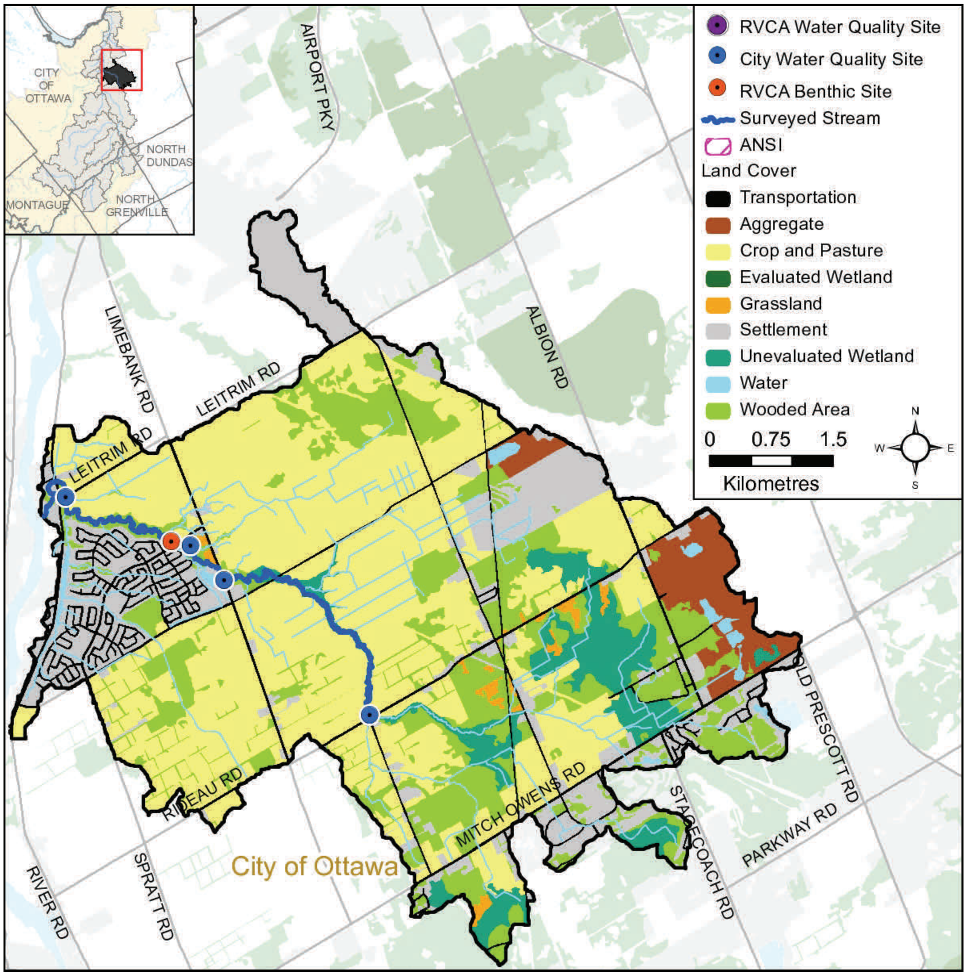
MOSQUITO CREEK CATCHMENT

LOWER RIDEAU RIVER SUBWATERSHED REPORT 2012

RIDEAU VALLEY CONSERVATION AUTHORITY



The RVCA produces individual reports for 16 catchments in the Lower Rideau 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 Mosquito 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 Lower Rideau catchments and Lower Rideau Subwatershed Report, please visit the RVCA website at www.rvca.ca.

Inside

Catchment Facts

- This catchment has been transitioning from a predominantly rural land use prior to the 1990's to an expanding area of suburban land uses today
- Construction of two stormwater management facilities on the creek's most westerly branch to achieve Rideau River/Mosquito Creek receiving stream objectives for quality and quantity
- The creek and its numerous tributaries are naturally meandering watercourses occupying well-defined valleys and ravines that are actively eroding, resulting in over steepened banks where the meanders are in contact with them
- Erosion and slope stability hazards are present throughout the stream/valley system
- Floodplain mapping is available along Mosquito Creek, downstream of River Road to its confluence with the Rideau River; flooding is not an issue further upstream, since high flows are contained within the well-defined valley
- Drains 41 sq. km of land or 5.4% of the Lower Rideau Subwatershed and 1.0% of the Rideau Valley Watershed
- Dominant land cover is crop and pastureland (47%), followed by woodland (19%), settlement (16%), wetland (7%), transportation (5%), aggregate site (4%), water (1%) and grassland (1%)
- Riparian buffer (30 m. wide along both sides of Mosquito Creek and its tributaries) is comprised of crop and pastureland (45%), wetland (19%), woodland (17%), settlement (11%), aggregate site (4%), transportation (3%) and grassland (1%)
- Contains a cool/warm water recreational and baitfish fishery with 34 fish species
- Contains six municipal drains
- Water quality rating along Mosquito Creek is poor at Rideau Road, poor at Limebank Road and poor at Leitrim Road, with no change in water quality ratings observed over a 12 year reporting period (2000-2005 vs. 2006-2011) and fair at Spratt Road over a six year period (2006-2011)
- Woodland cover has increased by 2.4 percent (99 ha.) from 2002 to 2008
- Major studies completed include: South Urban Community Drainage Planning Study. 1990 (UMA Engineering for RVCA); South Urban Community Master Drainage Plan, 1992 (Gore & Storrie Ltd. for City of Gloucester); Riverside South Master Drainage Plan Update. 2008 (Stantec for City of Ottawa)
- Between 2002 and 2009, fish sampling has been conducted on Mosquito Creek and its tributaries by the City Ottawa, City Stream Watch, volunteers and consultants for development related initiatives
- Since 2003, the RVCA has conducted benthic macroinvertebrate sampling downstream of Spratt Road; in 2004, 2005 and 2009, volunteers conducted macro stream surveys along Mosquito Creek; also in 2009, RVCA undertook temperature profiling to gain a better understanding of temperature and habitat variations in the creek
- Eight stewardship (landowner tree planting/clean water) projects have been completed
- In 2006 and 2007, CSW volunteers planted 450 trees and shrubs at the Spratt Road creek crossing

1) Surface Water Quality

Assessment of streams in the Lower Rideau is based on 24 parameters including nutrients (total phosphorus, total Kjeldahl nitrogen, nitrates), 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 Lower Rideau Subwatershed also looks at water quality targets that are presented in the 2005 Lower Rideau Watershed Strategy (LRWS), to see if they are being met. The LRWS identifies improving water quality as a priority concern; specifically reducing the levels of nutrients, bacteria and contaminants in the Lower Rideau.

1) a. Mosquito Creek

Surface water quality conditions in Mosquito Creek are monitored through the City of Ottawa's Baseline Water Quality Program. (CK20-10 upstream of Limebank Road bridge, CK20-16 upstream of Leitrim Road bridge culvert, CK20-22 downstream of Rideau Road and MSQ40 road crossing on Spratt Road, see Fig. 1 for their location)

The water quality rating for Mosquito Creek is "Poor" at all sites except for MSQ40 which is rated “Fair” as determined by the CCME Water Quality Index (CCME WQI); analysis of the data has been broken into two periods 2000-2005 and 2006-2011, to examine if conditions have changed in this timeframe. Table 1 outlines the WQI scores and their corresponding ratings For more information on the CCME WQI please see the Lower Rideau Subwatershed Report.

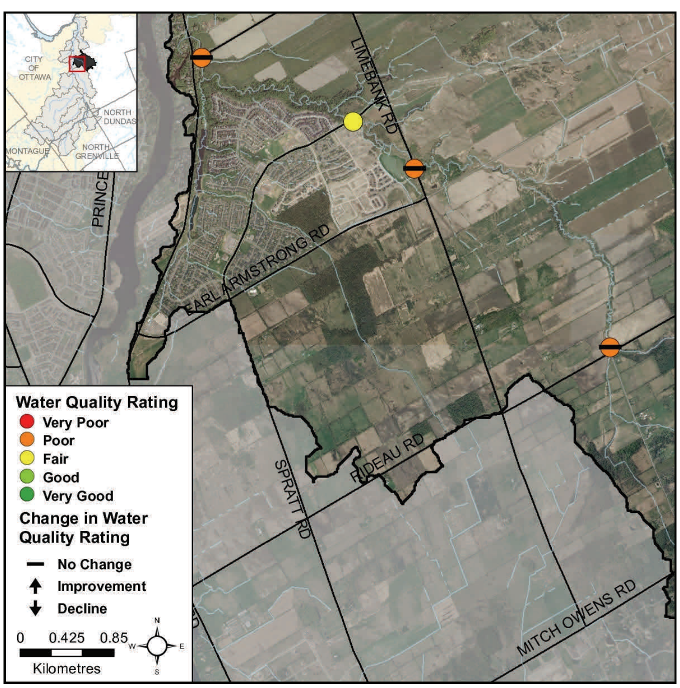


Figure 1. Sampling sites on Mosquito Creek

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

Mosquito Creek 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 Objectives (PWQO) of 0.030mg/l is used as the TP Guideline. Concentrations greater than 0.030 mg/l indicate an excessive amount of TP. Mosquito Creek TP results are shown in Figures 2a and 2b. In addition to the TP guideline, the LWRS set a target for TP concentration of 0.030 mg/l at the 85th percentile for tributaries of the Rideau River, such as Mosquito Creek. Percentile plots of TP data are shown for two time periods 2000-2005 (Fig. 3a) and 2006-2011 (Fig. 3b). Any point to the left of the 85th percentile line (vertical) and above the guideline (horizontal line) have failed to reach the LRWS target.

Total Kjeldahl nitrogen (TKN) is used as a secondary indicator of nutrient loading; RVCA uses a guideline of 0.500 mg/l (TKN Guideline) to assess TKN concentrations. Mosquito Creek TKN results are shown in Figures 4a and 4b.

Tables 3 and 4 summarize average nutrient concentrations at monitored sites on Mosquito Creek and shows the proportion of samples that meet guidelines. Highlighted values indicate averages that have exceeded the guideline

Mosquito Creek Nutrients: Site CK20-22

The majority of samples at site CK20-22 were above the TP guideline of 0.030mg/l for both time periods (Fig. 2a, 2000-2005 and 2b, 2006-2011), only nineteen percent of samples were below the guideline in the 2000-2005 period, this slightly declined to seventeen percent of samples in the 2006-2011 period. The average TP concentration was consistent at 0.055 mg/l in both time periods. The LRWS target of a TP concentration of 0.030mg/l at the 85th percentile has not been achieved at

Table 2. Summary of total phosphorous results for Mosquito Creek from 2000-2005 and 2006-2011

Total Phosphorus 2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK20-22	0.055	19	47
CK20-10	0.058	11	57
CK20-16	0.070	0	52
MSQ040			

Total Phosphorus 2006-2011			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK20-22	0.055	17	52
CK20-10	0.054	13	40
CK20-16	0.061	0	53
MSQ040	0.052	7	14

Table 3. Summary of total Kjeldahl nitrogen results for Mosquito Creek from 2000-2005 and 2006-2011

Total Kjeldahl Nitrogen 2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK20-22	0.686	9	47
CK20-10	0.703	4	57
CK20-16	0.740	0	52
MSQ040			

Total Kjeldahl Nitrogen 2006-2011			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK20-22	0.741	4	52
CK20-10	0.695	3	40
CK20-16	0.683	4	53
MSQ040	0.783	0	14

site CK20-22, though the concentration at the 85th percentile did decrease from 0.083 mg/l (2000-2005, Fig 3a) to 0.069 mg/l (2006-2011, Fig. 3b).

TKN is used as a secondary indicatory of nutrient enrichment. Figures 4a and 4b show that the majority of results exceeded the TKN guideline of 0.500 mg/l, only nine percent of samples were below the guideline in 2000-2005 and four percent were below the guideline in the 2006-2011 period. The average concentration decreased slightly from 0.686 mg/l to 0.741 mg/l, exceeding the guideline.

Mosquito Creek Nutrients Site CK20-10

The majority of samples at site CK20-10 were also above the TP guideline of 0.030mg/l for both time periods (Fig. 2a, 2000-2005 and 2b, 2006-2011), only eleven percent of samples were below the guideline in the 2000-2005 period; this improved to thirteen percent of samples in the 2006-2011 period. Average TP concentration decreased from 0.058 mg/l (2000-2005) to 0.054 mg/l (2006-2011). Percentile plots of TP data for the two time periods 2000-2005 (Fig.3a) and 2006-2011 (Fig. 3b) for site CK20-10 show that the target set by the LRWS has not been achieved. The concentration at the 85th percentile decreased from 0.082 mg/l (2000-2005, Fig. 3a) to 0.077 mg/l (2006-2011, Fig. 3b).

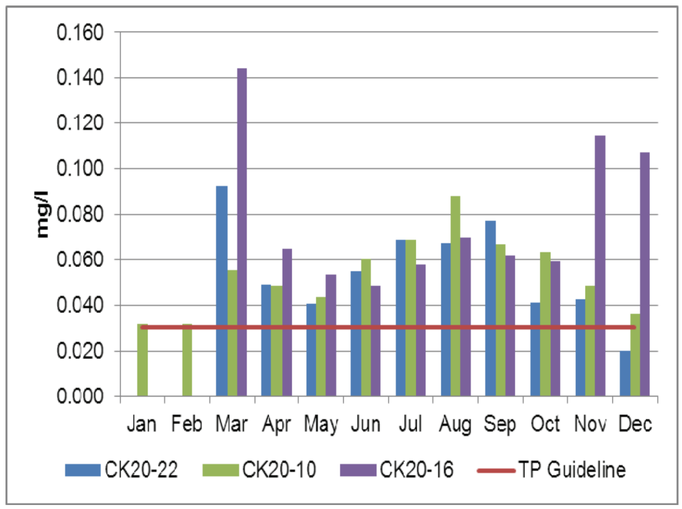


Figure 2a. Total phosphorous concentrations in Mosquito Creek from 2000-2005

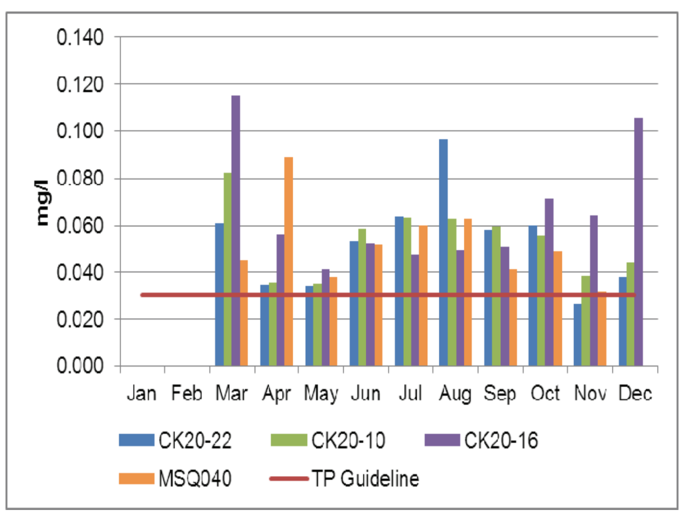


Figure 2b. Total phosphorous concentrations in Mosquito Creek from 2006-2011

TKN results show that the majority of results exceeded the TKN guideline of 0.500 mg/l (Fig. 4a, 2000-2005 and 4b, 2006-2011), in fact there were no samples with results below the guideline. The average concentration decreased slightly from 0.703 mg/l to 0.695 mg/l, far exceeding the guideline.

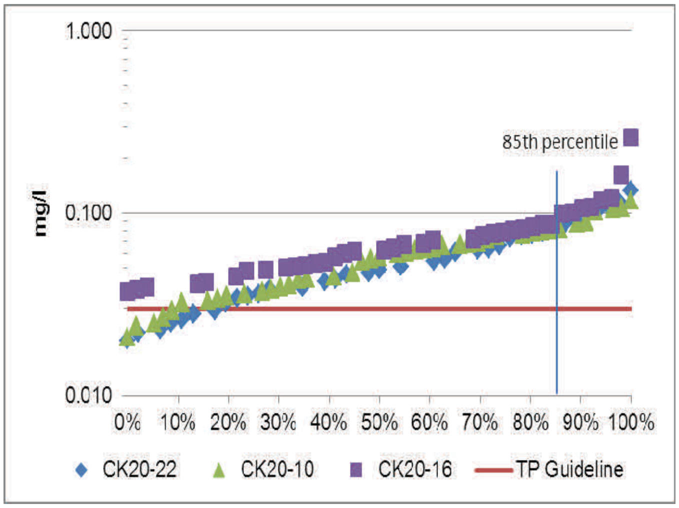


Figure 3a. Percentile plots of total phosphorous in Mosquito Creek from 2000-2005

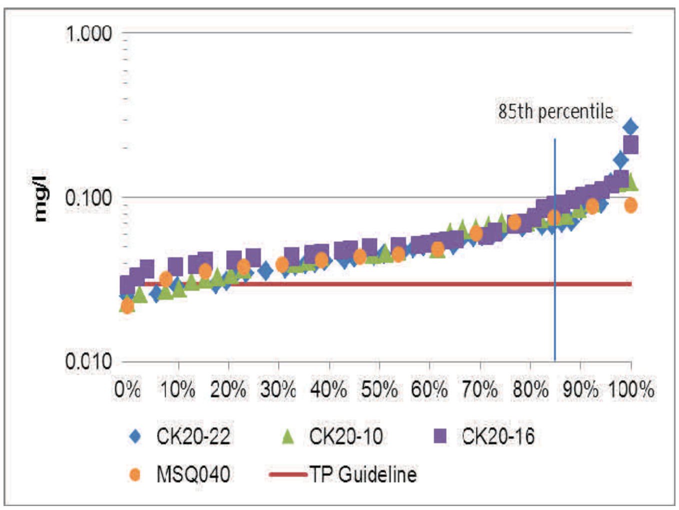


Figure 3b. Percentile plots of total phosphorous in Mosquito Creek from 2006-2011

Mosquito Creek Nutrients: Site CK20-16

The majority of samples at site CK20-16 were also above the TP guideline of 0.030mg/l for both time periods (Fig.2a, 2000-2005 and 2b, 2006-2011), there were no samples below the guideline in either time period, however the average TP concentration decreased from 0.070 mg/l (2000-2005) to 0.061 mg/l (2006-2011). Percentile plots of TP data indicate that the target set by the LRWS has not been achieved for site CK20-16. The concentration at the 85th percentile decreased from 0.092 mg/l (2000-2005, Fig. 3a) to 0.090 mg/l (2006-2011, Fig. 3b).

TKN results show that the majority of results exceeded the TKN guideline of 0.500 mg/l (Fig. 4a, 2000-2005 and 4b, 2006-2011), in fact there were no samples with results below the guideline. The average concentration decreased slightly from 0.740 mg/l to 0.683 mg/l, exceeding the guideline.

Mosquito Creek Nutrients: Site MSQ040

The majority of samples at site MSQ040 were also above the TP guideline of 0.030mg/l for both time periods (Fig. 2a, 2000-2005 and 2b, 2006-2011); only seven percent of samples were below the guideline and the average concentration was 0.052 in the 2006-2011 period. Percentile plots of TP data show that the LRWS target was not achieved at site MSQ040 (Fig. 3b) as the concentration at the 85th was 0.077 mg/l. Please note there was no data available for the 2000-2005 periods.

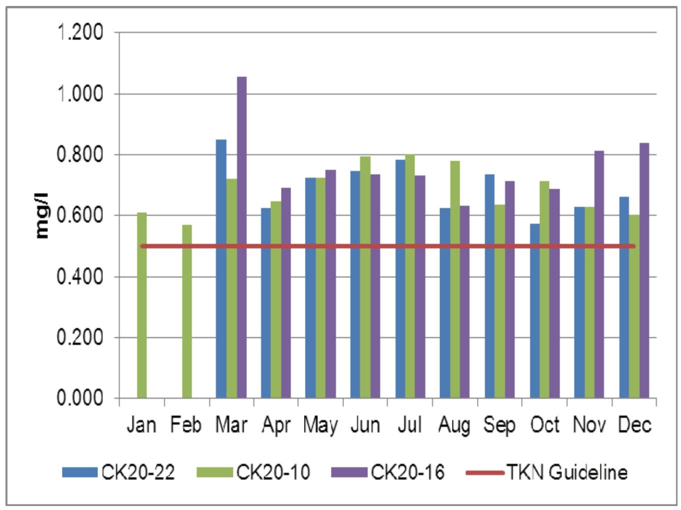


Figure 4a. Total Kjeldahl nitrogen concentrations in Mosquito Creek from 2000-2005

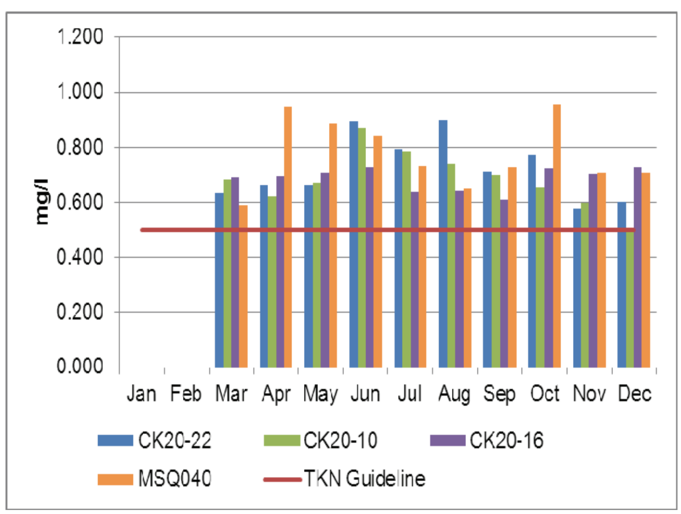


Figure 4b. Total Kjeldahl nitrogen concentrations in Mosquito Creek from 2006-2011

TKN results show that the majority of results also exceeded the TKN guideline of 0.500 mg/l (Fig. 4a, 2000 -2005 and 4b, 2006-2011), there were no samples with results below the guideline and the average concentration was 0.783 mg/l, exceeding the guideline.

Mosquito Creek Nutrients Summary

Overall the data suggests that nutrient loading is a significant problem at site CK20-22; efforts should be made to reduce nutrient inputs to the creek.

The data suggests that nutrient loading is a significant problem and concentrations have increased at site CK20-10, CK20-16 and MSQ040; efforts should be made to reduce nutrient inputs to the creek wherever possible.

Mosquito Creek 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 Objectives of 100 colony forming units/100 millilitres is used. E. coli counts greater than this guideline indicate that bacterial contamination may be a problem within a waterbody. The Lower Rideau Watershed Strategy also set a target for E. coli counts of 200 CFU/100 ml at the 80th percentile for tributaries of the Rideau River, such as Mosquito Creek.

Table 4 summarizes the geometric mean at monitored sites on Mosquito Creek and shows the proportion of samples that meet the E. coli guideline of 100 CFU/100ml. Highlighted values indicate averages that have exceeded the guideline

Figures 5a and 5b show the results of the geometric mean with respect to the guideline for the two periods 2000-2005 (Fig. 5a) and 2006-2011 (Fig 5b).Figures 6a and 6b show percentile plots of the data for the two time periods of interest 2000-2005 (Fig. 6a) and 2006-2011 (Fig. 6b). Any point to the left of the 80th percentile line (vertical) and above the guideline (horizontal line) have failed to reach the LRWS target

Table 4. Summary of E. coli results for Mosquito Creek for both time periods.

E. coli 2000-2005			
Site	Geometric mean	% Below Guideline	No. Samples
CK20-22	159	30	46
CK20-10	75	59	56
CK20-16	51	68	50
MSQ040			
E. coli 2006-2011			
Site	Geometric mean	% Below Guideline	No. Samples
CK20-22	196	33	52
CK20-10	147	30	40
CK20-16	91	51	53
MSQ040	96	36	14

Mosquito Creek E. coli: Site CK20-22

E. coli counts above the guideline of 100 colony forming units per 100 mL (CFU/100mL) were common at all water quality monitoring sites on Mosquito Creek. In comparing the two time periods at site CK20-22 the proportion of samples below the guideline increased from thirty percent (Fig. 5a) to thirty-three percent (Fig. 5b), indicating elevated counts occurred with slightly less frequency. The count at the geometric mean increased from 159 CFU/100 ml to 196 CFU/100 ml. Percentile plots of E. coli data at site CK20-22 are shown for both periods. Figures 6a and 6b show that this target was exceeded in both time periods, the E. coli count at the 80th percentile increased from 480 CFU/100 ml to 566 CFU/100 ml.

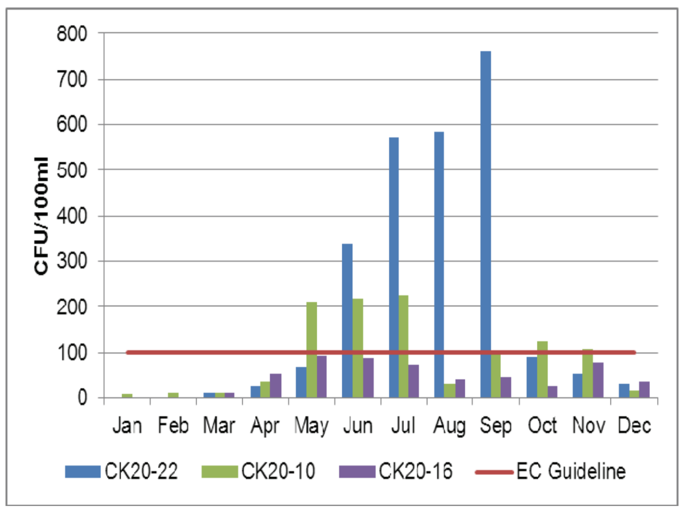


Figure 5a. E. coli counts in Mosquito Creek from 2000-2005

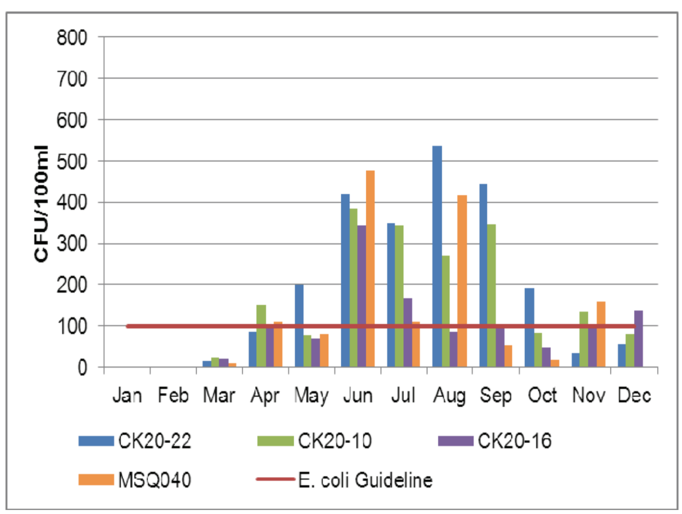


Figure 5b. E. coli counts in Mosquito Creek from 2006-2011

Mosquito Creek E. coli: Site CK20-10

A second water quality monitoring site, CK20-10 is located downstream of CK20-22. The proportion of samples below the guideline at CK20-10 decreased from fifty-nine percent (Fig. 5a) to thirty percent (Fig. 5b). The count at the geometric mean increased from 75 CFU/100 ml to 147 CFU/100 ml. Figures 6a and 6b show that the LRWS target for E. coli was exceeded in both time periods; the E. coli count at the 80th percentile increased from 280 CFU/100 ml to 356 CFU/100 ml.

Mosquito Creek E. coli: Site CK20-16

A fourth quality monitoring site, CK20-16 is furthest downstream and is the closest site to the Rideau River. The proportion of samples below the guideline at CK20-16 decreased from sixty-eight percent (Fig. 5a) to fifty-one percent (Fig. 5b). The count at the geometric mean increased from 51 CFU/100 ml to 91 CFU/100 ml. Figures 6a and 6b show that the LRWS target for E. coli was not achieved in the 2006-2011 time period; the E. coli count at the 80th percentile increased from 123 CFU/100 ml to 266 CFU/100 ml.

Mosquito Creek E. coli: Site MSQ040

Site MSQ040 is located downstream of the previously discussed sites (CK20-22 and CK20-10); please note that results for this site are only available for the 2006-2011 period. Thirty six percent of samples (Fig. 5b) were below the guideline and the count at the geometric mean is 96 CFU/100 ml. Figure 6b shows that the LRWS target for E. coli was exceeded; the E. coli count at the 80th equaled 330 CFU/100ml.

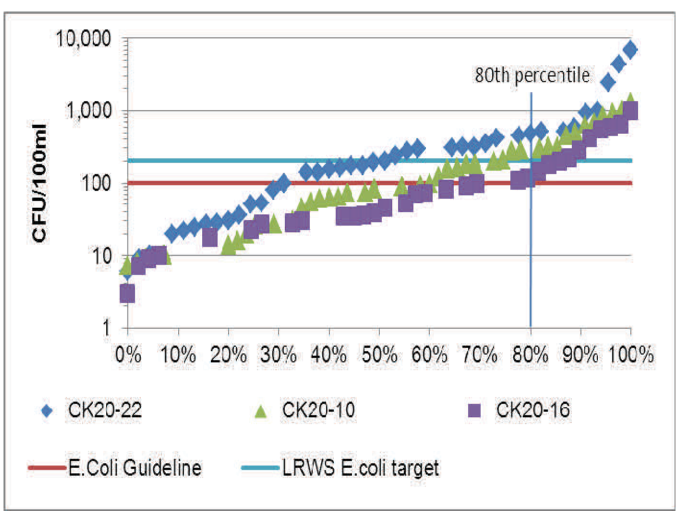


Figure 6a. Percentile plots of E. coli in Mosquito Creek from 2000-2005

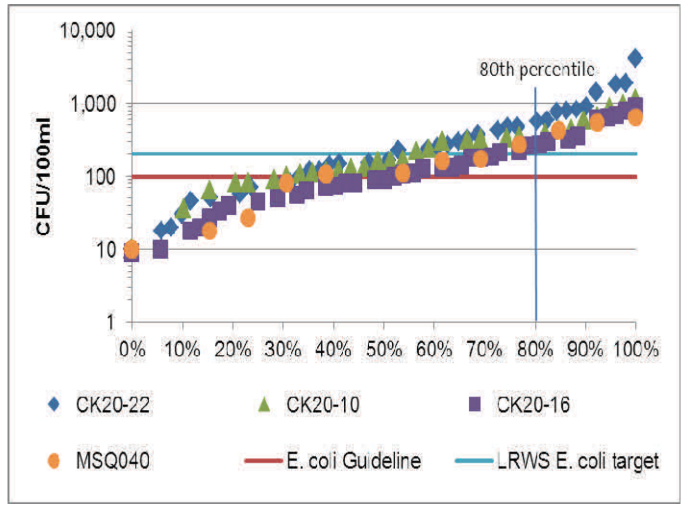


Figure 6b. Percentile plots of E. coli in Mosquito Creek from 2006-2011

Mosquito Creek E. coli Summary

These statistics indicated that E. coli counts are elevated throughout the monitored sites on Mosquito Creek. Counts are consistently high at site CK20-22, efforts should be made to reduce any upstream sources of contamination to reduce these high results.

Bacterial counts have also increased at site CK20-10 and site CK20-16 efforts should also be made throughout these reaches to limit any sources of contamination

The presented statistics also indicate a concern at site MSQ040 as E. coli exceedances are common. Steps should be continued to reduce any additional sources of bacterial pollution to the creek to improve overall water quality and protect aquatic life.

Mosquito Creek Metals

Of the metals routinely monitored in Mosquito Creek; aluminum (Al), copper (Cu) and iron (Fe) were metals that reported concentrations above their respective PWQO. In elevated concentrations these metals can have toxic effects on sensitive aquatic species.

Table 5 summarizes average metal concentrations at monitored sites on Mosquito Creek and shows the proportion of samples that meet guidelines. Highlighted values indicate averages that have exceeded the guideline

Figures 7, 8 and 9, show the results for each site with respect to guidelines for the two periods 2000-2005 (Figures 7a, 8a and 9a) and 2006-2011 (Figures 7b, 8b and 9b). The guidelines for each metal as stated by the PWQO are Al 0.075 mg/l, Cu 0.005 mg/l and Fe 0.300 mg/l. The Lower Rideau Watershed Strategy set a target for Cu concentration of 0.005 mg/l (Cu guideline) at the 80th percentile for tributaries of the Rideau River, such as

Table 5. Summary of metal concentrations in Mosquito Creek.

Aluminum 2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK20-22	0.255	18	45
CK20-10	0.364	2	56
CK20-16	0.585	35	51
MSQ040			
Aluminum 2006-2011			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK20-22	0.364	13	52
CK20-10	0.448	0	40
CK20-16	0.545	12	52
MSQ040	0.567	0	14
Iron 2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK20-22	0.447	36	46
CK20-10	0.548	14	56
CK20-16	0.695	51	51
MSQ040			
Iron 2006-2011			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK20-22	0.576	33	53
CK20-10	0.599	20	40
CK20-16	0.658	40	52
MSQ040	0.690	29	14
Copper 2000-2005			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK20-22	0.002	91	46
CK20-10	0.003	86	56
CK20-16	0.003	84	51
MSQ040			
Copper 2006-2011			
Site	Average (mg/l)	% Below Guideline	No. Samples
CK20-22	0.005	63	52
CK20-10	0.005	73	40
CK20-16	0.006	53	53
MSQ040	0.007	21	14

Mosquito Creek. Percentile plots of Cu data are shown for the two time periods 2000-2005 (Fig. 10a) and 2006-2011 (Fig. 10b). Any point to the left of the 80th percentile line (vertical) and above the guideline (horizontal line) have failed to reach the LRWS target

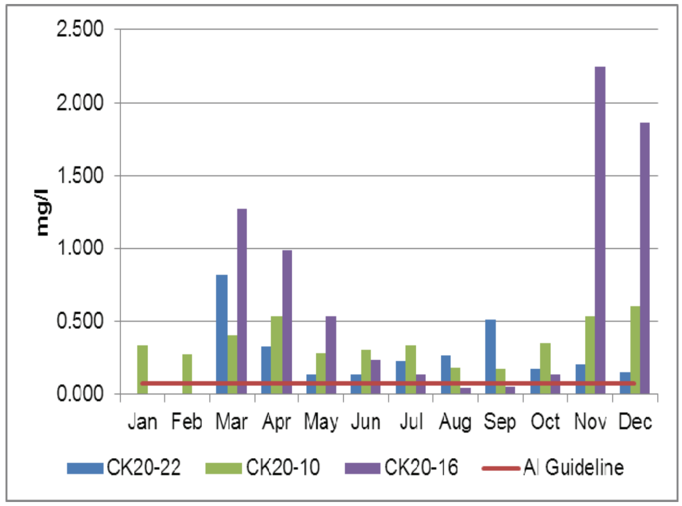


Figure 7a. Aluminum concentrations in Mosquito Creek from 2000-2005

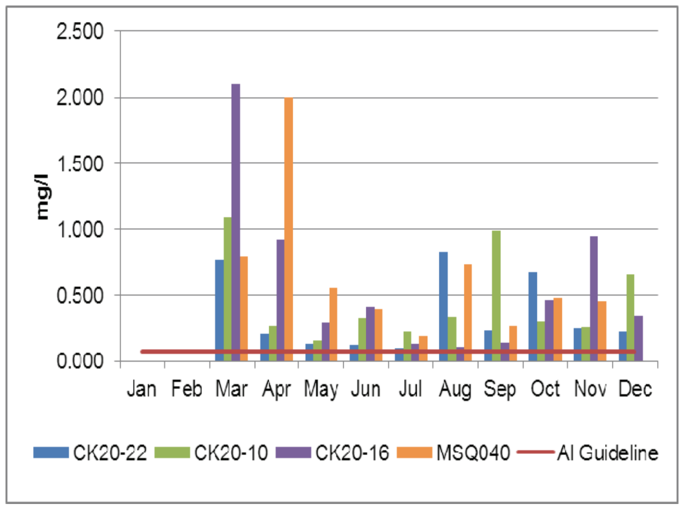


Figure 7b. Aluminum concentrations in Mosquito Creek from 2006-2011

Mosquito Creek Metals: Site CK20-22

The majority of metals monitored at site CK20-22 were below guidelines however results for aluminum (Al), iron (Fe) and copper (Cu) were occasionally elevated.

The Al guideline of 0.075 mg/l was generally exceeded in both time periods (Fig. 7a, 2000-2005 and 7b, 2006-2011), eighteen percent of samples were below the guideline in the 2000-2005 period; this remained fairly consistent as thirteen percent of samples in the 2006-2011 period were below the guideline. There was an increase in average Al concentration from 0.255mg/l (2000-2005) to 0.364 mg/l (2006-2011).

Figures 8a (2000-2005) and 8b (2006-2011) show that the Fe results often exceed the guideline of 0.300 mg/l and there was an overall increase in concentrations over the periods of interest. Thirty-six percent of samples were below the guideline in 2000-2005 and decreased slightly to thirty-three percent in the 2006-2011 period. The average concentration increased from 0.447 mg/l to 0.576 mg/l, exceeding the guideline.

Results for Cu concentrations were also occasionally above the guideline of 0.005 mg/l. The proportion of samples below the guideline decreased from ninety-one percent (Fig. 9a, 2000-2005) to sixty-three percent (Fig. 9b, 2006-2011); the average concentration increased from 0.002 mg/l to 0.005 mg/l . The target of a Cu concentration of 0.005 mg/l at the 80th percentile has not been achieved in the 2006-2011 period at site CK20-22. The concentration at the 80th percentile increased from 0.004 mg/l (2000-2005, Fig. 10a) to 0.007 mg/l (2006-2011, Fig. 10b).

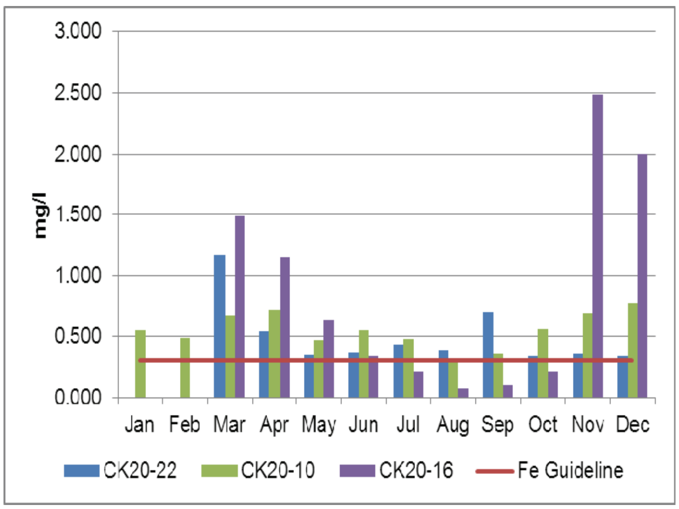


Figure 8a. Iron concentrations in Mosquito Creek from 2000-2005

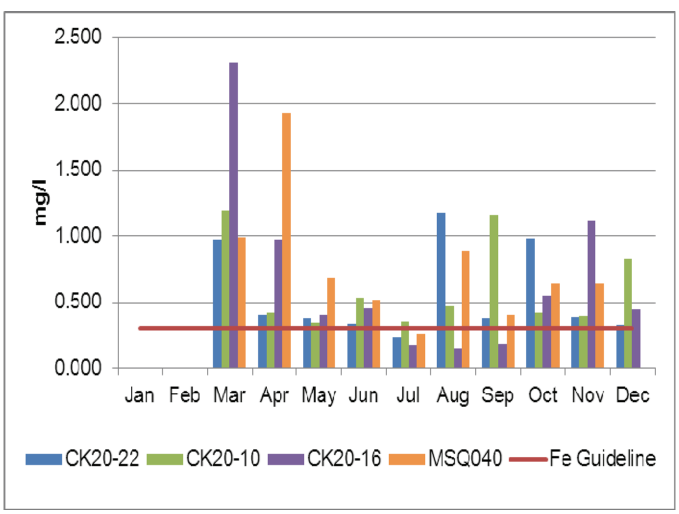


Figure 8b. Iron concentrations in Mosquito Creek from 2006-2011

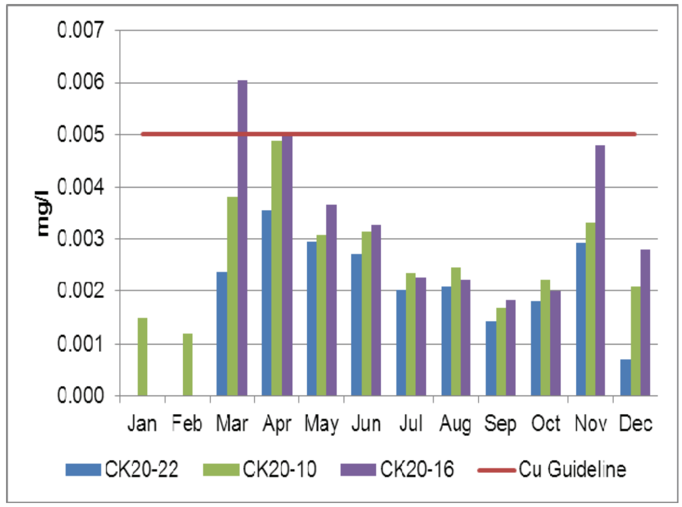


Figure 9a. Copper concentrations in Mosquito Creek from 2000 -2005

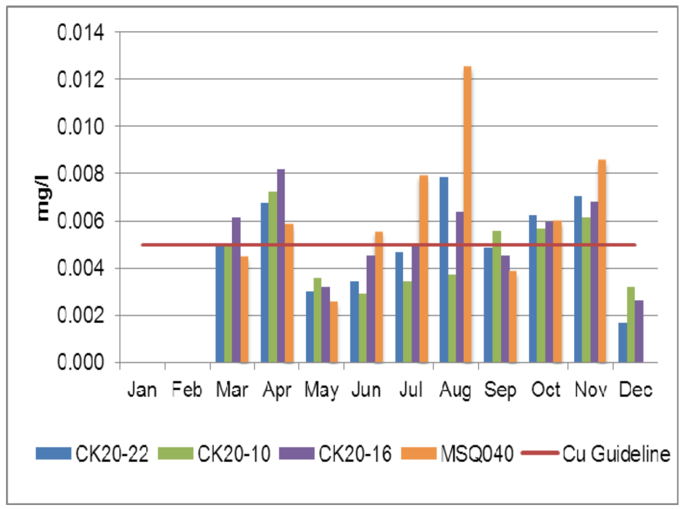


Figure 9b. Copper concentrations in Mosquito Creek from 2006 -2011

Mosquito Creek Metals: Site CK20-10

Results for Al were generally above the guideline at CK20-10; two percent of samples were below the guideline in the 2000-2005 period (Fig. 7a) and none were below the guideline in the 2006-2011 period (Fig. 7b). There was an increase in the average Al concentration from 0.364 mg/l (2000-2005) to 0.448 mg/l (2006-2011).

Figure 8a and 8b show that the Fe results also often exceed the guideline of 0.300 mg/l and there was an overall increase in concentrations over the periods of interest. Fourteen percent of samples were below the guideline in 2000-2005 and increased slightly to twenty percent in the 2006-2011 period. The average concentration increased from 0.548 mg/l to 0.559 mg/l, exceeding the guideline.

Results for Cu concentrations were also occasionally above the guideline of 0.005 mg/l. The proportion of samples below the guideline decreased from eighty-six percent (Fig. 9a, 2000-2005) to seventy-three percent (Fig. 9b, 2006-2011), and the average concentration increased from 0.003 mg/l to 0.005mg/l .The target of a Cu concentration of 0.005 mg/l at the 80th percentile was not achieved at site CK20-10 in the 2006-2011 period, the concentration at the 80th percentile increased from 0.004 mg/l (2000-2005, Fig. 10a) to 0.006 mg/l (2006-2011, Fig. 10b).

Mosquito Creek Metals: Site CK20-16

Results for Al were usually above the guideline at site CK20-16, thirty-five percent of samples (Fig. 7a) were below the guideline in the 2000-2005 period and this decreased to twelve percent (Fig. 7b) in the 2006-2011 period. There was a decrease in the average Al concentration from 0.585 mg/l (2000-2005) to 0.545 mg/l (2006-2011).

Figures 8a and 8b show that the Fe results often exceed the guideline of 0.300 mg/l and there was an overall increase in concentrations over the periods of interest. Fifty-one percent of samples were below the guideline in 2000-2005 (Fig. 8a) and decreased to twenty-nine percent in the 2006-2011 period (Fig. 8b). The average concentration increased from 0.695 mg/l to 0.658 mg/l, exceeding the guideline.

Results for Cu concentrations were also occasionally above the guideline of 0.005 mg/l. The proportion of samples below the guideline decreased from eighty-four percent (Fig. 9a, 2000-2005) to fifty three percent (Fig. 9b, 2006-2011), the average concentration also increased from 0.003 mg/l to 0.006 mg/l. The target of a Cu concentration of 0.005 mg/l at the 80th percentile in site CK20-16 was not achieved in the 2006-2011 period. The concentration at the 80th percentile increased from 0.005 mg/l (2000-2005, Fig. 9a) to 0.007 mg/l (2006-2011, Fig. 9b).

Mosquito Creek Metals: Site MSQ040

Results were only available for the 2006-2011 period at site MSQ040. All Al results exceeded the guideline at MSQ040, and the average Al concentration was 0.567mg/l (Fig. 7b) surpassing the guideline of 0.075 mg/l.

Figure 8b shows that the Fe results typically exceed the guideline of 0.300 mg/l. Twenty nine percent of samples were below the guideline and the average concentration was 0.690 mg/l.

Twenty-one percent of samples (Fig. 9b) for Cu concentrations were above the guideline of 0.005 mg/l the average concentration was equal to 0.008 mg/l. Percentile plots of Cu data shows that the target of a Cu concentration of 0.005 mg/l at the 80th percentile was not achieved at site MSQ040, as the concentration at the 80th percentile equaled 0.007 mg/l.

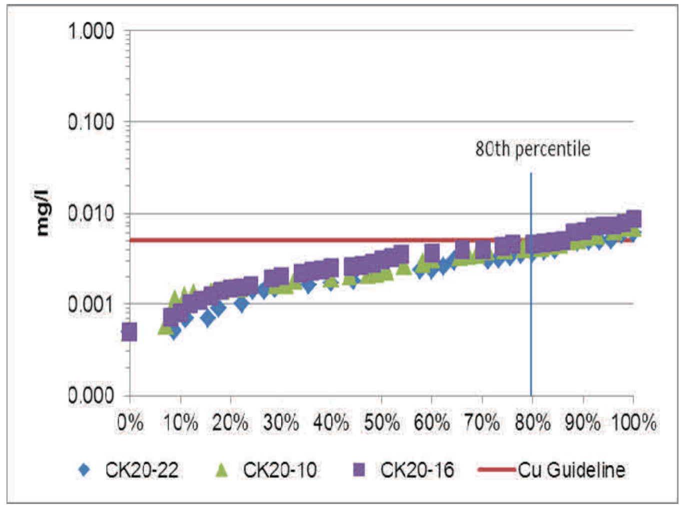


Figure 10a. Percentile plots of copper in Mosquito Creek from 2000-2005

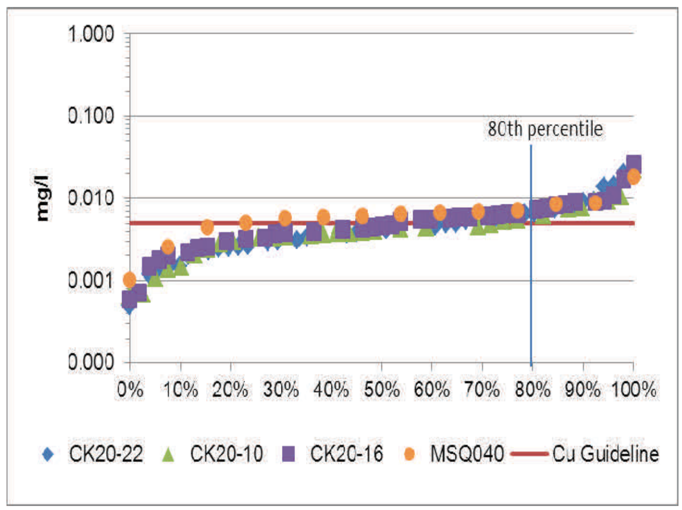


Figure 10b. Percentile plots of copper in Mosquito Creek from 2006-2011

Mosquito Creek Metals Summary

Overall the data shows that elevated metal concentrations occur at all monitored sites on Mosquito Creek.

An increasing trend in aluminum, iron and copper has generally been observed at all four sites (CK20-22, CK20-10, CK20-16 and MSQ040).

Efforts should be made to reduce sources of pollution throughout the creek wherever possible to improve water quality and protect sensitive species from toxic effect that may result from elevated metal concentrations.

Mosquito Creek 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 one location on Mosquito Creek at Spratt Road since 2003. Monitoring data is analyzed and the results are presented using the Family Biotic Index, Family Richness and percent Ephemeroptera, Plecoptera and Trichoptera.

Benthic sampling site replicate one on Mosquito Creek at Spratt Rd in the City of Ottawa; this image was captured in the spring of 2008.

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 Mosquito Creek show that it has “Poor” to “Good” water quality conditions for the period from 2006 to 2011 (Fig.11) and scores an overall “Fair” surface water quality rating using a grading scheme developed by Conservation Authorities in Ontario for benthic invertebrates.

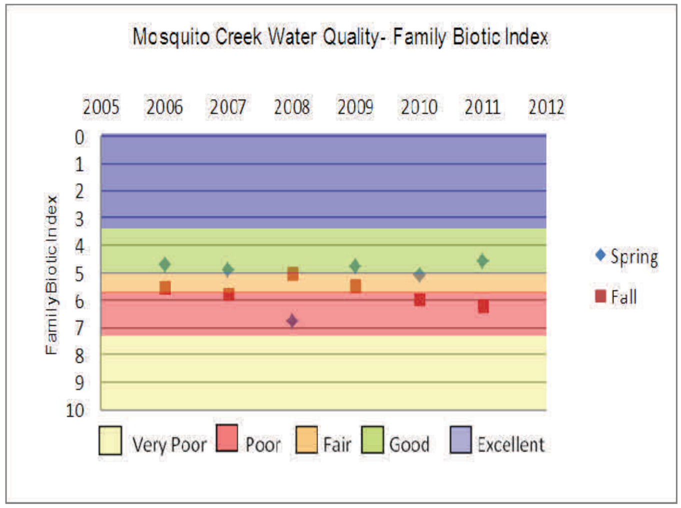


Figure 11. Surface water quality conditions in Mosquito Creek based on the Family Biotic Index

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, Mosquito Creek is reported to have overall “Fair” water quality (Fig.12).

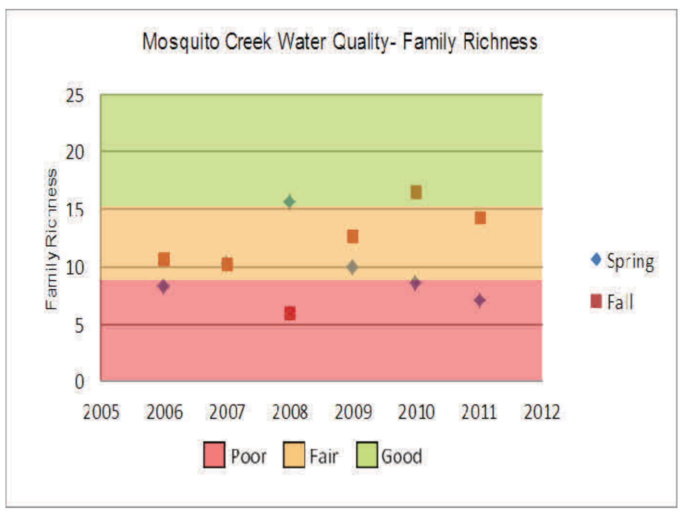


Figure 12. Surface water quality conditions in Mosquito Creek based on Family Richness

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, Mosquito Creek is reported to have water quality ranging from “Poor” to “Good” (Fig.13) from 2006 to 2011.

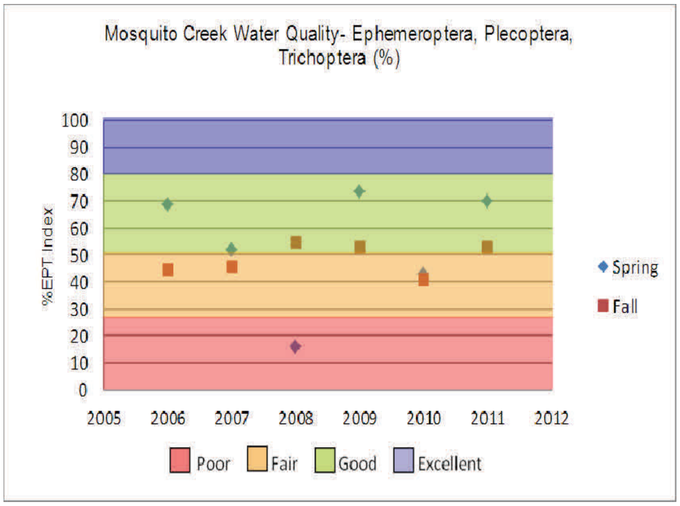


Figure 13. Surface water quality conditions in Mosquito Creek using the EPT Index

Overall Mosquito Creek has a water quality rating of “Poor” from 2006 to 2011.

The mouth of Mosquito Creek

Collecting water quality using a YSI

A pool, riffle , run sequence in Mosquito Creek

Image of a golden shiner caught

2) a. Overbank Zone

Riparian Buffer along Mosquito Creek and Tributaries

Figure 14 shows the extent of the naturally vegetated riparian zone in the catchment, 30 metres on either side of all waterbodies and watercourses. Results from the RVCA's Land Cover Classification Program show that 37 percent of streams, creeks and lakes are buffered with woodland, wetland and grassland; the remaining 63 percent of the riparian buffer is occupied by settlement, aggregate site, transportation, crop and pastureland.

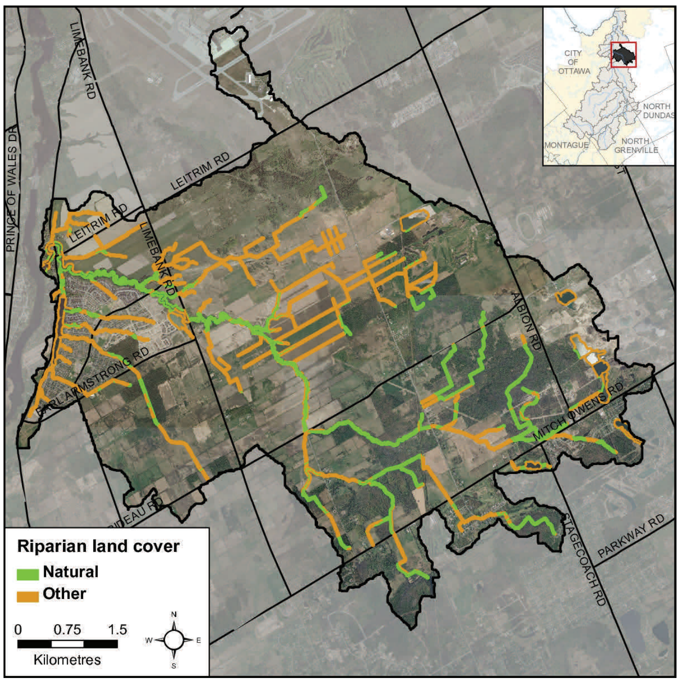


Figure 14. Catchment land cover in the riparian zone

Data from the RVCA's Macrostream Survey Program (Stream Characterization) is used in this section of the report and is generated from an assessment of 85 (100 metre long) sections along Mosquito Creek in 2009.

Riparian Buffer along Mosquito Creek

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 15 demonstrates the buffer conditions of the left and right banks separately. Mosquito Creek had a buffer of greater than 30 metres along 70 percent of the left bank and 66 percent of the right bank.

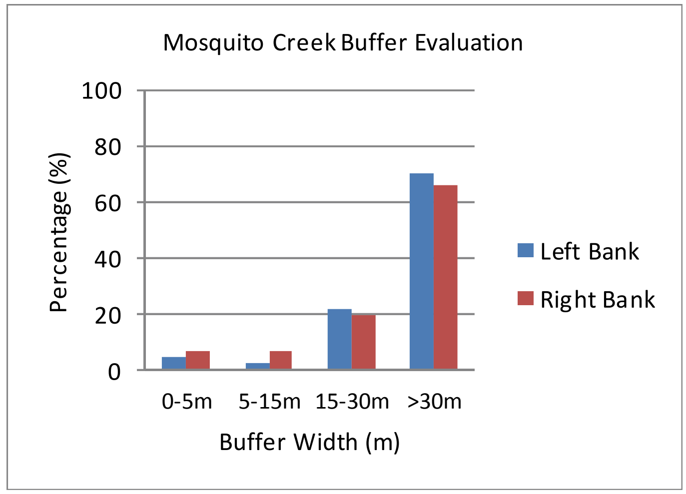


Figure 15. Vegetated buffer width along Mosquito Creek

Land Use beside Mosquito Creek

The RVCA's Macrostream Survey Program identifies nine different land uses beside Mosquito Creek (Figure 16). Surrounding land use is considered from the beginning to end of the survey section (100m) and up to 100m 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 63 percent of the stream, characterized by wetland, forest, scrubland and meadow. The remaining land use consisted of residential, abandoned agriculture, active agriculture, infrastructure, and recreational.

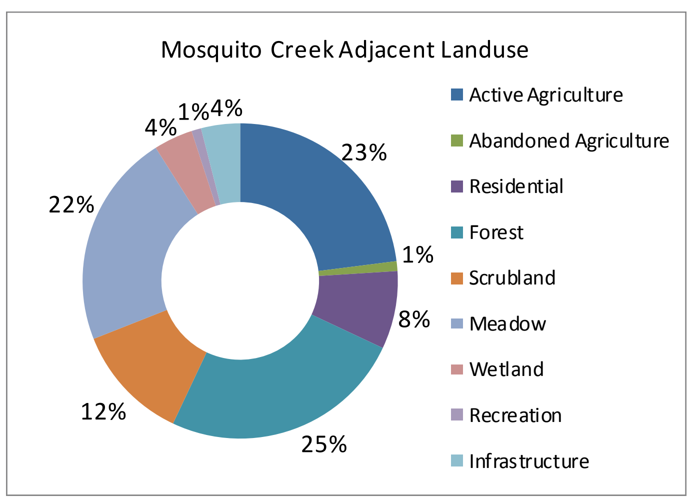


Figure 16. Land use alongside Mosquito Creek

2) b. Shoreline Zone

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. Bank stability indicates how much soil has eroded from the bank into the stream. 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 17 shows the bank stability of the left and right bank along Mosquito Creek.

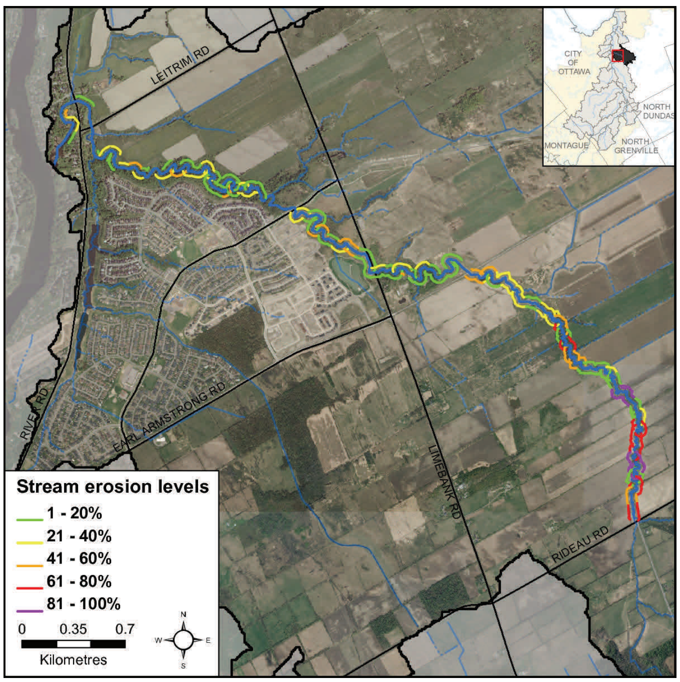


Figure 17. Erosion along Mosquito Creek

Streambank Undercutting

Undercut banks are a normal and natural part of stream function and can provide excellent refuge areas for fish. Figure 18 shows that Mosquito Creek had several locations with identified undercut banks.

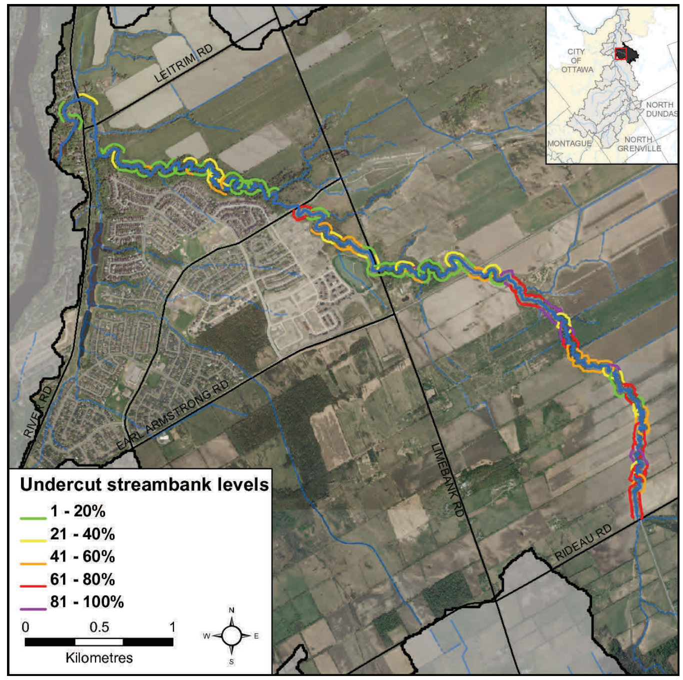


Figure 18. Undercut streambank along Mosquito Creek

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 19 shows the stream shading locations along Mosquito Creek.

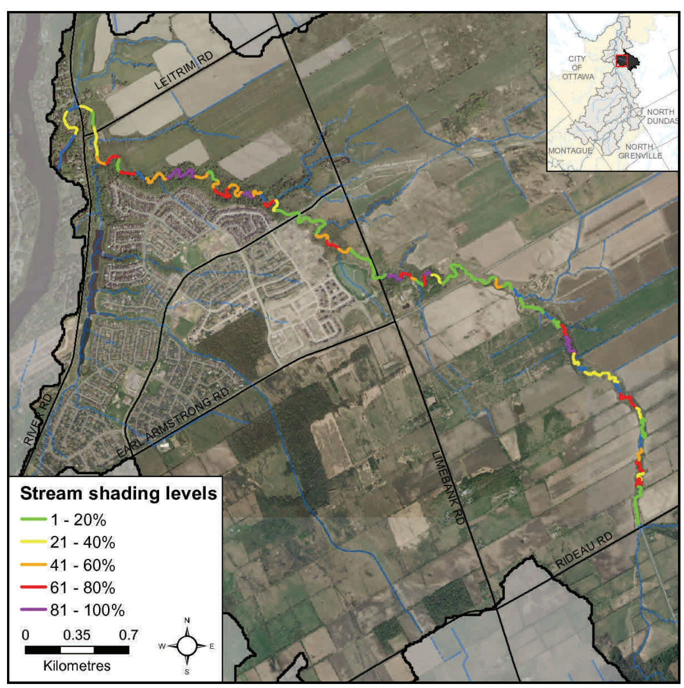


Figure 19. Stream shading along Mosquito Creek

Human Alterations

Figure 20 shows that 47 percent of Mosquito Creek remains “unaltered.” Sections considered “natural” with some human changes account for 40 percent of sections. "Altered" sections accounted for 12 percent of the stream, with only one percent of sections sampled being considered “highly altered” (e.g., including road crossings and areas of little or no buffer).

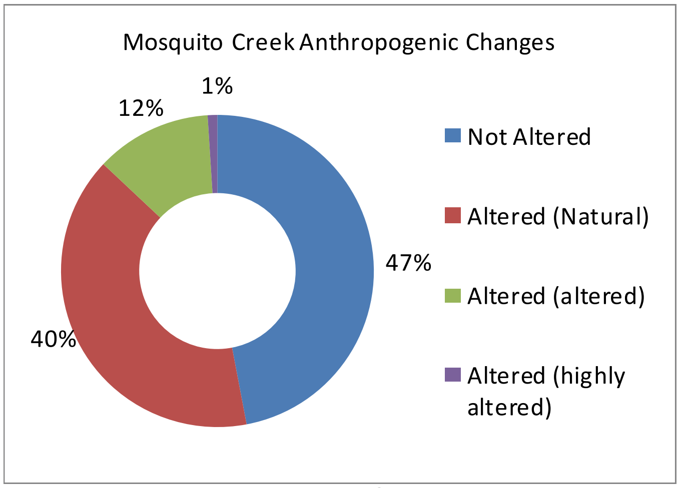


Figure 20. Alterations to Mosquito Creek

Overhanging Trees and Branches

Figure 21 shows that the majority of Mosquito Creek has varying levels of overhanging trees and branches. Overhanging trees and branches provide a food source, nutrients and shade which helps to moderate instream water temperatures.

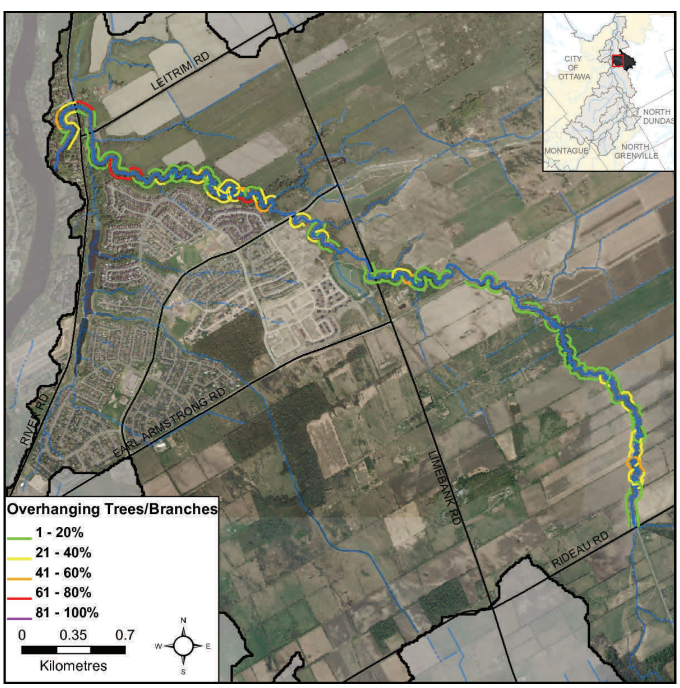


Figure 21. Overhanging trees and branches

Instream Woody Debris

Figure 22 shows that the majority of Mosquito Creek had varying 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.

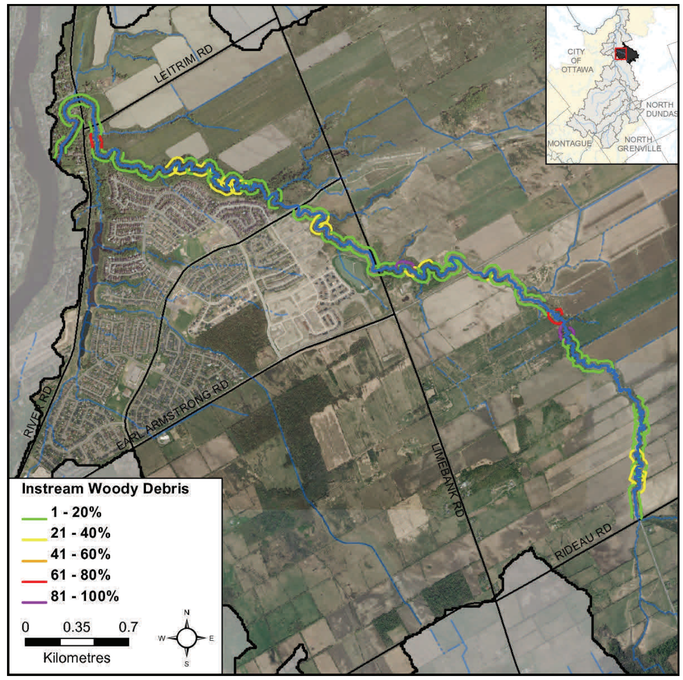


Figure 22. Instream woody debris

2) c. Instream Aquatic Habitat

Habitat Complexity

Streams are naturally meandering systems and move over time; there are varying degrees of habitat complexity, depending on the creek. A high percentage of habitat complexity (heterogeneity) typically increases the biodiversity of aquatic organisms within a system. Seventy-six percent of Mosquito Creek was considered heterogeneous, as seen in Figure 23.

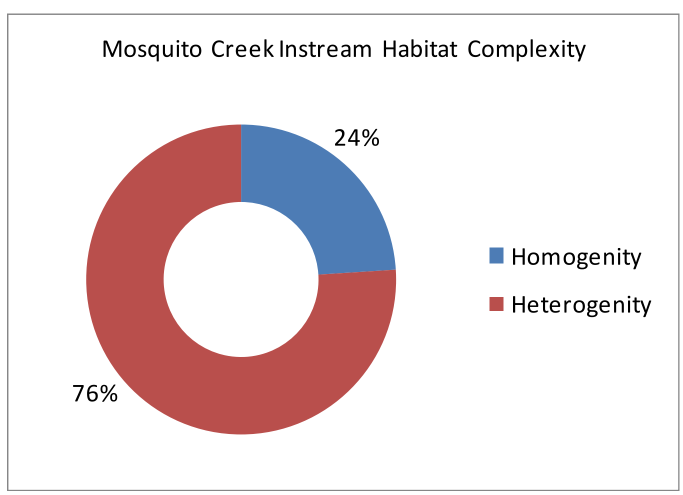


Figure 23. Instream habitat complexity in Mosquito Creek.

Instream Substrate

Diverse substrate is important for fish and benthic invertebrate habitat because some species will only occupy certain types of substrate and will only reproduce on certain types of substrate. Figure 24 shows the instream substrate diversity for Mosquito Creek.

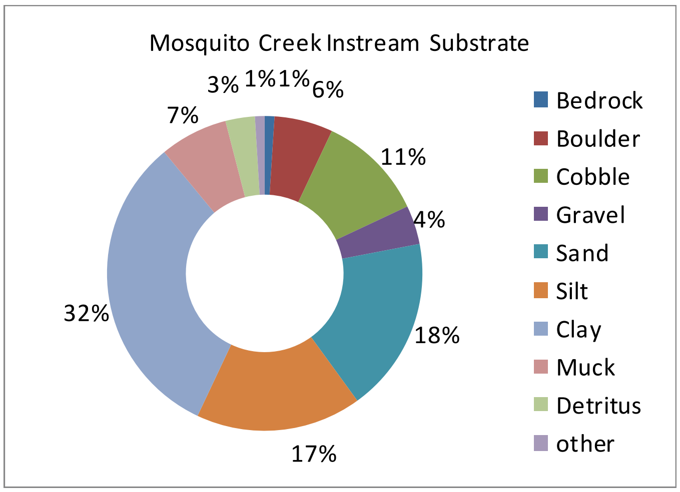


Figure 24. Instream substrate in Mosquito Creek

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 25 shows where cobble and boulder substrate is found in Mosquito Creek.

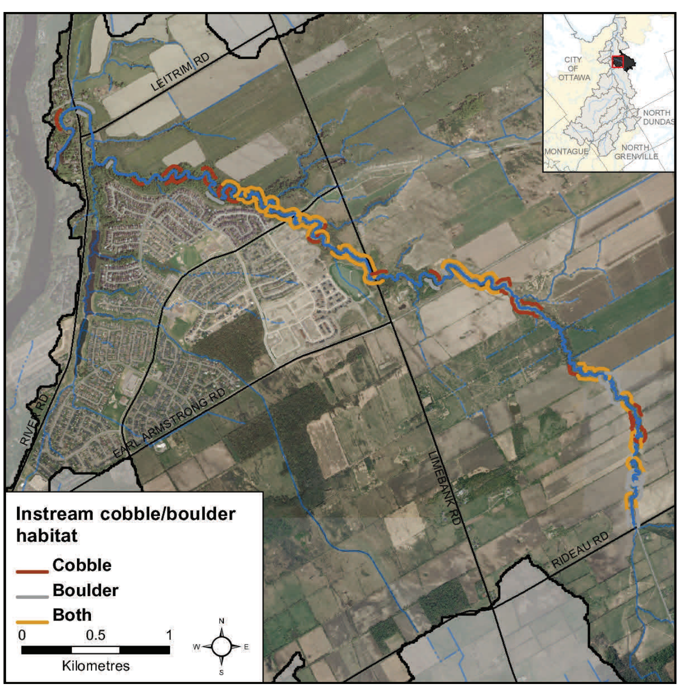


Figure 25. Instream cobble and boulder habitat along Mosquito Creek

Instream Morphology

Pools and riffles are important features for fish habitat. Riffles are areas of agitated water and they contribute higher dissolved oxygen to the stream and act 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 26 shows that Mosquito Creek was somewhat variable; 81 percent consisted of runs, 14 percent pools and five percent riffles.

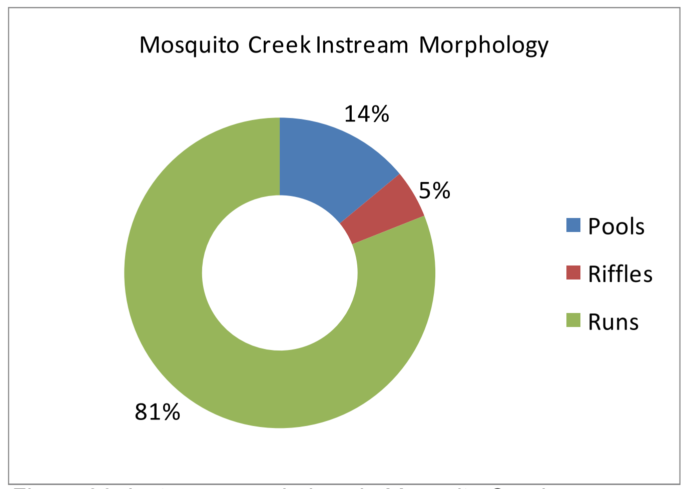


Figure 26. Instream morphology in Mosquito Creek

Types of Instream Vegetation

Mosquito Creek had fairly diverse types of instream vegetation (Figure 27). The dominant vegetation type recorded at forty-two percent consisted of algae. Submerged vegetation was recorded at 22 percent. Narrow and broad emergent vegetation were both recorded at 12 percent. Robust emergents were recorded at seven percent. Free floating and floating vegetation made up the remaining five percent of the vegetation community.

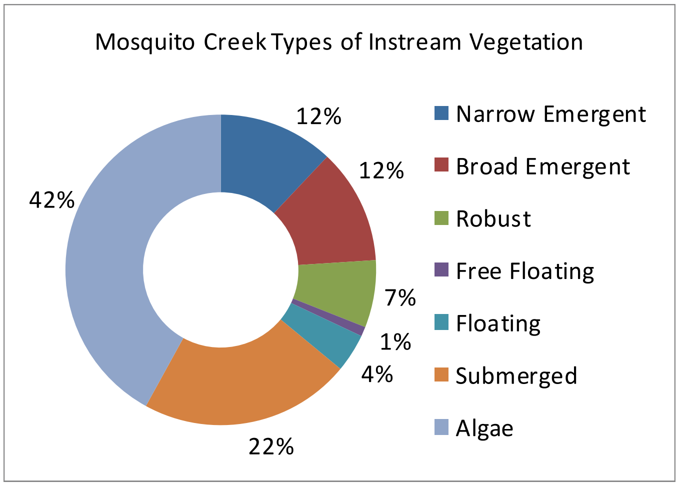


Figure 27. Instream vegetation types in Mosquito Creek.

Amount of Instream Vegetation

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 28 demonstrates that Mosquito Creek had variable levels of instream vegetation for most of its length.

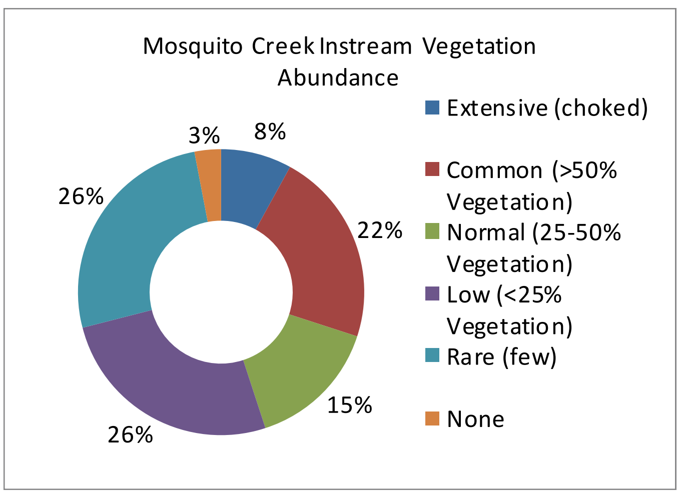


Figure 28. Vegetation abundance in Mosquito Creek

Riparian Restoration

Figure 29 depicts the locations where various riparian restoration activities can be implemented as a result of observations made during the stream survey assessments.

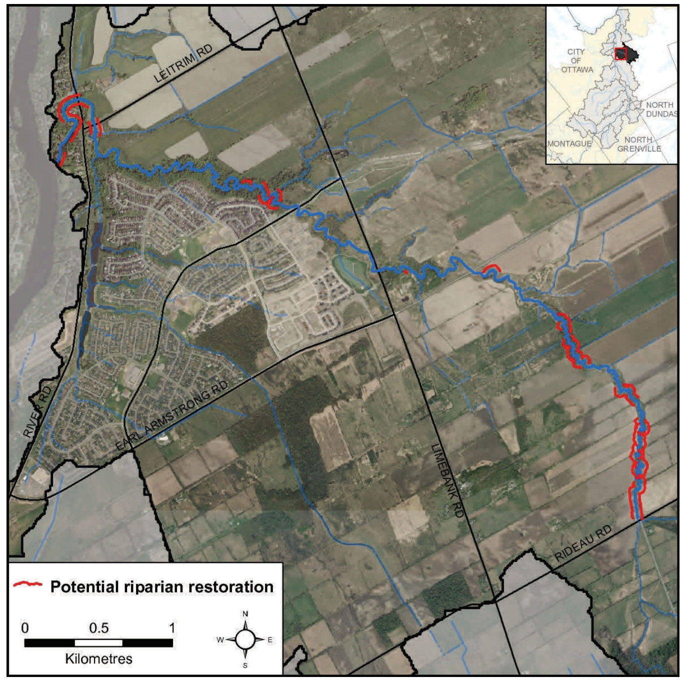


Figure 29. Riparian restoration opportunities

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. Forty-five percent of the sections surveyed along Mosquito Creek had invasive species (Figure 30). The species observed in Mosquito Creek were flowering rush, European frogbit, garlic mustard, phragmytes, purple loosestrife, poison parsnip.

An example of how European frogbit can choke out other native aquatic plant species

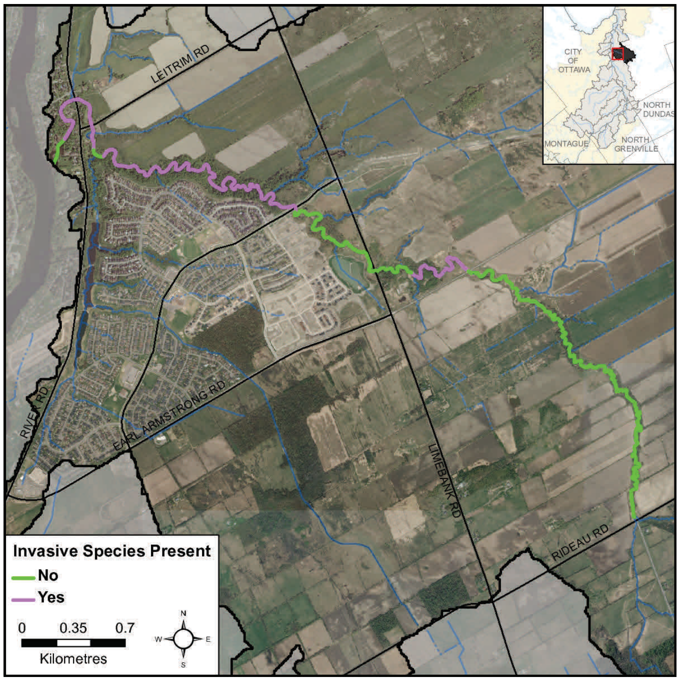


Figure 30. Invasive species along Mosquito Creek

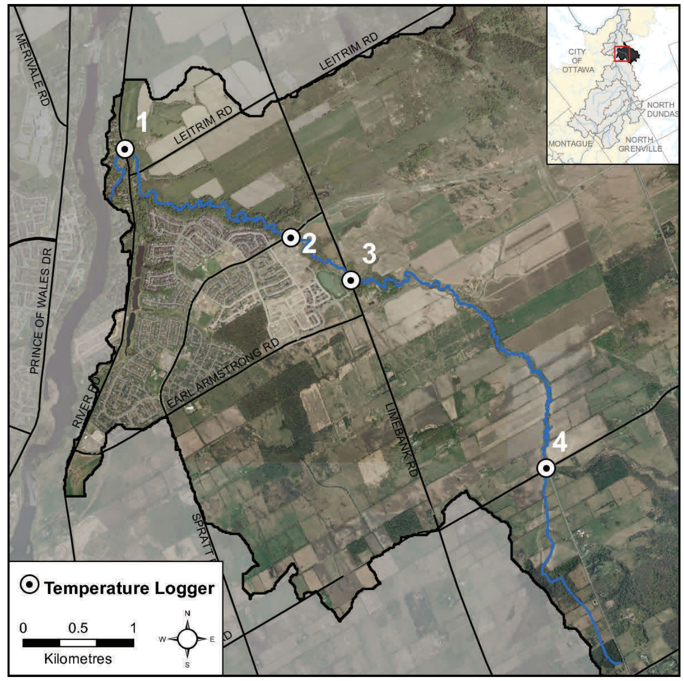


Figure 31. Temperature dataloggers along Mosquito Creek

Thermal Classification

Temperature is an important parameter in streams as it influences many aspects of physical, chemical and biological health. Four temperature dataloggers were deployed in Mosquito Creek from April to late September 2009 (Figure 31) to give a representative sample of how water temperature fluctuates. 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 warmwater, coolwater or cold water. Analysis of the data collected indicates that Mosquito Creek is a coolwater system.

RVCA staff identifying fish species on Mosquito Creek

Fish Sampling

Fish sampling sites located along Mosquito Creek are shown in Figures 32 and 33. The provincial fish codes shown on the maps below are listed (in Table 6) beside the common name of those fish species identified in Mosquito Creek and Mosquito Creek tributaries (Data source: RVCA, Niblett Environmental Associates and City of Ottawa).

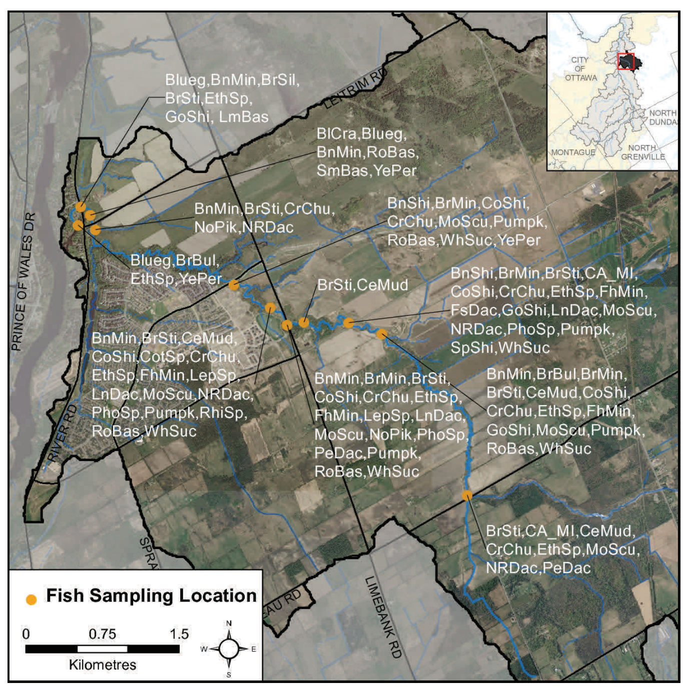


Figure 32. Fish species observed along Mosquito Creek

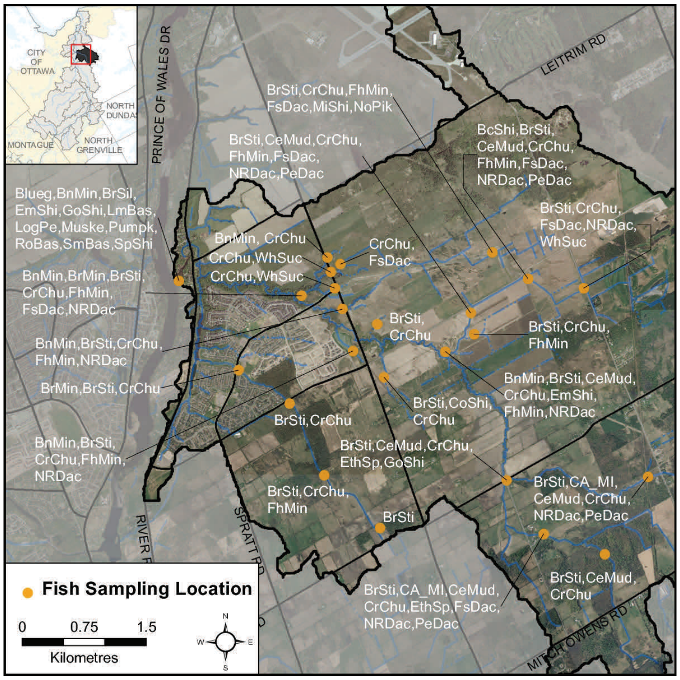


Figure 33. Fish species observed along Mosquito Creek tributaries

Fish sampling along Mosquito Creek

Table 6. Fish species observed in Mosquito Creek and tributaries

BlCra black crappie	**BcShi** blackchin shiner	**BnShi** blacknose shiner	**Blueg** bluegill	**BnMin** bluntnose minnow
BrMin brassy minnow	**BrSil** brook silverside	**BrSti** brook stickleback	**BrBul** brown bullhead	**CeMud** central mudminnow
CoShi common shiner	**CrChu** creek chub	**EmShi** emerald shiner	**EthSp** etheostoma spp.	**FhMin** fathead minnow
FsDac finescale dace	**GoShi** golden shiner	**LnDac** longnose dace	**MoScu** mottled scultpin	**NoPik** northern pike
NRDac northern redbelly dace	**PeDac** pearl dace	**PhoSp** phoxinus spp.	**Pumpk** pumpkinseed	**RoBas** rock bass
SmBas smallmouth bass	**SpShi** spottail shiner	**WhSuc** white sucker	**YePer** yellow perch	**CA_MI** carp and minnows
LmBas largemouth bass	**MiShi** mimic shiner	**Muske** muskellunge	**CotSp** cottus species	**LepSp** lepomis species
RhiSp rhinichthys species	**Logpe** logperch			

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 34). Migratory obstructions can be natural or manmade, and they can be permanent or seasonal. There were two within the Mosquito Creek catchment at the time of the survey.

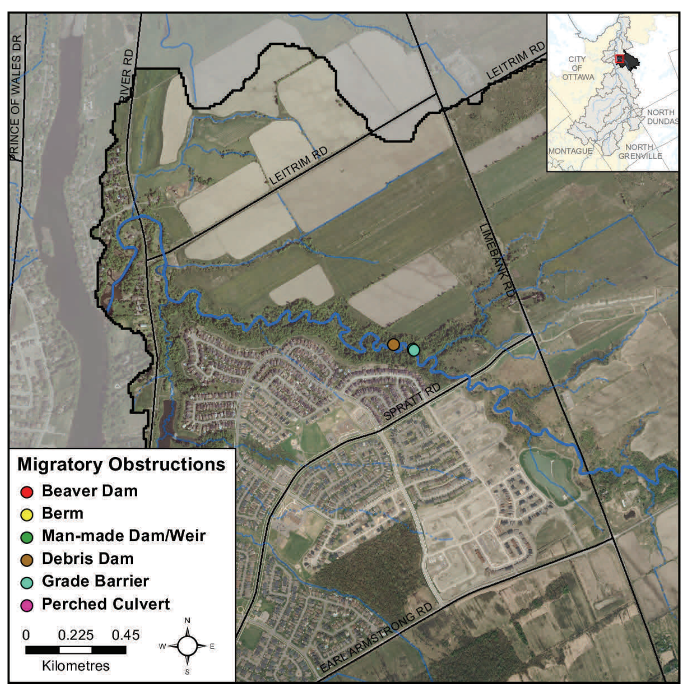


Figure 34. Migratory obstructions in Mosquito Creek

Water Chemistry

During the macrostream 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 warmwater fish and 9.5 mg/L for cold water fish (CCME, 1999). A saturation value (concentration of oxygen in water) of 90% or above is considered healthy
- 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.

2009 data for these three parameters is summarized in Table 7.

Table 7. 2009 Water Chemistry collected along Mosquito Creek

Month	Range	DO (mg/L)	DO (%)	Conductivity	pH
May-09	low	9.82	90	549	8.11
	high	11.39	102	604	8.25
Jun-09	low	6.87	75	532	8.03
	high	14.75	148	874	8.63
Jul-09	low	8	95	315	7.41
	high	14.6	156	873	8.67
Aug-09	low	8.7	98	653	7.73
	high	9.68	114	734	7.81

Students checking a windemere trap for fish

Young of the year northern pike caught in Mosquito Creek

A leopard frog found along Mosquito Creek

A seine net is a method used for fish sampling

3) Land Cover

Crop and pastureland is the dominant land cover type in the catchment as shown in Table 8 and displayed on the front cover of the report.

Table 8. Catchment land cover type

Cover Type	Area (ha)	Area (% of Cover)
Crop & Pasture	1936	47
Woodland	791	19
Settlement	672	16
Wetland	275	7
Transportation	204	5
Aggregate Site	163	4
Water	36	1
Grassland	31	1

Woodland Cover

The Mosquito Creek catchment contains 791 hectares of woodland (Fig.35) that occupies 19 percent of the drainage area. This figure is less than the 30 percent of woodland area required to sustain forest birds, according to Environment Canada's Guideline: "How much habitat is enough?" When woodland cover declines below 30 percent, forest birds tend to disappear as breeders across the landscape.

Sixty-nine (48%) of the 145 woodland patches in the catchment are very small, being less than one hectare in size. Another 66 (46%) 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 10 (7% of) wooded patches range between 23 and 100 hectares. Nine 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, one (1%) of the 145 woodland patches in the drainage area exceeds the 100 plus hectare size needed to support most forest dependent, area sensitive birds and is large enough to support approximately 60 percent of edge-intolerant species. No patch tops 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 conditions.

Forest Interior

The same 145 woodlands contain 33 forest interior patches (Fig.35) that occupy 2 percent (90 ha.) of the catchment land area. This is less than the ten 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..

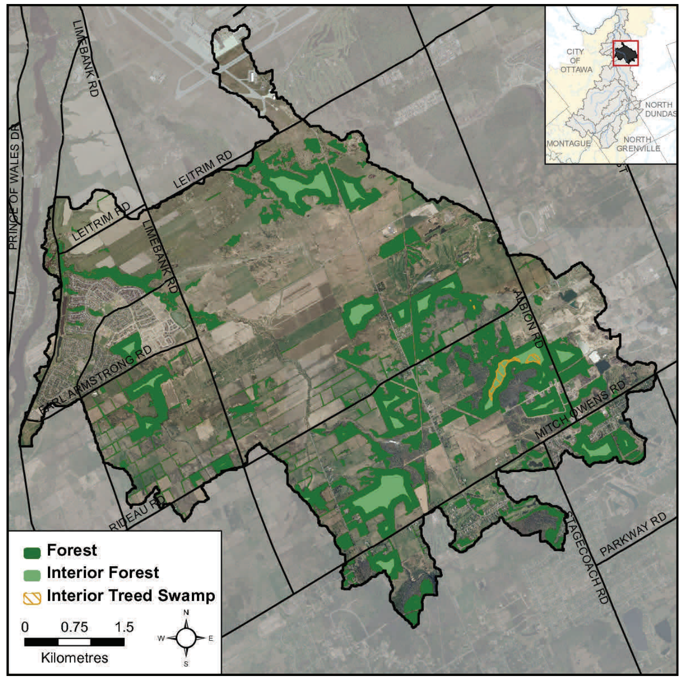


Figure 35. Catchment woodland cover and forest interior

Most patches (30) have less than 10 hectares of interior forest, 18 of which have small areas of interior forest habitat less than one hectare in size. Conversely, three patches have greater than 10 hectares of interior forest, containing 14, 17 and 23 hectares of interior forest habitat respectively.

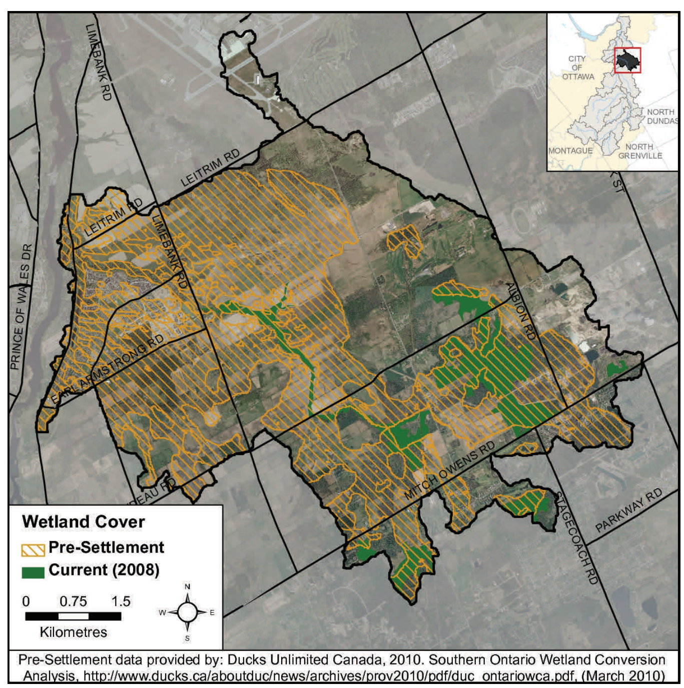


Figure 36. Pre-settlement and current wetland cover

3) Stewardship and Protection

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

Rural Clean Water Projects

Figure 37 shows the location of all Rural Clean Water Projects in the Mosquito Creek drainage area. From 2006 to 2011, landowners completed 2 septic system repair/replacements and 1 well upgrade. In total, RVCA contributed $4,500 in grant dollars to projects valued at $49,895.

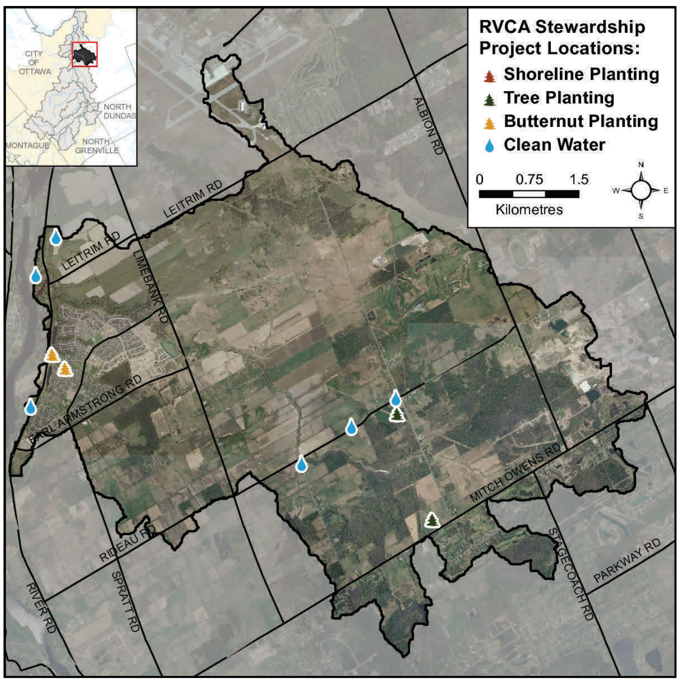


Figure 37. RVCA stewardship program project locations

Prior to 2006, the RVCA completed 3 projects in the area consisting of 2 septic repair/replacements and 1 surface wastewater disposal. In total, RVCA contributed $6,788 in grant dollars to projects valued at $19,927.

Tree Planting Projects

The location of all tree planting and shoreline projects is also shown in Figure 37. From 2006 to 2011, 550 trees, valued at $721, were planted on 1 project site through the RVCA Tree Planting Program.

Before that, from 1984 to 2006, landowners helped plant 7,100 trees, valued at $14,200, on1 project site on 3.55 hectares of private land; fundraising dollars account for $1,775 of that amount.

City Stream Watch Program

The City Stream Watch Program and its volunteers planted 450 trees and shrubs in total along Mosquito Creek in 2006 and 2007.

Valley, Stream, Wetland and Hazard Land Regulation

Less than one percent of the catchment drainage area is within the regulation limit of Ontario Regulation 174/06 (Fig.38), giving protection to wetland areas and river or stream valleys that are affected by flooding and erosion hazards.

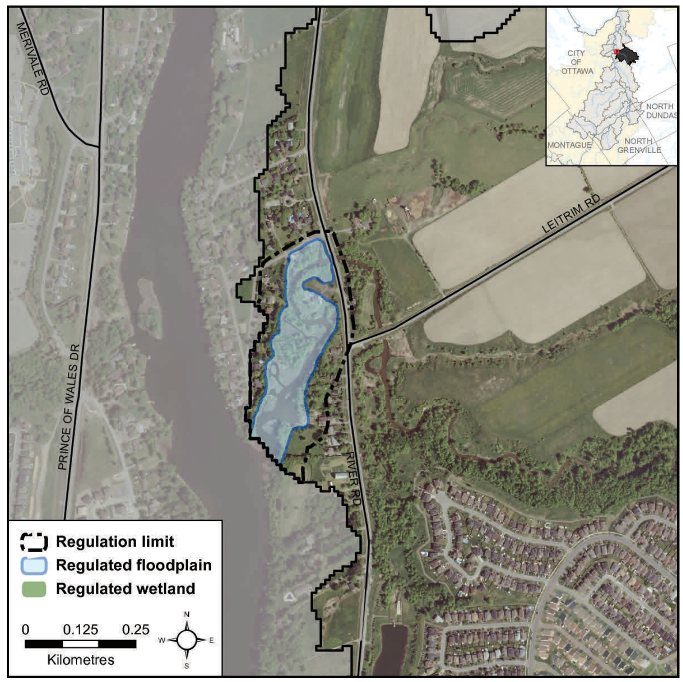


Figure 38 RVCA regulation limits

Natural features within the regulation limit include 0.9 kilometres of streams (representing one percent of all streams in the catchment).

Plotting of the regulation limit on the remaining 72.6 km (or 99 percent) of streams requires identification of flood and erosion hazards and valley systems.

Within the regulation limit, “development” and “site alteration” require RVCA permission, as do any proposed works to alter a watercourse, which are subject to the “alteration to waterways” provision of Ontario Regulation 174/06.

5) Issues

- Loss of headwater tributaries due to drainage practices
- Removal of natural riparian vegetation
- Loss of aquatic habitat in urban area
- Reduced biodiversity
- Nutrient, E.coli and metal exceedances observed in water samples taken

6) Opportunities for Action

- Undertake subwatershed and master servicing studies to identify optimal strategy for servicing development and protecting/enhancing natural features
- Assess slope stability to identify limit of hazard land beyond which development is not permitted
- Implement erosion control measures as necessary (i.e. where post-development flows exceed downstream erosion thresholds)
- Target riparian and instream restoration at sites identified in this report (as shown in Figures 29 and 35) and explore other restoration and enhancement opportunities along the Mosquito Creek riparian corridor
- Work with landowners to implement agricultural best management practices and pursue improvements to the riparian corridor along Mosquito Creek and tributaries (by increasing buffers through reforestation/riparian plantings and invasive species removal)