Mosquito Creek 2023 Catchment Report

Catchment Features	
Area	41.08 square kilometers 0.97% of the Rideau Valley watershed
Land Use	21.46% agriculture 15.84% settlement 15.75% forest 26.42% meadow 6.04% transportation 10.44% wetlands
Surficial Geology	40.3% clay 3.84% organic deposits 24.89% sand 13.68% diamicton 14.82% gravel 2.74% Paleozoic bedrock
Watercourse Type	2023 thermal conditions warmwater to coolwater
Invasive Species	Fourteen invasive species were identified in 2023: bull thistle, common buckthorn, curly-leaved pondweed, Eurasian water-milfoil, European frog-bit, flowering rush, garlic mustard, glossy buckthorn, Himalayan balsam, non-native honeysuckles, Manitoba maple, purple loosestrife, rusty crayfish and wild parsnip.
Fish Community	Thirty-four species have been observed from 2009 to 2023; game species include: black crappie, bluegill, brown bullhead, largemouth bass, muskellunge, northern pike, pumpkinseed, Redhorse sp. rock bass, smallmouth bass, walleye, white sucker, yellow perch

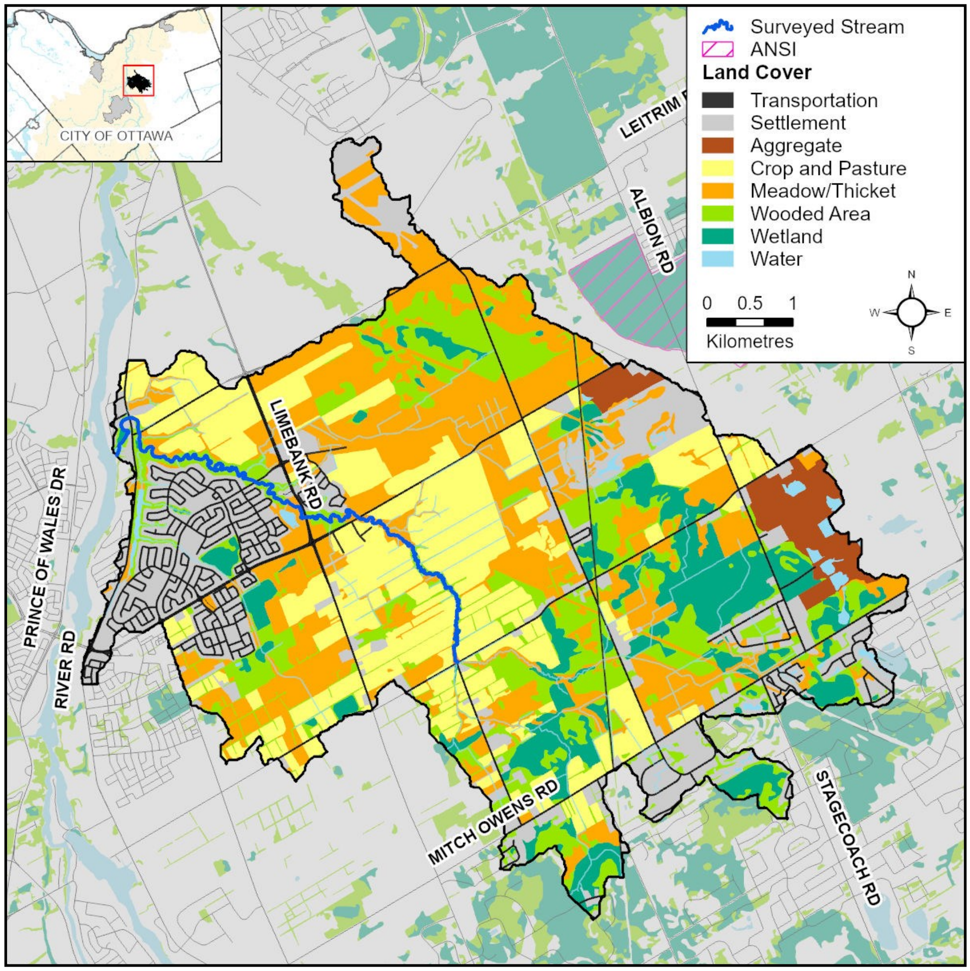


Figure 1 Land cover in the Mosquito Creek catchment

Woodlot Analysis		
Size Category	**Number of Woodlots**	**Percent of Woodlots**
1 Hectare	146	64.04%
1 to <10 Ha	75	32.89%
10 to <30 Ha	6	2.63%
>30 Ha	1	0.44%
Total Cover	**228**	**100%**

Vegetation Cover		
Type	**Hectares**	**Percent of Cover**
Wooded Areas:	**1076.16**	**60.14%**
Hedgerow	40.56	3.77%
Plantation	28.02	2.60%
Treed	431.53	40.10%
Regenerative	147.11	13.67%
Wetlands*	**428.94**	**39.86%**
Total Cover	**1505.1**	**100%**
*Includes treed swamps		

The Rideau Valley Conservation Authority in partnership with the City of Ottawa, National Capital Commission, Ottawa Flyfishers Society, Canadian Forces Ottawa Fish and Game Club, Ottawa Stewardship Council, Rideau Roundtable, South Nation Conservation and Mississippi Valley Conservation Authority form the City Stream Watch 2023 collaborative.

Introduction

The headwaters of Mosquito Creek begin at Rideau Road, at the confluence of the Spratt and Nolan municipal drains. Dancy and Downey municipal drains flow into Spratt and Nolan upstream of that confluence. Mosquito Creek then winds its way through agricultural fields north of Earl Armstrong Road, where land use changes from agricultural to residential. Halfway between Spratt Road and Leitrim Road, Mosquito Creek becomes deeper and requires a canoe or kayak to survey. Mosquito Creek winds around River Road, and becomes quite wide where it flows into the Rideau River (RVCA, 2015).

The Mosquito Creek catchment has experienced increased development with the creation of the Riverside South Community north of Earl Armstrong Road beginning in the mid 1990's. In the early 2000's, residential development was extended to the area east of Limebank Road. Since last survey in 2015, much of the residential development that was being constructed in the area south of Earl Armstrong Road, west of Limebank Road is now complete. The second stage expansion of Ottawa's Light Rail Project (LRT) is also currently being constructed within the catchment. While not yet complete, the new LRT line now extends from the Ottawa airport, through Letrium and Bowesville, and ends at the Limebank station in Riverside South. The LRT line itself is being constructed along the area south of Earl Armstrong Road, and crosses over Mosquito Creek.

In 2023, 77 sections (7.7 km) of Mosquito Creek were surveyed as part of the City Stream Watch monitoring activities. The following is a summary of observations made by staff and volunteers along those 77 sections.

Mouth of Mosquito Creek at the Rideau River

Stage two LRT expansion crossing over Mosquito Creek upstream of Earl Armstrong Road

Mosquito Creek Overbank Zone

Riparian Buffer Width Evaluation

The riparian buffer is the adjacent land area surrounding a stream or river. Naturally vegetated buffers are important to protect the health of streams and watersheds. Natural shorelines provide buffering capacity of contaminants and nutrients that would otherwise run off freely into aquatic systems. Well established shoreline plant communities will hold soil particles in place preventing erosion and will also provide the stream with shading and cover. Environment and Climate Change Canada recommends a guideline of 30 meters of natural vegetation on both sides of the stream for at least 75 percent of the stream length (Environment Canada, 2013).

Figure 2 demonstrates buffer conditions along the left and right banks of the surveyed sections of Mosquito Creek. Buffers greater than 30 meters were present along 81 percent of the left bank and 79 percent of the right bank. A 15 to 30 meter buffer was present along 13 percent of the left bank and 11 percent of the right bank. A five meter buffer or less was present along two percent of the left bank and five percent of the right bank. The buffer width evaluation on the sections surveyed of Mosquito Creek are above the recommended guidelines from Environment and Climate Change Canada.

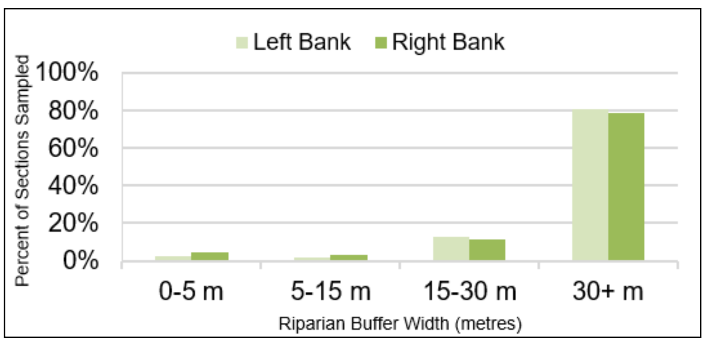


Figure 2 Vegetated buffer width along Mosquito Creek

Vegetated buffer greater than 30 meters in width along Mosquito Creek upstream of Spratt road

Riparian Buffer Alterations

Alterations within the riparian buffer were assessed within three distinct shoreline zones (0-5 m, 5-15 m, 15-30 m), and evaluated based on the dominant vegetative community and/or land cover type. The evaluation of anthropogenic alterations to the natural riparian cover are shown in Figure 3.

Mosquito Creek surveyed riparian zones were primarily natural, with 73 percent of the left and 68 percent of the right bank having dominant natural riparian vegetative communities. Alterations to the riparian buffer accounted for eight percent of the left bank and 11 percent on the right bank; highly altered conditions were observed on two percent of the left bank, and four percent of the right bank. These alterations were associated with infrastructure such as roadways and piping.

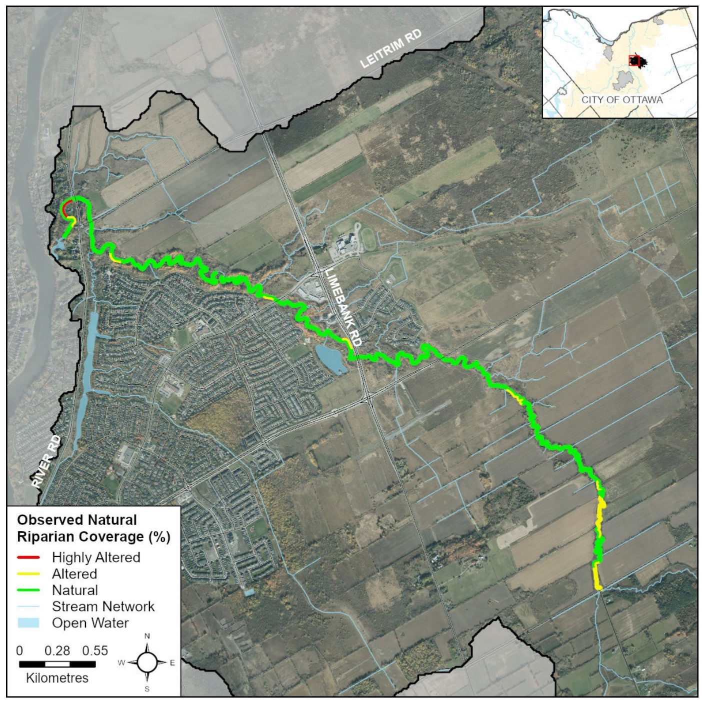


Figure 3 Riparian buffer alterations in Mosquito Creek

Roadway infrastructure along Mosquito Creek

Adjacent Land Use

Surrounding land use is considered from the beginning to the end of the survey section (100 m) and up to 100 meters 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. Figure 4 shows the percent of surveyed sections that contain each type of land use.

Forest and scrubland were present in 95 percent and 99 percent of the sections surveyed, being the most common land use observed. Wetlands were present in 23 percent of the surveyed areas, and meadow was present in 69 percent of sections.

Aside from the natural areas, the most common land use in the catchment was active agriculture with 60 percent of the sections containing residential properties. Residential land use was also fairly common with observed in 42 percent of sections. Recreational use was observed in 17 percent of sections, and infrastructure, such as roads, bridges and culverts was observed in 13 percent of sections. The least common land use was commercial which was observed in four percent of sections.

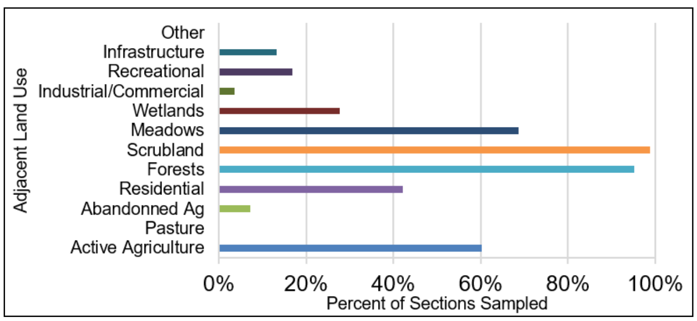


Figure 4 Adjacent land use 100 meters from each shoreline and percentage of presence along Mosquito Creek

Section along Mosquito Creek with scrubland, meadow, residential and infrastructure land uses near Limebank Road

Mosquito Creek Shoreline Zone

Anthropogenic Alterations

Stream alterations were classified based on specific functional criteria associated with potential human influences on the riparian buffer, shoreline state, flow conditions and channel structure.

Figure 5 shows the level of anthropogenic alterations for the 77 sections surveyed in the Mosquito Creek catchment, with 42 sections remaining without any human alteration. Of the areas surveyed, 35 sections fell in the classification of natural. Natural sections had a riparian buffer greater than 15 meters in width and natural shorelines.

Two sections were classified as altered. They contained straightened sections and riparian buffers of five to 15 meters in width. Shoreline alterations included concrete bridges, rip-rap, armour stone, and gabion cages.

Three of the surveyed sections were highly altered. The riparian buffers were less than five meters in width, shoreline alterations were found on most of the sections and storm water outlets were present at road crossings. These sections were mostly found near road and highway infrastructure.

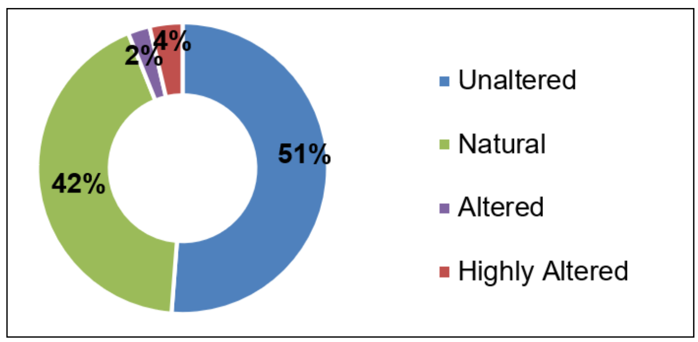


Figure 5 Anthropogenic alterations along Mosquito Creek

One of many unaltered sections of Mosquito Creek near Earl Armstrong Road

Erosion

Stream erosion is the process by which water erodes and transports sediments, resulting in dynamic flows and diverse habitat conditions. Excessive erosion can result in drastic environmental changes, as habitat conditions, water quality and aquatic life are all negatively affected. Bank stability was assessed as the extent of each section with "unstable" shoreline conditions. These conditions are defined by the presence of significant exposed soils/roots, minimal bank vegetation, undercutting, slumping or scour and potential failed erosion measures (rip rap, gabion baskets, etc.).

Figure 6 shows significant erosion was observed across the surveyed portions. Bank instability was observed in 81 percent of the left bank and 86 percent of the right bank of the sections surveyed.

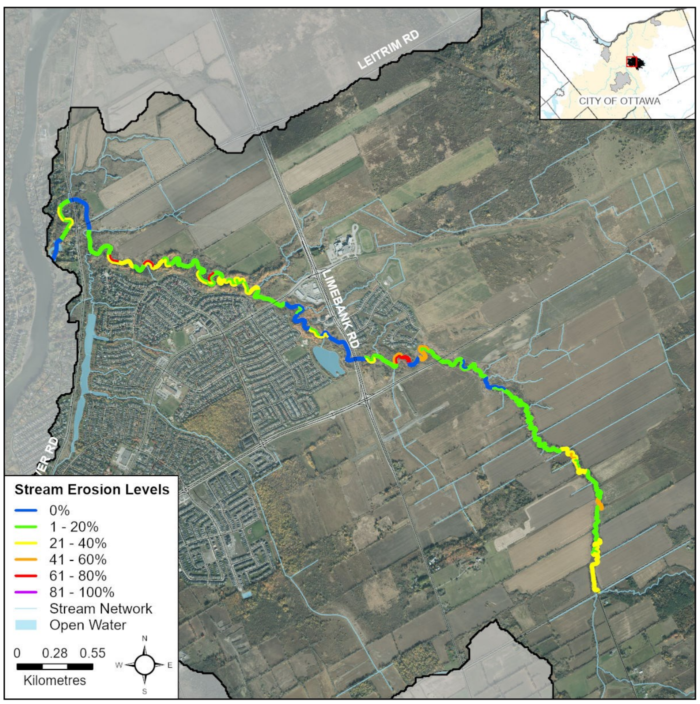


Figure 6 Erosion levels along Mosquito Creek

Bank erosion along Mosquito Creek near Limebank Road

Undercut Stream Banks

Stream bank undercuts can provide excellent cover habitat for aquatic life, however excessive levels can be an indication of unstable shoreline conditions. Bank undercut was assessed as the extent of each surveyed section with overhanging bank cover present.

Figure 7 shows where undercut banks were present and to what extent each section contained them in Mosquito Creek. Along the left bank, 51 percent of sections had undercut banks; and the right bank had 58 percent of sections with undercut banks.

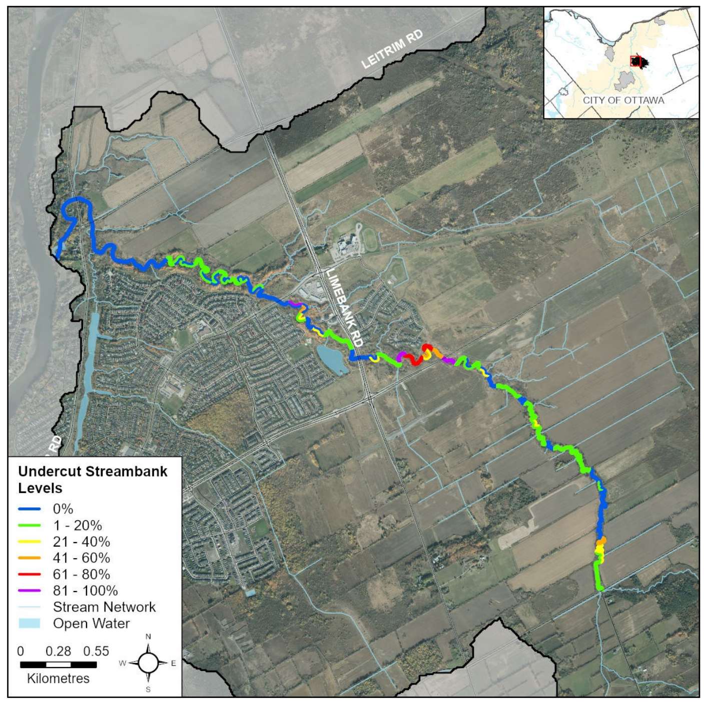


Figure 7 Undercut stream banks along Mosquito Creek

Undercut banks on Mosquito Creek downstream of Spratt Road

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. Stream cover is assessed as the total coverage area in each section that is shaded by overhanging trees/grasses and tree canopy, at greater than one meter above the water surface.

Figure 8 shows the percentage of sections surveyed with various levels of stream shading. The majority of sections, 35 of them, had a shade cover of one to 20 percent. Twenty-three sections had 21 to 40 percent shade cover; ten sections had 41-60 percent cover; seven sections had 61-80 percent cover; and two sections had 81-100 percent cover. Only six sections of Mosquito Creek had no shade cover. Figure 9 shows the distribution of these shading levels as a percentage of sections surveyed along Mosquito Creek.

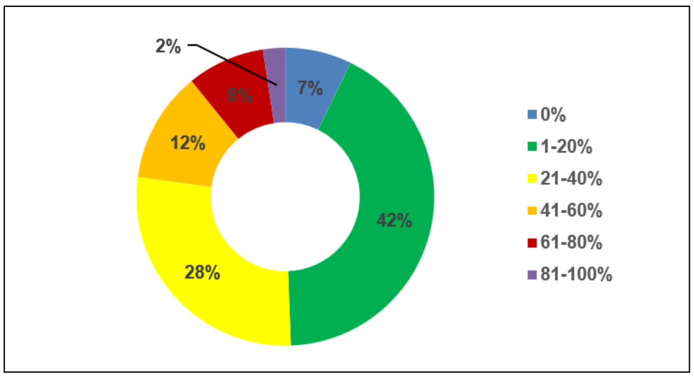


Figure 8 Percent of stream shading along Mosquito Creek

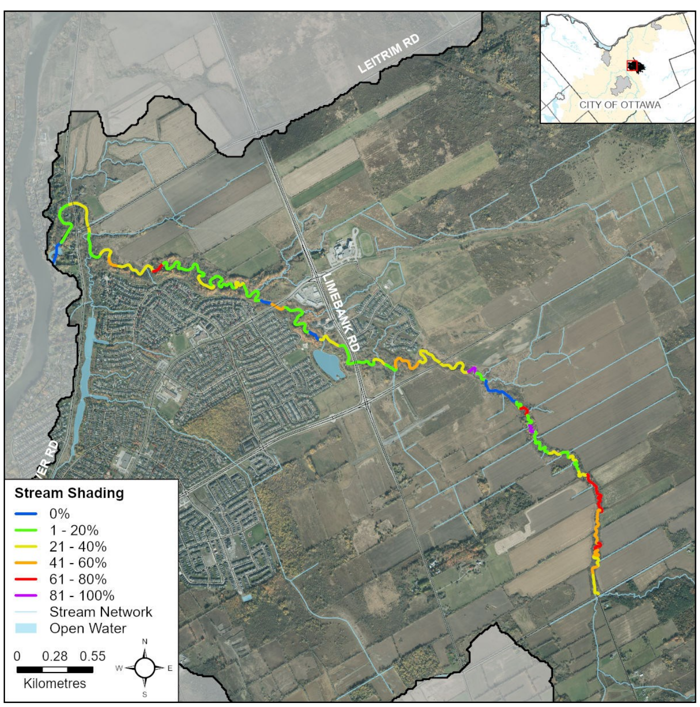


Figure 9 Stream shading along Mosquito Creek

A mix of trees and plants comprised the majority of shading. Overhanging plants, mainly grasses, robust and broad leaved emergent plants, were seen in 75 percent of the left banks and 73 percent of the right banks.

Overhanging Trees and Branches

Trees and branches that are less than one meter from the surface of the water are defined as overhanging. Overhanging branches and trees provide a food source, nutrients and shade which helps to moderate instream water temperatures.

Figure 10 shows the presence and percentage within each section of overhanging trees and branches that were observed along Mosquito Creek. Of the surveyed portions, 83 percent of the sections had overhanging trees and branches on the left bank, and 88 percent of the sections had overhanging trees on the right bank.

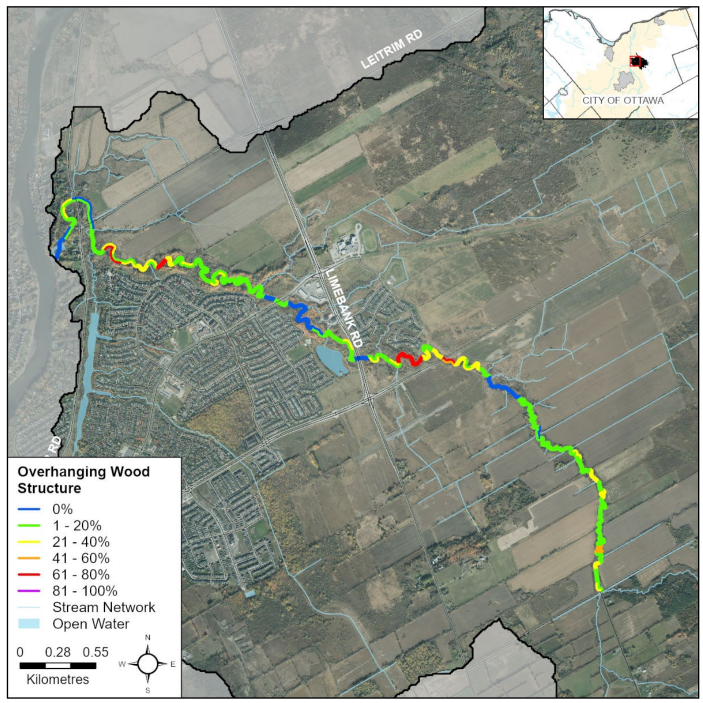
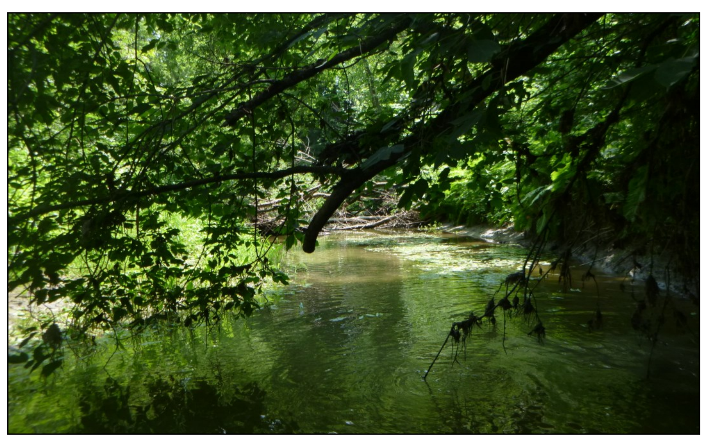


Figure 10 Overhanging trees and branches along Mosquito Creek



Overhanging trees and shrubs contribute to most of the shading along Mosquito Creek

Mosquito Creek Instream Aquatic Habitat

Habitat Complexity

Habitat complexity is a measure of the diversity of habitat types and features within a stream. Streams with high habitat complexity support a greater variety of species niches, and therefore contribute to greater diversity. Factors such as substrate, morphologic conditions (pools, riffles) and cover material (vegetation, wood structure, etc.) all provide crucial habitat to aquatic life. Habitat complexity is assessed based on the presence of boulder, cobble and gravel substrates, as well as the presence of instream wood structure. A higher score shows greater complexity where a variety of species can be supported. Figure 11 shows habitat complexity of the sections surveyed. Only one percent of the sections surveyed had no complexity. Fourteen percent had a score of one; 41 percent scored two; 30 percent scored three; and 11 percent of the sections surveyed scored four for habitat complexity.

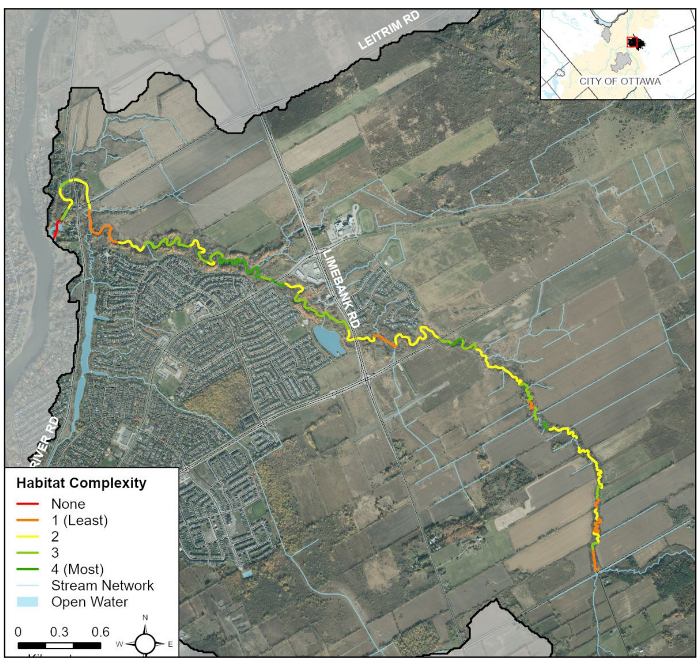


Figure 11 Instream habitat complexity along Mosquito Creek

Section of Mosquito Creek with complex habitat features including cobble, gravel and instream vegetation

Instream Substrate

Diverse substrate is important for fish and benthic invertebrate habitat because some species have specific substrate requirements and for example will only reproduce on certain types of substrate. The absence of diverse substrate types may limit the diversity of species within a stream.

Substrate complexity along Mosquito Creek was observed to be fairly homogenous in 73 percent of sections surveyed, and heterogenous in the remaining 27 percent. Figure 12 shows the substrate types observed. It is a system dominated by clay, with 93 percent of sections containing this type of substrate. 75 percent of sections surveyed also contained cobble. Other substrate types included silt, gravel, boulders, sand, and bedrock.

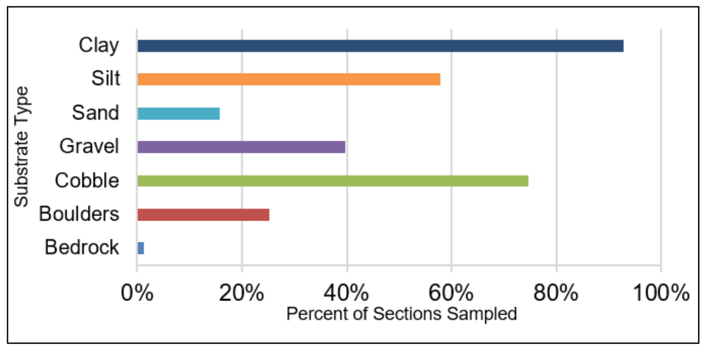


Figure 12 Instream substrate along Mosquito Creek

Figure 13 shows the dominant substrate types along the creek. From the assessed areas, clay was the dominant substrate type in 63 percent of sections surveyed, silt in 20 percent, cobble in 14 percent, and bedrock was dominant in one percent of sections.

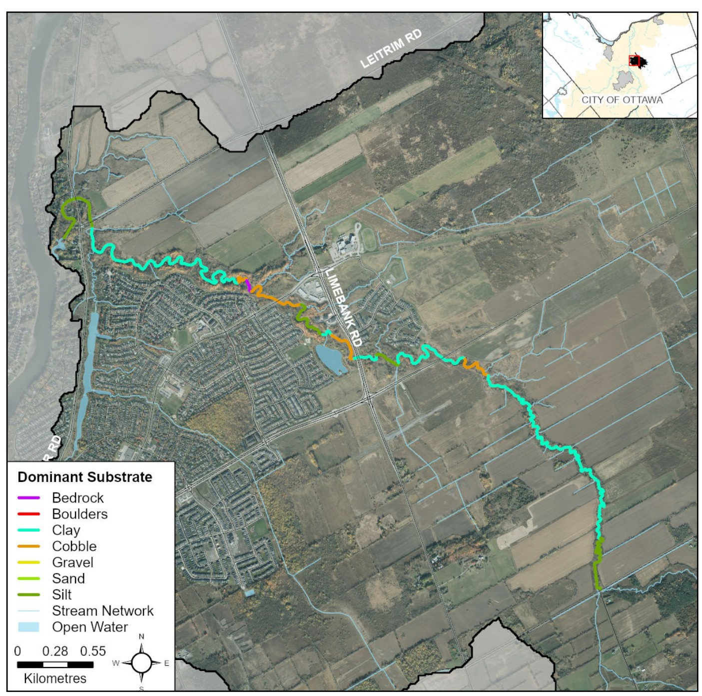


Figure 13 Dominant instream substrates along Mosquito Creek

Instream Morphology

Pools and riffles are important habitat features for aquatic life. Riffles are fast flowing areas characterized by agitation and overturn of the water surface. Riffles thereby play a crucial role in contributing to dissolved oxygen conditions and directly support spawning for some fish species. They are also areas that support increased benthic invertebrate populations which are an important food source for many aquatic species. Pools are characterized by minimal flows, with relatively deep water and winter and summer refuge habitat for aquatic species. Runs are 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 14 shows that the surveyed portions of Mosquito Creek only has a moderate diversity of morphological conditions due to the lack of riffles and an abundance of runs within the catchment. However, this moderate diversity of morphological conditions still provides suitable habitat for a variety of aquatic species and life stages. 94 percent of sections contained pools, 40 percent of sections contained riffles and 99 percent contained runs. Figure 15 shows the locations of sections surveyed which contained riffle habitat and the extent of presence within each section.

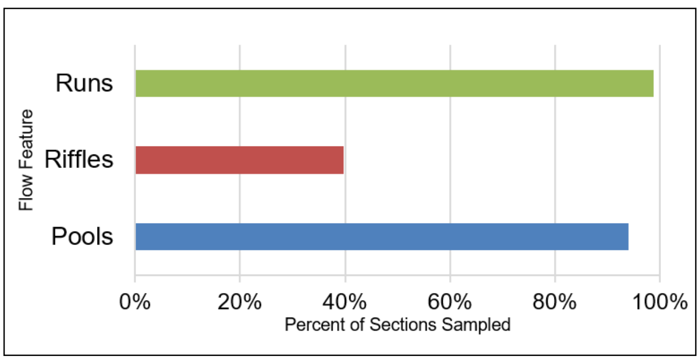


Figure 14 Instream morphology along Mosquito Creek

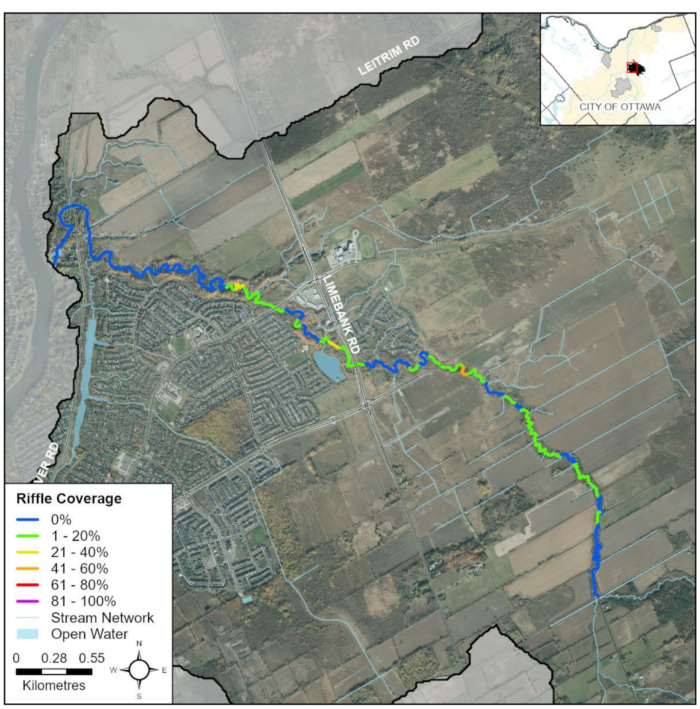


Figure 15 Riffle habitat locations along Mosquito Creek

Instream Wood Structure

Figure 16 shows that a large portion of Mosquito Creek had moderate levels of instream wood structure in the form of branches and trees. Instream wood structure is important for fish and wildlife habitat, by providing refuge and feeding areas. Excessive amounts can result in temporary seasonal migration barriers.

Instream wood structures found along Mosquito Creek are important for fish and wildlife habitat (above), some can become seasonal migration barriers (below)

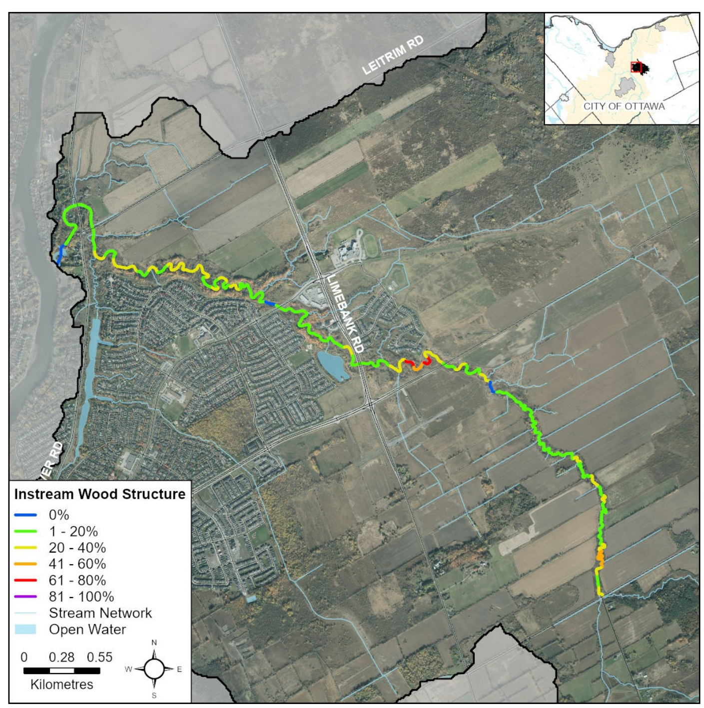


Figure 16 Instream wood structures along Mosquito Creek

Instream Aquatic Vegetation Type

Instream vegetation is a key component of aquatic ecosystems. It promotes stream health by:

- Providing riparian and instream habitat.
- Maintaining water quality by erosion control, nutrient cycling, and pollutant absorption.
- Stabilizing flows and reducing shoreline erosion.
- Contributing dissolved oxygen via photosynthesis.
- Moderating temperatures through shading.

Figure 17 shows the aquatic vegetation community structure along Mosquito Creek. Vegetation types included: broad-leaved emergent present in 67 percent of sections; narrow-leaved emergent vegetation in 58 percent; submerged vegetation in 49 percent of sections; algae in 34 percent of sections; floating plants in 33 percent; free-floating in 30 percent; and robust emergent plants in 29 percent of sections.

Figure 18 shows Mosquito Creek had diverse instream aquatic vegetation and floating vegetation was the most dominant type. Floating plants dominated 10 percent of sections; submerged plants were dominant in five percent; and algae, narrow-leaved emergents, as well as broad-leaved emergent plants were dominant in two percent of sections.

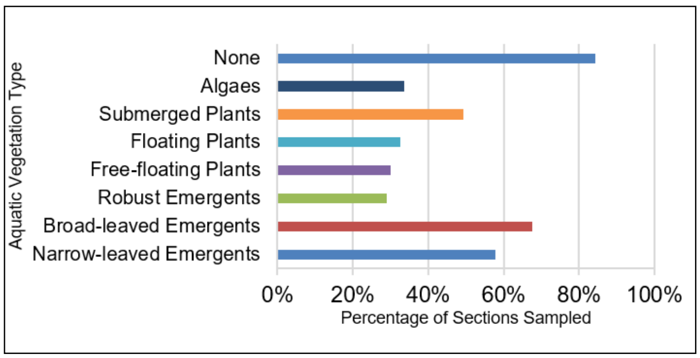


Figure 17 Aquatic vegetation presence along Mosquito Creek

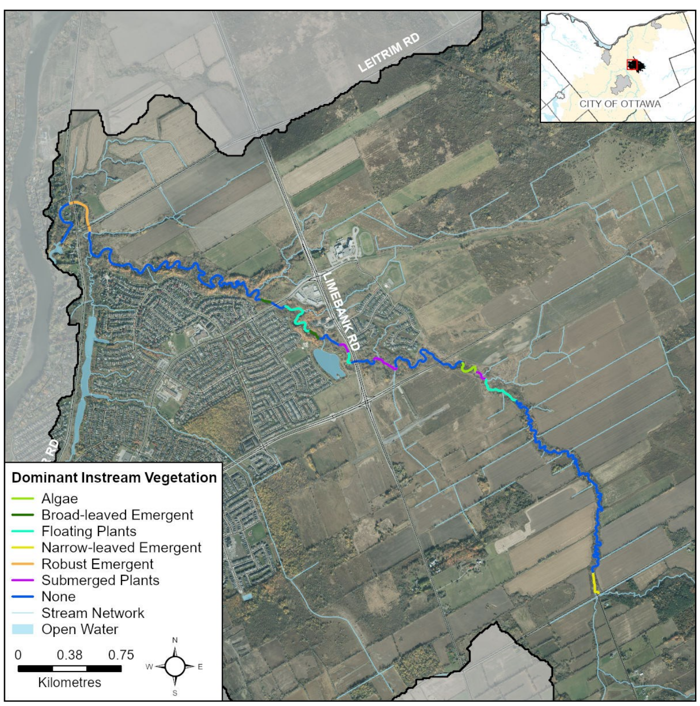


Figure 18 Dominant instream vegetation in Mosquito Creek

Instream Vegetation Abundance

The abundance of instream vegetation is also crucial for aquatic ecosystem health. Lack of vegetation, rare or low abundances can impair the ability of plants to contribute adequately to dissolved oxygen, provide habitat, and remove nutrients and contaminants. Extensive amounts of vegetation can also have negative impacts by lowering dissolved oxygen levels. It can act as a physical barrier for humans and wildlife, and it can lead to a reduction in plant diversity. Invasive species in particular tend to have this extensive mode of growth.

Abundance of vegetation is classified by the amount of vegetation present along each section. Levels of vegetation are categorized based on the extent of coverage of a section from none and sparse to an entire section choked with vegetation. As seen in Figure 19, 47 percent of sections along Mosquito Creek had low levels of vegetation in part, 37 percent had extensive, 28 percent had rare, and 23 percent had common levels of vegetation. Normal levels of vegetation was observed in 19 percent of sections surveyed, and no vegetation was found along 86 percent of sections.

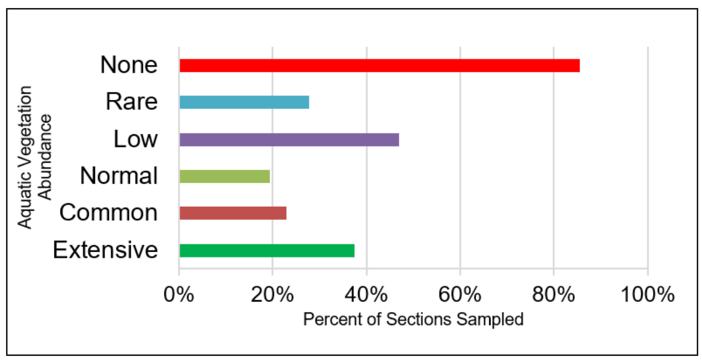


Figure 19 Instream vegetation abundance along Mosquito Creek

Floating-leaved pond weed is a common aquatic vegetation observed along Mosquito Creek

Mosquito Creek Stream Health

Invasive Species

Invasive species are harmful to the environment, the economy and our society. They have high reproduction, quick establishment of dense colonies, tolerate a variety of environmental conditions and lack natural predators. They can have major implications on stream health and reduce species diversity (OMNR 2012). They can be difficult to eradicate, however it is important to continue to research, monitor and manage them.

Invasive species were observed in all but one section surveyed along Mosquito Creek. Figure 20 shows the diversity of species observed per section surveyed.

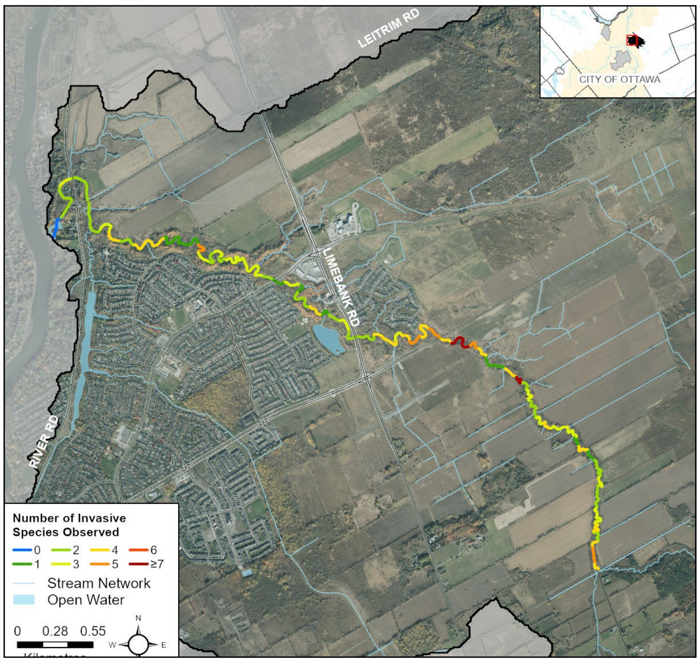


Figure 20 Invasive species diversity along Mosquito Creek

The following are a list of species observed in 2023 in the surveyed portions of Mosquito Creek:

- bull thistle (*Cirsium vulgare*)
- common buckthorn (*Rhamnus cathartica*)
- curly-leaved pondweed *(Potamogeton crispus*)
- Eurasian water-milfoil (*Myriophyllum spicatum*)
- European frog-bit (*Hydrocharis morsus-ranae*)
- flowering rush *(Butomus umbellatus*)
- garlic mustard (*Alliaria petiolata*)
- glossy buckthorn (*Rhamnus frangula*)
- Himalayan balsam (*Impatiens glandulifera*)
- non-native honeysuckles (*Lonicera spp.)*
- Manitoba maple (*Acer negundo*)
- poison/wild parsnip (*Pastinaca sativa*)
- purple loosestrife (*Lythrum salicaria*)
- rusty crayfish (*Orconectes rusticus*)

Invasive honeysuckle observed along surveyed portions of Mosquito Creek

To report and find information about invasive species visit

http://www.invadingspecies.com

Managed by the Ontario Federation of Anglers and Hunters

Pollution

Figure 21 shows where pollution was observed along Mosquito Creek. The levels of garbage found in the main portion of the stream were low, with 64 percent of sections surveyed containing no garbage. Floating garbage was found in 27 percent of sections surveyed, while garbage on the stream bottom was found in 16 percent. There were no other types of pollution observed within the sections surveyed.

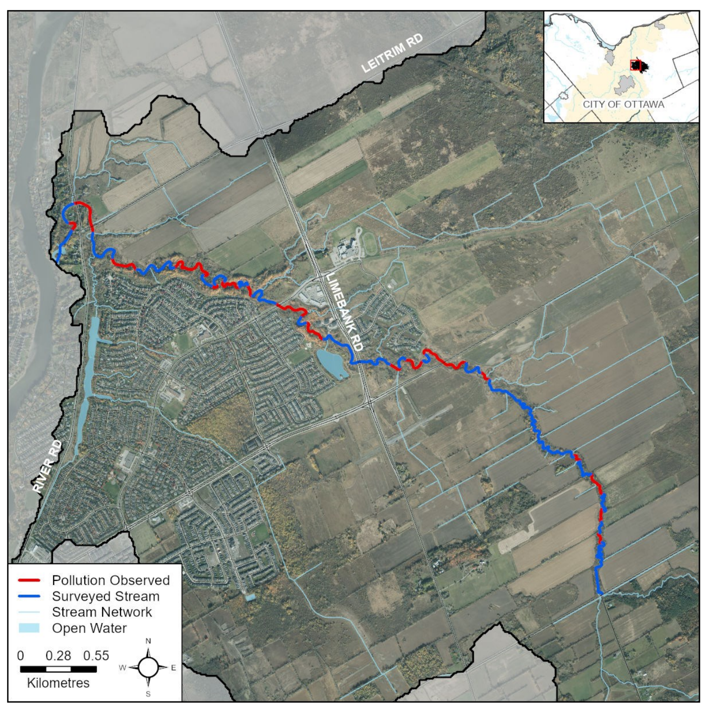


Figure 21 Pollution observed along Mosquito Creek

Wildlife

The diversity of fish and wildlife populations can be an indicator of water quality and stream health (Table 1). Wildlife observations are noted during monitoring and survey activities; they do not represent an extensive evaluation of species presence in the Mosquito Creek catchment.

Baetidae mayfly found along Mosquito Creek

Virginia tiger moth observed along Mosquito Creek

Red admiral butterfly found along Mosquito Creek

Table 1 Wildlife observations along Mosquito Creek

Birds	American crow, American gold finch, American robin, belted kingfisher, black-capped chickadee, blue jay, Canada goose, cardinal, downy woodpecker, Eastern starling, European starling, flycatcher spp., gold finch, grackle, great blue heron, grey catbird, house sparrow, kingfisher spp., mallard, morning dove, nuthatch spp., owl spp., phebe spp., red–shouldered hawk, red-wing blackbird, sparrow spp., swallow spp., turkey, turkey vulture, woodpecker spp.
Reptiles & Amphibians	American bullfrog, American toad, gray treefrog, green frog, northern leopard frog, snapping turtle
Mammals	American beaver tracks, deer tracks, raccoon tracks, red squirrel, chipmunk,
Aquatic Insects & Benthic Invertebrates	dragonfly larvae, damselfly larvae, water striders, whirling beetles, leeches, mayfly
Other	Cabbage moths, butterflies, Virginia tiger moth

American toad observed along Mosquito Creek

Mosquito Creek Water Chemistry

Water Chemistry Assessment

Water chemistry collection is done at the start and end of each 100 meter section with a multiparameter YSI probe. The parameters monitored are: air and water temperature, pH, conductivity, dissolved oxygen concentration and saturation.

Volunteer collecting water chemistry measurements with a multiparameter YSI probe

Dissolved Oxygen

Dissolved oxygen is essential for a healthy aquatic ecosystem, fish and other aquatic organisms need oxygen to survive. The level of oxygen required is dependent on the particular species and life stage. The lowest acceptable concentration for the early and other life stages according to the Canadian water quality guidelines for the protection of aquatic life are: 6.0 milligrams per liter in warm-water biota and 9.5 milligrams per liter for cold-water biota (CCME 1999).

Figure 22 shows the concentration levels found in the surveyed portions of Mosquito Creek. The two dashed lines depicted represent the Canadian water quality guidelines. Most of the surveyed portions were found to have oxygen levels within the Canadian water quality guidelines. However, multiple sections near Limebank Road observed oxygen levels below the Canadian water quality guidelines. The sections of Mosquito Creek that contain dissolved oxygen levels above this guideline are sufficient to support warm-water aquatic life. However, any sections with oxygen concentrations that fall below the guideline are likely not sufficient to support aquatic life and may represent impairment. Average concentration levels across the system were 6.5 mg/L.

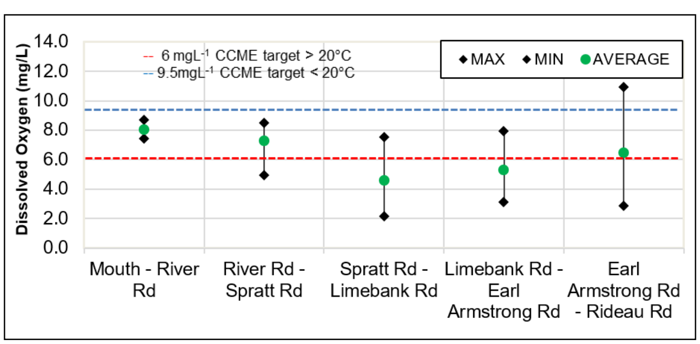


Figure 22 Dissolved oxygen ranges along surveyed sections of Mosquito Creek: Sections 1-83.

Conductivity

Conductivity is a measure of water's capacity to conduct electrical flow. This capacity is dictated by the presence of conductive ions that originate from inorganic materials and dissolved salts. Water conductivity in natural environments is typically dictated by the geology of the area, however anthropogenic inputs also have a profound effect. Conductivity measurements outside of normal range across a system are good indicators of anthropogenic inputs including unmitigated discharges and storm water input.

The average specific conductivity level in Mosquito Creek is 958.5 µS/cm. Figure 23 shows that conductivity levels were lower in areas approaching the stretch of the creek from the mouth to River Road (sec. 1-6). Higher levels were observed in the remaining sections of the creek (sec.7-83).

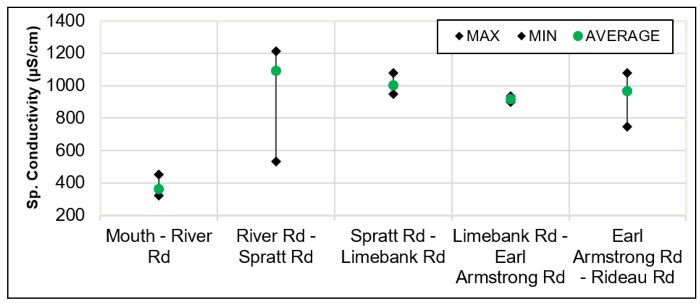


Figure 23 Specific Conductivity ranges along surveyed sections of Mosquito Creek: sections 1-83

pH

pH is a measure of alkalinity or acidity. This parameter is also influenced by the geology of the system but can also be influenced by anthropogenic input. For pH, the provincial water quality objective (PWQO) is the range of 6.5 to 8.5 to protect aquatic life (MOEE 1994).

Figure 24 shows Mosquito Creek had all pH levels that met the PWQO, depicted by the dashed lines. Average levels across the system were pH 7.88.

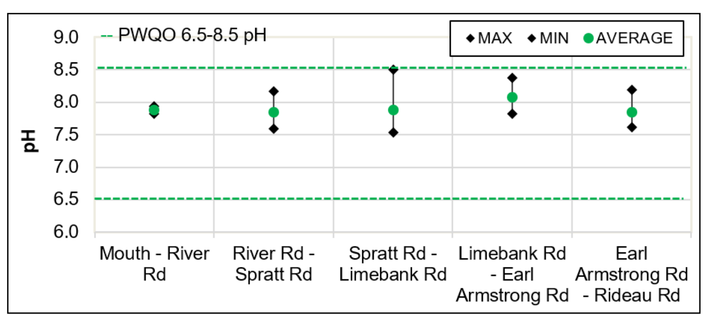


Figure 24 pH ranges along surveyed sections of Mosquito Creek: sections 1-83.

Oxygen Saturation (%)

Oxygen saturation is measured as the ratio of dissolved oxygen relative to the maximum amount of oxygen that will dissolve based on the temperature and atmospheric pressure. Well oxygenated water will stabilize at or above 100 percent saturation, however the presence of decaying matter/pollutants can drastically reduce these levels. Oxygen input through photosynthesis has the potential to increase saturation above 100 percent to a maximum of 500 percent, depending on the productivity level of the environment. In order to represent the relationship between concentration and saturation, the measured values have been summarized into 6 classes:

1) <100% Saturation / <6.0 mg/L Concentration

Oxygen concentration and saturation are not sufficient to support aquatic life and may represent impairment.

2) >100% Saturation / <6.0 mg/L Concentration

Oxygen concentration is not sufficient to support aquatic life, however saturation levels indicate that the water has stabilized at its estimated maximum. This is indicative of higher water temperatures and stagnant flows.

3) <100% Saturation / 6.0—9.5 mg/L Concentration

Oxygen concentration is sufficient to support warm-water biota, however depletion factors are likely present and are limiting maximum saturation.

4) >100% Saturation / 6.0—9.5 mg/L Concentration

Oxygen concentration and saturation levels are optimal for warm-water biota.

5) <100% Saturation / >9.5 mg/L Concentration

Oxygen concentration is sufficient to support cold-water biota, however depletion factors are likely present and are limiting maximum saturation.

6) >100% Saturation / >9.5 mg/L Concentration

Oxygen concentration and saturation levels are optimal for warm and cold-water biota.

Section on Mosquito Creek South of Earl Armstrong Road with **optimal** oxygen conditions (Dissolved oxygen levels of 10.93 mg/L and 131.4 % saturation)

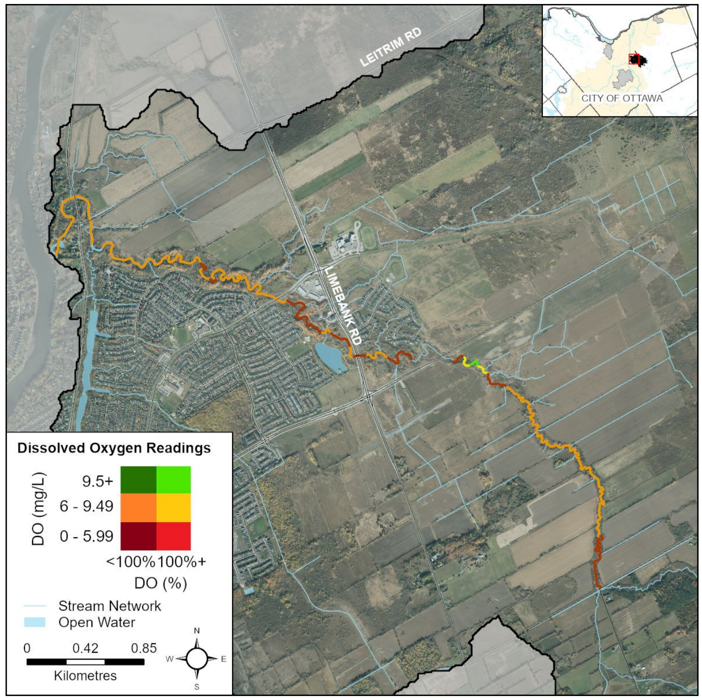


Figure 25 Bivariate assessment of dissolved oxygen concentration (mg/L) and saturation (%) along Mosquito Creek

Figure 25 shows the dissolved oxygen conditions across the areas that were surveyed in 2023. Oxygen levels were not recorded throughout a small section between Limebank and Earl Armstrong Road due to equipment malfunction. Oxygen conditions in Mosquito Creek were sufficient to sustain warm-water biota in areas from the mouth of Mosquito Creek to Spratt Road, and Limebank Road to Rideau Road. Sections shown in dark red in Figure 25, had significant levels of impairment both in concentration and percent saturation. The residential areas near Limebank Road with especially high impairment levels have likely been influenced by the lack of shaded areas and riffle environment. There were also some pockets that contained slightly higher concentrations and saturation conditions just south of Earl Armstrong Road. Even though the average conditions are low in oxygen in these areas, various fish species were observed as the system still contains suitable habitat/refuge. An increase in shading conditions, through riparian planting of trees and shrubs can potentially help cool conditions and possibly increase levels of dissolved oxygen.

Section on Mosquito Creek south of Spratt Road with **impaired** oxygen conditions for warm-water biota (Dissolved oxygen levels of 2.18 mg/L and 36.8 % saturation)

Specific Conductivity Assessment

Specific conductivity (SPC) is a standardized measure of electrical conductance, collected at or corrected to a water temperature of 25°C. SPC is directly related to the concentration of ions in water, and is influenced by the area geology and anthropogenic input as it contributes to the presence of dissolved salts, alkalis, chlorides, sulfides and carbonate compounds. The higher the concentration of these compounds, the higher the conductivity. Common sources of elevated conductivity include stormwater, agricultural inputs as well as commercial and industrial effluents.

In order to summarize the conditions observed, levels were evaluated as either normal, moderately elevated or highly elevated. These categories are defined by the amount of variation (standard deviation) at each section compared to the system's average.

Average levels of specific conductivity measured in the surveyed portions of Mosquito Creek (958.5 µS/cm) exceeded the 500 µS/cm guideline used for the Canadian Environmental Performance Index (Environment Canada 2011).

Figure 26 shows relative specific conductivity levels in Mosquito Creek. Normal levels were maintained for most of the surveyed portions. Moderately elevated conditions were observed between River Road and Spratt Road. This area has agricultural land use influences from the north, and storm water influences from the south due to adjacent development. These factors combined can contribute to elevated conductivity levels.

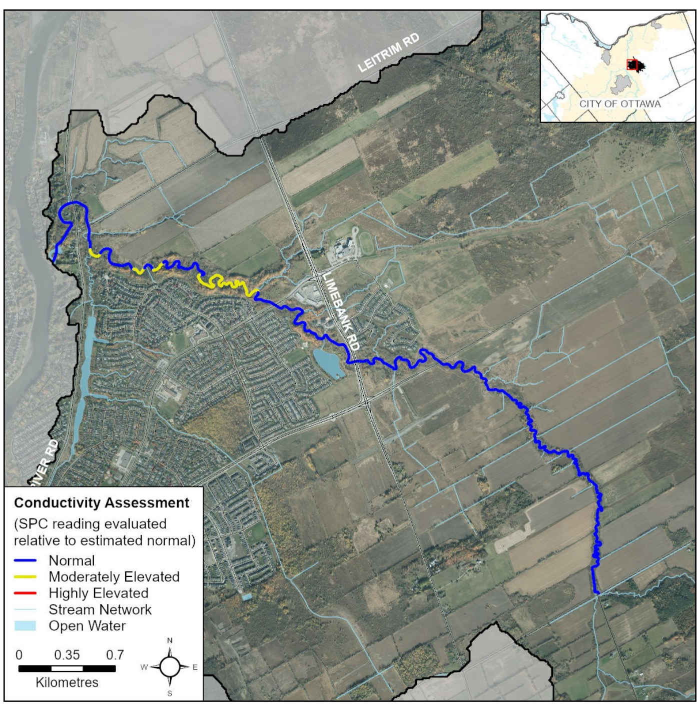


Figure 26 Relative specific conductivity levels along Mosquito Creek

Groundwater

Groundwater discharge areas can influence stream temperature, contribute nutrients, and provide important stream habitat for fish and other biota. During stream surveys, indicators of groundwater discharge were noted when observed (Figure 29). Indicators included: springs/ seeps, watercress, iron staining, significant temperature changes and rainbow mineral film.

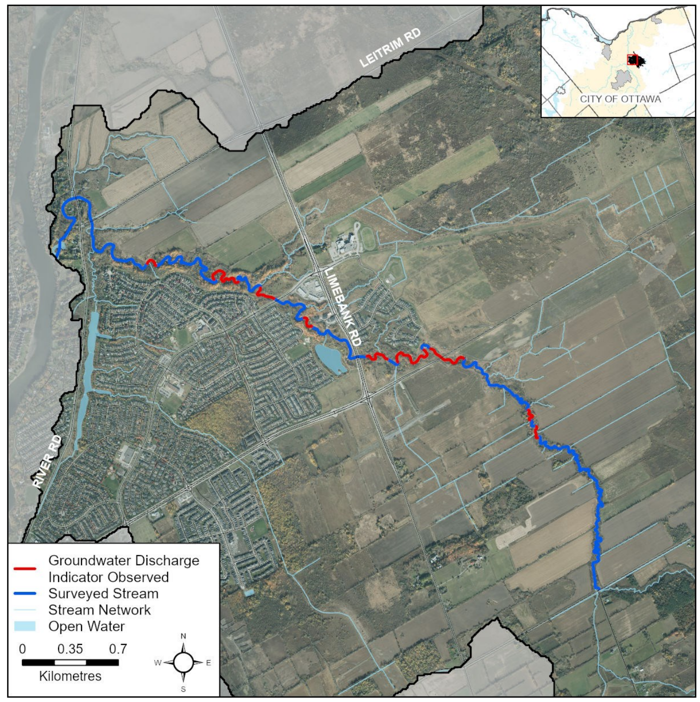


Figure 29 Groundwater indicators observed in the Mosquito Creek catchment

A spring observed in the upper reaches of Mosquito Creek

Mosquito Creek Thermal Classification

Thermal Classification

Instream water temperatures are influenced by various factors including, season, time of day, precipitation, storm water run off, springs, tributaries, drains, discharge pipes, stream shading from riparian vegetation and artificial shade created by infrastructure. To monitor water temperatures in Mosquito Creek, four temperature loggers were placed in April and retrieved in early November.

Figure 27 shows where thermal sampling sites were located. Analysis of data from all four loggers (using the Stoneman and Jones, 1996, method adapted by Chu et al., 2009), indicate that the thermal classification of Mosquito Creek ranges between warmwater and coolwater. Figures 28 and 29 show a comparison between 2015 and 2023. Due to instrument malfunction in 2015, only two thermal sampling sites were recorded at Spratt Road and Earl Armstrong Road. Fish species observed in that area have thermal preferences from cool to warm as indicated by Cocker at al. (2001).

Figure 27 Temperature logger locations on Mosquito Creek

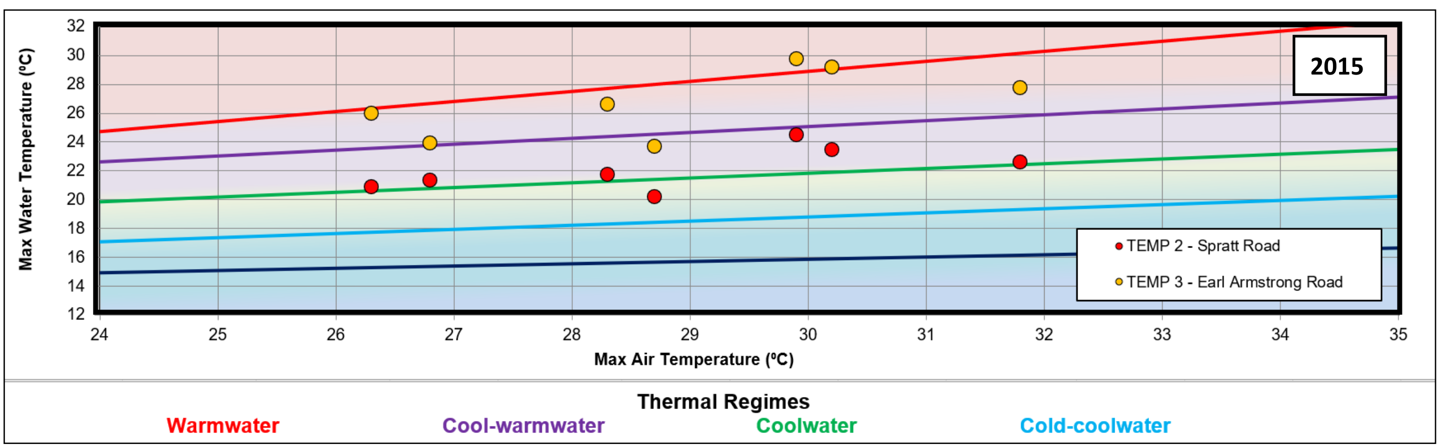


Figure 28 Thermal Classification for Mosquito Creek with the five thermal regimes adapted from Stoneman and Jones (1996) by Chu et al. (2009): warmwater to coolwarm on Mosquito Creek in 2015

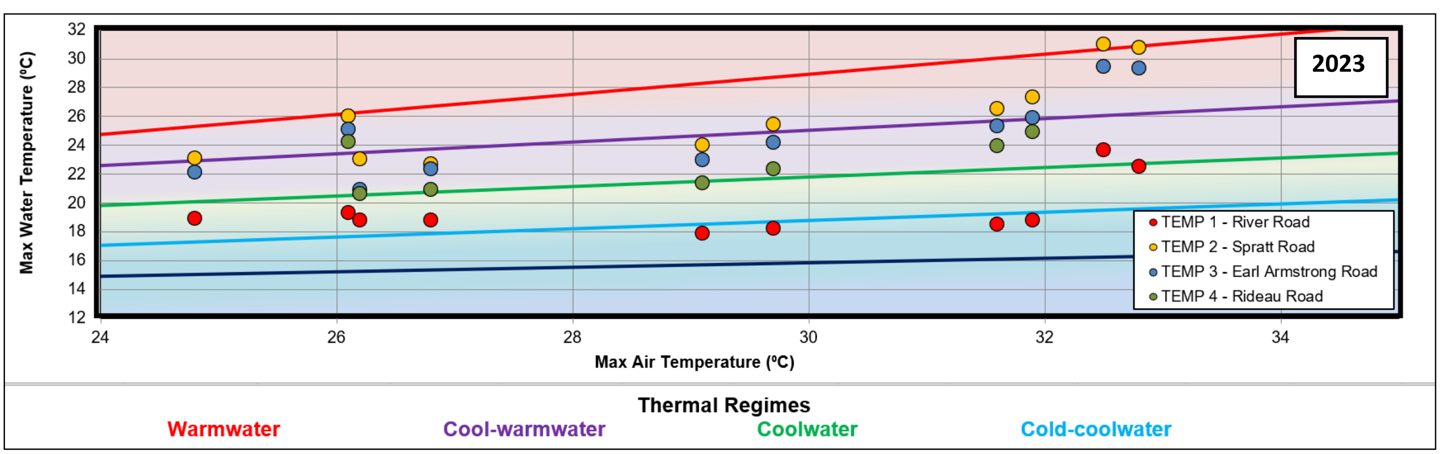


Figure 29 Thermal Classification for Mosquito Creek with the five thermal regimes adapted from Stoneman and Jones (1996) by Chu et al. (2009): coolwarm to coolwater on Mosquito Creek in 2023

Mosquito Creek Fish Community

Fish Community Summary

Five fish sampling sites were evaluated between May and July 2023. Four site locations were sampled with the use of a backpack electrofishing unit, and one site was sampled with a bag seine net.

Twenty species were captured in 2023, they are listed in Table 2 along with their thermal classification preferences (Coker et al., 2001) and MNR species codes. Mosquito Creek had a mixed fish community ranging from cold-cool to warm water species.
The sampling locations where these species were observed, as well as RVCA historical sites, are depicted in Figure 30. The codes used in the figure are the MNR species codes provided in Table 2. For comparisons across sampling years and a complete list of RVCA historical fish records from Mosquito Creek refer to page 23 of this report.

Table 2 Fish species observed in Mosquito Creek in 2023

Species	Thermal Class	MNR Species Code
blacknose dace *Rhinichthys atratulus*	**Cool**	BnDac
blackside darter *Percina maculata*	**Cool**	BsDar
bluegill *Lepomis macrochirus*	**Warm**	Blueg
bluntnose minnow *Pimephales notatus*	**Warm**	BnMin
brassy minnow *Hybognathus hankinsoni*	**Cool**	BrMin
brook stickleback *Culaea inconstans*	**Cool**	BrSti
central mudminnow *Umbra limi*	**Cool**	CeMud
common shiner *Luxilus cornutus*	**Cool**	CoShi
creek chub *Semotilus atromaculatus*	**Cool**	CrChu
fathead minnow Pimephales promelas	**Warm**	FhMin
darter species *Etheostoma spp.*	**Cool**	JoDar
logperch *Percina caprodes*	**Cool-warm**	Logpe
longnose dace *Rhinichthys cataractae*	**Cool**	LnDac
mottled sculpin *Cottus bairdii*	**Cold**	MoScu
northern pearl dace *Margariscus nachtriebi*	**Cold-Cool**	PeDac
northern redbelly dace *Chrosomus eos*	**Cool-warm**	NRDac
pumpkinseed *Lepomis gibbosus*	**Warm**	Pumpk
rock bass *Ambloplites rupestris*	**Cool**	RoBas
rosyface shiner *Notropis rubellus*	**Warm**	RoShi
white sucker *Catostomus commersonii*	**Cool**	WhSuc
Total Species		**20**

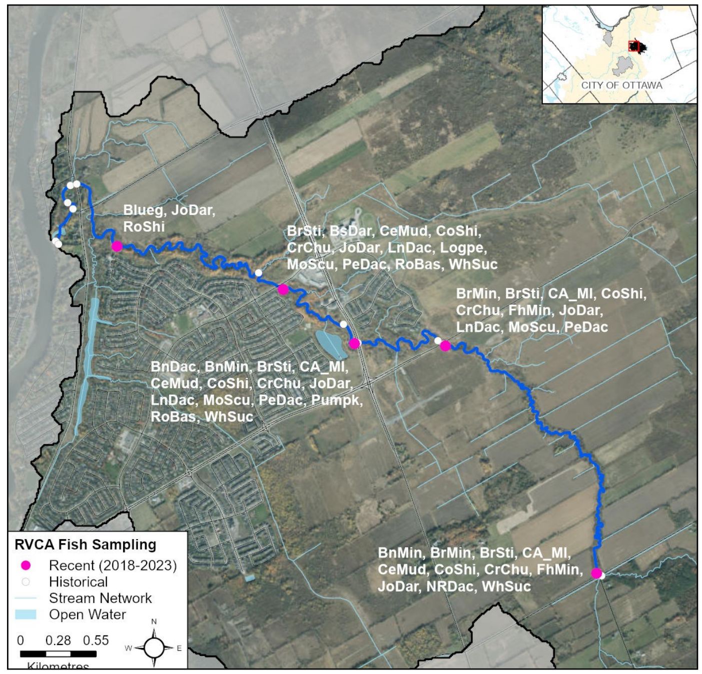


Figure 30 Mosquito Creek fish sampling locations and fish species observations from 2013-2023

Creek chubs were prominent in all sampling locations of Mosquito Creek

Fish community sampling by electrofishing (above) and a logperch (below) observed in Mosquito Creek

Migratory Obstructions

It is important to know locations of migratory obstructions because these can prevent fish from accessing important spawning and rearing habitat. Migratory obstructions can be natural or manmade, and they can be permanent or seasonal.

There were three migratory obstructions observed along the surveyed portions of Mosquito Creek. These migratory obstructions observed during stream surveys in 2023 are shown in Figure 31. All of these were debris dams which can become migratory obstructions when water levels are low.

Beaver Dams

Beaver dams create natural changes in the environment. Some of the benefits include providing habitat for wildlife, flood control, and silt retention. Additional benefits come from bacterial decomposition of wood material used in the dams which removes excess nutrient and toxins. Beaver dams may be seasonal potential barriers to fish migration.

In 2023 a total of seven beaver dams were identified on the surveyed portions of Mosquito Creek and are shown in Figure 32. Additionally, one beaver lodge was documented near the month of Mosquito Creek.

Debris dams in Mosquito Creek create seasonal migratory obstructions.

An active beaver dam along Mosquito Creek downstream of Spratt Road.

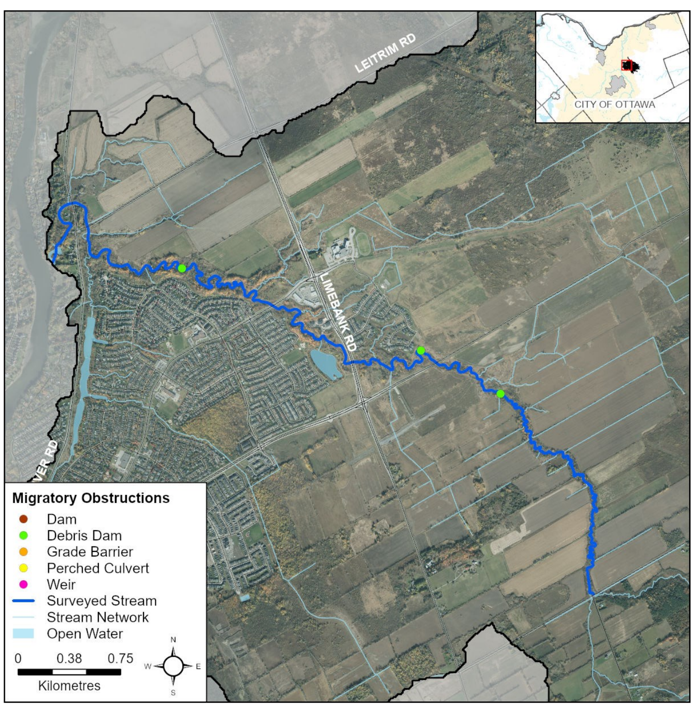


Figure 31 Locations of migratory obstructions along Mosquito Creek catchment

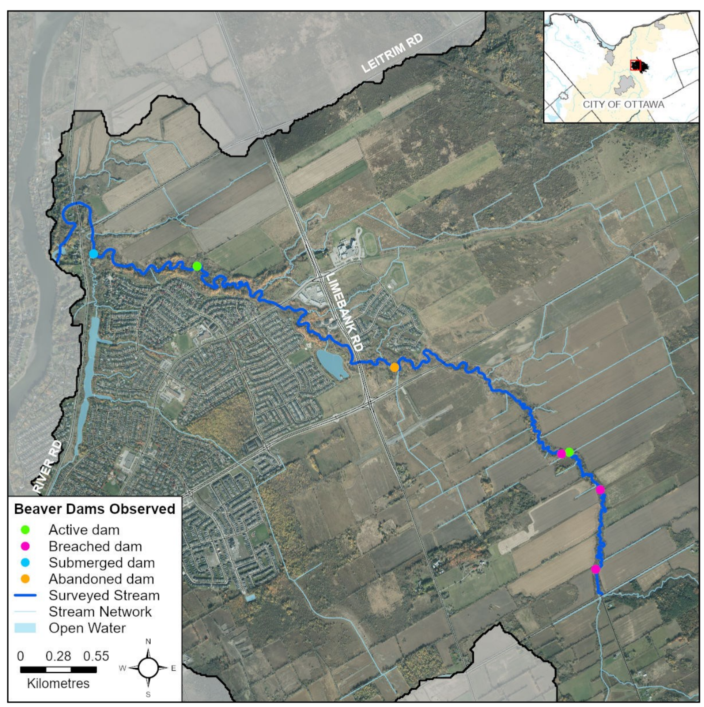


Figure 32 Locations of beaver dams along Mosquito Creek

Headwater Drainage Feature Assessment

Headwater drainage features (HDF) represent the origin from which water enters a watershed. These are small depressions, stream and wetland features that capture flows from groundwater discharge, rain and snow melt water and transport it to larger streams and rivers. In their natural state, they provide (OSAP, 2017):

- flood mitigation as water storage capacity
- water purification and groundwater discharge
- seasonal and permanent habitat refuge for fish, including spawning and nursery areas
- wildlife migration corridors/breeding areas
- storage and conveyance of sediment, nutrients and food sources for fish and wildlife

Headwaters Sampling

RVCA is working with other Conservation Authorities and the Ministry of Natural Resources and Forestry to implement the protocol with the goal of providing standard datasets to support science development and monitoring of headwater drainage features.

Features were evaluated as per the Ontario Stream Assessment Protocol (OSAP, 2017). This protocol measures zero, first and second order headwater drainage features. It is a rapid assessment method characterizing the amount of water, sediment transport, and storage capacity within headwater drainage features. In 2023, a total of 28 HDF sites were assessed in the Mosquito Creek Catchment (Figure 33).

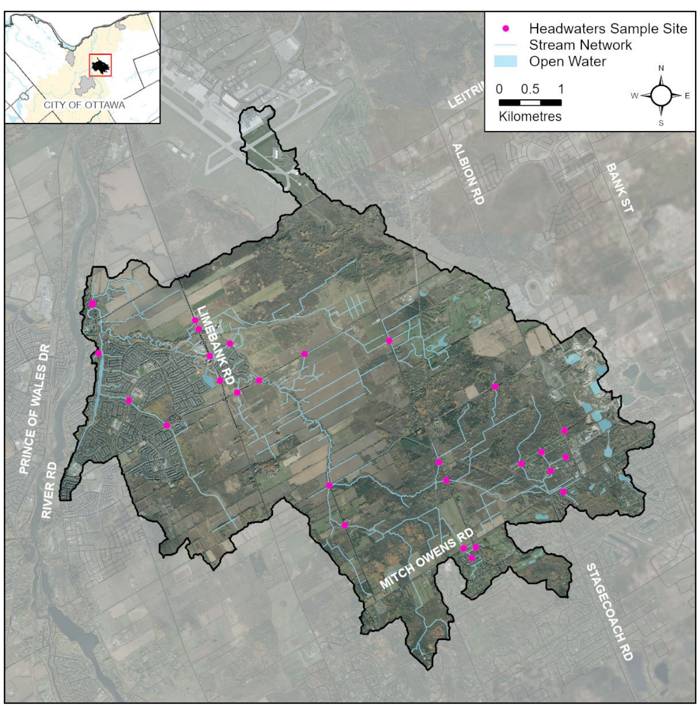


Figure 33 Location of headwater drainage feature sampling sites in the Mosquito Creek catchment

Feature Type

The headwater sampling protocol assesses the feature type in order to understand the function of each feature. The evaluation includes the following classifications: defined natural channel, channelized or constrained, multi-thread, no defined feature, tiled, wetland, swale, roadside ditch and pond outlet. By assessing the values associated with the headwater drainage features in the catchment area we can understand the ecosystem services that they provide to the watershed in the form of hydrology, sediment transport, and aquatic and terrestrial functions.

Figure 34 shows the feature type of the primary feature at the sampling locations. Channelized features were dominant, with 11 sites being observed. Five road-side ditches and two pond outlets were also sampled. The remaining features were natural with two of them being wetland features.

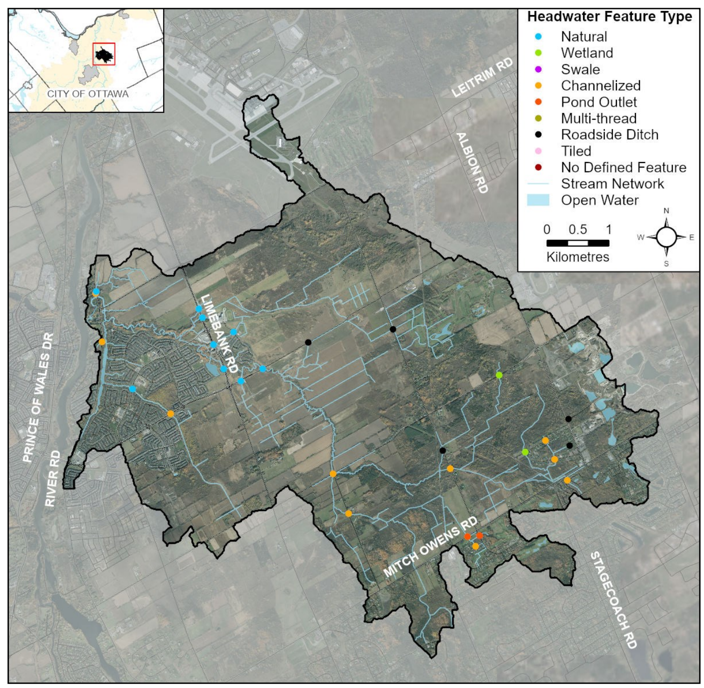


Figure 34 Map of Mosquito Creek catchment headwater drainage feature types

A wetland headwater feature near Rideau Road within the Mosquito Creek catchment

Headwater Feature Flow

Flow conditions in headwater features can be variable throughout the year in response to yearly seasonal weather conditions. This protocol targets features that are perennial or intermittent. Intermittent flow conditions are those where water typically flows at least six months of the year. Perennial systems flow year round. Sites were observed in the spring and summer; flow conditions were compared. Flow conditions in the Mosquito Creek catchment area are shown in Figure 35.

Intermittent headwater drainage feature with spring and summer conditions near Earl Armstrong Road

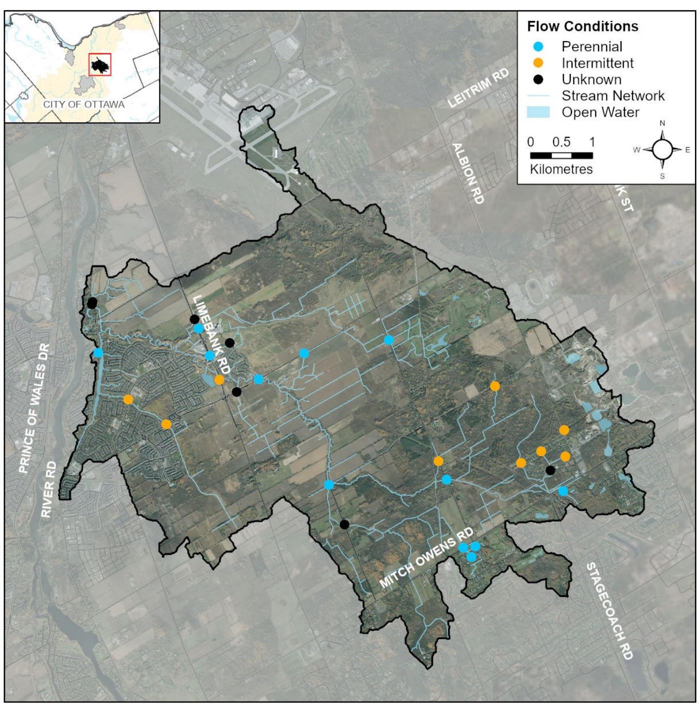


Figure 35 Headwater drainage feature flow conditions in the Mosquito Creek catchment

Feature Channel Modifications

Channel modifications can influence HDF conditions and function. Modifications that were of focus included dredging (and historical channel straightening), hardening (e.g. rip-rap, armour stone, gabion baskets) or on-line ponds.

Figure 36 shows channel modifications observed in Mosquito Creek headwater drainage features. Modifications in this catchment for its headwater drainage features are channel hardening with rip rap, along with channel straightening.

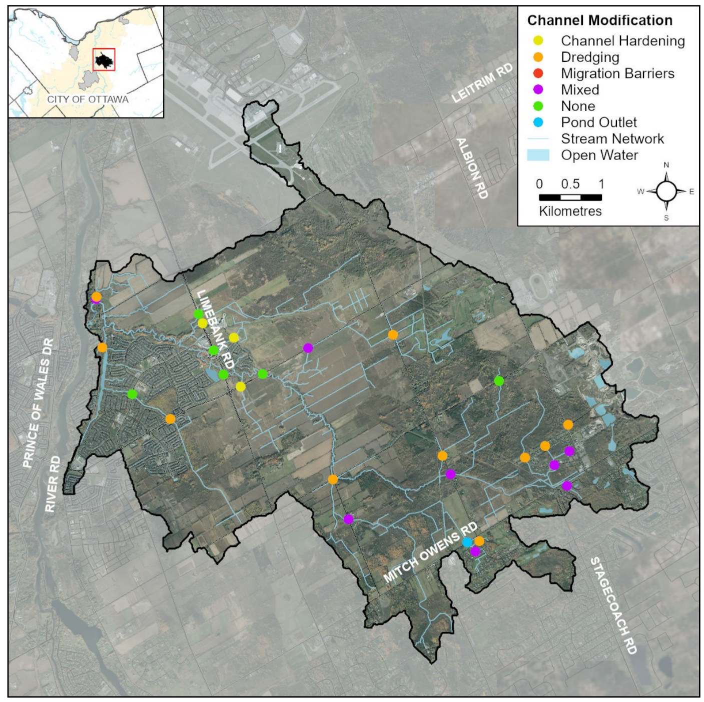


Figure 36 Headwater drainage feature channel modifications in the Mosquito Creek catchment

An example of channel straightening on a headwater drainage feature near Mitch Owens Road

Headwater Feature Vegetation

Headwater feature vegetation evaluates the type of vegetation that is found within the drainage feature. The type of vegetation within the channel influences the aquatic and terrestrial ecosystem values that the feature provides. For some types of headwater features the vegetation within the feature plays an important role in flow, sediment movement and provides wildlife habitat. The following classifications are evaluated: none, lawn, wetland, meadow, scrubland and forest.

Figure 37 depicts the dominant vegetation observed at the sampled sites in the Mosquito Creek catchment. Thirteen features were dominated by wetland vegetation. Five features were dominated by meadow vegetation. The remaining features (11) had no vegetation in the spring, where flows and sediment transport are unmitigated by the lack of vegetation.

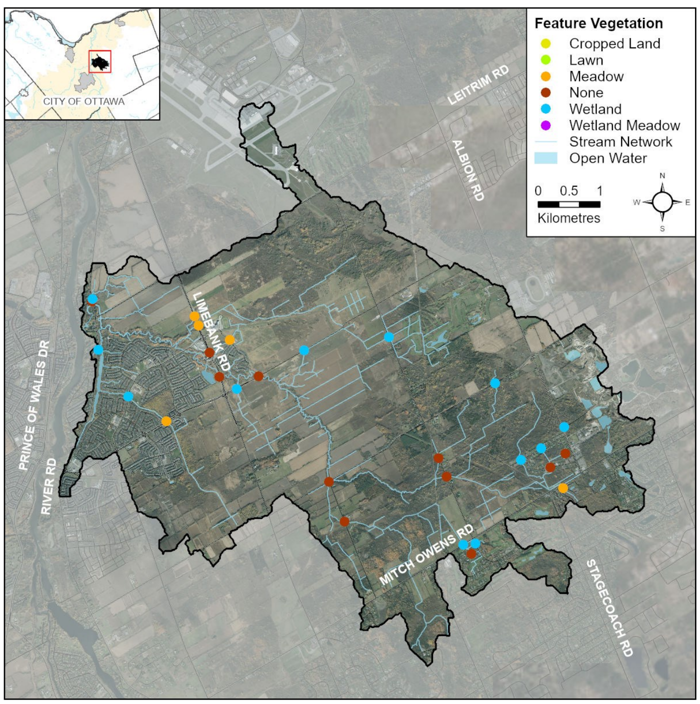


Figure 37 Headwater drainage in feature vegetation in the Mosquito Creek catchment

Headwater feature with no instream vegetation on Rideau Road

Headwater Feature Riparian Vegetation

Headwater riparian vegetation evaluates the type of vegetation that is found along the adjacent lands of a headwater drainage feature. The type of vegetation within the riparian corridor influences the aquatic and terrestrial ecosystem values that the feature provides to the watershed.

Figure 38 shows the type of riparian vegetation observed at the sampled headwater sites in the Mosquito Creek catchment. They are grouped as natural, and other riparian zones which have anthropogenic influences from agricultural areas, residential areas as well as road infrastructure.

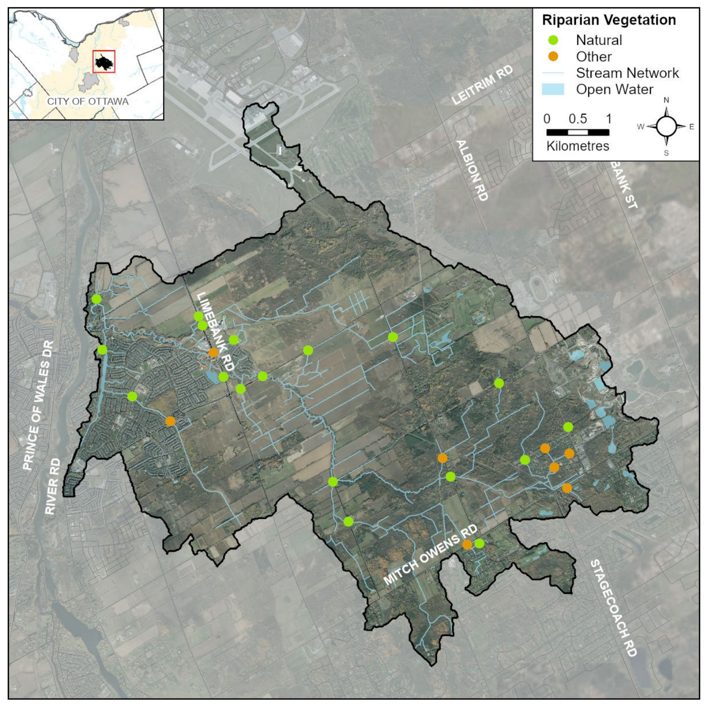


Figure 38 Riparian vegetation types along headwater drainage features in the Mosquito Creek catchment

Headwater drainage feature with natural meadow, scrubland and wetland riparian vegetation off of Bowesville Road

Headwater Feature Sediment Deposition

Assessing the amount of recent sediment deposition in a channel provides an index of the degree to which the feature could be transporting sediment downstream (OSAP, 2017). Sediment transport is a natural process, however, excessive sedimentation can be indicative of higher erosion than a natural system can accommodate. High sediment deposition can indicate the need for further assessment and potential implementation of best management practices.

From the features assessed, sediment deposition ranged from minimal to extensive. Thirteen features had evidence of minimal deposition levels. Eleven features had moderate amounts of deposition. Two features had substantial levels, while another two features had extensive deposition levels. Figure 39 displays the levels of sediment deposition observed in the headwater features of the Mosquito Creek catchment.

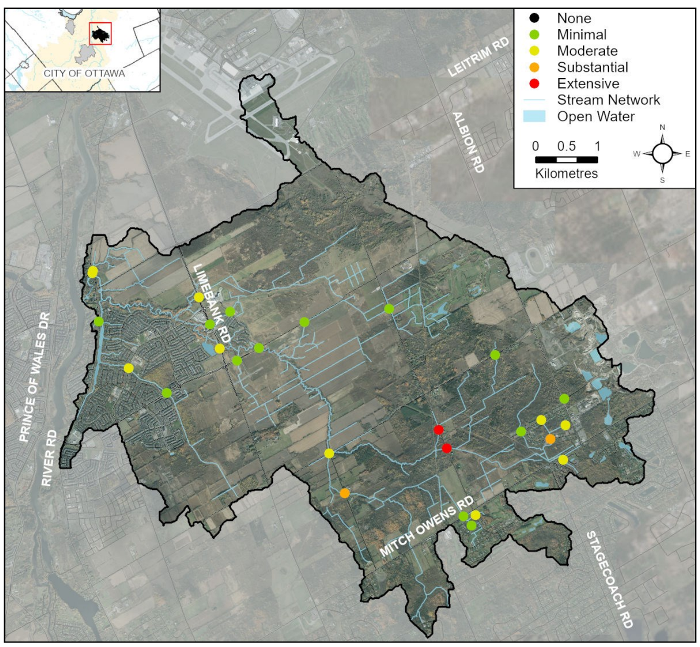


Figure 39 Headwater drainage feature sediment deposition in the Mosquito Creek catchment

Substantial sediment deposition observed in a headwater drainage feature on Bowesville Road

Headwater Feature Upstream Roughness

Feature roughness is a relative measure of the amount of material within the feature that diffuses flows (OSAP, 2017). Materials on the channel bottom that provide roughness include vegetation, wood material as well as boulders and cobble substrates. Roughness can reduce erosion downstream of the feature, as well as providing important habitat to a variety of aquatic organisms, and producing food sources.

This parameter is categorized depending on the amount of roughness coverage in a channel: minimal (less than 10 %), moderate (10-40 %), high (40-60 %), and extreme (more than 60 %). Due to the presence of wetlands in the headwaters of Mosquito Creek, several headwater drainage features exhibited extreme roughness as seen in Figure 40.

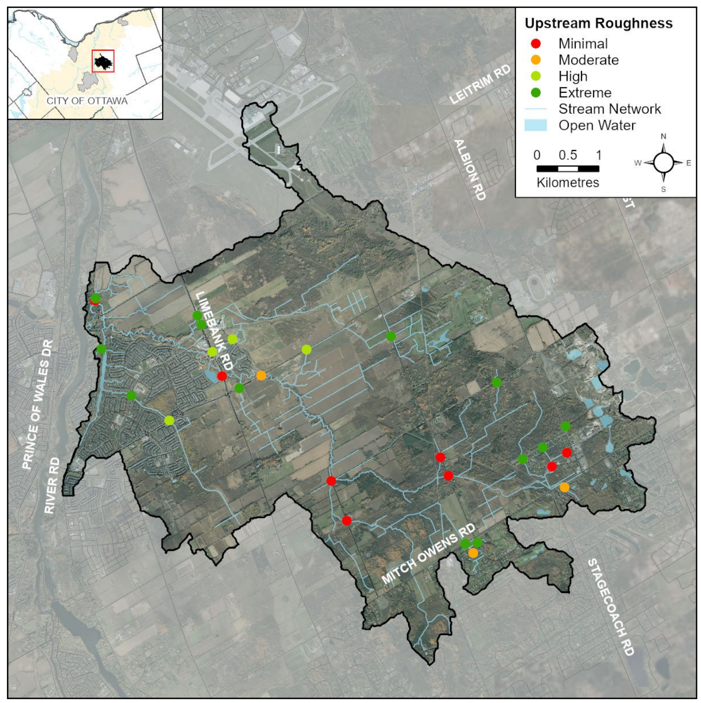


Figure 40 Headwater drainage feature roughness in the Mosquito Creek catchment

Extreme roughness due to high presence of vegetation on Bowesville Road

Stream Comparison Between 2009, 2015 and 2023

The following tables provide a comparison of observations on Mosquito Creek between the 2009, 2015 and 2023 survey years (RVCA 2009, RVCA 2015). As monitoring protocols since 2009 have been modified and enhanced, only certain data from that year can be compared to later years. This information is a comparative evaluation and doesn't represent the entirety of our assessment.

Water Chemistry

Water chemistry parameters are collected throughout all the sections surveyed in the stream. This criteria reflects the conditions and changes in the environment. Variation in these conditions can be attributed to environmental and ecological changes. Some can be in part due to natural variability within the system from various weather, seasonal, and annual conditions. Table 3 shows a comparison of these water chemistry parameters between 2009, 2015, and 2023.

Table 3 Water chemistry comparison (2009/2015/2023)

Water Chemistry (2009/2015/2023)				
Year	Parameter	Unit	Average	STND Error
2009	pH	-	8.17	±0.03
2015	pH	-	7.90	±0.02
2023	pH	-	7.88	±0.02
2009	Sp. Conductivity	us/cm	738.7	±17.27
2015	Sp. Conductivity	us/cm	1034.4	±12.93
2023	Sp. Conductivity	us/cm	958.5	±20.24
2009	Dissolved Oxygen	mg/L	10.4	±0.20
2015	Dissolved Oxygen	mg/L	8.4	±0.25
2023	Dissolved Oxygen	mg/L	6.5	±0.23
2009	Water Temperature	ºC	18.6	±0.25
2015	Water Temperature	ºC	18.8	±0.20
2023	Water Temperature	ºC	20.6	±0.34
2009	Standardized Stream Temperature[1]	ºC Water / 1ºC Air	0.79	±0.50
2015	Standardized Stream Temperature[1]	ºC Water / 1ºC Air	0.85	±0.32
2023	Standardized Stream Temperature[1]	ºC Water / 1ºC Air	0.80	±0.25

[1] ***Standardized Stream Temperature:*** Temperature data is collected via logger and standardized based on the following conditions:

- Daily maximum air temperatures must exceed 24.5 ºC
- No precipitation for 3 days preceding measurement
- Measurements to be taken between 4:00PM—6:00PM
- Water temperature points collected from July 1st —September 10th
- Logger must be deployed in flowing waters

The average pH and specific conductivity in 2023 were nearly the same as in 2015. pH only decreased by 0.02, and specific conductivity only decreased 75.9 µS/cm since 2015. These slight changes may reflect seasonal variability. Average dissolved oxygen levels appear to be lowering over time. These changes can also be attributed to seasonal conditions and warmer temperatures which are less conducive to the stream's ability to hold more oxygen.

Average summer water temperatures ranges are increasing over time from cooler water in 2009 (18.8°C) to warmer values in 2023 (20.6°C). Aside from these general temperature observations, loggers provide a detailed recording of stream thermal conditions. Standardized stream temperature assessments account for climatic factors including air temperatures and precipitation. With the data collected from temperature loggers, standardized stream temperature factors were calculated and summarized in Table 3. This factor has fluctuated over time from 0.79 for every degree of air in 2009, to 0.85 in 2015, and 0.80 in 2023.

Volunteer collecting water chemistry in Mosquito Creek

Invasive Species

The percentage of sections surveyed where invasive species were observed had a small decrease of one percent (Table 4). Half of the invasive species previously reported had an increase in the number of sections they were observed in. The other half of invasive species reported a decrease in the number of sections they were observed in, including curly-leaved pondweed, European frogbit, flowing rush, garlic mustard, Manitoba maple, Phragmites, and purple loosestrife. These species are likely still present in strong numbers, but may have been noted less in the surveys than in 2015. There are also species that were not previously reported, including bull thistle and rusty crayfish.

Table 4 Invasive species presence (% of sections) observed in 2009, 2015 and 2023 (NR are species that were not reported in that survey year)

Invasive Species	2009	2015	2023	+/-
bull thistle	NR	NR	8%	▲
common buckthorn	NR	29%	57%	▲
curly-leaved pondweed	NR	17%	16%	▼
European frogbit	5%	9%	1%	▼
flowering rush	11%	20%	13%	▼
garlic mustard	4%	23%	10%	▼
glossy buckthorn	NR	1%	18%	▲
Himalayan balsam	NR	3%	10%	▲
Manitoba maple	5%	71%	81%	▲
non-native honeysuckles	NR	11%	17%	▲
Phragmites (common reed)	2%	1%	NR	▼
poison/wild parsnip	4%	20%	39%	▲
purple loosestrife	35%	81%	14%	▼
rusty crayfish	1%	NR	5%	▲
Total percent of sections invaded	**44%**	**100%**	**99%**	-

Recorded observations of non-native honeysuckles has increased in 2023

Instream Aquatic Vegetation

Table 6 shows increases and decreases in instream aquatic vegetation from 2009-2023. Narrow-leaved emergent plants (e.g. sedges) and robust emergent plants (e.g. cattails) had decreases in presence within catchment sections. Submerged plants (e.g. pondweed) and algae also had a decrease of presence, though experienced more drastic declines of 28 percent or higher. Broad– leaved emergent plants, free-floating plants (e.g. frog-bit), and floating plants (e.g. water lilies) had higher observations in the number of sections surveyed. These changes in instream aquatic vegetation can be associated with different seasonal plant emergence or seasonal variances in temperature and precipitation.

Table 6 Instream aquatic vegetation (presence in % of sections) comparison between 2009-2023

Instream Vegetation	2009	2015	2023	+/-
narrow-leaved emergent plants	60%	72%	58%	▼
broad-leaved emergent plants	59%	56%	67%	▲
robust emergent plants	26%	45%	29%	▼
free-floating plants	18%	15%	30%	▲
floating plants	22%	20%	33%	▲
submerged plants	84%	77%	49%	▼
algae	87%	96%	34%	▼

Section of Mosquito Creek with the presence of narrow-leaved emergent plants, and an abundance of submergent plants downstream of Limebank Road.

Fish Community

Fish sampling was carried out by the City Stream Watch program in 2009, 2015 and 2023 to evaluate fish community composition in Mosquito Creek (see Table 6). In total, 35 species have been observed in Mosquito Creek. In 2009, 29 fish species were captured at six sites; in 2015, 17 species were observed in seven sites; and 20 species were observed in five sites in 2023. Sample locations in 2023 were similar to those sampled in 2015.

The majority of species observed in 2023 had been captured in previous years, with the blacknose dace, blackside darter, and rosyface shiner as new observations.

Table 7 Comparison of fish species caught between 2009-2023

Species	2009	2015	2023
black crappie *Pomoxis nigromaculatus*		X	
blackchin shiner *Notropis heterodon*	X		
blacknose dace *Rhinichthys atratulus*			X
blacknose shiner *Notropis heterolepis*	X		
blackside darter *Percina maculata*			X
bluegill Lepomis macrochirus	X		X
bluntnose minnow *Pimephales notatus*	X	X	X
brassy minnow *Hybognathus hankinsoni*	X		X
brook silverside *Labidesthes sicculus*	X	X	
brook stickleback *Culaea inconstans*	X	X	X
brown bullhead *Ameiurus nebulosus*	X		
central mudminnow *Umbra limi*	X		X
common shiner *Luxilus cornutus*	X	X	X
creek chub *Semotilus atromaculatus*	X	X	X
darter species *Etheostoma spp.*			X
emerald shiner *Notropis atherinoides*	X		
fathead minnow Pimephales promelas	X	X	X
finescale dace *Chrosomus neogaeus*	X		
golden shiner *Notemigonus crysoleucas*	X	X	

Species continued	2009	2015	2023
goldfish *Carassius auratus*		X	
largemouth bass *Micropterus salmoides*	X		
logperch *Percina caprodes*	X	X	X
longnose dace *Rhinichthys cataractae*	X	X	X
mottled sculpin *Cottus bairdii*	X	X	X
muskellunge *Esox masquinongy*	X		
northern pearl dace *Margariscus nachtriebi*	X	X	X
northern pike *Esox lucius*	X		
northern redbelly dace *Chrosomus eos*	X	X	X
pumpkinseed *Lepomis gibbosus*	X		X
Redhorse sp. *Moxostoma spp.*	X		
rock bass *Ambloplites rupestris*	X	X	X
rosyface shiner *Notropis rubellus*			X
smallmouth bass *Micropterus dolomieu*	X		
spotfin shiner *Cyprinella spiloptera*	X		
walleye *Sander vitreus*	X		
white sucker *Catostomus commersonii*	X	X	X
yellow perch *Perca flavescens*	X	X	
Total Species 37	**31**	**17**	**20**

White sucker, a coolwater species, was observed in Mosquito Creek in all three sample years.

Monitoring and Restoration

Monitoring on Mosquito Creek

Table 8 highlights recent and past monitoring that has been done on Mosquito Creek by the Rideau Valley Conservation Authority's City Stream Watch program. Monitoring activities and efforts have changed over the years.

Table 8 City Stream Watch monitoring on Mosquito Creek

Accomplishment	Year	Description
City Stream Watch Stream Monitoring	2009	8.5 km of stream was surveyed
	2015	7.5 km of stream was surveyed
	2023	7.7 km of stream was surveyed
City Stream Watch Fish Sampling	2009	six fish community sites were sampled
	2015	seven fish community sites were sampled
	2023	five fish community sites were sampled
City Stream Watch Thermal Classification	2009	two temperature probes were deployed from June to September
	2015	four temperature probes were deployed from June to September
	2023	four temperature probe was deployed from April to October
Headwater Drainage Feature Assessment	2015	17 headwater drainage feature sites were sampled in the catchment
	2023	28 headwater drainage feature sites were sampled in the catchment

RVCA staff measuring stream width on Mosquito Creek downstream of Limebank Road

<u>Potential Riparian Restoration Opportunities</u>

Riparian restoration opportunities include potential enhancement through erosion control, riparian planting and invasive species control. Opportunities were identified along Mosquito Creek surveyed areas (Figure 41).

Erosion Control

There are multiple areas along the creek that would benefit from erosion control measures to stabilize the banks. Bioengineering methods such as installation of fascines, brush mattresses, soil wrapping and livestaking of shrubs are some methods to prevent further erosion.

Area of Mosquito Creek downstream of Spratt Road would benefit from erosion control

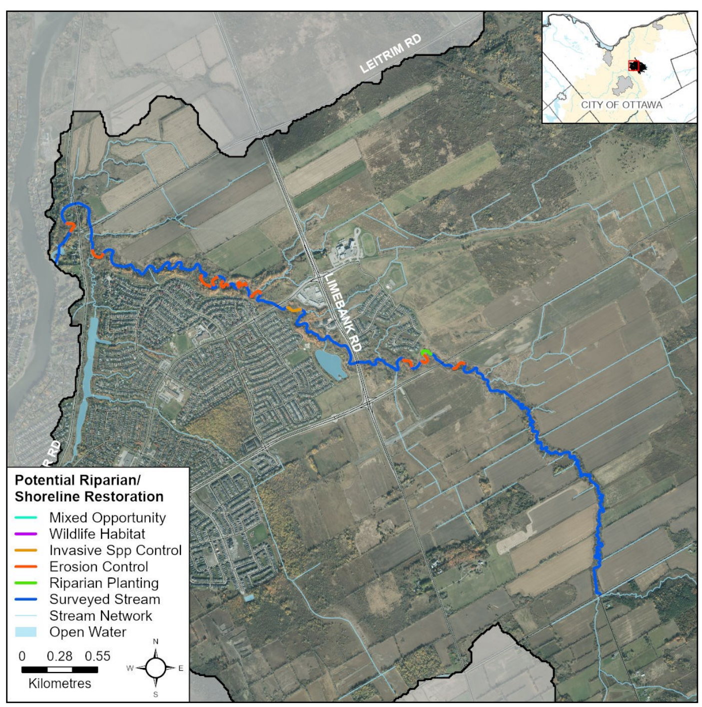


Figure 41 Potential erosion control opportunities along Mosquito Creek



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For more information on the 2023 City Stream Watch Program and the volunteer activities, please refer to the City Stream Watch 2023 Summary Report:

https://www.rvca.ca/rvca-publications/city-stream-watch-reports

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