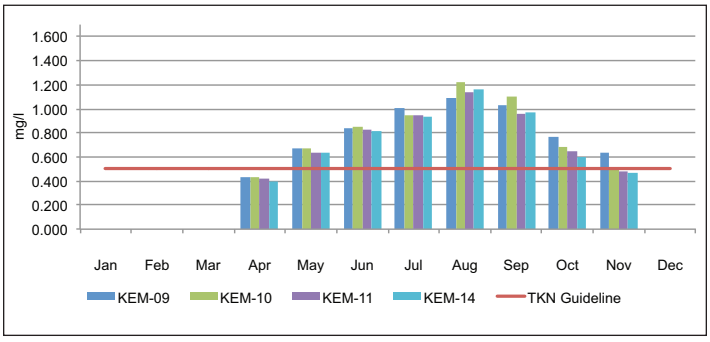


Figure 3a Total Kjeldahl nitrogen concentrations in South Branch from 2001–2006

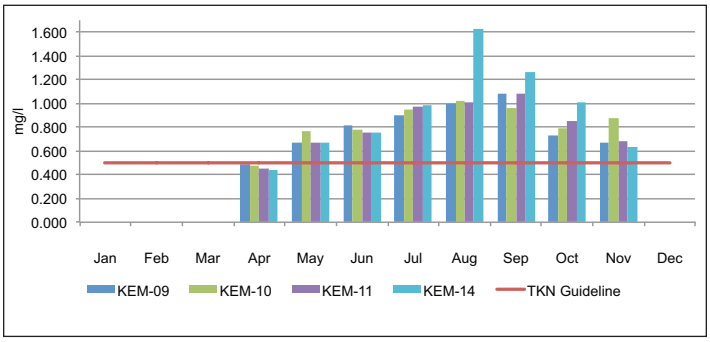


Figure 3b Total Kjeldahl nitrogen concentrations in South Branch from 2007–2012

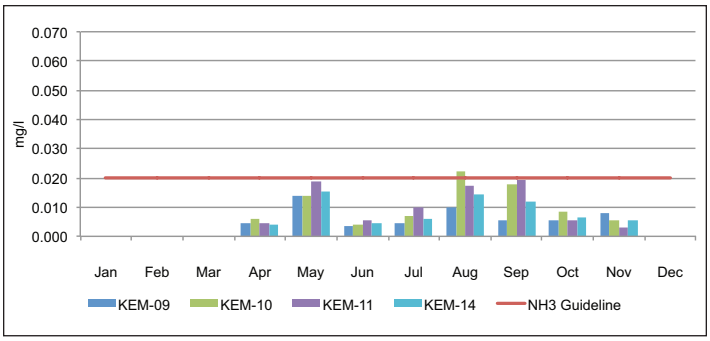


Figure 4a Ammonia concentrations in South Branch from 2001–2006

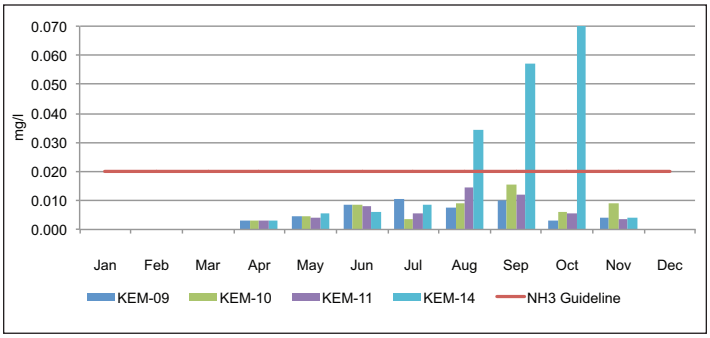


Figure 4b Ammonia concentrations in South Branch from 2007–2012

South Branch *E. coli*

E. coli is used as an indicator of bacterial pollution from human or animal waste; in elevated concentrations it can pose a risk to human health. The PWQO of 100 colony forming units/100 milliliters (CFU/100 ml) is used. *E. coli* counts greater than this guideline indicate that bacterial contamination may be a problem within a waterbody. The KCWP also set a target of *E. coli* counts of 100 CFU/100 ml at the 70th percentile.

Table 6 summarizes the geometric mean[2] at monitored sites on South Branch and shows the proportion of samples that meet the *E. coli* guideline of 100 CFU/100 ml. Highlighted values indicated averages that have exceeded the guideline.

Figure 5 shows the results of the geometric mean with respect to the guideline for the two periods 2001–2006 and 2007–2012. Figure 6 shows percentile plots of the data for the same two time periods. Any point to the left of the 70th percentile line (vertical) and above the guideline (horizontal line) has failed to reach the KCWP target.

KEM-14

E. coli counts at site KEM-14 show improvement with regard to bacterial contamination. Counts at the 70th percentile decreased from 102 CFU/100 ml (Figure 6a) to 96 CFU/100 ml (Figure 6b). The proportion of samples below the guideline remained consistent at 69 percent (Figures 5a and 5b), and the count at the geometric mean increased from 51 CFU/100 ml (2001-2006) to 73 CFU/100 ml (2007-2012).

KEM-11

At site KEM-11 *E. coli* counts at the 70th percentile increased from 76 CFU/100 ml (Figure 6a) to 120 CFU/100 ml (Figure 6b). The proportion of samples below the guideline declined from 87 percent (Figure 5a) to 64 percent (Figure 5b) and the count at the geometric mean increased from 43 CFU/100 ml (2001-2006) to 63 CFU/100 ml (2007-2012).

KEM-10

E. coli counts increased at the 70th percentile over the 2001–2012 monitoring period at site KEM-10. In comparing the two time periods *E. coli* counts at the 70th percentile have increased from 48 CFU/100 ml (Figure 6a) to 60 CFU/100 ml (Figure 6b). The proportion of samples below the guideline decreased from 97 percent (Figure 5a) to 92 percent (Figure 5b), and the geometric mean increased from 25 CFU/100 ml (2001–2006) to 35 CFU/100 ml (2007–2012).

Table 6 Summary of *E. coli* results for Kemptville Creek from 2001-2006 and 2007-2012

***E. coli* 2001–2006**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
KEM-14	51	69%	29
KEM-11	43	87%	30
KEM-10	25	97%	30
KEM-09	25	90%	30
***E. coli* 2007–2012**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
KEM-14	73	69%	39
KEM-11	63	64%	39
KEM-10	35	92%	39
KEM-09	74	67%	39

KEM-09

Percentile plots of *E. coli* data at site KEM-09 show counts at the 70th percentile increased to exceed the KCWP target, from 38 CFU/100 ml (Figure 5a) to 112 CFU/100 ml (Figure 5b). The proportion of samples below the guideline decreased from 90 percent (Figure 6a) to 67 percent (Figure 6b), indicating higher counts occur more frequently. The count at the geometric mean increased from 25 CFU/100 ml to 74 CFU/100 ml.

E. coli Summary

The results indicate that bacterial contamination continues to be a concern iin Kemptville Creek. The target set by the KCWP has not been achieved by all sites, the proportion of samples below guidelines decreased at all sites and there was a general increase of the counts at the geometric mean.

[2] A type of mean or average, which indicates the central tendency or typical value of a set of numbers by using the product of their values (as opposed to the arithmetic mean which uses their sum). It is often used to summarize a variable that varies over several orders of magnitude, such as *E. coli* counts.

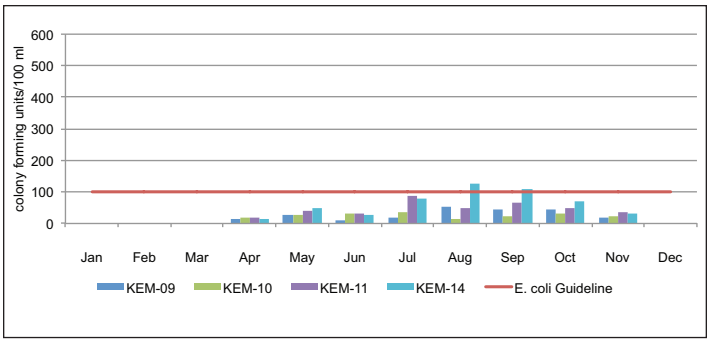


Figure 5a *E. coli* counts in South Branch from 2001–2006

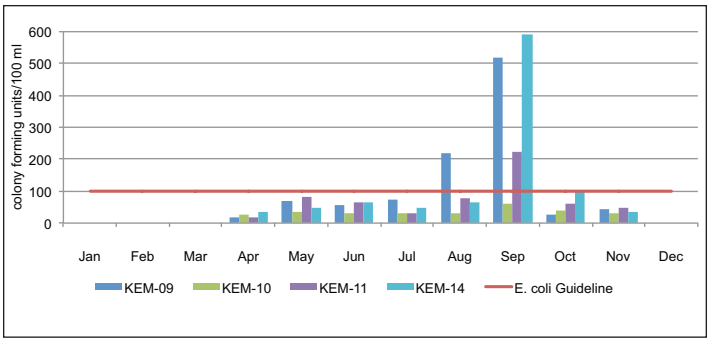


Figure 5b *E. coli* counts in South Branch from 2007–2012

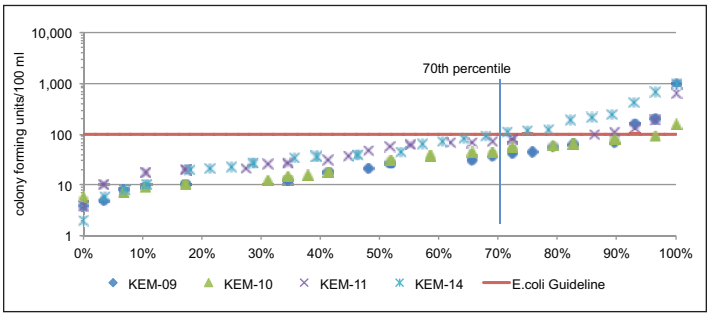


Figure 6a Percentile plots of *E. coli* in South Branch for 2001–2006

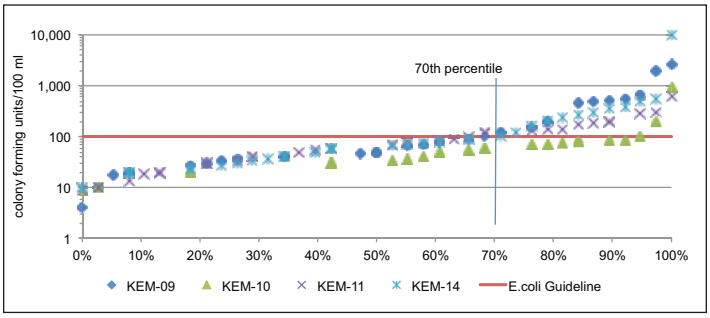


Figure 6b Percentile plots of *E. coli* in South Branch for 2007–2012

South Branch

2. South Branch Riparian Conditions

SOUTH BRANCH OVERBANK ZONE

Riparian Buffer Width Evaluation

Figure 8 shows the extent of the naturally vegetated riparian zone in the catchment, 30 metres on either side of all water bodies and watercourses. Results from the RVCA's Land Cover Classification Program show that 77 percent of rivers, streams and creeks are buffered with woodland, and wetland; the remaining 23 percent of the riparian buffer is occupied by settlement, transportation, sand and gravel and crop and pastureland.

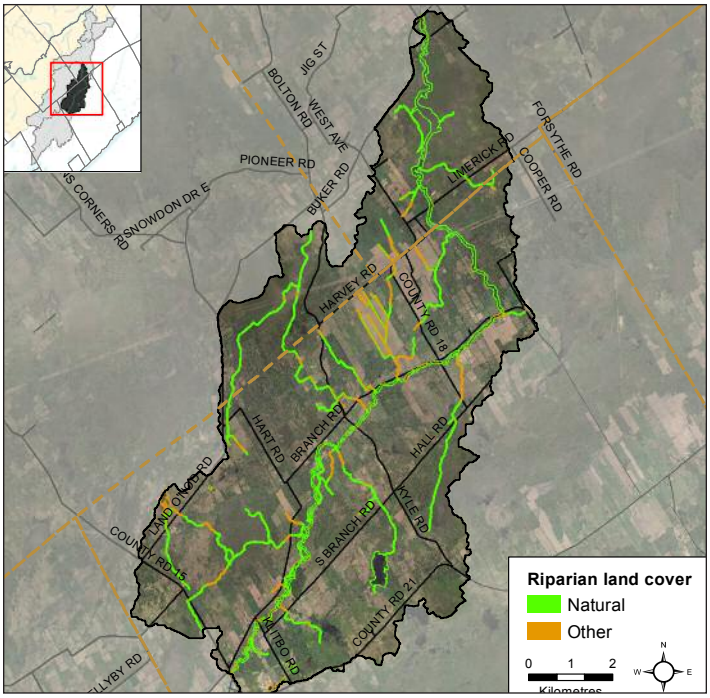


Figure 7 Natural and other riparian land cover along South Branch

The riparian or shoreline zone is that special area where the land meets the water. Well-vegetated shorelines are critically important in protecting water quality and creating healthy aquatic habitats, lakes and rivers. Natural shorelines intercept sediments and contaminants that could impact water quality conditions and harm fish habitat in streams. Well established buffers protect the banks against erosion, improve habitat for fish by shading and cooling the water and provide protection for birds and other wildlife that feed and rear young near water. A recommended target (from Environment Canada's Guideline: How Much Habitat is Enough?) is to maintain a minimum 30 metre wide vegetated buffer along at least 75 percent of the length of both sides of rivers, creeks and streams. Figure 8 demonstrates the buffer conditions of the left and right banks separately. The South Branch of Kemptville Creek had a buffer of greater than 30 metres along 94 percent of the right bank and 97 percent along the left bank.

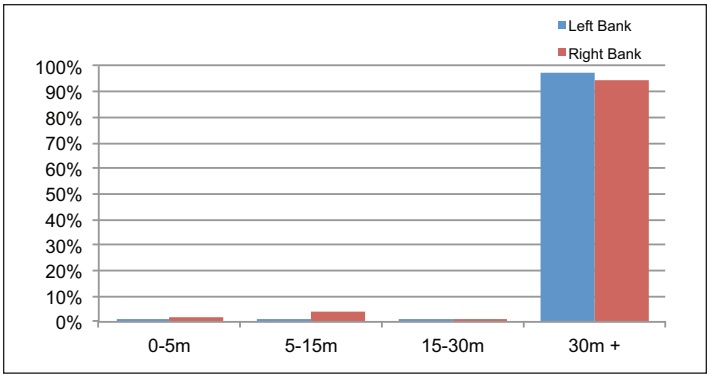


Figure 8 Riparian Buffer Evaluation along South Branch

Adjacent Land Use

The RVCA's Macro stream Survey Program identifies seven different land uses beside South Branch of Kemptville Creek (Figure 9). Surrounding land use is considered from the beginning to end of the survey section (100 metres) and up to 100 metres on each side of the creek. Land use outside of this area is not considered for the surveys but is nonetheless part of the subwatershed and will influence the creek. Natural areas made up 93 percent of the stream, characterized by forest, scrubland, wetland and meadow. The remaining land use consisted of residential, agriculture, infrastructure, and pasture.

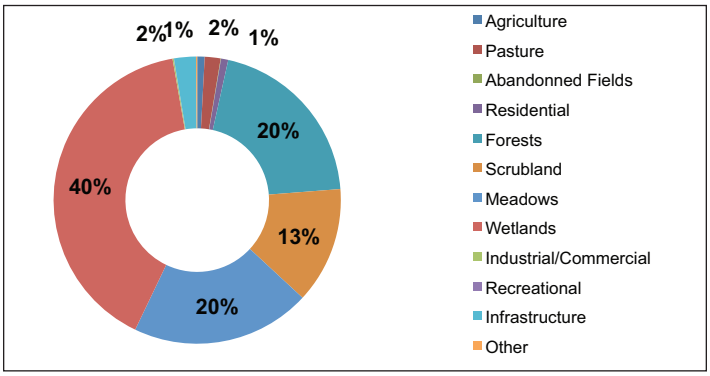


Figure 9 Land Use along South Branch

40 percent of South Branch is wetlands

SOUTH BRANCH SHORELINE ZONE

Instream Erosion

Erosion is a normal, important stream process and may not affect actual bank stability; however, excessive erosion and deposition of sediment within a stream can have a detrimental effect on important fish and wildlife habitat. Poor bank stability can greatly contribute to the amount of sediment carried in a waterbody as well as loss of bank vegetation due to bank failure, resulting in trees falling into the stream and the potential to impact instream migration. Figure 10 shows that there was very limited bank erosion observed on the left and right bank along Kemptville Creek within the South Branch catchment.

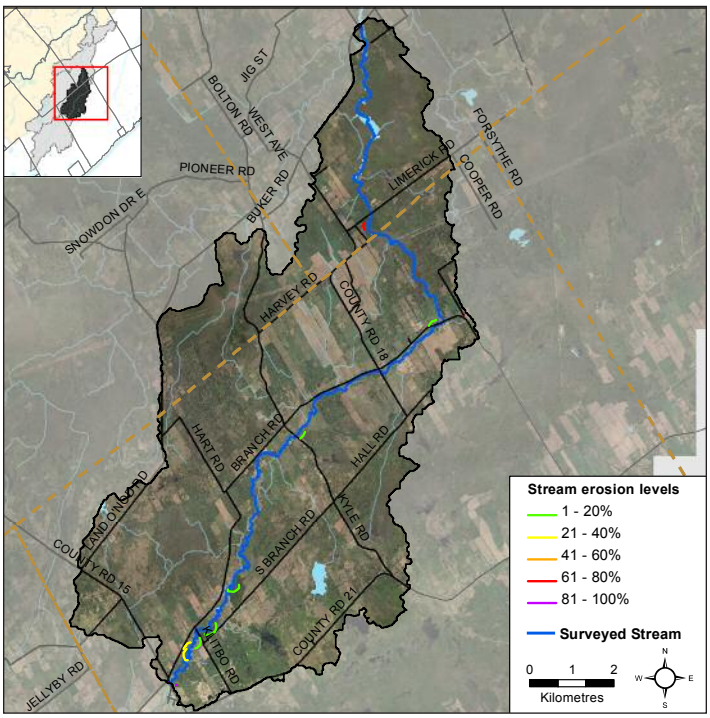


Figure 10 Erosion along South Branch

There is very limited bank erosion on South Branch

Undercut Stream Banks

Undercut banks are a normal and natural part of stream function and can provide excellent refuge areas for fish. Figure 11 shows that the South Branch of Kemptville Creek had low to moderate levels of undercut banks.

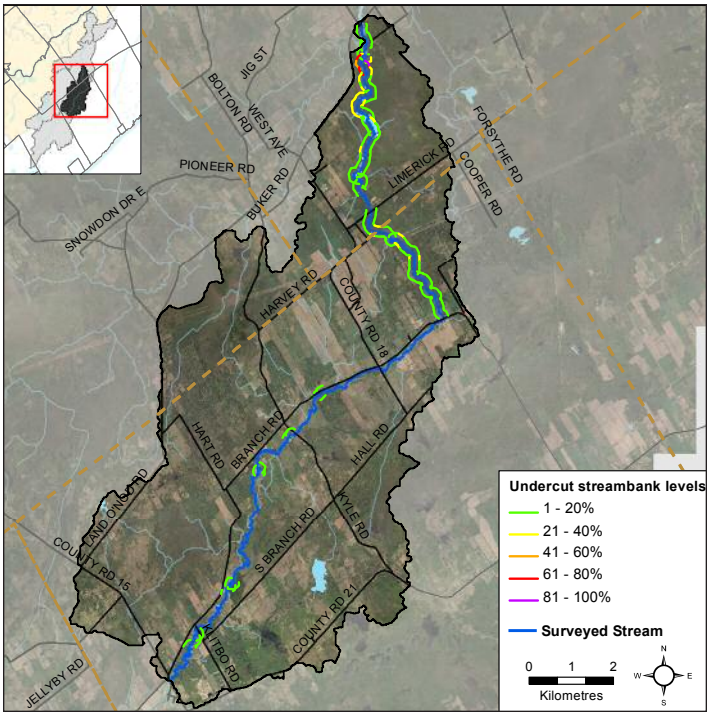


Figure 11 Undercut stream banks along South Branch

South Branch has low to moderate levels of undercut banks

Stream Shading

Grasses, shrubs and trees all contribute towards shading a stream. Shade is important in moderating stream temperature, contributing to food supply and helping with nutrient reduction within a stream. Figure 12 shows the stream shading locations along the South Branch of Kemptville Creek.

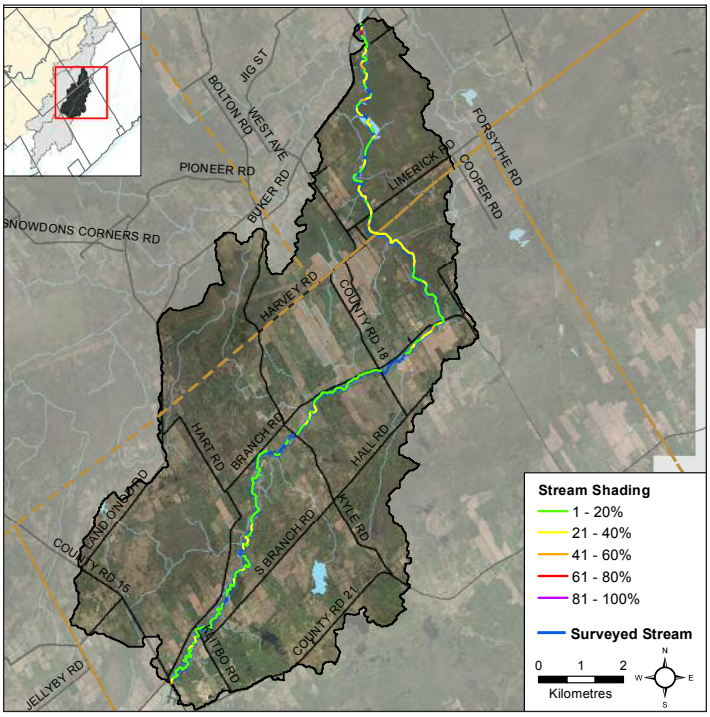


Figure 12 Stream shading along South Branch

Instream Woody Debris

Figure 13 shows that the majority of the South Branch of Kemptville Creek had low to moderate levels of instream woody debris in the form of branches and trees. Instream woody debris is important for fish and benthic habitat, by providing refuge and feeding areas.benthic habitat, by providing refuge and feeding areas.

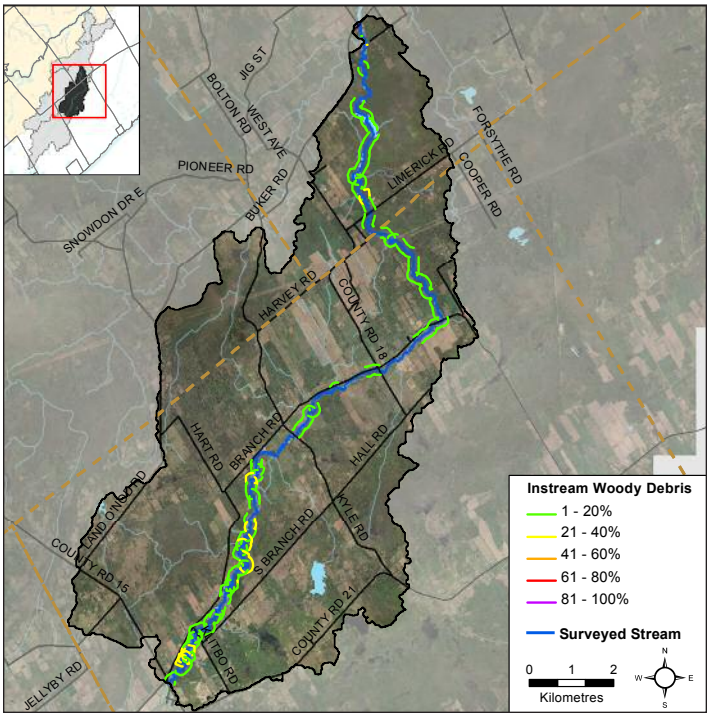


Figure 13 Instream woody debris along South Branch

Stream shading on South Branch

Instream woody debris on South Branch

Overhanging Trees and Branches

Figure 14 shows that the majority of the South Branch of Kemptville Creek had low to moderate levels of overhanging branches and trees. Overhanging branches and trees provide a food source, nutrients and shade which helps to moderate instream water temperatures.

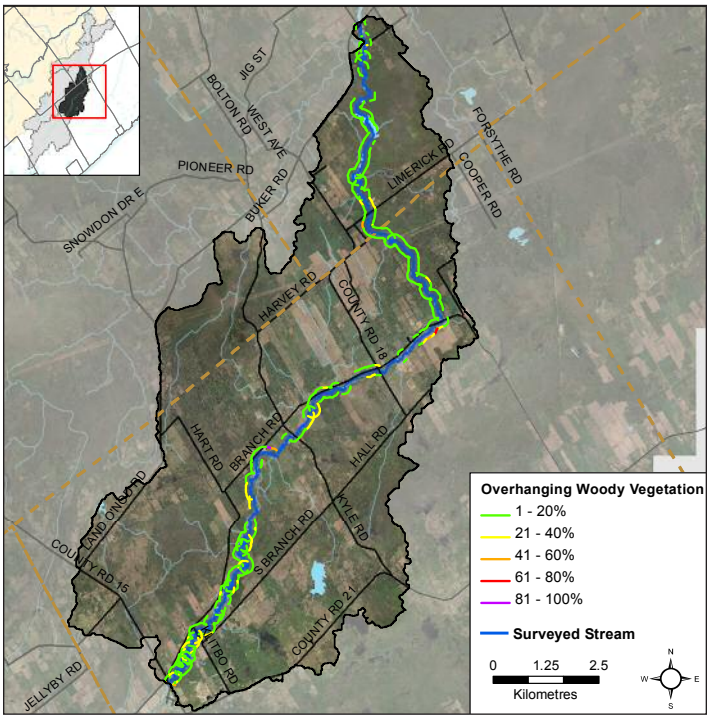


Figure 14 Overhanging trees and branches along South Branch

Overhanging trees and branches

Anthropogenic Alterations

Figure 15 shows 97 percent of the South Branch of Kemptville Creek remains “not altered.” Sections considered “natural” with some human changes account for 3 percent of sections. No sections were classified as "Altered" and “highly altered.” Areas classified as natural with some human changes included areas with existing road crossings.

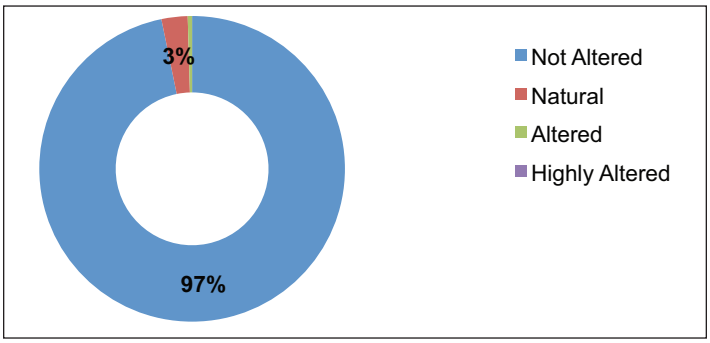
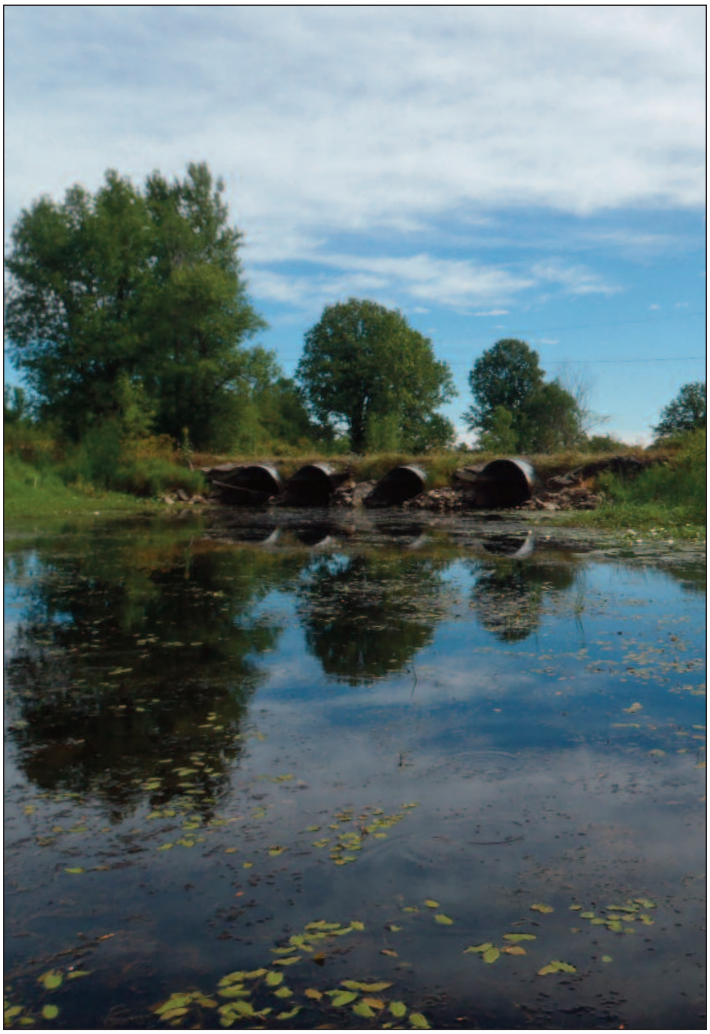


Figure 15 Anthropogenic alterations along South Branch



Man-made alterations along South Branch

SOUTH BRANCH INSTREAM AQUATIC HABITAT

Benthic Invertebrates

Freshwater benthic invertebrates are animals without backbones that live on the stream bottom and include crustaceans such as crayfish, molluscs and immature forms of aquatic insects. Benthos represent an extremely diverse group of aquatic animals and exhibit wide ranges of responses to stressors such as organic pollutants, sediments and toxicants, which allows scientists to use them as bioindicators. As part of the Ontario Benthic Biomonitoring Network (OBBN), the RVCA has been collecting benthic invertebrates at the Kemptville Creek sample location in North Augusta since 2003. Monitoring data is analyzed and the results are presented using the Family Biotic Index, Family Richness and percent *Ephemeroptera, Plecoptera* and *Trichoptera.*

Hilsenhoff Family Biotic Index

The Hilsenhoff Family Biotic Index (FBI) is an indicator of organic and nutrient pollution and provides an estimate of water quality conditions for each site using established pollution tolerance values for benthic invertebrates. FBI results for Kemptville Creek at the North Augusta sample location show that it has "Fair" water quality conditions for the period from 2007 to 2012 (Figure 16) using a grading scheme developed by Conservation Authorities in Ontario for benthic invertebrates.

Family Richness

Family Richness measures the health of the community through its diversity and increases with increasing habitat diversity suitability and healthy water quality conditions. Family Richness is equivalent to the total number of benthic invertebrate families found within a sample. Using Family Richness as the indicator, Kemptville Creek is reported to have "Fair" water quality (Figure 17).

EPT

Ephemeroptera (Mayflies), *Plecoptera* (Stoneflies), and *Trichoptera* (Caddisflies) are species considered to be very sensitive to poor water quality conditions. High abundance of these organisms is generally an indication of good water quality conditions at a sample location. With the EPT indicator, Kemptville Creek is reported to have "Fair" water quality (Figure 18) from 2007 to 2012.

Conclusion

Overall Kemptville Creek at the North Augusta sample location has a water quality rating of "Fair" from 2007 to 2012.

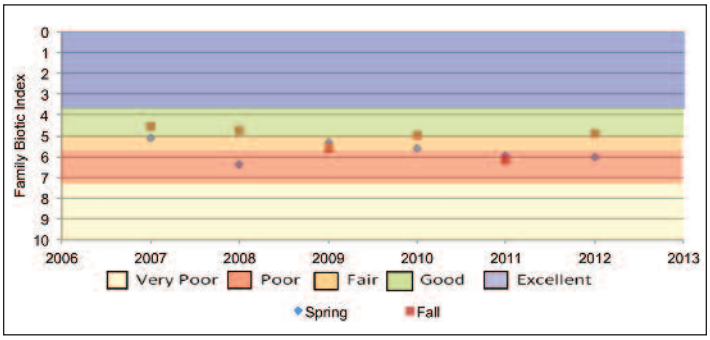


Figure 16 Hilsenhoff Family Biotic Index on South Branch

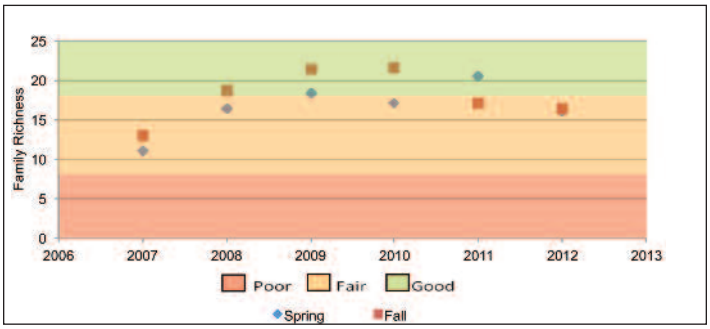


Figure 17 Family Richness in South Branch

Figure 18 EPT in South Branch

Nymph

Habitat Complexity

Streams are naturally meandering systems and move over time; there are varying degrees of habitat complexity, depending on the creek. Examples of habitat complexity include variable habitat types such as pools and riffles as well as substrate variability and woody debris structure. A high percentage of habitat complexity (heterogeneity) typically increases the biodiversity of aquatic organisms within a system. Seventy-five percent of the South Branch of Kemptville Creek was considered heterogeneous, as shown in Figure 19.

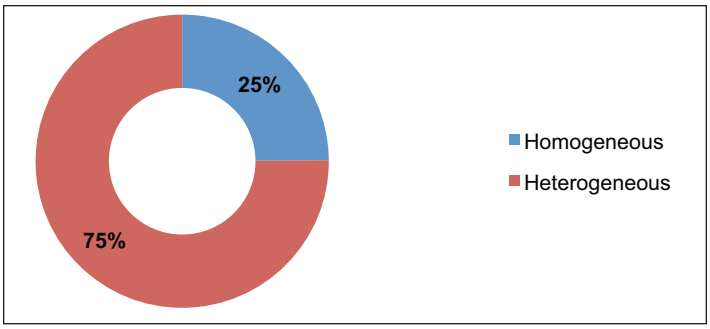


Figure 19 Habitat complexity along South Branch

Instream Substrate

Boulders create instream cover and back eddies for large fish to hide and/or rest out of the current. Cobble provides important over wintering and/or spawning habitat for small or juvenile fish. Cobble can also provide habitat conditions for benthic invertebrates that are a key food source for many fish and wildlife species. Figure 20 shows where cobble and boulder substrate is found in the South Branch of Kemptville Creek. Diverse substrate is important for fish and benthic invertebrate habitat because

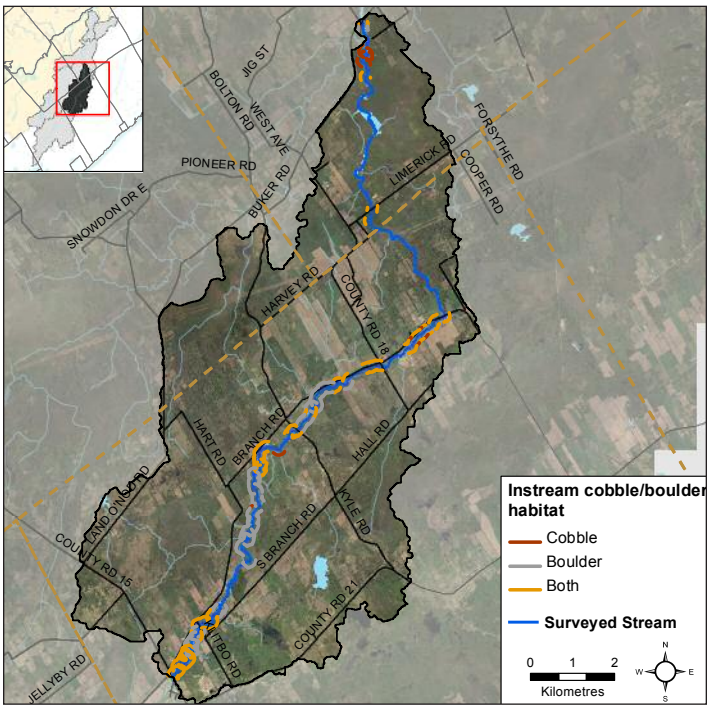


Figure 20 Instream substrate along South Branch

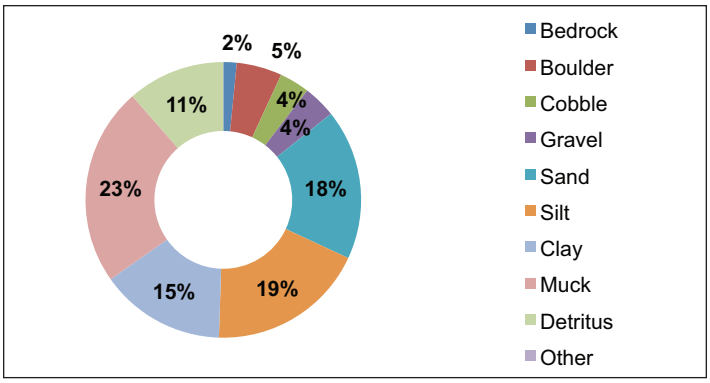


Figure 21 Instream substrate along South Branch

some species have specific substrate requirements and for example will only reproduce on certain types of substrate (Figure 21).

Instream Morphology

Pools and riffles are important habitat features for fish. Riffles are areas of agitated water and they contribute higher dissolved oxygen to the stream and as spawning substrate for some species of fish, such as walleye. Pools provide shelter for fish and can be refuge pools in the summer if water levels drop and water temperature in the creek increases. Pools also provide important over wintering areas for fish. Runs are usually moderately shallow, with unagitated surfaces of water and areas where the thalweg (deepest part of the channel) is in the center of the channel.

Figure 22 shows that the South Branch of Kemptville Creek is very uniform; 99 percent of the stream consists of runs with only one percent pools along the system.

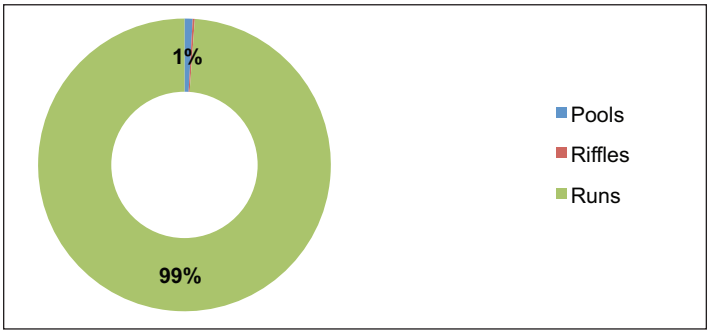


Figure 22 Instream morphology along South Branch

Vegetation Type

Instream vegetation provides a variety of functions and is a critical component of the aquatic ecosystem. For example emergent plants along the shoreline can provide shoreline protection from wave action and important rearing habitat for species of waterfowl. Submerged plants provide habitat for fish to find shelter from predator fish while they feed. Floating plants such as water lilies shade the water and can keep temperatures cool while reducing algae growth. The South Branch of Kemptville Creek was classified as having a healthy diversity of instream vegetation. The dominant vegetation type recorded at thirty-two percent consisted of submerged vegetation. Figure 23 depicts the plant community structure for this reach of Kemptville Creek.

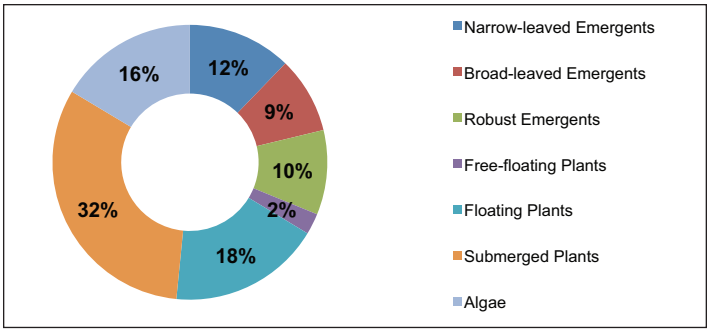


Figure 23 Vegetation type along South Branch

Instream Vegetation Abundance

Instream vegetation is an important factor for a healthy stream ecosystem. Vegetation helps to remove contaminants from the water, contributes oxygen to the stream, and provides habitat for fish and wildlife. Too much vegetation can also be detrimental. Figure 24 demonstrates that the South Branch of Kemptville Creek has healthy to extensive levels of instream vegetation for most of its length. European Frogbit can be found to choke the channel within this reach.

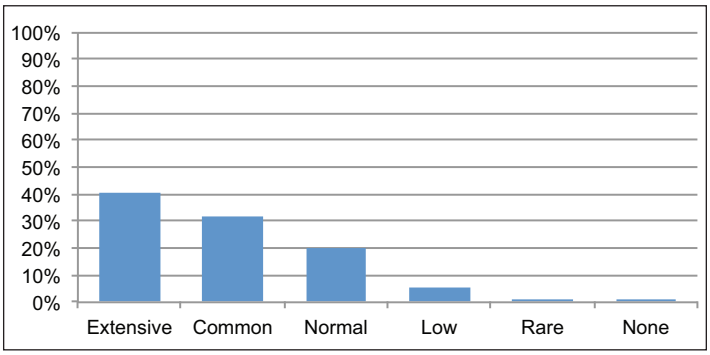
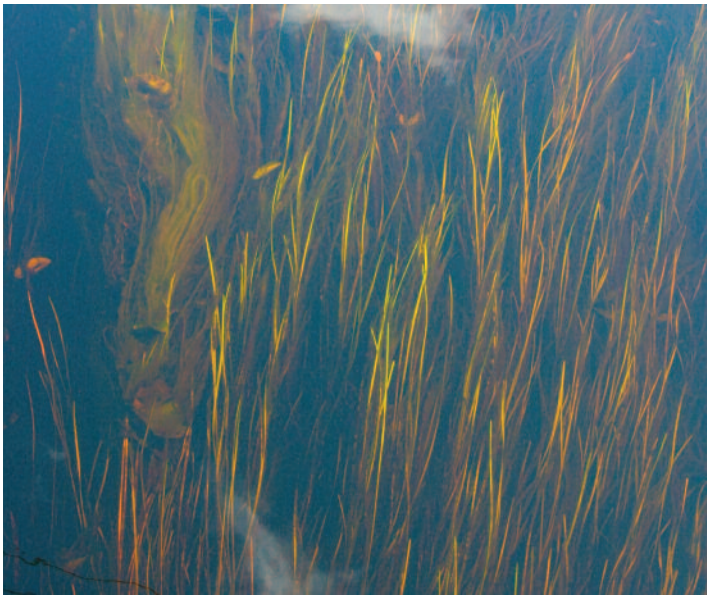


Figure 24 Instream vegetation abundance along South Branch



32 percent of vegetation on South Branch consists is submerged

Invasive Species

Invasive species can have major implications on streams and species diversity. Invasive species are one of the largest threats to ecosystems throughout Ontario and can outcompete native species, having negative effects on local wildlife, fish and plant populations. One hundred percent of the sections surveyed along Kemptville Creek had invasive species (Figure 25). The invasive species observed in the South Branch of Kemptville Creek were common buckthorn, European frogbit and purple loosestrife.

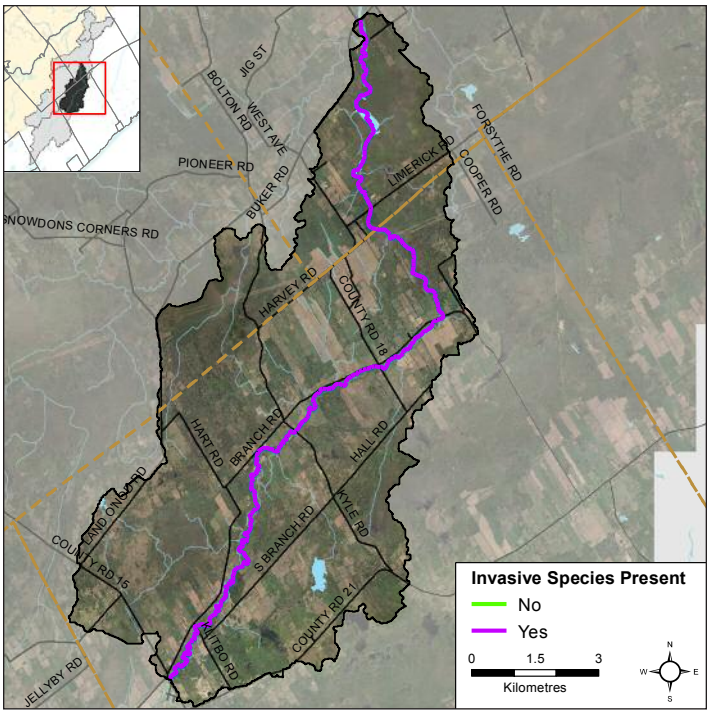


Figure 25 Invasive species along South Branch

Thermal Regime

Many factors can influence fluctuations in stream temperature, including springs, tributaries, precipitation runoff, discharge pipes and stream shading from riparian vegetation. Water temperature is used along with the maximum air temperature (using the Stoneman and Jones method) to classify a watercourse as either warm water, cool water or cold water. Analysis of the data collected indicates that the North Branch is classified as a warm water system (Figure 27). Figure 26 shows the location of temperature loggers at one sampling location on the South Branch.

Discharge pipes can affect water temperatures

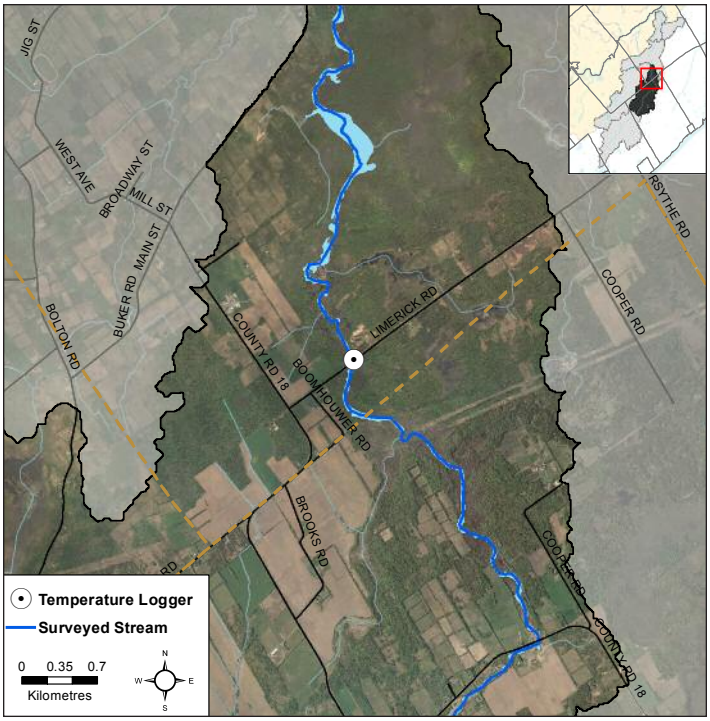
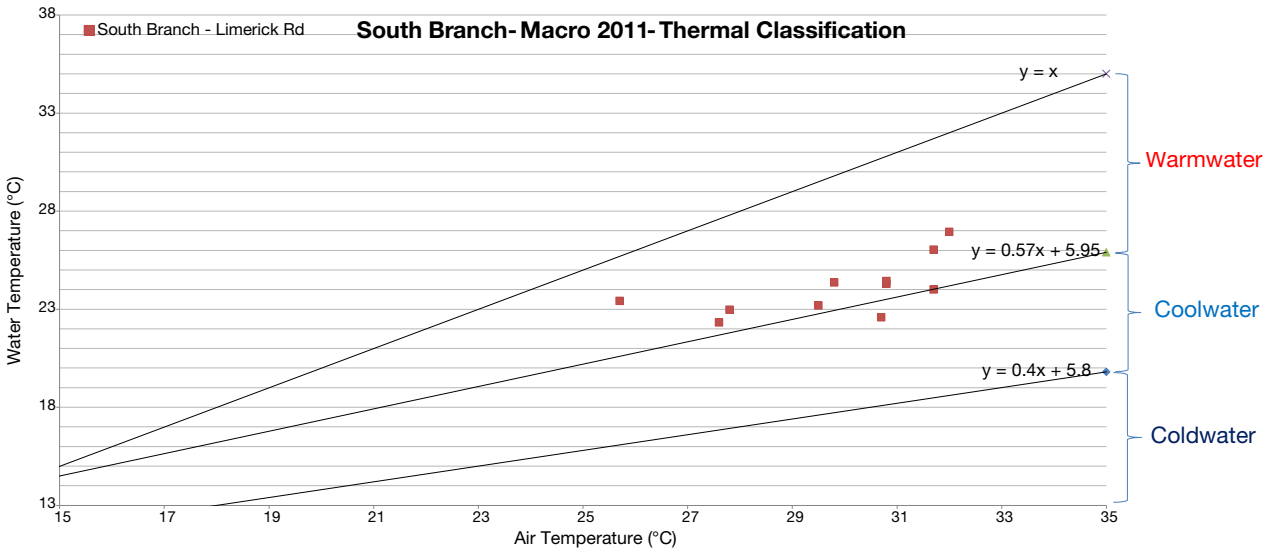


Figure 26 Temperature loggers in South Branch



SITE ID	SOURCE_ID	Y_WATER	X_AIR	CLASSIFICATION	PROGRAM	YEAR
South Branch - Limerick	KMPT-1	24.22	30.3	WARMWATER	MACRO	2011

Figure 27 Temperature logger data for one site location on Kemptville Creek in the South Branch catchment. Each point on the graph represents a temperature that meets the following criteria:

- Sampling dates between July 1 and September 7
- Sampling date is preceded by two consecutive days above 24.5 °C, with no rain
- Water temperatures are collected at 4 p.m.
- Air temperature is recorded as the max temperature for that day.

Migratory Obstructions

It is important to know the locations of migratory obstructions because they can prevent fish from accessing important spawning and rearing habitat (Figure 28). Migratory obstructions can be natural or manmade, and they can be permanent or seasonal. There were several beaver dams and a debris dam within the South Branch of Kemptville Creek catchment at the time of the survey. This reach of Kemptville Creek does consistently have beaver dam activity each year.

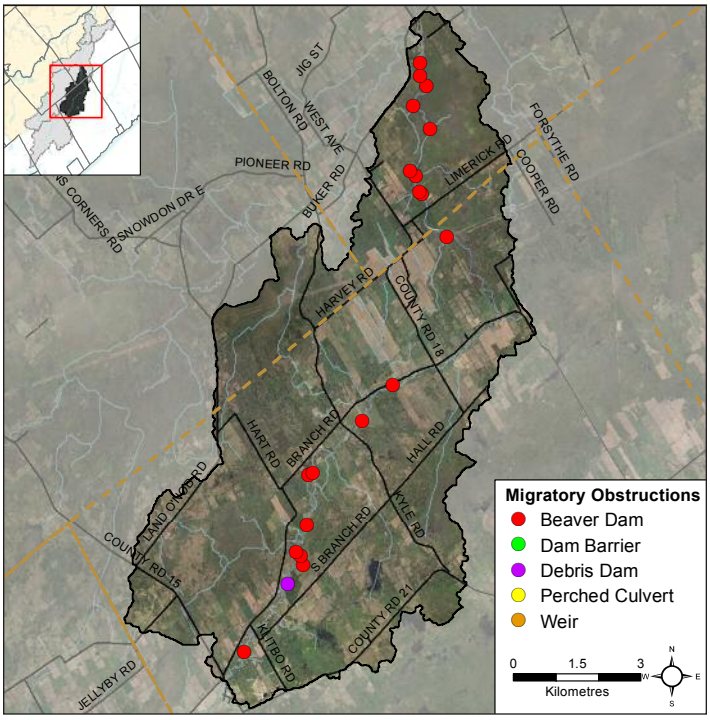


Figure 28 Migratory obstructions along South Branch

Beaver dam — a migratory obstruction on South Branch

Fish Sampling

Fish sampling sites located along the South Branch of Kemptville Creek catchment are shown in Figure 29. The provincial fish codes shown on the preceding map are listed (in Table 7) beside the common name of those fish species identified in the South Branch of Kemptville Creek. Kemptville Creek is classified as a warm/cool water recreational and baitfish fishery with 22 species observed in the South Branch reach.

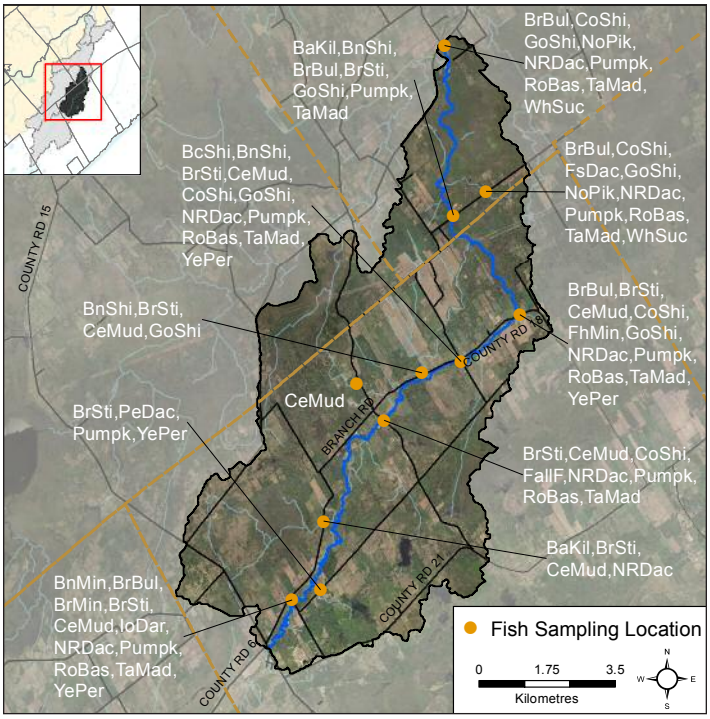


Figure 29 Fish sampling along South Branch

Table 7 Fish species identified in South Branch

Species observed in South B (with fish code)			
banded killifish	BaKil	golden shiner	GoShi
blackchin shiner	BcShi	iowa darter	IoDar
blacknose shiner	BnShi	northern pike	NoPik
bluntnose minnow	BnMin	northern redbelly dace	NRDac
brassy minnow	BrMin	pearl dace	PeDac
brook stickleback	BrSti	pumpkinseed	Pumpk
central mudminnow	CeMud	rock bass	RoBas
common shiner	CoShi	tadpole madtom	TaMad
fallfish	FallF	white sucker	WhSuc
fathead minnow	FhMin	yellow perch	YePer
finescale dace	FsDac		

Riparian Restoration

Figure 30 depicts the locations where various riparian restoration activities can be implemented as a result of observations made during the stream survey assessments.

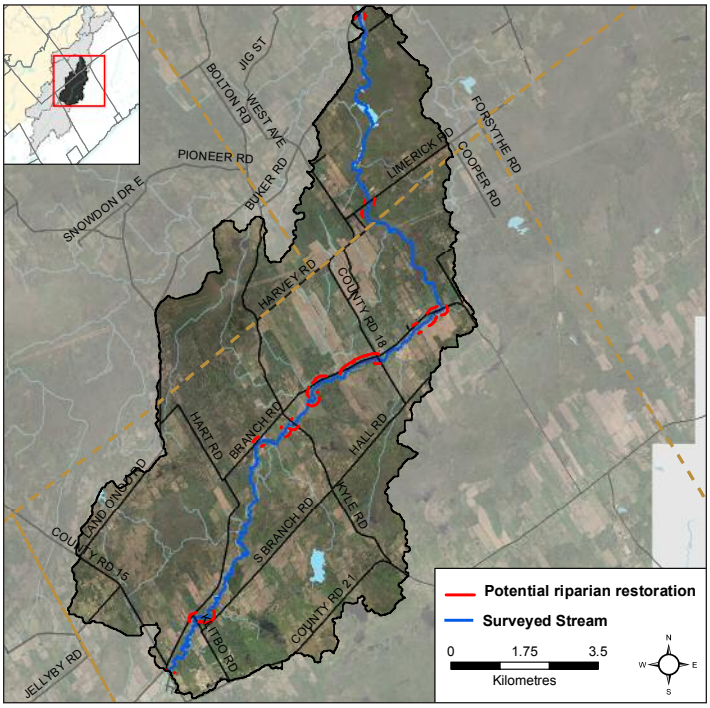


Figure 30 Riparian restoration along South Branch

Water Chemistry

During the macro stream survey, a YSI probe is used to collect water chemistry, as follows:

- Dissolved Oxygen is a measure of the amount of oxygen dissolved in water. The lowest acceptable concentration of dissolved oxygen is 6.0 mg/L for early stages of warm water fish and 9.5 mg/L for cold water fish (CCME, 1999).
- A saturation value (concentration of oxygen in water) of 90 percent or above is considered healthy. Saturation levels above 100 percent are not uncommon in sections of stream where there are high amounts of algae and other aquatic plants.
- Conductivity is the ability of a substance to transfer electricity. This measure is influenced by the presence of dissolved salts and other ions in the stream.
- pH is a measure of relative acidity or alkalinity, ranging from 1 (most acidic) to 14 (most alkaline/basic), with 7 occupying a neutral point.

2011 data for these four parameters is summarized in Table 8.

Table 8 Water chemistry in South Branch

Month	Range	DO (mg/L)	DO(%)	Conductivity (µs/cm)	pH
June 2011	Low	2.68	32.9	319	NA
	High	6.31	77.4	371	NA
July 2011	Low	1.75	21.0	158	7.87
	High	9.07	109.0	393	8.44
August 2011	Low	0.45	5.2	273	7.48
	High	10.56	121.4	416	8.60

South Branch near Limerick

3. Land Cover

Woodland is the dominant land cover type in the catchment as shown in Table 9 and displayed in the map on the front cover of the report.

Table 9 Catchment land cover type

Cover Type	Area (ha)	Area (% of Cover)
Woodland*	2,965	37
Crop & Pasture	2,333	30
Wetland**	2,165	27
Settlement	288	4
Transportation	161	2

* Does not include treed swamps ** Includes treed swamps

Woodland Cover

The South Branch of Kemptville Creek catchment contains 2965 hectares of upland forest and 515 hectares of lowland forest (treed swamps) (Figure 31) that occupies 44 percent of the drainage area (versus the 36 percent of woodland cover in the Kemptville Creek Subwatershed). This figure is greater than the 30 percent of woodland area required to sustain forest birds, according to Environment Canada's Guideline: "How Much Habitat is Enough?" When forest cover declines below 30 percent, forest birds tend to disappear as breeders across the landscape.

Forty-six (33 percent) of the 140 woodland patches in the catchment are very small, being less than one hectare in size. Another 64 (46 percent) of the wooded patches ranging from one to less than 20 hectares in size tend to be dominated by edge-tolerant bird species. The remaining 30 (21 percent of) woodland patches range between 20 and 415 hectares. Eighteen of these patches contain woodland between 20 and 100 hectares and may support a few area-sensitive species and some edge intolerant species, but will be dominated by edge tolerant species.

Conversely, 12 (nine percent) of the 140 woodland patches in the drainage area exceed the 100 plus hectare size needed to support most forest dependent, area sensitive birds and are large enough to support approximately 60 percent of edge-intolerant species. Four of these patches top 200 hectares, which according to the Environment Canada Guideline will support 80 percent of edge-intolerant forest bird species (including most area sensitive species) that prefer interior forest habitat conditions.

Forest Interior

The same 140 woodlands contain 34 forest interior patches (Figure 31) that occupy 11 percent (872 hectares) of the catchment land area (versus the eight percent of interior forest in the Kemptville Creek Subwatershed). This is above the 10 percent figure referred to in the Environment Canada Guideline that is considered to be the minimum threshold for supporting edge intolerant bird species and other forest dwelling species in the landscape.

Most patches (14) have less than 10 hectares of interior forest, four of which have small areas of interior forest habitat less than one hectare in size. Another eight patches contain between 10 and 30 hectares of interior forest. Conversely, 12 patches have greater than 30 hectares of interior forest, with one patch exceeding 100 hectares (at 128 hectares).

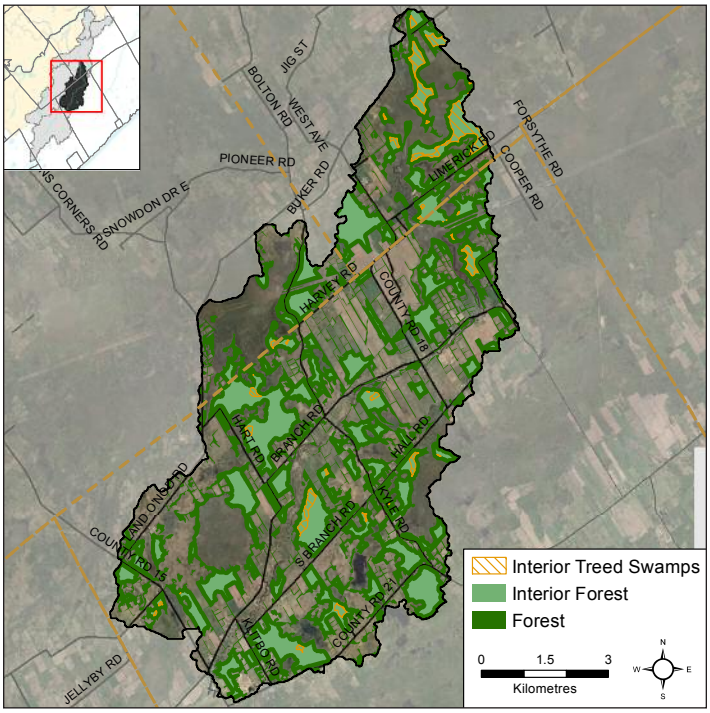
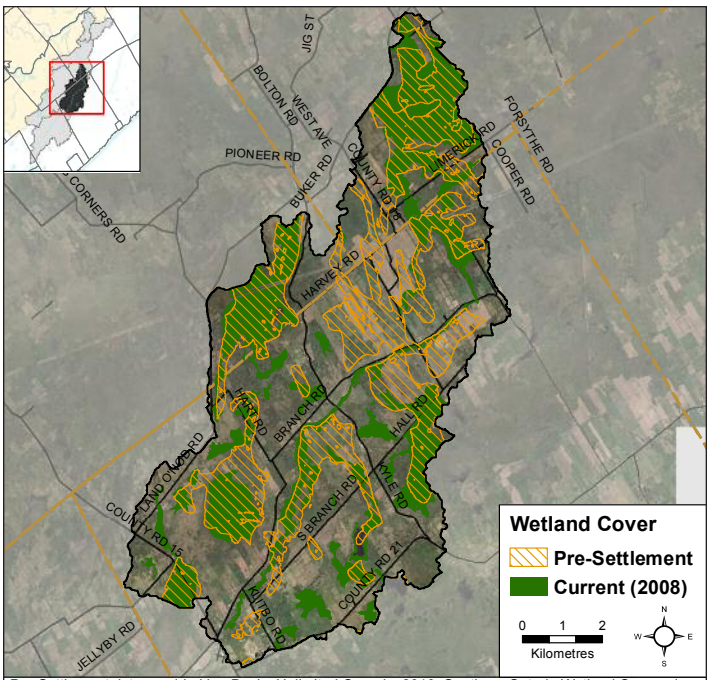


Figure 31 Catchment woodland cover and forest interior

Wetland Cover

Figure 32 shows pre-settlement versus current (2008) wetland cover in the catchment



Pre-Settlement data provided by: Ducks Unlimited Canada, 2010. Southern Ontario Wetland Conversion Analysis, http://www.ducks.ca/aboutduc/news/archives/prov2010/pdf/duc_ontariowca.pdf, (March 2010)

Figure 32 Catchment wetland cover

4. Stewardship and Protection

The RVCA and its partners are working to protect and enhance environmental conditions in the Kemptville Creek Subwatershed.

Rural Clean Water Projects

Figure 33 shows the location of all Rural Clean Water Projects in the Kemptville Creek — South Branch drainage area. From 2007 to 2012, landowners completed five projects including four well decommissionings and one septic system repair/replacement. In total, RVCA contributed $5,900 in grant dollars towards the total project cost of $14,863.

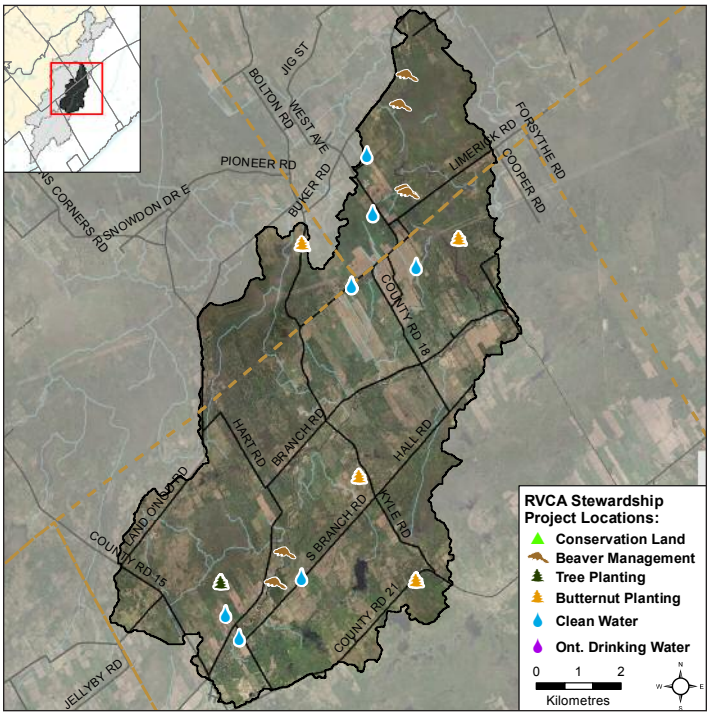


Figure 33 RVCA stewardship program project locations

Prior to 2007, the RVCA completed five projects in the area consisting of two well upgrades, one septic system replacement/repair, one surface water diversion and one livestock water restriction fencing project. In total, RVCA contributed $4,936 in grant dollars to projects valued at $9,454.

Tree Planting Projects

The location of all tree planting projects is also shown in Figure 33. In 2005, 500 trees valued at $672 were planted on one project site. Fundraised dollars from the RVCA Tree Planting Program accounted for $75 of that amount.

Beaver Management

The Kemptville Creek Beaver Dam Pilot Project was initiated by the Rideau Valley Conservation Authority in 2003 to tackle landowner flooding concerns along the North and South Branch of Kemptville Creek (see Figure 33 for beaver management locations in the South Branch). The pilot project consisted of: beaver dam surveys; aquatic habitat and fish community surveys; nuisance beaver trapping; beaver dam removal; water level monitoring of beaver dam removals and a database recording landowner flooding concerns. Final results show a total of 64 beaver and six dams being removed from 2003 to 2005 along with the breaching of 11 dams.

Valley, Stream, Wetland and Hazard Land Regulation

Nineteen square kilometres or 24 percent of the catchment drainage area is within the regulation limit of Ontario Regulation 174/06 (Figure 34), giving protection to wetland areas and river or stream valleys that are affected by flooding and erosion hazards.

Natural features within the regulation limit include 6.0 square kilometres of wetlands (representing 28 percent of all wetlands in the catchment) and 54.9 kilometers of streams (representing 61 percent of all streams in the catchment). Some of these regulated watercourses (34.2 km or 38 percent of all streams) flow through regulated wetlands.

Regulation limit mapping has been plotted along 20.7 km (or 38 percent) of the streams that are outside of wetlands. Plotting of the regulation limit on the remaining 35.5 km (or 39 percent) of streams requires identification of flood and erosion hazards and valley systems.

Within the regulation limit, “development” and “site alteration” require RVCA permission. The “alteration to waterways” provision of Ontario Regulation 174/06 applies to all watercourses.

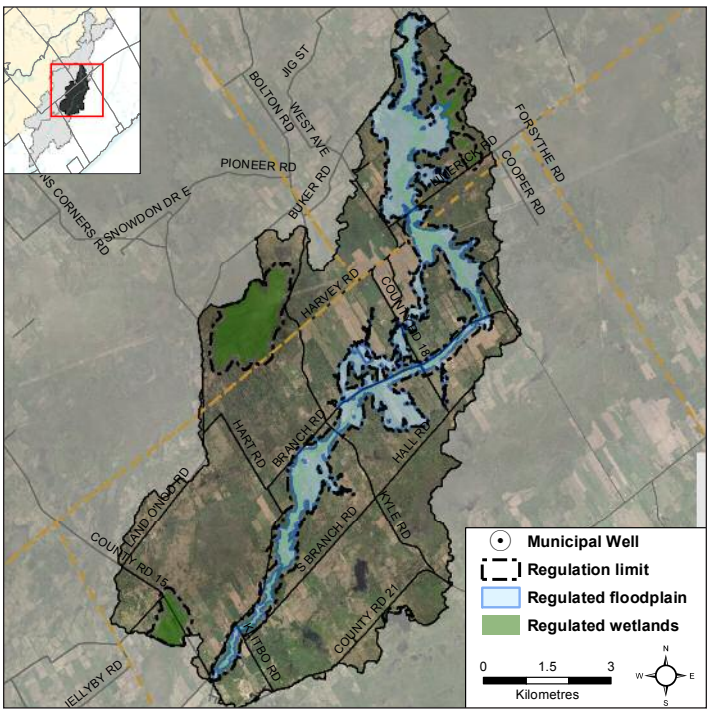


Figure 34 RVCA regulation limits

5. Issues

- Biological water quality is "Fair" along the upper most reach of Kemptville Creek through North Augusta as determined by benthic invertebrate data. Surface water quality is "Fair" at the most up and downstream monitoring sites along Kemptville Creek at Kyle and Buker Roads and "Good" at the sites in-between, where the creek crosses Branch and Limerick Roads. It has declined from "good" to "Fair" at Kyle Road and remains unchanged ("Good") at the three other downstream sites over a 12 year reporting period. Exceedances of total Kjeldahl nitrogen, total phosphorus and *E. coli* above water quality guidelines are largely responsible for the decline at Kyle Road
- There are flood susceptible areas adjacent to Kemptville Creek as identified by the RVCA's Kemptville Creek Floodplain Mapping Study (2009). Although private property extends into the flood risk area, most development is located outside the floodplain due to past (and ongoing) efforts to minimize landowner exposure to natural hazards by regulating development in the floodplain. Regulations administered by the RVCA have been in place around wetlands since 2006 and along the creek since 2009
- Water levels and land drainage have been a subject of controversy within the catchment for many years. Work carried out by the RVCA (from 2003 to 2007) through the Kemptville Creek Beaver Dam Management Pilot Project included aquatic habitat/beaver surveys and beaver/dam removals and has had a positive effect on the creek's aquatic ecosystem and concerns about high water levels.
- The catchment contains 1,405 hectares of unevaluated wetland (occupying 18 percent of its total area) that provides many important social, hydrological, biological and ecological functions/services. Although not under imminent threat from development activity, they do remain vulnerable to drainage and land clearing activities in the absence of any regulatory and planning controls that would otherwise protect them

6. Opportunities for Action

- Investigate cause of "Fair" surface water quality rating along Kemptville Creek. Reported decline (from "Good" to "Fair") in the rating may be attributed to sources such as land use conversions, wetland cover change and wildlife activity within the catchment. Further study is necessary to better understand the contributing factors
- Continue to use official plan policy, zoning and regulatory controls under Section 28 of the *Conservation Authorities Act* to restrict development in and adjacent to the Kemptville Creek floodplain and the Provincially Significant Wetlands found in the catchment (i.e., Kemptville Creek Wetland Parts One and Two, Limerick Wetland and Mud Lake and Creek Wetland; although not designated as Provincially Significant, the Wolford Bog Wetland Part Five is regulated by the RVCA)
- Consider establishing RVCA regulations limits in areas of unevaluated wetlands subject to site alteration
- Target riparian restoration at areas shown in Figure 30 (to address minimal shoreline buffers and identified erosion sites)
- Work with landowners to implement agricultural best management practices and pursue improvements to the riparian corridor along the South Branch of Kemptville Creek and tributaries (by increasing buffers through reforestation/riparian plantings and invasive species removal)
- Protect shorelines, floodplains, locally/regionally/provincially significant natural heritage features such as wetlands, woodlands, valleylands, wildlife habitat, areas of natural and scientific interest, aquatic habitat and municipal drinking water intake/wellhead protection zones/areas through conservation agreements/easements or land acquisition programs