Poole Creek
2018 Catchment Report

Monitoring Activity in the City of Ottawa

The City Stream Watch program (CSW) is an in-depth survey of a watercourse where data is collected by wading through the stream and taking detailed observations every 100 meters (m). In 2013, Mississippi Valley Conservation Authority (MVCA) joined the City Stream Watch working group and adopted the program. Since implementing the CSW program, MVCA staff and volunteers have surveyed more than 470 sections across 10 watercourses. This information has fed into the planning of riparian planting sites, habitat improvements, stream garbage pick-ups in Poole Creek and the Carp River, and invasive species removal events.

The CSW Program has three main goals:

- To provide long-term documentation of the aquatic and riparian conditions in our watershed
- To enhance public awareness about the condition and value of freshwater streams through volunteer engagement and the creation of catchment reports
- To encourage community driven restoration projects

When possible, each CSW assessment is enhanced with the application of other monitoring programs such as benthic biomonitoring, fish community sampling, temperature monitoring and assessing headwater drainage features.

Seasonal weather conditions in 2018 resulted in an above average spring flood followed by a drought which lasted through the summer and into the fall. Given the atypical seasonal conditions in 2018, all assessments were subject to the effects of low water and may not reflect the overall health of the systems. With the efforts of MVCA staff and volunteers, 109 sections in two catchments were assessed in 2018.

Poole Creek was previously monitored in 2013 resulting in 28 sections being surveyed. Where possible, this report will reflect on the differences found since our last survey of the creek.

Figure 1 shows the location of the Poole Creek subwatershed within MVCA's City Stream Watch program area.

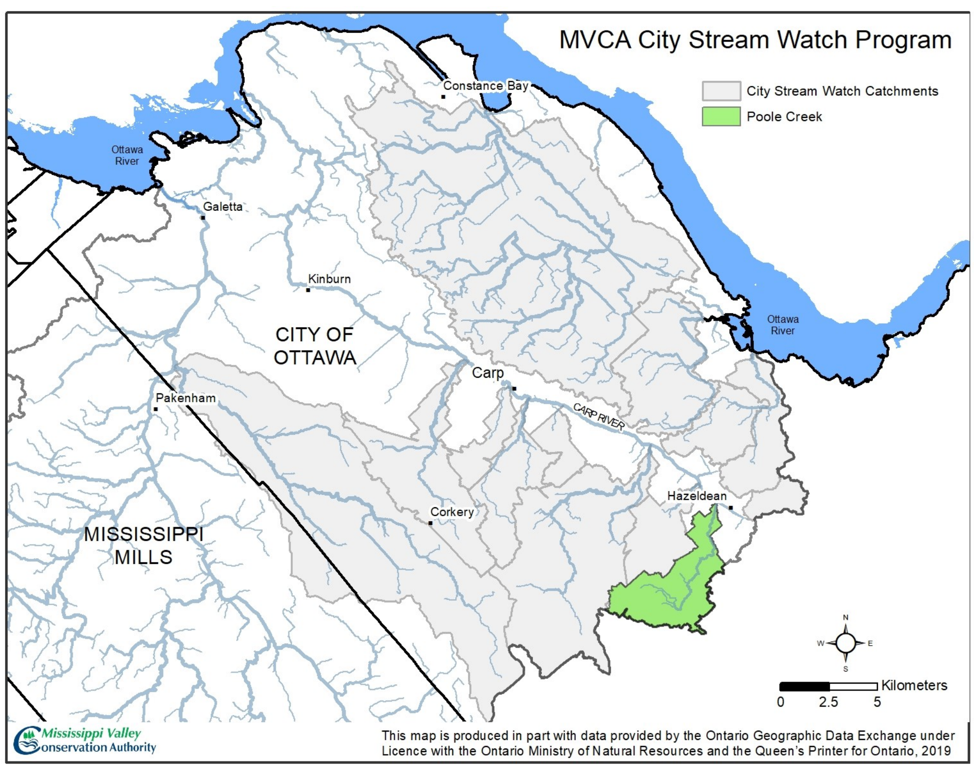


Figure 1: *MVCA's City Stream Watch area highlighting the location of the Poole Creek subwatershed.*

Poole Creek

Located in the west end of the City of Ottawa, Poole Creek is one of eight major tributaries of the Carp River. It has a length of 11.4 kilometers (km) and drains an area of 17.3 km^2.

Poole Creek's headwaters originate in a grouping of wetlands located in the area where Highway 7 and Hazeldean Road meet, called the Goulbourn Provincially Significant Wetland Complex. The wetlands outlet near Westridge Drive and the creek flows north east to the Carp River outletting north of Maple Grove Road. Table 1 present a summary of several key features of the Poole Creek Subwatershed.

Table 1: Subwatershed Features

Area	17.3 Square Kilometers 5.6% of the Carp River Watershed
Length	11.4 Kilometers
Type	100% Permanent Cold-Cool water upstream Warm water downstream 73% Natural 27% Channelized
Land Use	28.7% Urban land-use 5.3% Rural land-use 5.3% Agriculture 22.9% Wooded area 18.7% Wetlands 5.3% Grassland 13.5% Roads
Surficial Geology	6.4% Clay 9.2% Diamicton 34.1% Organic deposits 38.1% Bedrock 3.5% Sand 8.7% Gravel

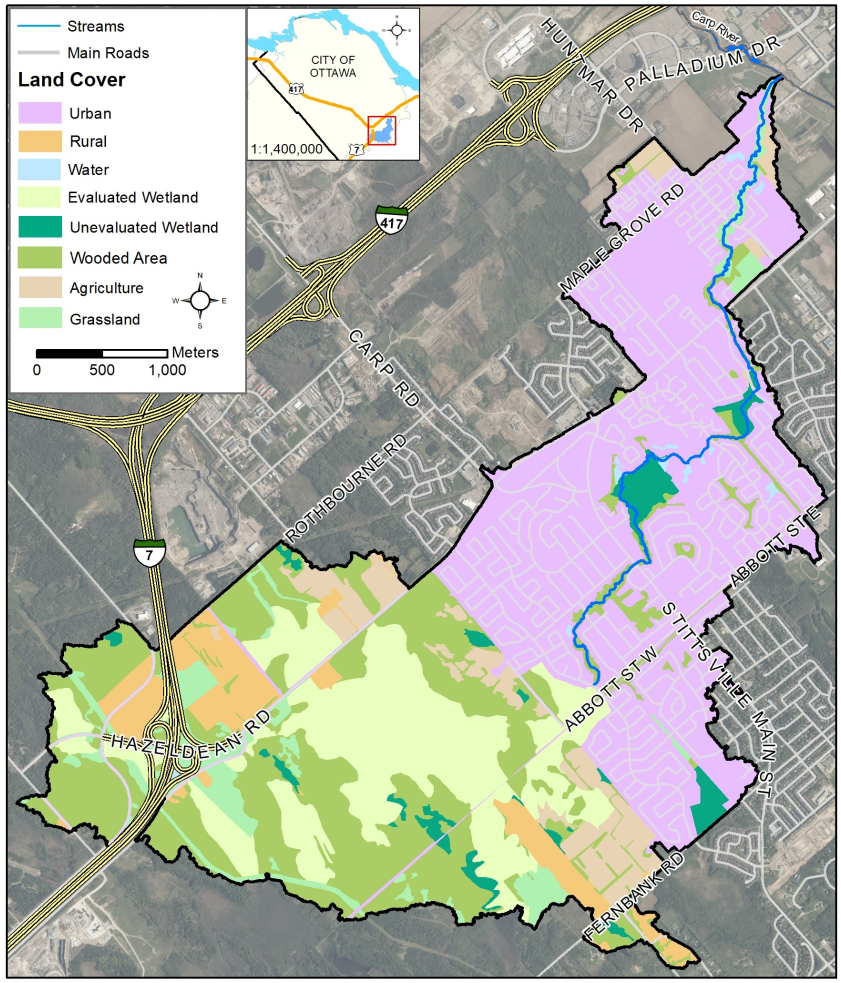


Figure 2: *Land Use in the Poole Creek subwatershed.*

The Poole Creek Subwatershed

As shown in Figure 2, the Poole Creek subwatershed is dominated by a mix of wooded and wetland areas in the headwaters and urban spaces in the remainder of the subwatershed. Of note is the Goulbourn Provincially Significant Wetland Complex in the headwaters, as well as other riparian wetlands along the creek.

Crossing a mixture of wetland, woodland and urban residential areas, the creek provides a natural corridor and habitat for a range of aquatic and terrestrial species. The City of Ottawa's Carp River Watershed Subwatershed Study describes the upper reach of Poole Creek as being in good condition and able to support a cold water fishery.

Supporting many of the natural features in Poole Creek is the cold to cool water that flows through it. The availability of cold water creates ideal living conditions for thermally sensitive fish species, such as brown trout and mottled sculpin, and is considered rare on the landscape. The forested corridor along large sections of the creek provides shade which helps protect the waters from warming and further enhances the Poole Creek watershed.

Monitoring in Poole Creek

In 2018, permission was granted to survey 53 sections of Poole Creek, shown on Figure 3, which cover approximately 5.3 km of the creek.

While these sections provide a good representation of the overall condition of Poole Creek, it should be noted that there are a few sections of the creek that are not represented in this assessment. These areas provide an additional diverse habitat with valuable natural functions. The portions of the creek that were not sampled represent mostly the wetland areas that could not be assessed using the macro stream assessment protocol and areas where permission was not granted.

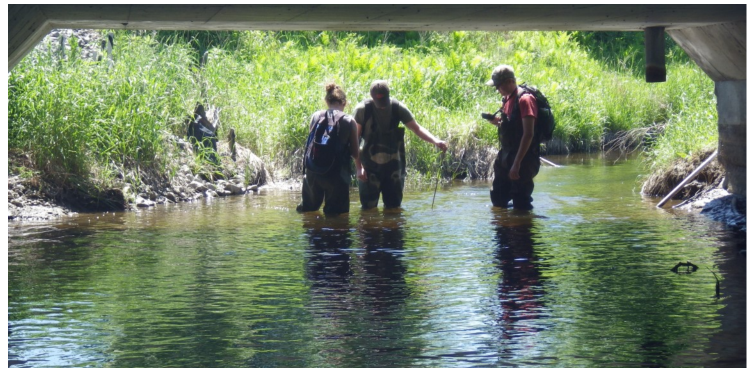
Table 2 shows a number of basic assessment measurements for Poole Creek.

Table 2: Poole Creek Assessment Facts			
	Minimum	**Maximum**	**Average**
Stream Wetted Width (m)	0.75	30.00	5.32
Stream Depth (m)	0.06	2.00	0.46
Hydraulic Head (mm)	0	250	12

Methodology

The macro stream assessment is completed using a protocol that divides the entire length of the creek into 100 m sections. Starting at the downstream end, a monitoring crew wades the creek and completes a detailed assessment of every 100 m section. If a section of the creek is unwadeable, that section is bypassed and the assessment is continued once the creek becomes wadeable again. The parameters assessed include general land use, in-stream morphology, human alterations, water chemistry, plant life, and other features presented in this report.

In 2018, MVCA sampled 25 more reaches than in 2013. Additionally, MVCA launched 4 temperature loggers, sampled the fish community at those 4 sites and sampled the benthic community at two of those sites. This made for a more robust review of conditions in Poole Creek in 2018.



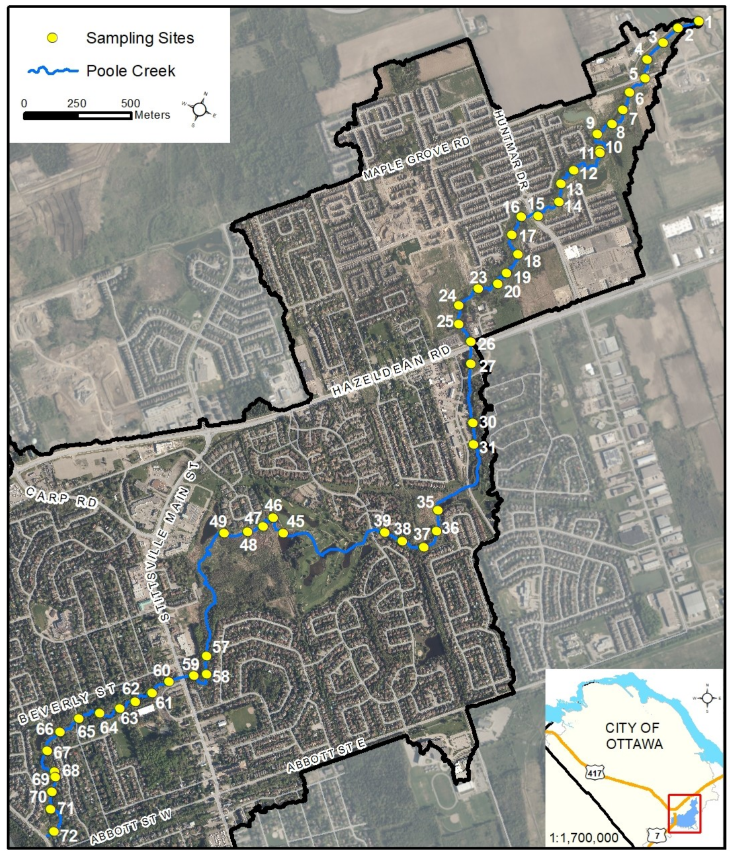


Figure 3: *Locations of the monitoring sites along Poole Creek.*

General Land Use Adjacent to Poole Creek

General land use along each surveyed section of Poole Creek is considered from the beginning to the end of each survey section (100 m) and extending outward 100 m on each side of the creek. Land use outside of this area is not included in the surveys but is nonetheless part of the subwatershed and will influence the creek (Castelle et al, 1994).

The categories of land use include infrastructure, active agriculture, pasture, abandoned agricultural fields, residential, forests, scrubland, meadow, and wetland. Figure 4 shows the overall percent of land use that was observed adjacent to Poole Creek.

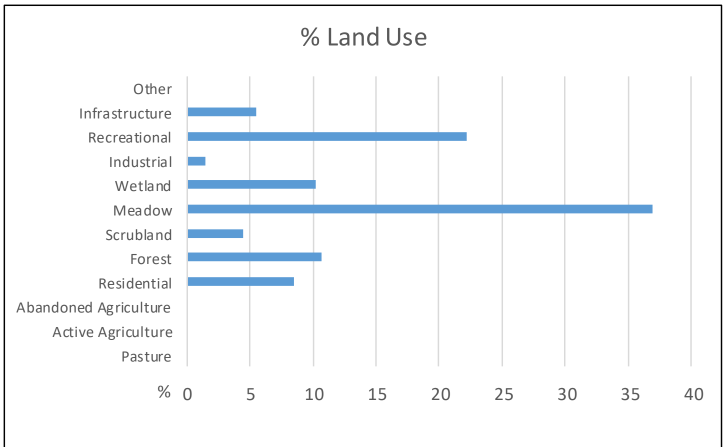


Figure 4: *Land use alongside Poole Creek.*

The three agricultural categories were not found to be present along surveyed sections of Poole Creek.

At 37%, meadow represents the most prominent category of land use followed by recreational at 22%, and forest at 11%.

The land use in the overall watershed is dominated by forest and wetland cover in the headwaters and urban development with park space corridors along the creek (Figure 2). Figure 4 shows the land use types found along the surveyed sections of Poole Creek. The meadow spaces are predominately in the lower reaches of the creek where there is less forest cover. This meadow habitat may not provide much shade to the water but it does provide a wide vegetated buffer which supports a diversity of plants and animals and helps slow overland runoff and soak up nutrients that might other wise impact the creek.

The distribution of the 11% forest cover, and its associated shade provided to the creek, is best illustrated in Figure 10.

Human Alterations to Poole Creek

In this assessment, human alterations refer to artificial changes to the actual channel of the watercourse either by straightening or relocation. Such alterations can be made in streams and rivers for many reasons including to accommodate development, such as road crossings and culverts, to make more land available for agriculture, to allow navigation of large boats, and to minimize natural erosion caused by the natural meandering pattern of flowing water. As seen in Figure 5, 2% of Poole Creek was found to be completely unaltered, 71% was natural (with minor alterations), and 25% was altered (with considerable human impact). 2% were considered highly altered.

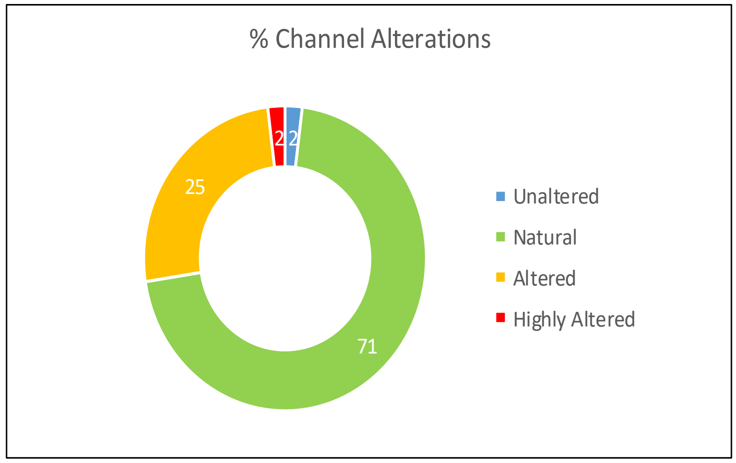


Figure 5: *Extent of human alterations to the shoreline of Poole Creek.*

It is beneficial to the overall health of the system that so much of the creek is in an unaltered or natural condition. Poole Creek does have a large number of sections that have alterations, which are associated with the number of road crossings and adjacent land uses.

Riparian Buffer along Poole Creek

The riparian buffer refers to the amount of vegetated area along the edges of the stream banks. It can consist of a variety of vegetation types including trees, shrubs, grasses and other plants. Vegetated buffers are important for protecting water quality and creating healthy aquatic habitats. They intercept sediments and contaminants as well as protect the stream banks against erosion. Buffers also improve habitat for aquatic species by shading and cooling the water and providing protection for birds and other wildlife that need to be near water for feeding or rearing young. Riparian buffers along the creek corridor also provide a natural area for wildlife movement and dispersal. While it is not the only factor affecting stream health, studies assessing adjacent land use largely show a positive relationship between buffer size and stream health (Stanfield and Kilgour, 2012).

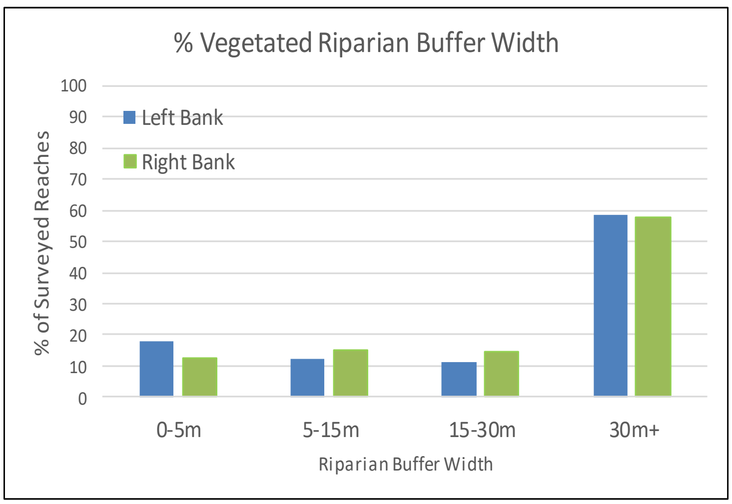


Figure 6: *Riparian buffer widths along Poole Creek.*

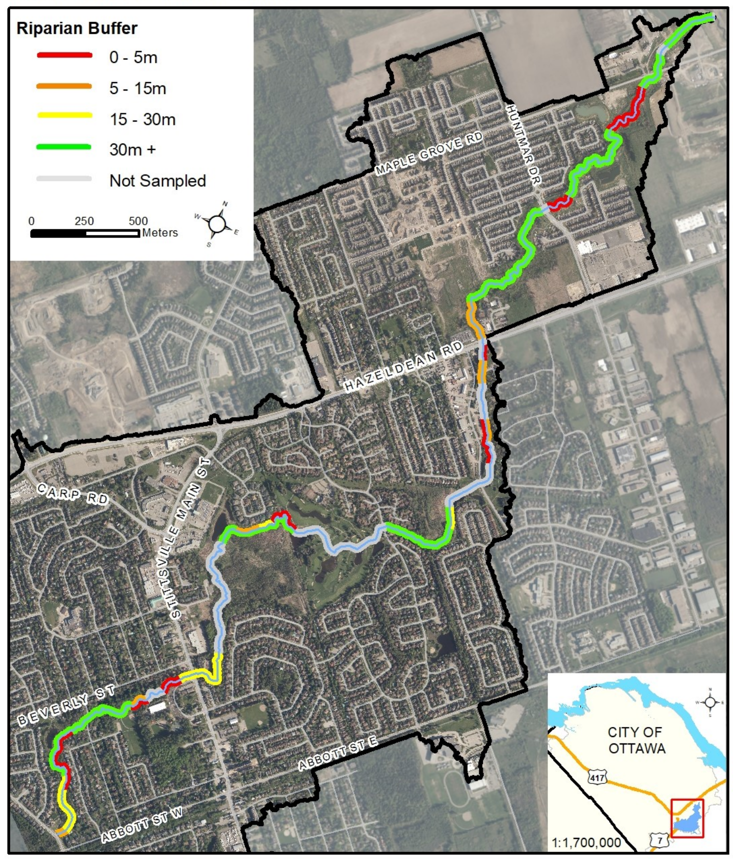


Figure 7: *Vegetated buffer widths along Poole Creek.*

Environment Canada's Guideline: *How Much Habitat is Enough?* recommends a minimum 30 m wide vegetated buffer along at least 75% of the length of both sides of a watercourse. Therefore, for this assessment, we record the width of the riparian buffer within 30 m of either side of the watercourse. As summarized in Figure 6, we found that the sections of Poole Creek that were surveyed have an excellent riparian buffer. Results for surveyed sections are very positive with 58% of the left and right banks having a buffer width greater than 30 meters. 30% of sections on the left bank and 27% of sections on the right bank had a buffer of 15 m or less. These are areas where opportunities for stewardship should be investigated.

Figure 7 shows the differences in riparian buffer widths along the surveyed reaches of Poole Creek.

Overhanging Trees and Branches

Overhanging branches and trees, a byproduct of a good riparian buffer, provide crucial nutrients in the form of coarse particulate organic matter (leaves, insects, seeds etc.) to small streams (Vannote et al. 1980). This organic matter is broken down and eaten by aquatic insects, phytoplankton and zooplankton, which are an important food source for fish and other wildlife. Overhanging branches also provide stream shading, and fallen logs create excellent habitat for fish.

Overall, Poole Creek has a high amount of coverage from overhanging trees and branches, as seen in Figure 8, with 60% of the reaches having some level of overhanging trees and branches. This reflects the surrounding natural vegetative community where the creek passes through forested areas and treed park spaces.

Figure 8 shows the data quantified as the percentage of creek sections classified according to the various amounts of overhanging trees and branches. For example, over 40% of the 53 surveyed stream sections were classified as having zero overhanging trees and branches along both the left and right bank. In contrast, over 40% of the surveyed stream sections were found to have greater than 41% overhanging branches providing food and shade to the creek.

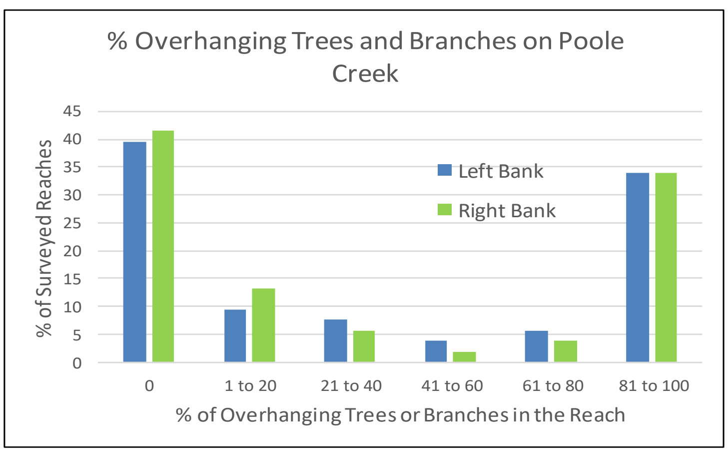


Figure 8: *Percentage of each surveyed section of Poole Creek with overhanging trees and branches.*

Figure 9 shows the distribution of the areas with overhanging trees and branches or without. For example the portion of the creek east of Stittsville Main Street (behind the grocery store) has few overhanging trees or branches as it is a cattail marsh, whereas the portions of the creek west of Stittsville Main Street are in the forested area beside the arena and have a high abundance of overhanging trees and branches.

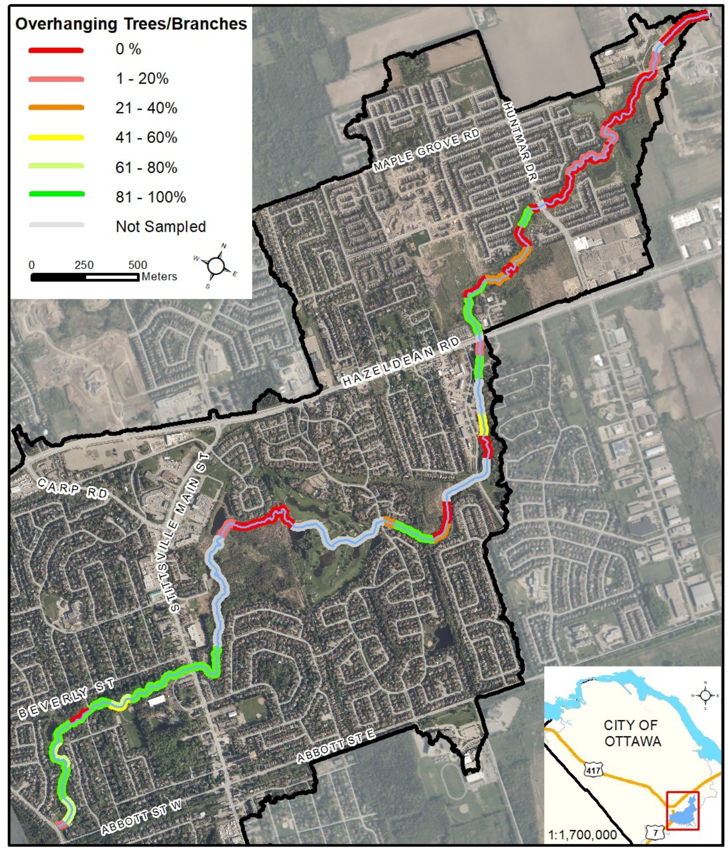


Figure 9: *Overhanging trees and branches along Poole Creek.*

Stream Shading

In addition to the previously noted benefits of having overhanging trees and shrubs along a watercourse, they also create shade. Shade is important in moderating stream temperature, contributing to food supply and helping reduce nutrients within a stream. Grasses, shrubs and trees can all provide shading to a stream, with trees providing more full coverage and grasses providing much needed shade directly along the edges where shading from trees may not be available.

Figure 10 shows the variability in the amount of stream shading along different sections of Poole Creek. The variability is due to the diversity of riparian vegetation along the creek, with large sections of open meadow, wetland or shrub land contrasted with areas of shade producing forest. (Figure 7)

Figure 11 shows the data quantified as the percentage of creek sections classified according to the various levels of shading. For example, 26% of the 53 stream sections that were surveyed were classified as having 0% shading, 23% having 1-20% shading and 8% having 21 to 40 percent. More than half of the surveyed stream sections were found to have less than 41% shading.

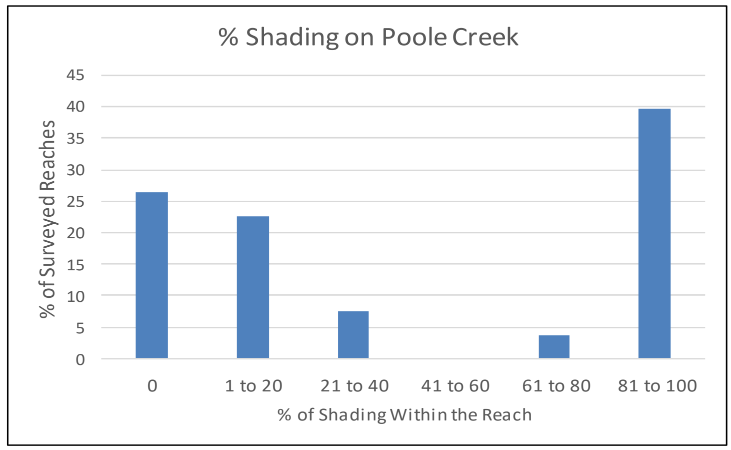


Figure 11: *Shading along Poole Creek.*

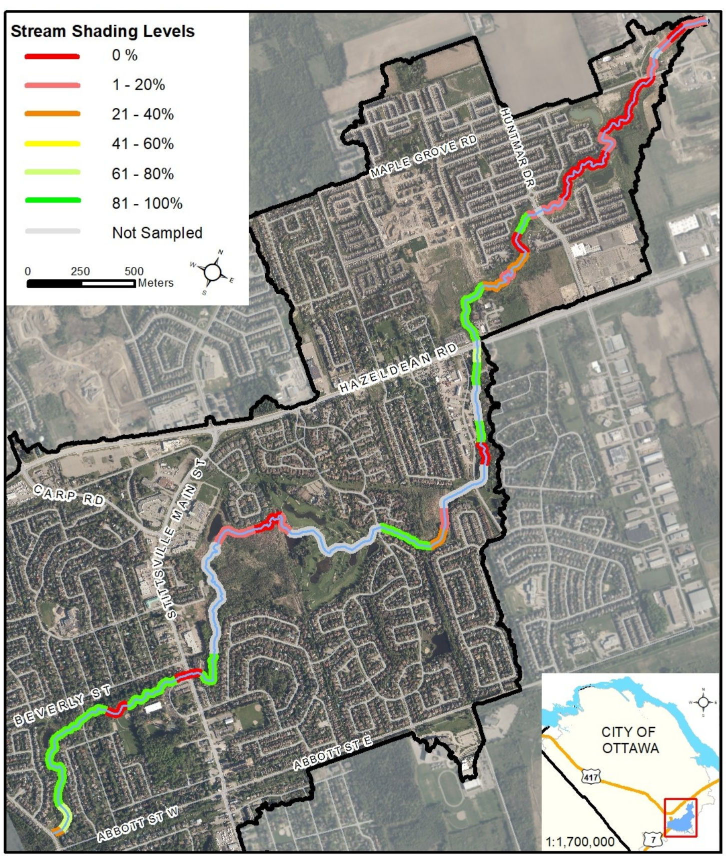
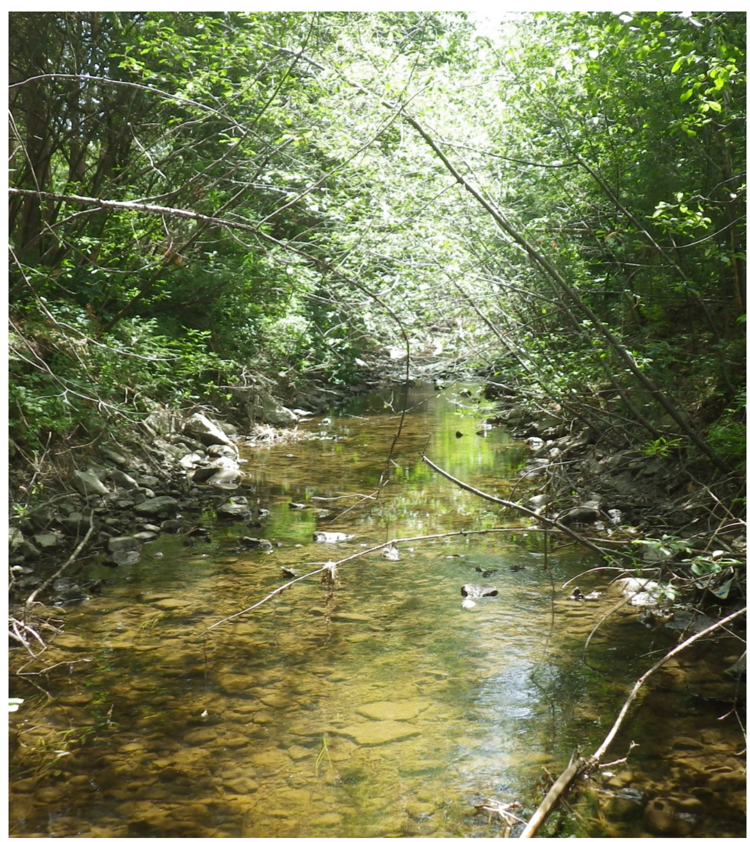


Figure 10: *Stream Shading along Poole Creek.*



Erosion and Streambank Undercutting

Rivers and streams are dynamic hydrologic systems, which are constantly adjusting in response to changes in the watershed. Streambank erosion is a natural process that can produce beneficial outcomes by helping to regulate flow and shape a variety of habitat features. When the natural rate of erosion is accelerated or changed through human activities, such as stream straightening and over-clearing of catchment and stream bank vegetation, the system is thrown off balance. Urbanization and the reduction of infiltration opportunities for surface water results in quick increases in water levels and velocities within the creek which can increase bank erosion.

The acceleration of the natural erosion process can lead to stream channel instability, land loss, sedimentation, habitat loss and other adverse effects that negatively impact water quality and important fish and wildlife habitat.

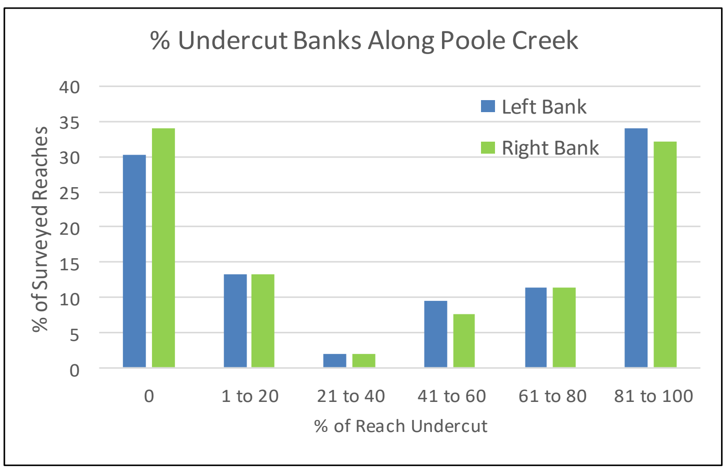


Figure 12: *Percent of undercut stream banks along Poole Creek.*

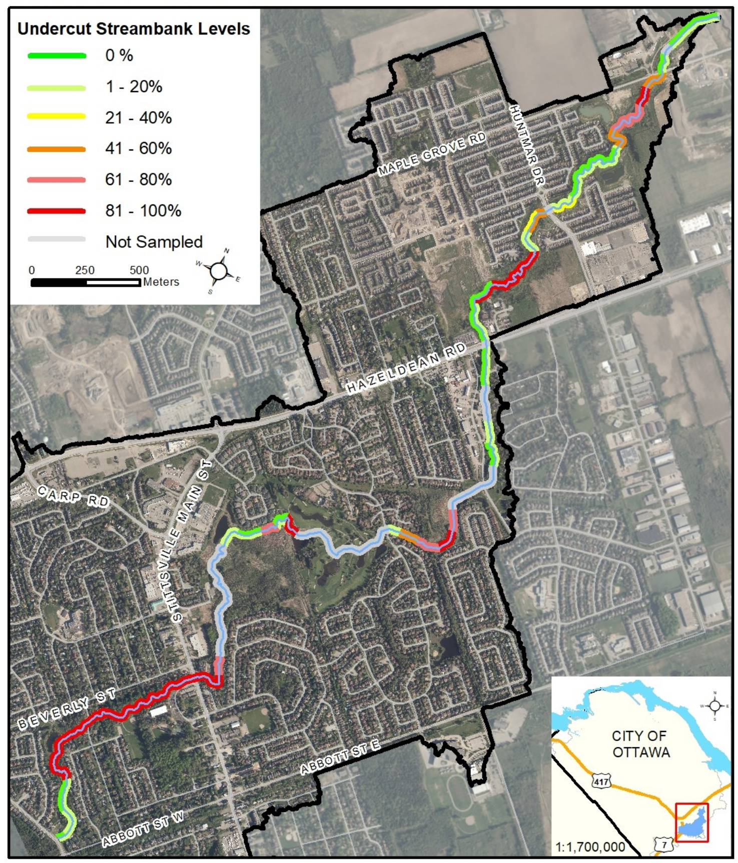


Figure 13: *Map of undercut banks in Poole Creek.*

One of the features created by erosion is the undercut, where the creek is then able to flow underneath the banks. While some undercutting of stream banks can provide excellent refuge for fish, too much undercutting can become harmful if it results in bank instability, erosion and sedimentation.

Figure 12 shows the percentage of undercut stream banks along each surveyed section of Poole Creek. Overall, the sections of Poole Creek that were surveyed were found to have a high amount of undercutting with over 40% having greater than 60% undercutting along their lengths.

Figure 13 illustrates the extent of undercutting occurring in the streambanks within the surveyed sections of Poole Creek.

In-stream Substrate

In-stream substrate describes the composition of the bed of the watercourse. A diversity of substrates is important for fish and benthic invertebrates because some species have specific habitat requirements and will only reproduce on certain types of substrate. A healthy stream will generally have a large variety of substrate types which will support a greater diversity of organisms.

Figure 14 summarizes the abundance and dominance of different types of substrate which make up the bed of Poole Creek.

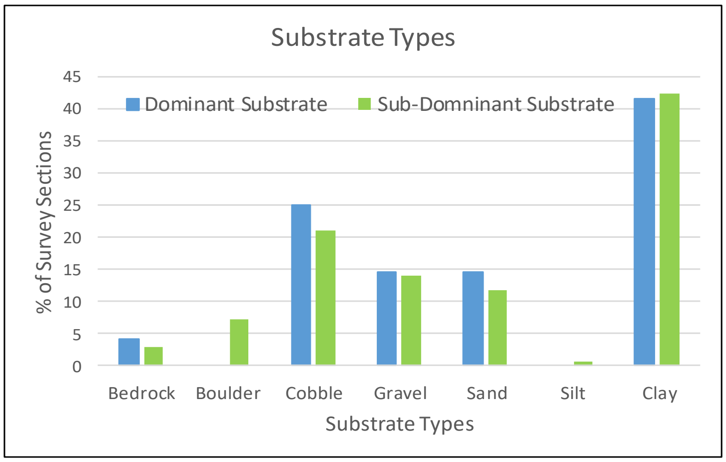


Figure 14: *Percentages of dominant and sub-dominant substrate types in Poole Creek.*

Poole Creek is composed of high percentages of clay with cobble, gravel and sand as alternate substrates (Figure 14). These rocky alternate substrates provide spawning habitat for fish and habitat for benthic invertebrates (organisms that live on the bottom of a water body or in the sediment) that are a key food source for many fish and wildlife species. Boulders, which make up 7% of the sub-dominant in-stream substrate, create cover and back eddies for larger fish to hide and rest out of the current.

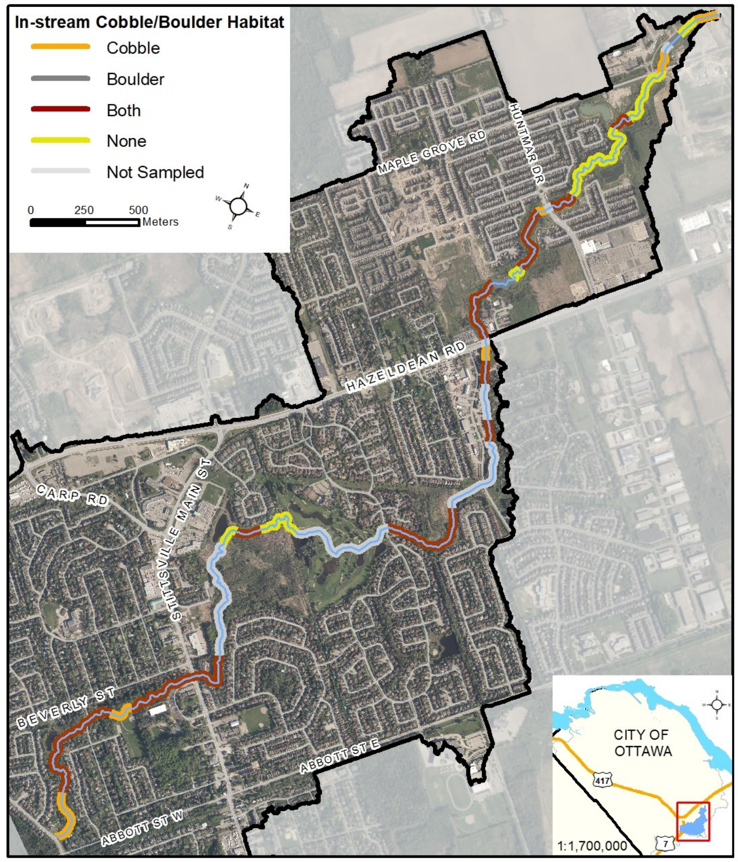


Figure 15: *Cobble and boulder habitat along Poole Creek.*

Cobble and Boulder Habitat

As discussed above, cobble and boulders both provide important fish habitat. Figure 15 shows the sections of Poole Creek where cobble and boulders were found on the stream bed. This demonstrates that the creek has a healthy distribution of cobble and boulder substrates with a large number of sections containing both features.

In-stream Morphology

In-stream morphology is categorized as pools, riffles, and runs. Pools and riffles are both particularly important for fish habitat. Pools, which are deeper and usually slower flowing sections in the stream, provide shelter for fish, especially when water levels drop or when water temperatures increase. Riffles are sections of agitated and fast moving water that add dissolved oxygen to the stream and provide spawning habitat for some species of fish. Runs are areas along a creek that are typically shallow and have un-agitated water surfaces.

It is beneficial for the health of the ecosystem if there is a variety of these in-stream features, to allow oxygen to flow through the creek, to provide habitat, and to have a well-connected watercourse. As seen in Figure 16, Poole Creek was found to consist of 69% runs, 23% riffles and 8% pools. Stewardship efforts could be focused at creating more in-stream pool/riffle sequences to enhance fish habitat.

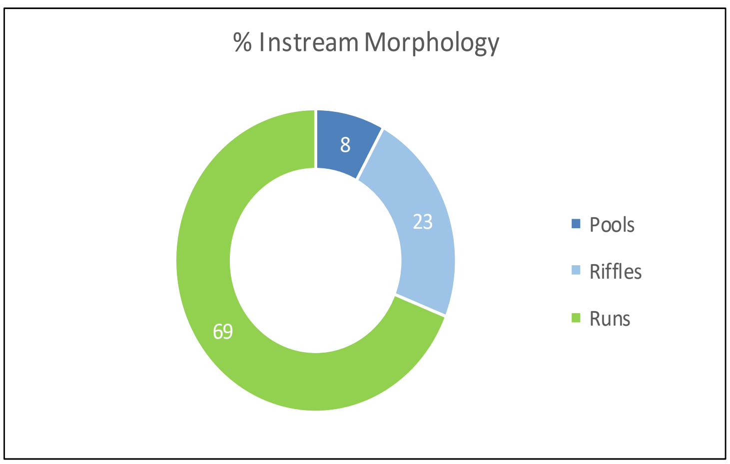


***Figure 16:** In-stream morphology along Poole Creek.*

Habitat Complexity

Habitat complexity is a measure of the overall diversity of habitat types and features within a stream. Streams with high habitat diversity support a greater variety of species niches, and therefore contribute to a greater potential for species diversity.

Factors such as substrate, flow conditions, and cover material all provide crucial habitat functions for aquatic life. The habitat complexity score seen in Figure 17 is based on the presence of gravel, cobble, or boulder substrates as well as the presence of woody material or vascular plants in each surveyed reach of Poole Creek. The presence of one of the variables carries a score of 1. A reach with all five features receives a score of 5 for high habitat complexity.

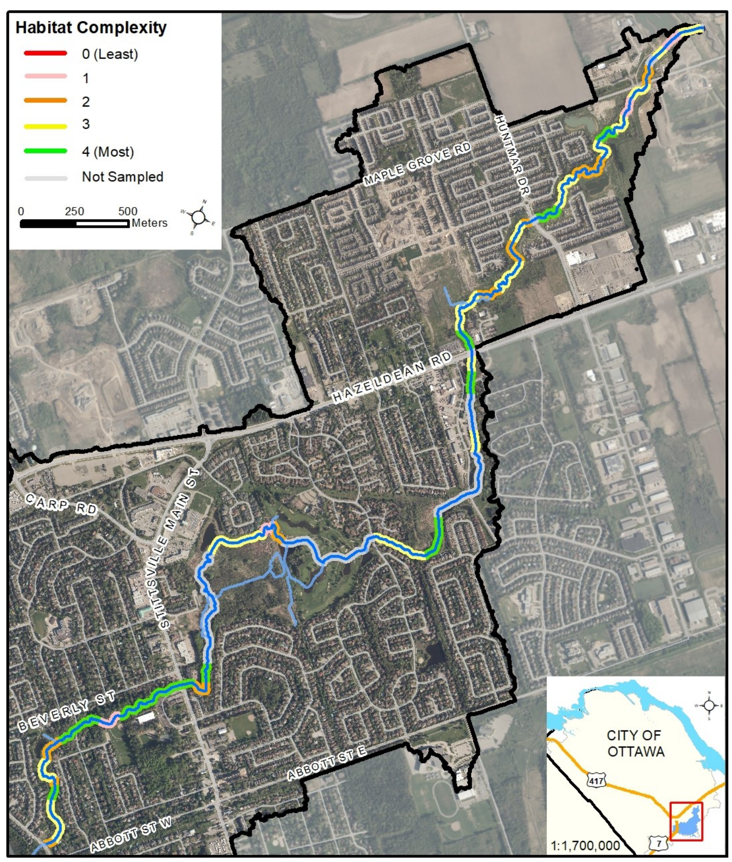


***Figure 17:** Habitat Complexity Scores for Poole Creek.*

In-Stream Vegetation

A well-balanced amount and suitable variety of in-stream vegetation is important for a healthy stream ecosystem. Aquatic plants provide habitat for fish and wildlife, contribute oxygen to the stream, and help to remove contaminants from the water. However, too much in-stream vegetation can be detrimental and can signify an unhealthy stream. Certain types of vegetation, such as algae, can also be indicative of poor stream health, as it is often seen in streams with high nitrogen and phosphorus inputs (from runoff or wastewater).

Types of In-stream Vegetation

There are many factors that can influence the presence of aquatic plants, some of which include the substrate type, increases in air and water temperature, and the time of year the assessment was completed. As seen in Figure 18, the in-stream vegetation that was observed in each surveyed section was divided into eight categories; narrow-leaved emergent, broad-leaved emergent, robust emergent, free floating plants, floating plants, submerged plants, algae and no plants. Algae (44%), narrow-leaved emergent (22%) and submerged plants (19%) were the top three types of in-stream vegetation in Poole Creek.

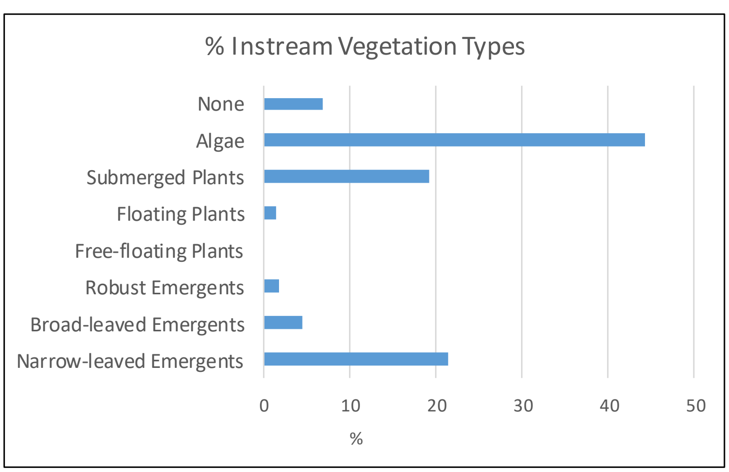


Figure 18: *Types of in-stream vegetation in Poole Creek.*

Amount of In-stream Vegetation

In-stream vegetation helps to remove contaminants from the water, contribute oxygen to the stream, provide habitat for fish and wildlife, and reduce current velocities, however too much vegetation can be detrimental. For this assessment, the amount of in-stream vegetation is measured according to five categories, ranging from “extensive”, where the stream is choked with vegetation, to “rare”, where there are very few plants.

Figure 19 shows the amounts of each in-stream vegetation category in Poole Creek. The creek was found to have a good diversity of vegetation abundance with almost all categories being represented. No sections were found to have extensive in-stream vegetation. Overall the creek had more sections with low vegetation densities.

Low in-stream vegetation levels in Poole Creek are likely due to substrate type. For example the areas that are rocky with cobble and gravel or are densely shaded do not facilitate easy plant growth. A lack of aquatic vegetation may also be the result of water depths or currents creating conditions that limit plant growth.

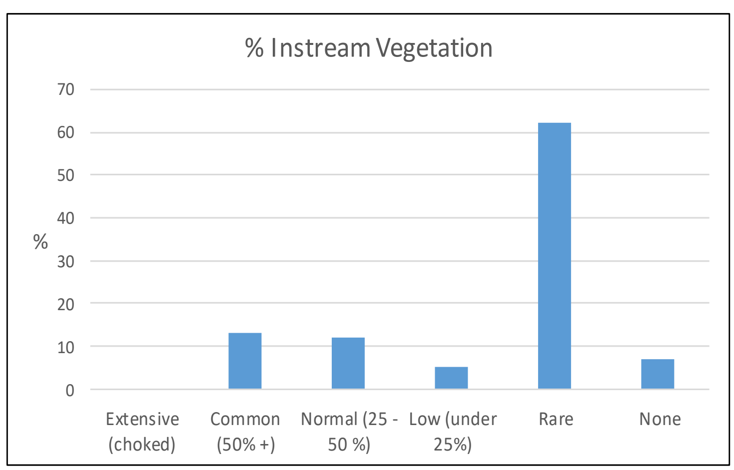


Figure 19: *Abundances of in-stream vegetation in Poole Creek.*

Water Chemistry and Quality

A YSI probe was used to collect water quality data including pH, dissolved oxygen, and conductivity, at each site assessed. The maximum, minimum and average readings for each of those parameters are presented in Table 3 and are discussed further on page 14.

Conductivity is defined as the ability of water to pass an electrical current, and is an indirect measure of the saltiness of the water caused by dissolved ions. Fish cannot tolerate large increases in ion concentrations in the water. Factors that can change the conductivity of freshwater include climate change and human activity. Warmer climate conditions increase the evaporation of water, leaving existing water with higher concentrations of dissolved ions (higher conductivity). Use of road salts and fertilizers around the stream can also elevate ion levels, along with industrial and human wastewater. Because of all these factors, conductivity of a stream can fluctuate greatly with readings between 0 and 10,000 microSiemens/centimeter (µS/cm). Environment Canada (2011) sets a target of 500 µS/cm as part their Environmental Performance Water Quality Index. The average specific conductivity of Poole Creek is 1097µS/cm (Table 3), putting it well above target levels for the majority of the creek.

Since background conductivity can vary between systems, the 2018 results have been compared to the surveyed average for Poole Creek as seen in Figure 20.

pH tells us the relative acidity or alkalinity of the creek. The scale ranges from 1 (most acidic) to 14 (most basic) and has 7 as the middle and most neutral point. A range of 6.5 to 8.5 should be maintained for the protection of aquatic life. As can be seen in Table 3, the pH values found in Poole Creek stay mostly within this ideal range. The average pH of Poole Creek is 7.80, a nearly neutral condition, which is ideal for many species of fish to thrive.

Table 3: Poole Creek Water Quality Data			
	Minimum	**Maximum**	**Average**
Water Temperature (˚C)	13.6	24.1	18.4
Specific Conductivity (µS/cm)	567	2043	1097
pH	6.93	9.90	7.80
Dissolved Oxygen Concentration (mg/L)	2.64	12.5	8.00

Dissolved oxygen concentration measures the amount of oxygen available within the water that is useable by wildlife. According to the Canadian Water Quality Guidelines for the Protection of Aquatic Life, the guideline value for the dissolved oxygen in freshwater for early life stages is 6.0 milligrams/liter (mg/L) for warm water ecosystems and 9.5 mg/L for cold water ecosystems. The average amount of dissolved oxygen in Poole Creek measured at 8.00 mg/L. The majority of the surveyed reaches fall within the range supporting warm water fish, but there are a number of sections that also have suitable concentrations for supporting warm and cold water fish, as seen in Figure 21. A few sections can also be seen to be below the lower threshold for warm water biota indicating a potentially stressed environment in these locations.

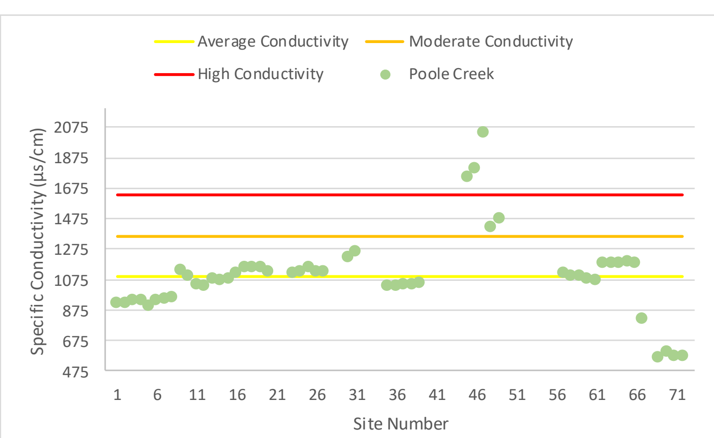


Figure 20: *Specific conductivity results for Poole Creek.*

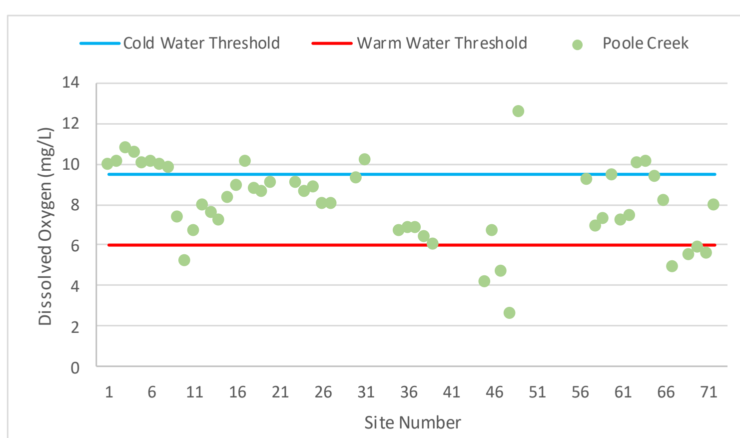


Figure 21: *Dissolved oxygen concentration results for Poole Creek.*

Dissolved Oxygen Saturation is measured as the ratio of dissolved oxygen relative to the maximum amount of oxygen that will dissolve depending on temperature and atmospheric pressure. Well oxygenated water will stabilize at or above 100% saturation, however the presence of decaying matter and pollutants, which consume oxygen, can drastically reduce these levels. Oxygen input through photosynthesis has the potential to increase saturation above 100% to a maximum of 500%, depending on the productivity level of the environment.

Combining the dissolved oxygen concentrations with the saturation values provides us with 6 categories to classify the suitability of stream for supporting various aquatic organisms. Results are shown in Figure 22.

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.

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.

6) >100% Saturation / >9.5 mg/L Concentration
Oxygen concentration and saturation levels are optimal for warm and cold water biota.

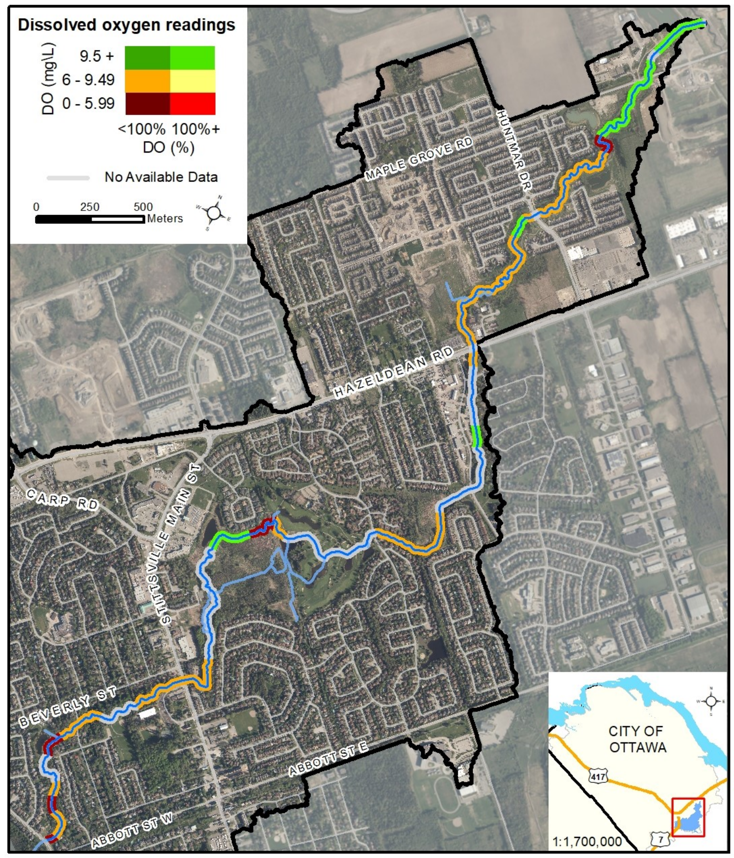


***Figure 22:** Dissolved oxygen concentration and saturation results for Poole Creek.*

Due to drought conditions dissolved oxygen concentration and saturation readings could not be taken at all surveyed reaches.

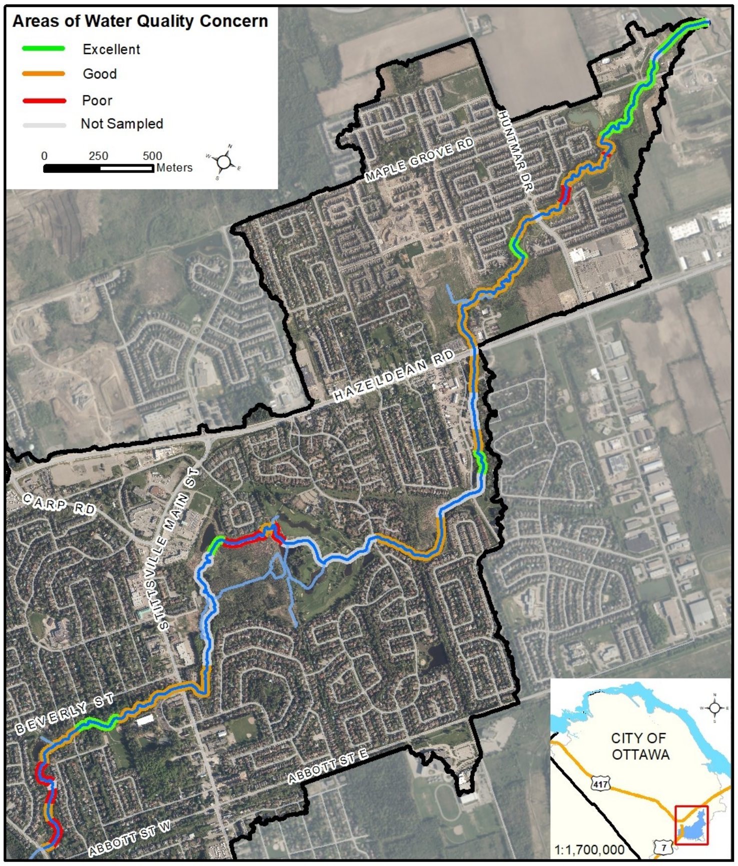


Figure 23: Areas of Water Quality Concern in Poole Creek.

Areas of Water Quality Concern

This is a summary of areas that are potentially under stress due to one or several water chemistry factors. Three water quality factors; oxygen saturation score, pH, and conductivity are used to classify the areas of concern.

Poole Creek's pH values only exceed the ideal range in two reaches. Conductivity values were fairly close to average throughout with values lowest at the upper reaches, and highest in one area in the middle. The oxygen concentration scores were predominantly less than ideal for aquatic organisms. Six of the reaches had low oxygen concentration and saturation results and 29 reaches had good concentrations but low saturation levels (Figure 22). 14 reaches had both good concentration and good saturation levels.

The reaches with poor scores shown in Figure 23 reflect areas where lower oxygen concentration and saturation scores combine with higher than average conductivity readings. One of these reaches also had a high pH level which reduced its score.

The sections receiving a good score reflect the areas that had moderate oxygen concentration and saturation scores combined with average or slightly above average conductivity scores.

The sections with an excellent score had moderate to low conductivity readings and high dissolved oxygen and concentrations values.

Thermal Classification

Temperature is an important parameter in streams as it influences many aspects of physical, chemical and biological health. Figure 24 shows where the four temperature dataloggers were deployed from May to October 2018. This time period provides a representative sample of how water temperature fluctuates throughout the summer season.

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 revised Stoneman and Jones method by Cindy Chu *et al*) to classify a watercourse as either warm, cool-warm, cool, cold-cool, or cold water. Figure 25 shows the thermal classifications of Poole Creek for 2018.

Analysis of the data collected indicates that Poole Creek should be classified as a cold to cool water stream between Westridge Drive and Hazeldean Road. A lack of shade and cool water inputs in the lower reach results in the creek warming up significantly by the time it reaches the outlet near Maple Grove Road.

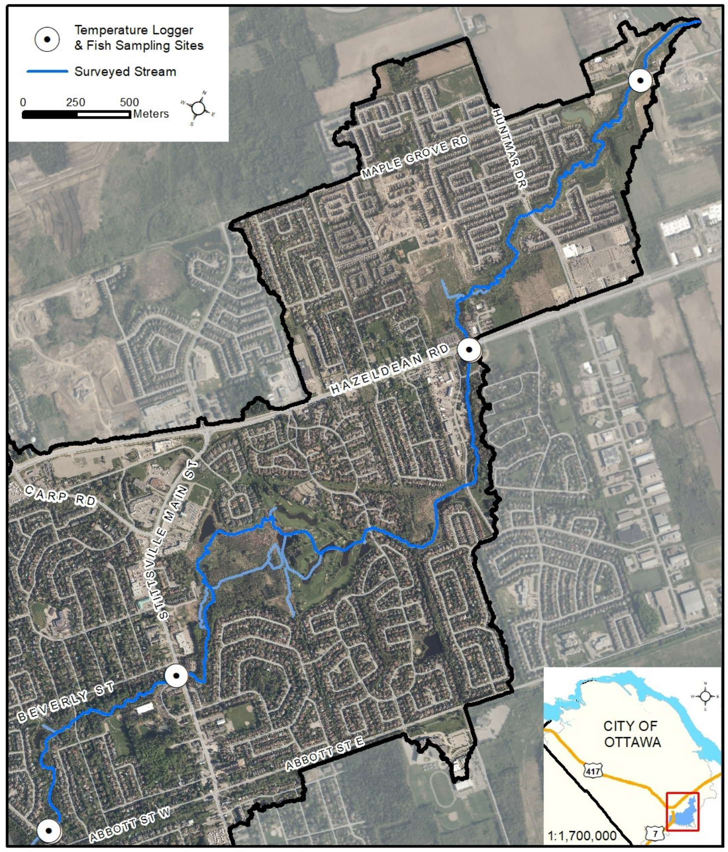


Figure 24: *Location of temperature loggers and fish sampling sites on Poole Creek.*

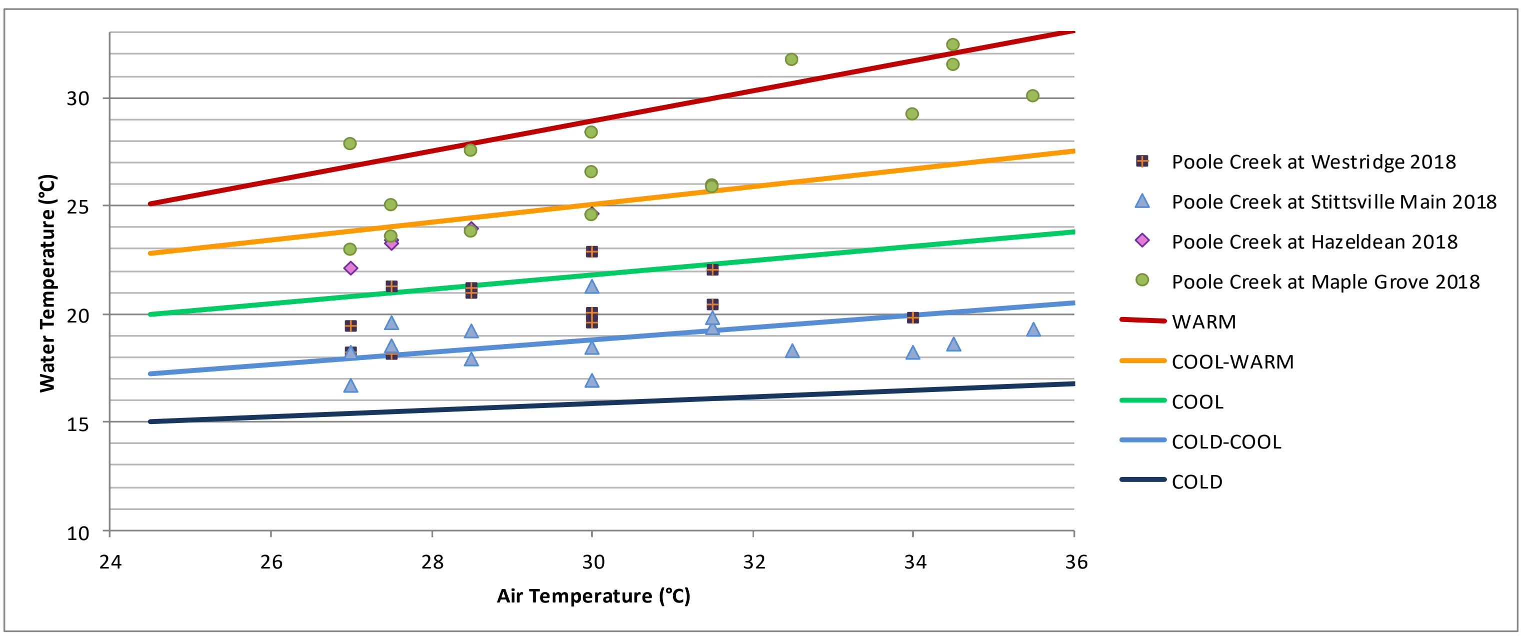


Figure 25: *Thermal classification of Poole Creek.*

Each point on the graph represents a water temperature that was taken under the following conditions:

- Sampling dates between July 1 and August 31.
- Sampling date has a maximum air temperature ≥ 24.5 °C and was preceded by two consecutive days with a maximum air temperature ≥ 24.5 °C during which time no precipitation occurred.
- Water temperature at 4:00 pm

Fish Sampling

In 2018, MVCA used a method called electrofishing to sample Poole Creek's fish population at all four of the temperature logger locations. Eighteen species of fish were captured in 2018. Of note is that an endangered American Eel was caught, which is the first record of this fish in the upper reaches of the Carp River watershed.

In previous electrofishing work conducted by MVCA, 13 species have been captured including the Brown Trout, a sensitive cold water species.

The total known species list for Poole Creek can be found in Table 4 below; species with a "*" indicate ones captured by MVCA in 2018. (Thermal classes from Coker, 2001)

Table 4: Fish Species Found In Poole Creek

Species Common Name	Thermal Class
American Eel *	Cool
Blackchin Shiner *	Cool
Brassy Minnow *	Cool
Bluntnose Minnow	Warm
Brook Stickleback *	Cool
Brown Trout	Cold
Central Mudminnow *	Cool
Common Shiner *	Cool
Creek Chub *	Cool
Eastern blacknose dace *	Cool
Finescale Dace	Cool
Golden Shinner	Cool
Iowa Darter *	Cool
Johnny/Tessellated Darter *	Cool
Logperch *	Warm
Longnose Dace *	Cool
Mottled Sculpin *	Cool
Northern Redbelly Dace *	Cool
Pumpkinseed *	Warm
Rock Bass *	Cool
Unknown young of the year *	Fish are too small to ID in the field
White Sucker *	Cool

Migratory Obstructions

Migratory obstructions are features in a water way that prevent fish from freely swimming up and downstream. This can effect successful migration to breeding or foraging habitats as well as restrict a fish's ability to access deeper, cooler water refuges when summer droughts come. These obstructions can be anthropogenic such as perched culverts or debris dams at road crossings, or they can be natural features such as waterfalls and beaver dams.

As shown in Figure 26, the surveyed portions of Poole Creek revealed that there is 1 debris jam, and 6 beaver dams acting as migratory obstructions.

Migratory obstructions can also be beneficial to a system as they create areas of deeper water and help maintain wetland habitat. The pro's and con's of proposing a stewardship focused removal activity need to be reviewed carefully on a site by site basis.

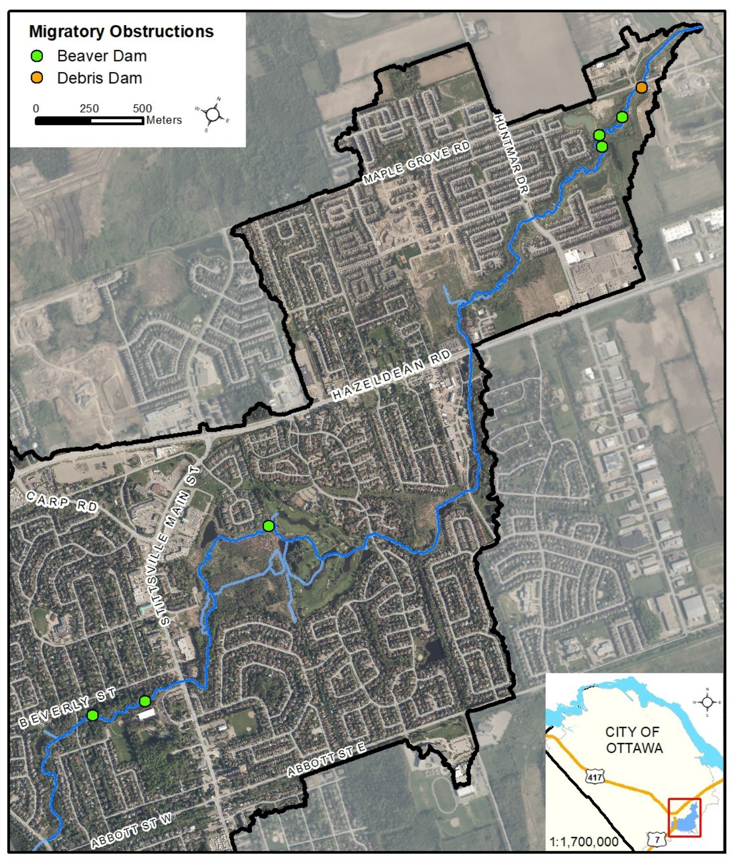
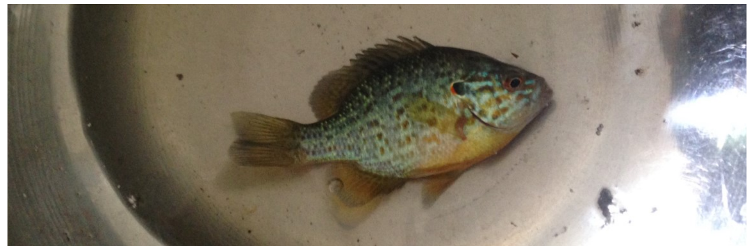


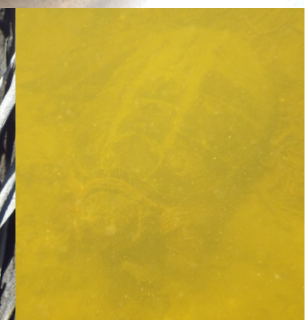
Figure 26: *Map of migratory obstructions in Poole Creek.*

Wildlife Observed

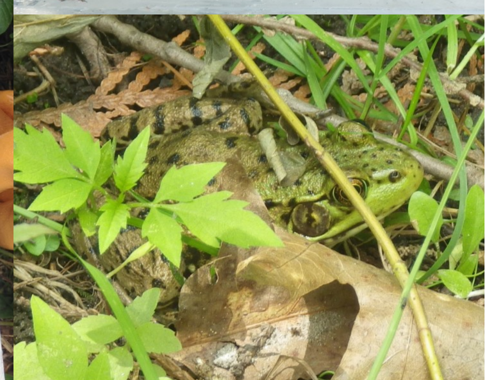
There were many species of wildlife observed during this assessment of Poole Creek. Of note there were encounters with a snapping turtle, and a beaver while doing the CSW survey. A complete list of species observed during the 2018 survey is shown in Table 5.

Table 5: Poole Creek Wildlife Observed	
Birds	Blue Jay, Canada Geese, Goldfinch, Grackle, Kingfisher, Mallard duck, Red-winged Blackbird, song birds, Warbler
Mammals	Beaver, Groundhog, Raccoon, White-tailed Deer
Reptiles and Amphibians	Bull frog, Leopard Frog, Green Frog, Pickerel Frog, Snapping Tur-tle, Wood Frog
Aquatic Insects	Beetles, Chronimidae, Crayfish, damselflies, dragonflies, Ebony Jewelwing, flies, Mosquito, spi-ders, Viceroy, wasps, Water Scor-pion, Water Strider
Other	Mussels





Benthic Invertebrates

Benthic invertebrate sampling was conducted in Poole Creek following the Ontario Benthic Biomonitoring Network (OBBN) Protocol in October of 2018. This protocol assesses the aquatic insect population at a site as they are less mobile and easier to catch than other aquatic organisms. Also, due to their small habitat range and sensitivity to water chemistry (such as available dissolved oxygen), benthic organisms are good indicators of aquatic habitat conditions. Sampling was conducted at two of the sites where fish sampling was conducted (Figure 24). Results are shown below in Table 6.

The three metrics MVCA uses to classify a benthic population are Species Richness, %EPT and Average FBI. Species Richness is the number of species found at each site. %EPT is the proportion of the benthic invertebrate community belonging to the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) families as they are indicator species of well oxygenated water conditions. The higher the percent the better the water quality. FBI stands for the Hilsenhoff Family Biotic Index which is derived by giving each benthic family a score based on their sensitivity to pollution (on a scale of 0-10). A higher score represents a benthic population high in families tolerant of low oxygen conditions, and therefore likely to have poorer water quality conditions. FBI scores were averaged across the 2 riffle samples taken at each site, whereas %EPT is an average of 1 pool and 2 riffle samples.

Each site had a good diversity of species, with a total of 16 different species found in Poole Creek. The proportions of sensitive species required for the other two indices were lower at the Main Street site compared to the site at Maple Grove. The substrate within this reach consisted of much finer sediment material and this habitat variability is likely the limiting factor influencing the site's species composition. Future surveys at these locations will assist with understanding trends in the benthic invertebrate populations.

Table 6: Benthic Results Summary

Site	Avg. Species Richness	Average % EPT	Average FBI	Condition
Maple Grove	12	4.44	4.54	Good
Main Street	11	0.28	5.02	Fair

Pollution

Pollution in the form of litter, such as cans, plastic, Styrofoam, building supplies and tires were found in Poole Creek. As shown in Figure 27, 85% of the reaches surveyed had some sort of visible pollution present. Community stream clean up events are highly recommended for this catchment.

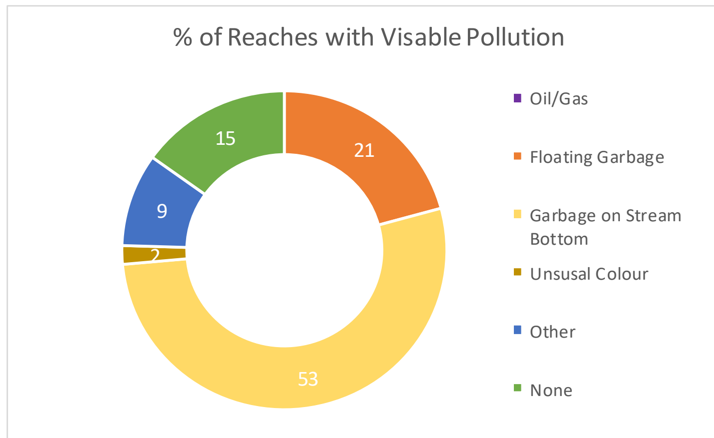


Figure 27: *Percentage of reaches where visible pollution was found in Poole Creek.*

Invasive Species

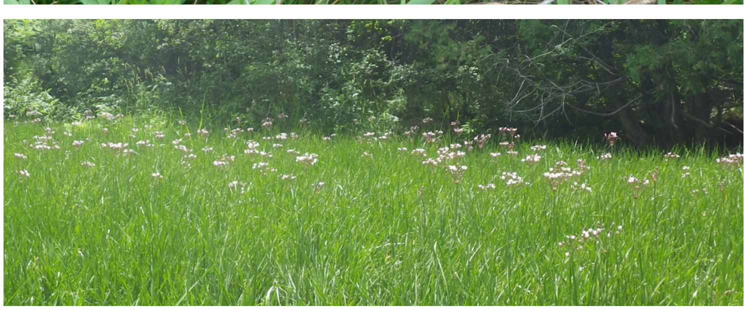
Invasive species are a concern as they can impact local species diversity and richness by outcompeting native species. This can result in the reduction of available food and habitat that our native plants and animals rely upon. Species such as Giant Hogweed and Poison Parsnip are also a human health concern as the sap from these plants can cause chemical burns to skin.

Figure 28 shows that although there are 11 identified invasive species in the Poole Creek Corridor, there are 19 sections with 1 or fewer identified invasive species. The photo below-right (showing both Wild Parsnip and Japanese Knotweed growing together) is an example of a site with more than one invasive species present. 33 sections have 2-5 identified invasive species, while the maximum number of invasive species identified in one reach was 7.

The list of species identified while surveying Poole Creek is as follows: Common Buckthorn, Curly Leafed Pondweed, European Alder, Flowering Rush, Himalayan Balsam, Manitoba Maple, Norway Maple, Periwinkle, Phragmites, Poison Parsnip, Purple Loosestrife, Dog Strangling Vine, Japanese Knotweed and Rusty Crayfish.

Consistent identification and mapping of invasive species will aid in improving our understanding of these results.

For more information on identifying and reporting invasive species visit www.invadingspecies.com managed by the Ontario Federation of Anglers and Hunters.



Top: Dog Strangling Vine seed pods on the banks of Poole Creek.

Bottom: A colony of Flowering Rush in Poole Creek.

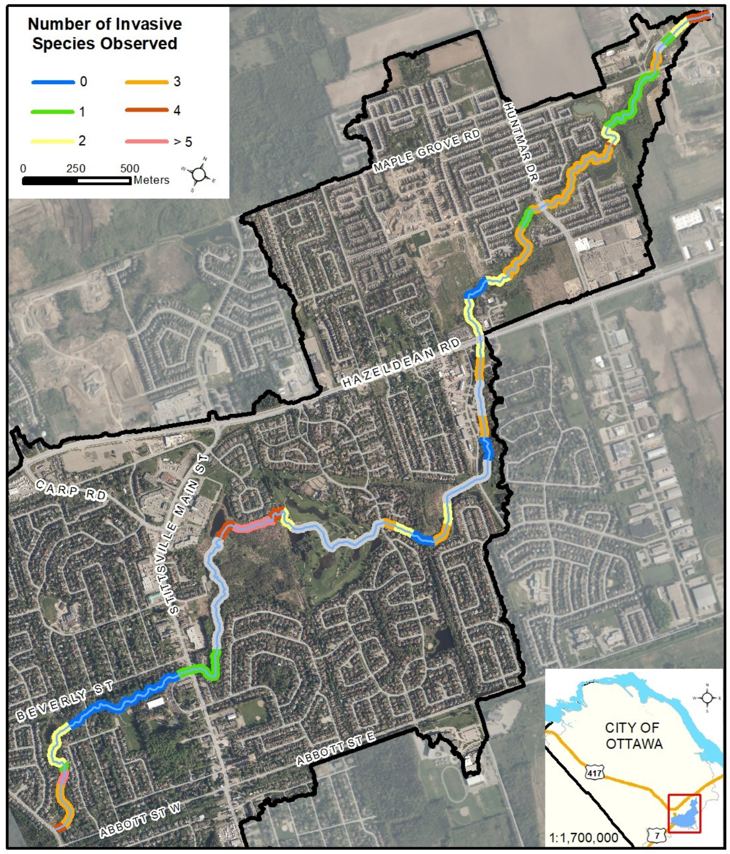


Figure 28: *Abundance of identified invasive species along Poole Creek.*

Poison Parsnip and Japanese Knotweed along Poole Creek.

For information on choosing local native species as part of your gardening and landscaping choices please read the Ontario Invasive Plants Council Document “Grow Me Instead” found here: www.ontarioinvasiveplants.ca

For information about promoting pollinators with local native plant species refer to: www.pollinator.org/canada

Potential Stewardship Opportunities

Naturally vegetated shorelines help reduce erosion, filter pollutants from entering the watercourse, assist in flood control and provide food and habitat for a diversity of wildlife.

42 reaches were identified as having a riparian buffer less than 30 m on at least one side, with 27 (right bank), 30 (left bank) of them having less than a 15 m buffer. Additionally, 26% of the stream surveyed has less than 20% shade cover.

MVCA has begun contacting landowners and exploring the potential for collaboration with them on a voluntary basis to enhance their shorelines through a number of activities, such as increasing the width of unmowed areas along the shore and/or agreeing to plant and maintain native shoreline species of trees or shrubs. This will improve shoreline buffer widths as well as improve stream shading as the trees and shrubs mature.

The photo above is from MVCA planting 120 m of Poole Creek's shoreline, downstream of Maple Grove Road, with native trees and shrubs in 2018.

In 2019 MVCA will be targeting the cool water upper reaches of Poole Creek with a number of stewardship activities, such as shoreline plantings and garbage and invasive species removal days. Additionally, a fish lunker, a habitat structure that will create a shaded refuge opportunity for fish, will be installed in 2019.

Water Chemistry Comparison Between 2013 and 2018

Water chemistry parameters are tracked throughout the entire surveyed system and reflect the general conditions of the environment. Shifts in these conditions can be indicative of general ecological changes within the environment. However due to the limited number of sampling years completed it is difficult to determine if a change in surveyed values is part of the system's natural variability or not.

The data comparison below in Table 7 is a generalization of overall conditions based only on the reaches that were surveyed in both 2013 and 2018. MVCA surveyed Poole Creek with the City Stream Watch protocol in 2013 (28 reaches) and in 2018 (53 reaches) with 26 reaches done in both years. Both summers experienced drought conditions but due to differences in the monitoring schedules and the weather patterns, different reaches were found to be dry in different years. Overall, the creek was found to have significantly deeper waters in 2018.

T-Tests were run on the data from the 26 reaches that were sampled in both 2013 and 2018 to determine the significance of the differences found. The results are summarized in Table 7. There is a significant difference in the mean results for three of the variables relating to Poole Creek's water chemistry in the 5 years since the last survey. Only the pH values were found to not be significantly different between the years.

Although the mean values for water temperature, pH, dissolved oxygen and specific conductivity are lower in 2018 than in 2013 it is too early to determine if this is caused by the deeper water levels, natural variations or some other factors.

Poole Creek will continue to be monitored with the City Stream Watch Program.

Table 7: Comparison of Water Quality Parameters in Poole Creek

	2013 Mean Results	2013 Variance	2018 Mean Results	2018 Variance	Significant Difference?
Water Temperature (°C)	20.04	6.28	17.75	6.05	Yes
pH	7.85	0.18	7.72	0.17	No
Dissolved Oxygen (mg/L)	9.16	1.49	7.91	2.18	Yes
Specific Conductivity (µS/cm)	1182	6120	1046	35049	Yes
Water Depth (m)	0.35	0.03	0.53	0.24	Yes

Headwater Drainage Features

The City Stream Watch program assessed 4 Headwater Drainage Features in the Poole Creek subwatershed in 2018 (Figure 29).

This protocol measures zero, first and second order headwater drainage features (HDF). An HDF is defined as a depression in the land that conveys surface flow. The protocol used is a rapid assessment method for characterizing the amount of water, sediment transport, and storage capacity within HDFs. Site visits are performed twice, once during the spring melt (high-water conditions) and once in mid-summer once the vegetation has grown in and water levels have receded. Assessing a feature in multiple seasons provides a broader understanding of the HDF's flow capacity and habitat variability.

This stream monitoring module provides a means of characterizing the connectivity, form and unique features associated with each HDF (Stanfield, 2017).

HDF Feature Types

The HDF 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 conditions 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.

The four headwater sites surveyed in the Poole Creek watershed consist of 3 of the 9 feature types. The existing feature types are characterized as defined natural channels, roadside ditches and channelized features.

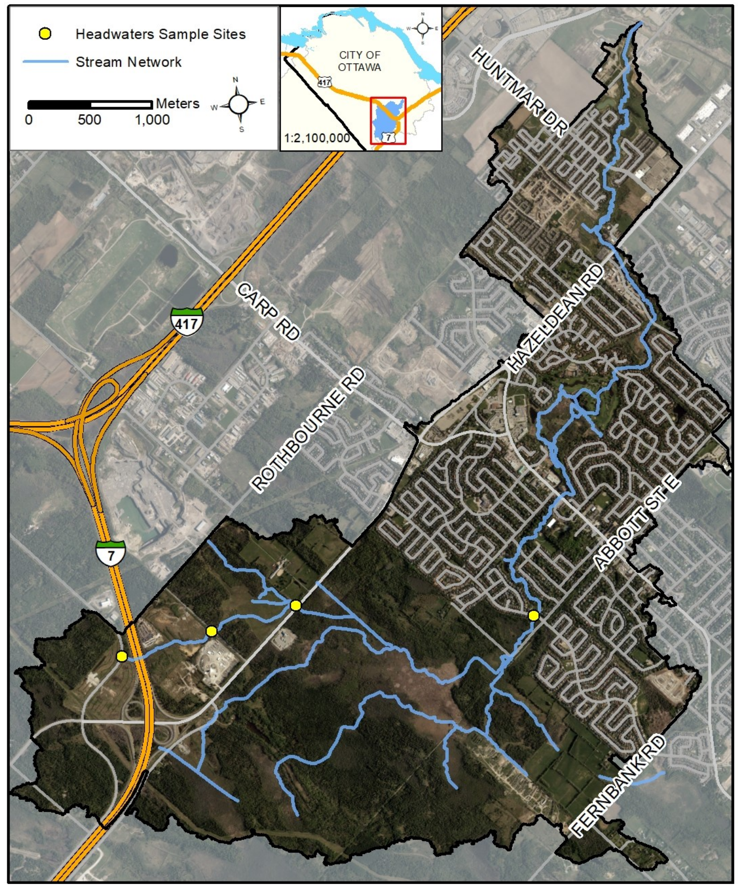


Figure 29: *Headwater drainage feature sampling sites in the Poole Creek watershed.*

HDF Feature Flow

Flow conditions within a HDF can be highly variable as a result of changing seasonal factors. Flow conditions are assessed in the spring and summer to determine if features are perennial (flowing year round), or if they are intermittent (drying up during the summer). Flow conditions in headwater systems will change year to year depending on local precipitation patterns.

All of the Poole Creek headwater sites had some level of water flow when they were revisited in early August of 2018. Standing water, interstitial flow and surface flow were present.

HDF Channel Modifications

Channel modifications are assessed at each headwater drainage feature site. Modifications include dredging, hardening, realignments, entrenchment and anthropogenic online ponds.

Channel modifications noted at the Poole Creek HDF sites include channelization and roadside ditch maintenance.

HDF Vegetation

Feature vegetation type is evaluated as the dominant vegetation type found directly within each headwater feature channel, whereas riparian vegetation type is evaluated as the dominant vegetation within 3 zones from the shoreline of each headwater feature (0-1.5 m, 1.5-10 m and 10-30 m).

There are 7 vegetation classifications; None, Lawn, Crops, Meadow, Scrubland, Wetland, and Forest.

Forest and none were the dominant feature vegetation types. Scrubland and none were the dominant riparian vegetation types. An example of a site with wetland vegetation can be seen below.

Land Owners & Volunteers

A big **"Thank You!"** needs to go out to the landowners as well as the dedicated volunteers, 4 summer students and 1 intern who came out in 2018 and helped make this monitoring program happen.

Report Summary

The results in Table 8 are a summary of the highlights from each of the report sections. Poole Creek has high amounts of natural shoreline vegetation, good shade coverage, and 8 reaches, out of 53, with a poor water quality concern. The stream is classified as cold-cool water and 18 species of fish were found across four sampling sites. The benthic populations found reflect their substrate and available habitats. 73% of sections have good to high habitat complexity which will lead to good diversity of habitats available for benthic organisms, fish and other aquatic animals that call Poole Creek home.

The main cause of the water quality concern rating is due to are high conductivity readings throughout most of the creek with the highest readings being downstream of Stittsville Main Street. This area also has poor oxygen concentration levels, making it a less than ideal habitat for aquatic organisms. The source of this increase in conductivity is unclear but it could be associated with the adjacent urbanized area and storm water pond. Further assessment for trends and potential causes should be completed on these water chemistry variables the next time Poole Creek is surveyed.

Table 8: Summary Of City Stream Watch Results for Poole Creek 2018

Sample Variable	Results Summary
Number of Sections Surveyed	53
Average Stream Width (m)	5.32
Average Stream Depth (m)	0.46
Average Hydraulic Head (mm)	12
Average Water Temperature (˚C)	18.4
Average Conductivity (µS/cm)	1097
Average pH	7.80
Average Dissolved Oxygen Concentration (mg/L)	8.00
Average Dissolved Oxygen Saturation (%)	84.1
# of Areas of Water Quality Concern with a Poor Score	8
Dominant Adjacent Land Uses	Urban Development
% Channel Alterations	27
% Vegetated Riparian Buffer Width (>30 m)	58% both banks
% Overhanging Trees & Branches >40% Section Coverage	Left Bank = 43%, Right Bank = 40%
% Stream Shading >40% Section Coverage	44%
% of Undercut Banks >60% Section Coverage	Left Bank = 45%, Right Bank = 43%
Dominant Substrate Type	Clay, Cobble
Sub-Dominant Substrate Type	Clay, Cobble
# Sections with a Habitat Complexity Score ≥3 variables	37
Dominant In-stream Morphology	Runs
Dominant In-stream Vegetation Types	Algae, Narrow-leaved Emergent
Dominant Amount of In-stream Vegetation	Rare
Thermal Class	Cold-cool upstream of Hazeldean Road
# Fish Species Found	18
# Benthic Species Found	16
Benthic Organism Scores	Maple Grove = Good, Main Street = Fair
Migratory Obstructions	6 Beaver Dams and 1 major Debris Jam
# of Identified Invasive Species	14
Potential Stewardship Activities	Garbage clean ups, Invasive pulls and shoreline planting
# Head Water Drainage Features Sampled	4

How Does This Information Get Used?

The City Stream Watch Program is an excellent monitoring program that allows MVCA to assess the condition of subwatersheds over time. Stewardship activities in areas that need further work are completed and improve the health of the ecosystem.

MVCA uses stream surveys to target specific areas that need restoration work. Stream garbage clean ups are carried out, blockages are removed, and shoreline planting, erosion control and habitat enhancements are organized.

MVCA is always looking for volunteers to help with monitoring and stewardship programs!

Call 613-253-0006 ext. 234, if you are interested!

Volunteer projects that are carried out as a result of the City Stream Watch Program are:

* Planting trees and shrubs along the shoreline
* Removing invasive plant species
* Stream garbage clean ups
* Learning about and participating in monitoring the streams
* Learning about and participating in fish sampling and wildlife identification
* Learning about and participating in benthic invertebrate sampling and identification
* Participating in nature photography

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The City Stream Watch Collaborative is made up of: Rideau Valley Conservation Authority, Mississippi Valley Conservation Authority, South Nation Conservation Authority, The City of Ottawa, National Capital Commission, Ottawa Flyfishers Society, Ottawa Stewardship Council, Rideau Roundtable, and the Canadian Forces Fish and Game Club.