Carp C Tributary Catchment Report 2019

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 CSW working group and adopted the program. Since implementing the CSW program, MVCA staff and volunteers have surveyed 542 sections across 12 watercourses. This information has been utilized for 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 use the information collected 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 2019 resulted in an above average spring flood followed by a hot summer and a late season drought which lasted until the end of October. Given the atypical seasonal conditions in 2019, all assessments were subject to the effects of low water and may not reflect the overall health of the systems. With the efforts of the MVCA staff and the volunteers, 45 sections in three catchments were assessed in 2019.

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

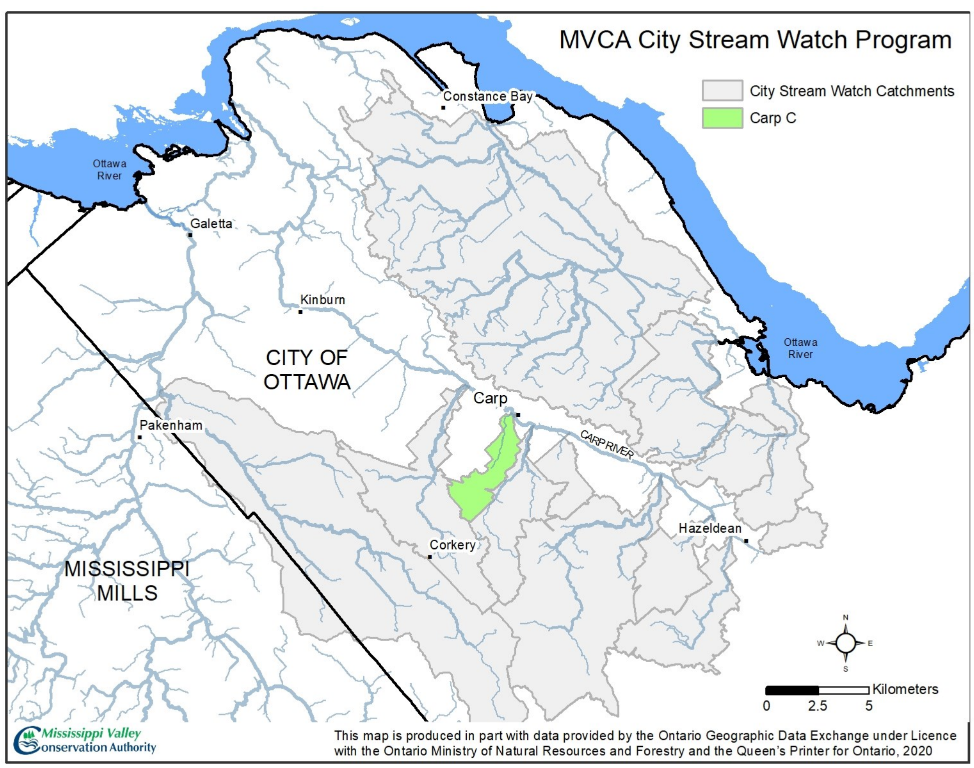


Figure 1: *MVCA's City Stream Watch area highlighting the location of the Carp C subwatershed.*

Carp C

Located north west of the village of Carp, the Carp C Tributary has a length of 6.4 kilometers (km) and draining an area of 7.06 km^2.

Carp C's headwaters originate in a wooded area west of Highway 417 and north of March Road. It flows north and east through agricultural lands and outlets to the Carp River just north of the Village of Carp. Table 1 presents a summary of some key features of the Carp C Tributary Subwatershed.

Table 1: Subwatershed Features

Area	7.06 Square Kilometers 2.3% of the Carp River watershed
Length	6.4 Kilometers
Type	100% Permanent Cold-cool water habitat
Land Use	41.0% Agriculture 0.0% Aggregate sites 28.3% Wooded area 8.2% Rural land-use 10.8% Wetlands 6.7% Grassland 4.9% Roads 0.1% Water
Surficial Geology	46.9% Clay 0.1% Diamicton 0.2% Organic deposits 11.4% Bedrock 36.9% Sand 4.5% Gravel

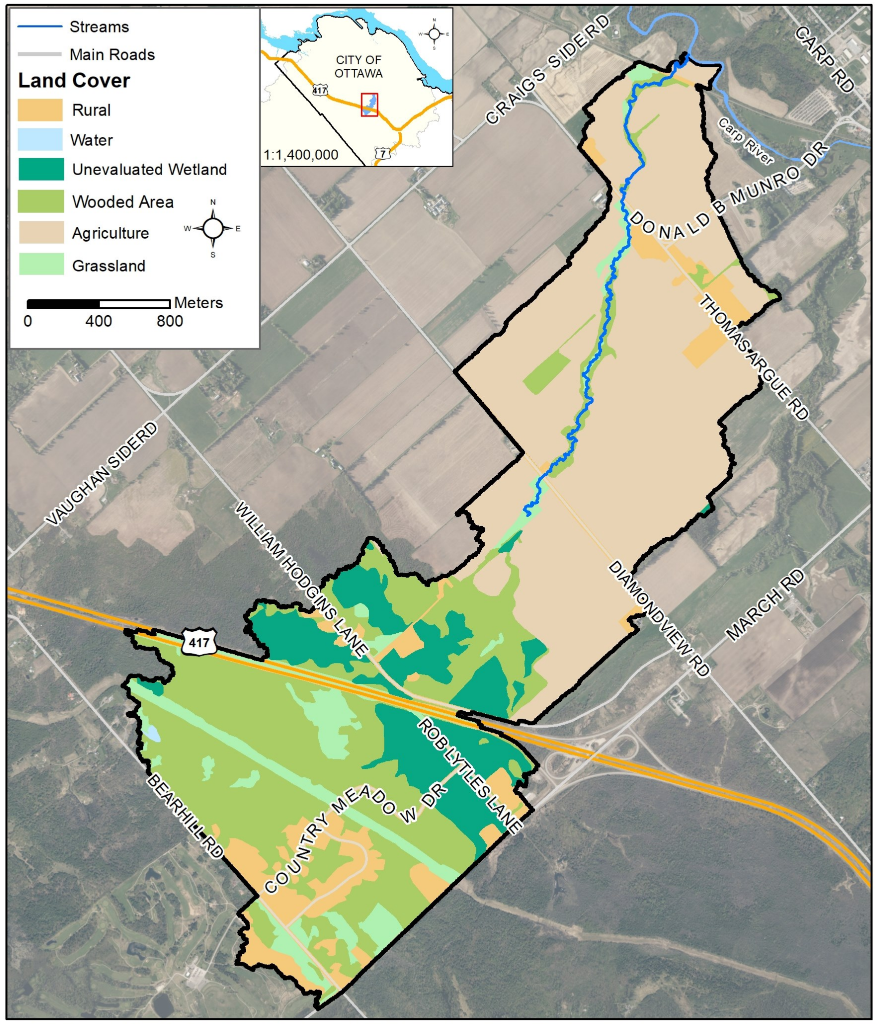
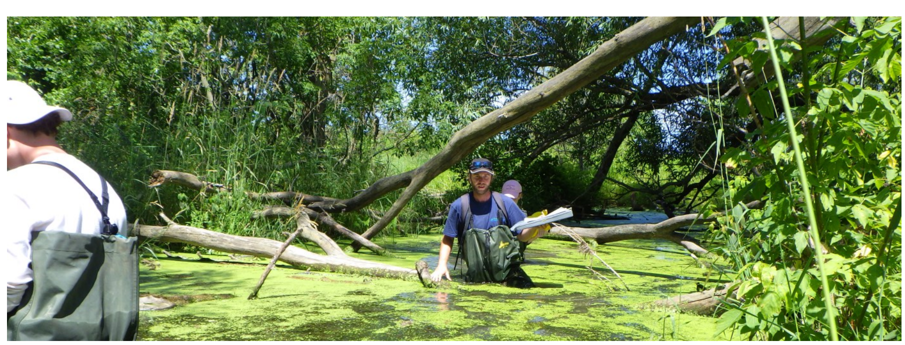


Figure 2: *Land Use in the Carp C subwatershed.*

The Carp C Subwatershed

As shown in Figure 2, the Carp C Tributary subwatershed is dominated by agricultural land uses such as tilled crops, hay fields and livestock pastures. The next most dominant land cover classifications are woodlands (28%) and wetlands (10.8%).

Crossing a mixture of wetland, woodland, farmland and rural residential areas, the creek and its tributaries provide a natural corridor and habitat for a range of aquatic and terrestrial species. Page 17 elaborates on the variety of species, or signs of species, that were observed during the 2019 survey.



Monitoring Carp C

In 2019, permission was obtained to survey 24 sections of Carp C, shown on Figure 3, which covers approximately 2.4 km of the main creek.

While these sections provide a good representation of the overall condition of Carp C, it should be noted that there are sections of the creek that are not represented in this assessment. These areas provide an additional diversity of habitat with valuable natural functions.The portions of the creek that were not sampled represent areas we did not have time to access, wetland areas that could not be assessed using the macro stream assessment protocol and areas where permission was not granted.

Table 2 shows some basic assessment measurements for Carp C. The surveyed sections had an average stream width of 4.1 meters (m), an average depth of 0.42 m, an average hydraulic head of 0.4 millimeters (mm), which is an indicator of surface water velocity.

Table 2: Carp C Creek Assessment Facts

	Minimum	Maximum	Average
Stream Wetted Width (m)	0.4	30.1	4.1
Stream Depth (m)	0.06	1.18	0.42
Hydraulic Head	0.0	15.0	0.4

Methodology

The macro stream assessment is completed using a protocol that divides the entire length of the creek into 100 meter (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.

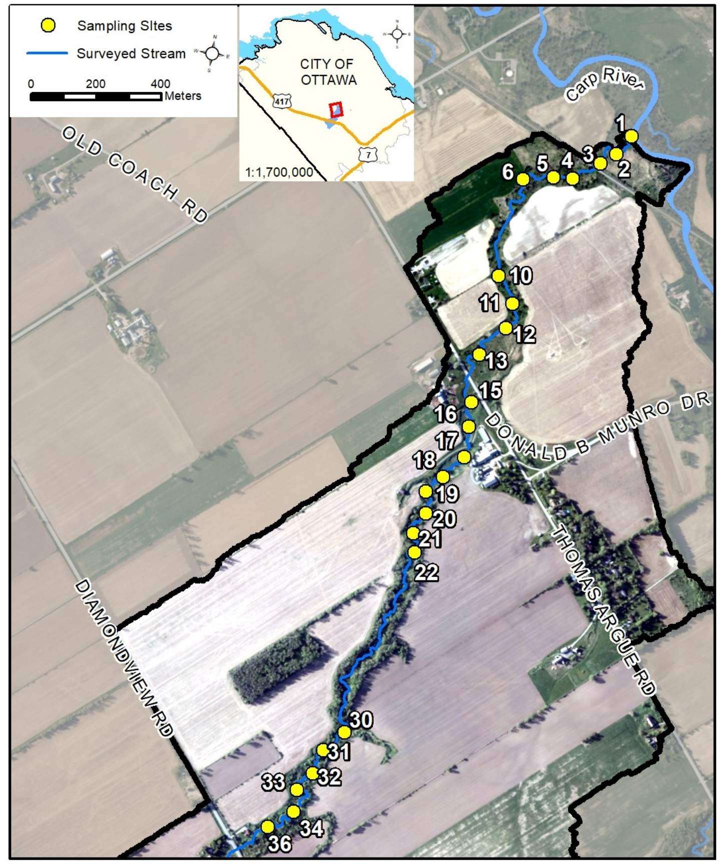


Figure 3: *Locations of the monitoring sites along carp C.*

General Land Use Adjacent to Carp C

General land use along each surveyed section of Carp C 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 Carp C.

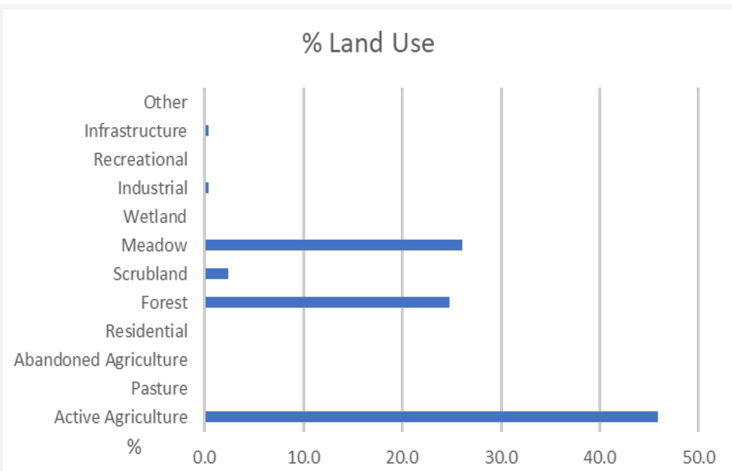


Figure 4: *Land use alongside Carp C.*

Of the eleven categories, active agricultural (46%) is the most prominent category of land use followed by meadow at 26%.

As described on page 2, the land use in the watershed is dominated by agriculture. This is reflected well in the percentages seen in Figure 4 (46% active agriculture). The remainder of the land uses adjacent to the surveyed sections were predominantly meadow and forest. This is a benefit to the creek as well as the surrounding landscape. Forest cover provides shade, habitat and food for a wide variety of animals, cools the water and protects the banks from erosion. Scrubland (2%) rounds out the diversity of habitats on the landscape and contributes to erosion mitigation.

Human Alterations to Carp C

In this assessment, human alterations refer to artificial changes to the actual 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, and to minimize natural erosion caused by the meandering pattern of flowing water. As seen in Figure 5, 29% of Carp C was found to be completely unaltered, 63% was natural (with minor alterations), and 8% was altered (with considerable human impact). No surveyed sections were considered highly altered.

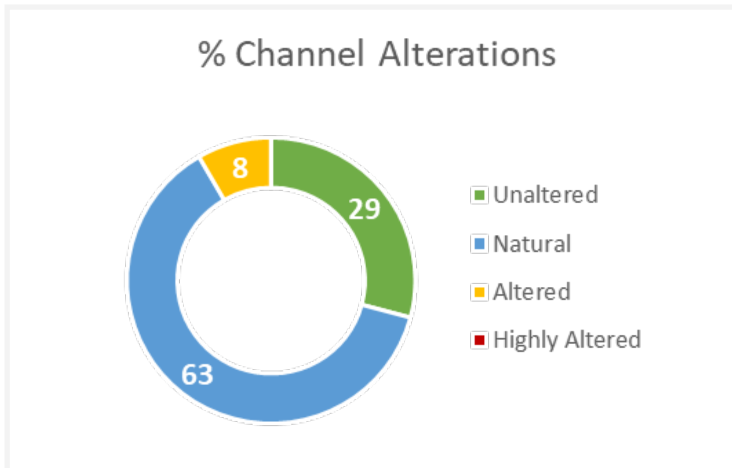


Figure 5: *Extent of human alterations to the shoreline of Carp C.*

It is beneficial to the overall health of the system that such a significant portion of the creek is in an unaltered or natural condition and has not been channelized. The sections that have been altered are mostly associated with the road and railbed crossings.

Riparian Buffer along Carp C

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. 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).

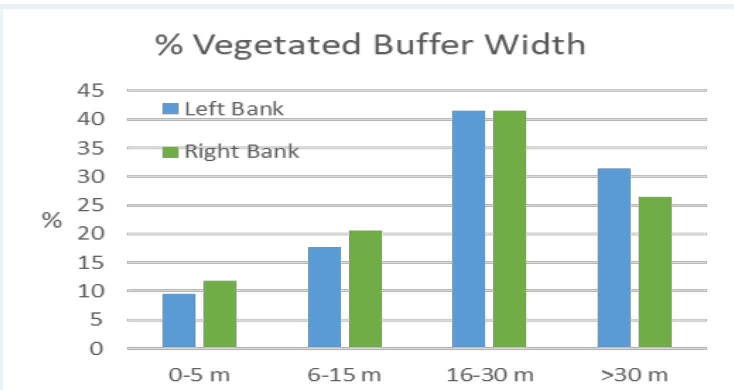


Figure 6: *Riparian buffer widths along Carp C.*

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, most (41%) of the surveyed sections of Carp C have a moderately wide riparian buffer between 16 and 30 m. Adding to this, 31% of the left bank and 26% of the right bank have a buffer greater than 30 m, while 10% of the left bank and 12% of sections on the right bank have a buffer less than 5 m.

Figure 7 shows the difference in riparian buffer widths along the surveyed reaches of Carp C. Even though the surveyed reaches are all entirely within active agricultural areas the majority of the surveyed tributary has wide (>15 m) natural buffers.

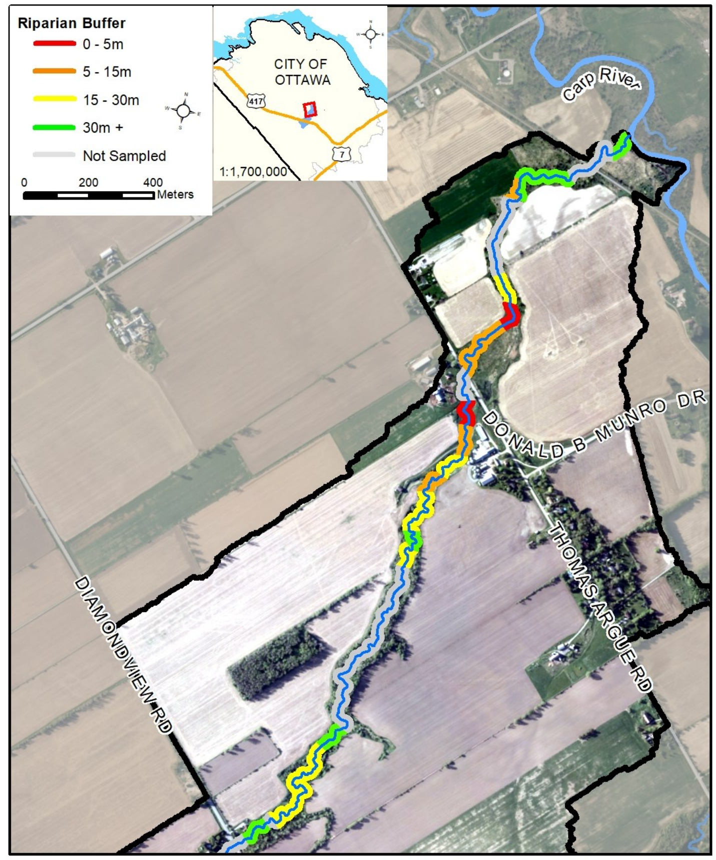


Figure 7: *Vegetated buffer widths along Carp C.*

Shoreline Classification

The shorelines throughout the surveyed reaches of Carp C were predominantly natural (55%) or regenerative (44%). Only 1% of the shorelines were considered to contain ornamental features and none were classified as degraded.

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, Carp C has a low percent coverage of overhanging trees and branches, as seen in Figure 8 with 92% of the left bank and 88% of the right bank having less than 41% overhanging cover. This reflects the surrounding natural vegetative community, where the creek passes through sections of wetland and meadow habitat, areas dominated by tall grasses or shrubs, and in some areas it reflects clearing of the vegetation too close to the creek.

Figure 8 shows the data quantified as the percent of creek sections classified according to the various amounts of overhanging trees and branches. For example, only 8% of the left bank reaches and 12% of the right bank reaches surveyed stream were found to have greater than 40% overhanging branches providing nutrients and shade to the creek.

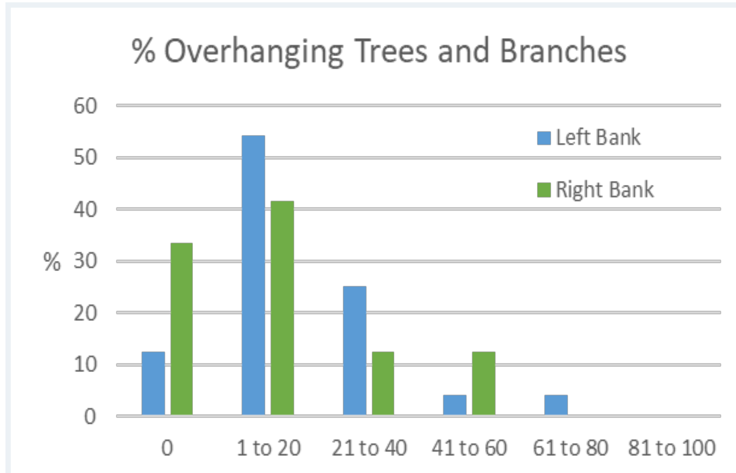


Figure 8: *Percentage of each surveyed section of Carp C with overhanging trees and branches.*

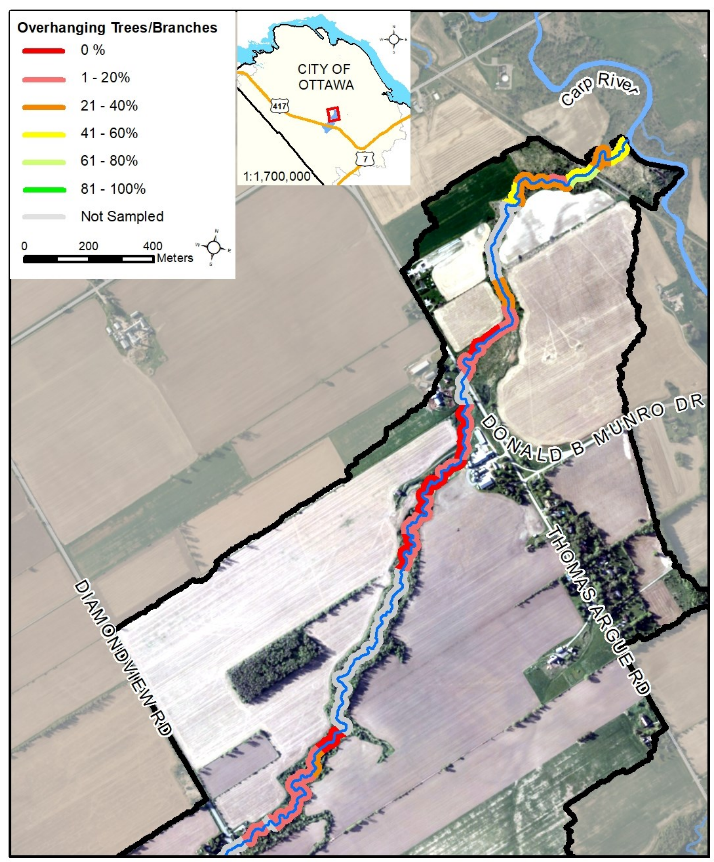


Figure 9: *Overhanging trees and branches along Carp C.*

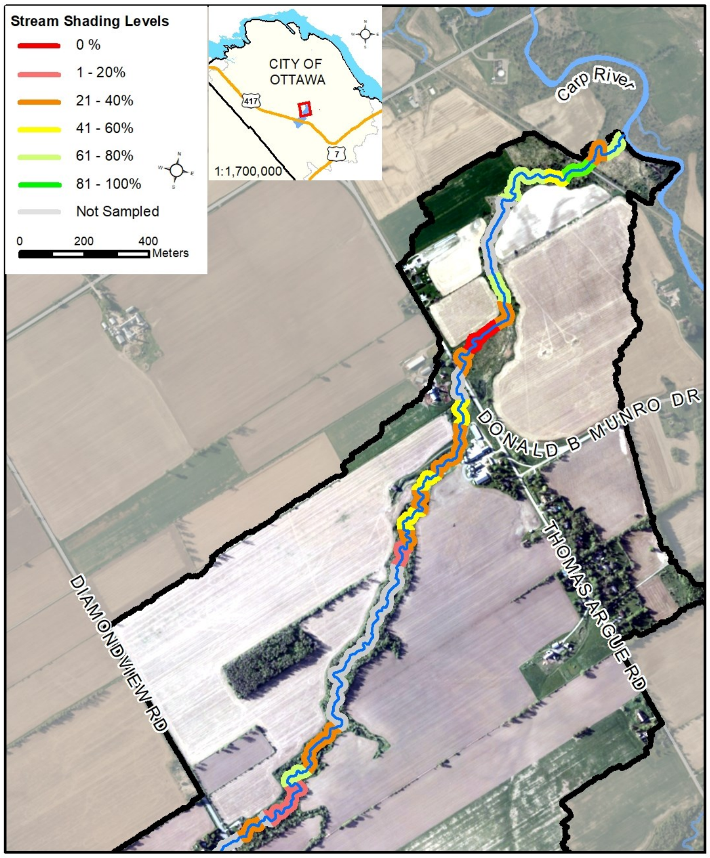
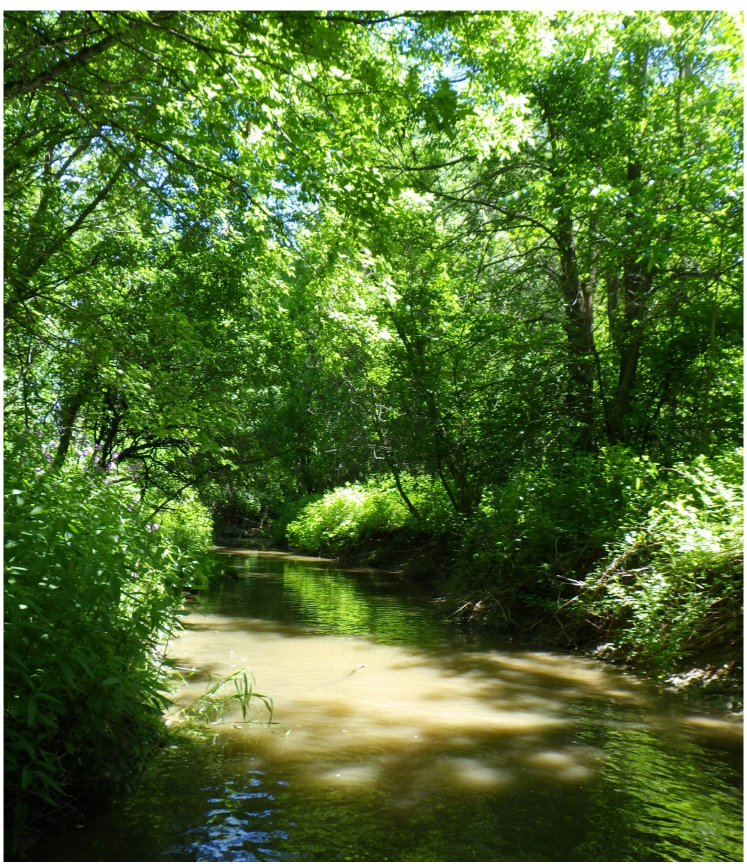


Figure 10: *Stream Shading along Carp C.*



Stream Shading

Shade is important in moderating stream temperature, contributing to food supply and helping nutrient reduction 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 of the channel, where shading from trees may not be available.

Figure 10 shows the variability in the amount of stream shading along different sections of Carp C. We can see that the shading is extremely variable. This is due to the diversity of riparian vegetation along the creek, with large sections of open meadow, pasture land or scrubland interspersed with areas of dense tree cover.

Figure 11 shows the data quantified as the percent of creek sections classified according to the various levels of shading. For example, 17% of the 24 stream sections that were surveyed were classified as having less than 20% shading.

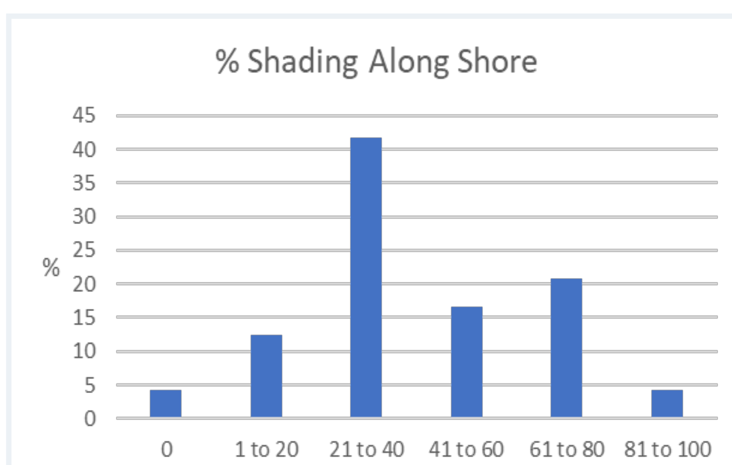


Figure 11: *Shading along Carp C.*

Erosion and Streambank Undercutting

Rivers and streams are dynamic hydrologic systems, which are constantly changing 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. 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.

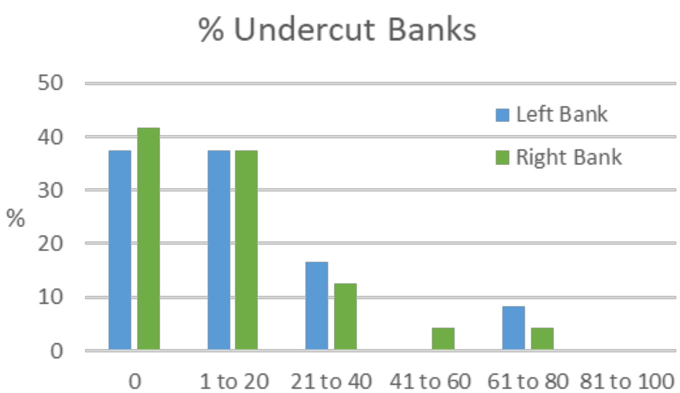


Figure 12: *Percent undercut stream banks along Carp C.*

One of the features created by erosion is the undercut, where the creek is then able to flow underneath of 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 Carp C. Overall, the sections of Carp C that were surveyed were found to have very little undercutting. However, 8% of the left bank and 4% of the right have a high degree undercutting.

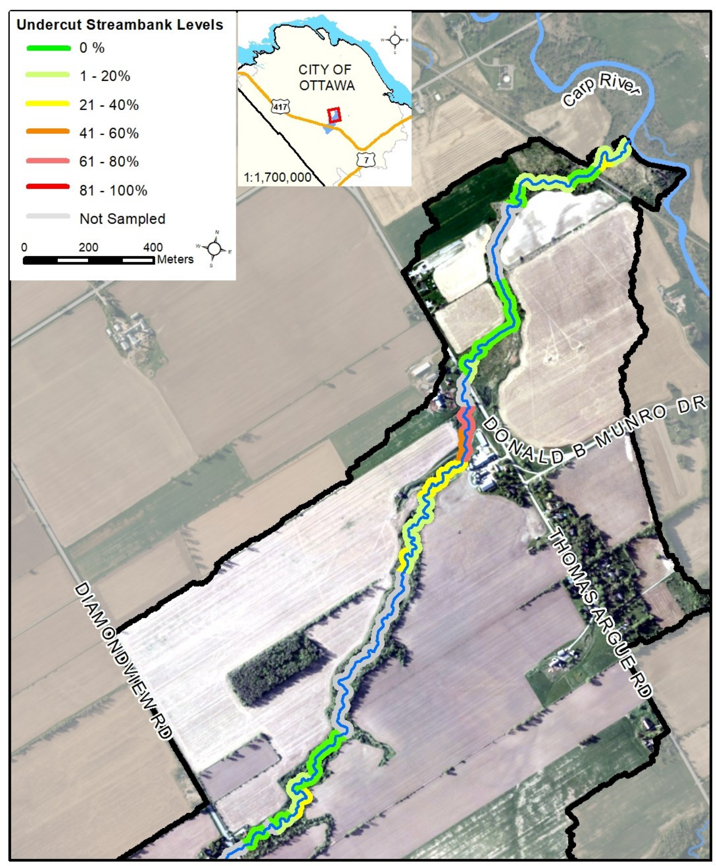


Figure 13: *Map of undercut banks in Carp C.*

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 different types of substrate which make up the bed of Carp C.

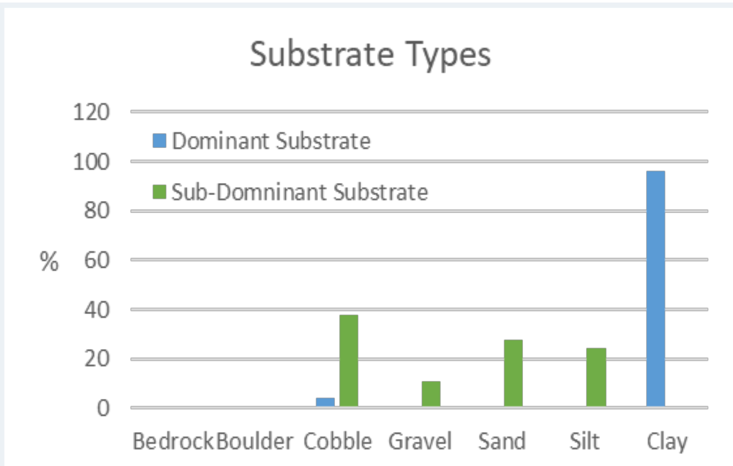


Figure 14: *Percentages of in-stream substrate types in Carp C*

Carp C is composed of high percentages of clay, with smaller percentages of cobble. Clay, which makes up 96% of the dominant in-stream substrate, is prone to disturbance and erosion. Cobble and gravel which make up 48% of Carp C's sub-dominant in-stream substrate, provides spawning habitat for fish and invertebrates. It also provides habitat for benthic invertebrates (organisms that live on the bottom of a water body or in the sediment) which are a key food source for many fish and wildlife species. Boulders, which were not found within the surveyed sections of the creek, create cover and back eddies for larger fish to hide and rest out of the current.

Cobble and Boulder Habitat

As discussed, cobble and boulders both provide important fish habitat. Figure 15 shows the sections of Carp C where cobble and boulders were found to either be present or not present on the stream bed. This map shows that the tributary has two long reaches containing cobble habitat. No reaches were noted to have boulders creating instream habitat.

Potential fish habitat enhancements could include adding cobble and boulders in key locations to create riffle habitat.

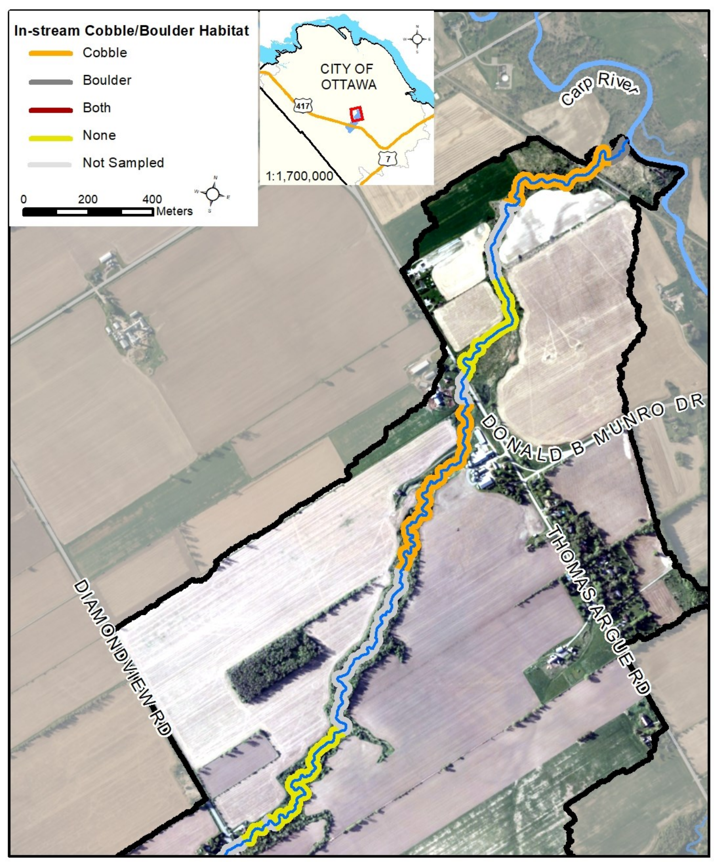


Figure 15: *Cobble and boulder habitat along Carp C*

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, Carp C was found to consist of 82% runs, 5% riffles and 13% pools. Stewardship efforts could be focused at creating more in-stream pool/riffle sequences to enhance fish habitat.

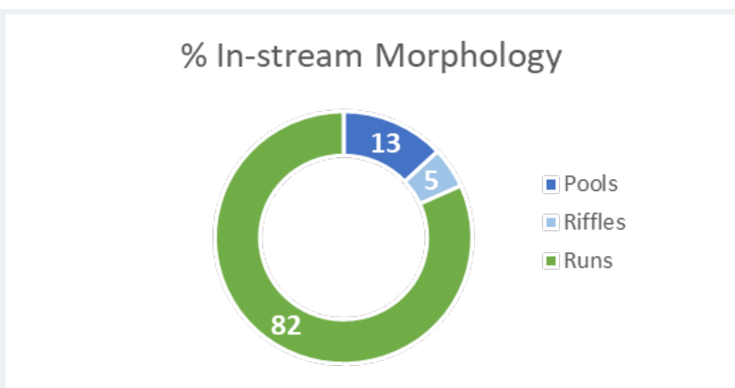


Figure 16: *In-stream morphology along Carp C.*

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 or vegetative material in each surveyed reach of Carp C. 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. 13 of the 24 surveyed reaches are considered to have low habitat complexity.

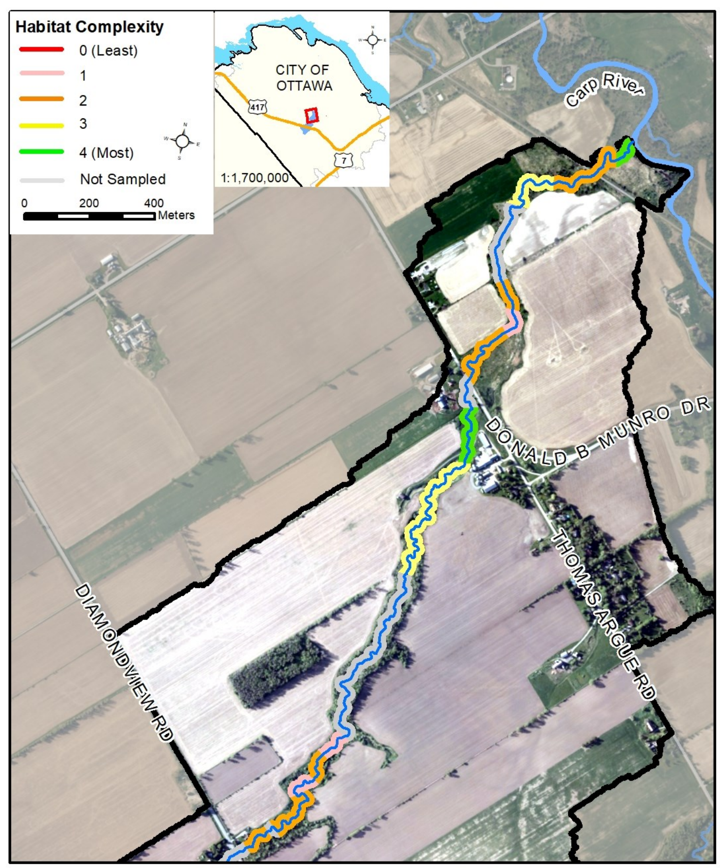
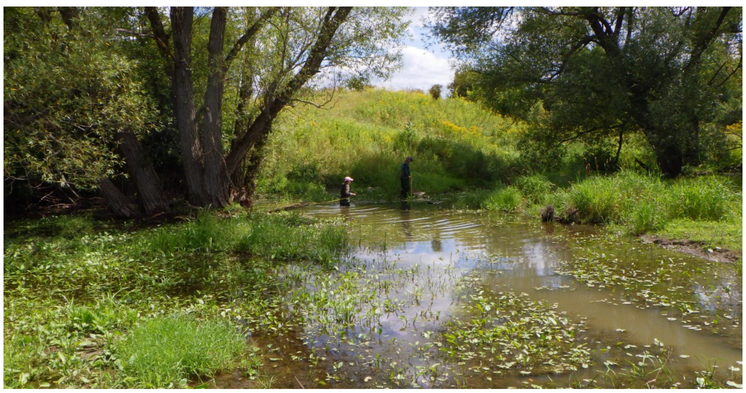


Figure 17: *Habitat Complexity Scores for Carp C.*

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 by type into eight categories; narrow-leaved emergent, broad-leaved emergent, robust emergent, free floating plants, floating plants, submerged plants, algae and no plants. Algae (21%) was the most prominent in-stream vegetation in Carp C.

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 in-stream vegetation in Carp C. The surveyed portions of the creek were found to have a good diversity of vegetation abundance with each category being represented. Overall the creek had more sections with low density vegetation, with 66% having less than 25% abundance.

Low in-stream vegetation levels in Carp C are likely due to substrate type. For example, areas near the lower end of the system were deep and had a hardpack clay bottom which are not conditions preferred by aquatic plants. A lack of aquatic vegetation may also be the result of water currents creating conditions that limit plant growth.

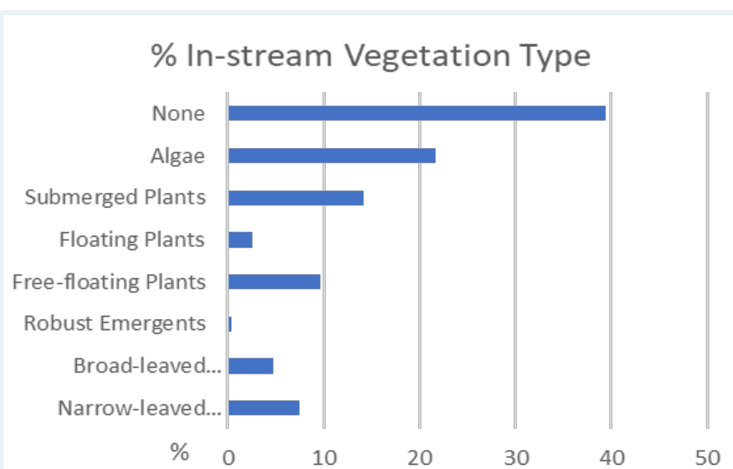


Figure 18: *Types of in-stream vegetation in Carp C.*

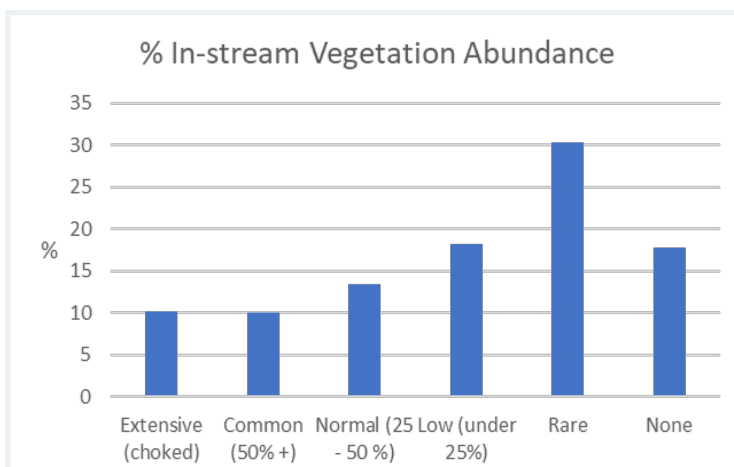


Figure 19: *Abundances of in-stream vegetation in Carp C.*

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 Carp C is 953 µS/cm, putting it above the target level.

Since background conductivity can vary between systems, the 2019 results have been compared to the surveyed average for Carp C 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 the Carp C tributary only drop below 6.5 within one reach. The average pH in Carp C is 7.69, a nearly neutral condition, which is ideal for many species of fish to thrive.

Table 3: Carp C Water Quality Data

	Minimum	Maximum	Average
Water Temperature (˚C)	15.0	21.5	18.3
Specific Conductivity (µS/cm)	707	1882	953
pH	6.38	8.17	7.69
Dissolved Oxygen Concentration (mg/L)	1.28	16.40	6.93

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 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 Carp C was 6.93 mg/L. Eleven reaches in the creek have less than 6 mg/L dissolved oxygen levels. This indicates a potentially stressed environment in these locations for warm water fish which will be discussed further on the following pages. 11 of the sections surveyed fall within the dissolved oxygen range required to support warm water fish and two sections There had suitable concentrations for supporting warm and cold water fish as seen Figure 21.

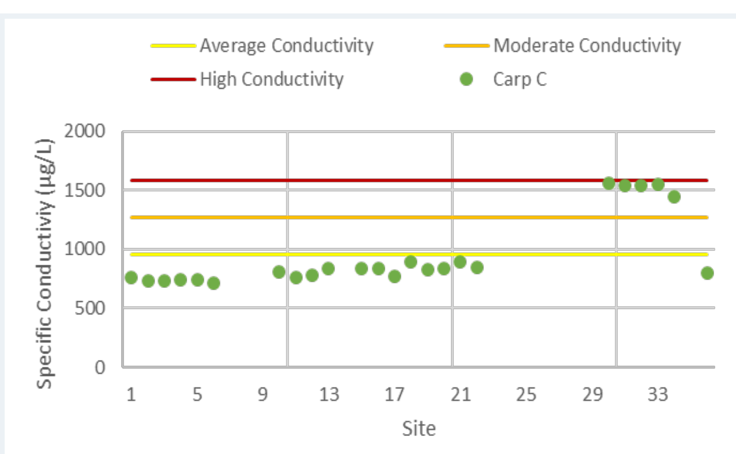


Figure 20: *Specific conductivity results from Carp C.*

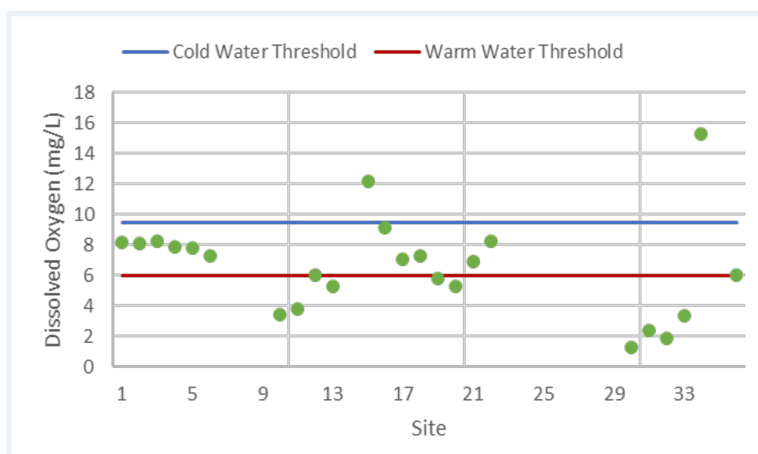


Figure 21: *Dissolved oxygen concentration results from Carp C.*

Dissolved Oxygen Saturation is measured as the ratio of dissolved oxygen relative to the maximum amount of oxygen that will dissolve depending on the 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 the 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.

The majority of the reaches had oxygen saturation amounts less that 100%, and nine of the 24 reaches had dissolved oxygen levels below 6 mg/L. Thirteen reaches had acceptable dissolved oxygen concentrations for warm water fish but low saturation levels, and two reaches had high concentration and saturation results.

This indicates that the majority of the surveyed sections in the Carp C tributary were in a low oxygen state during the summer site visits which would have placed stress on warm water fish species and other biota.

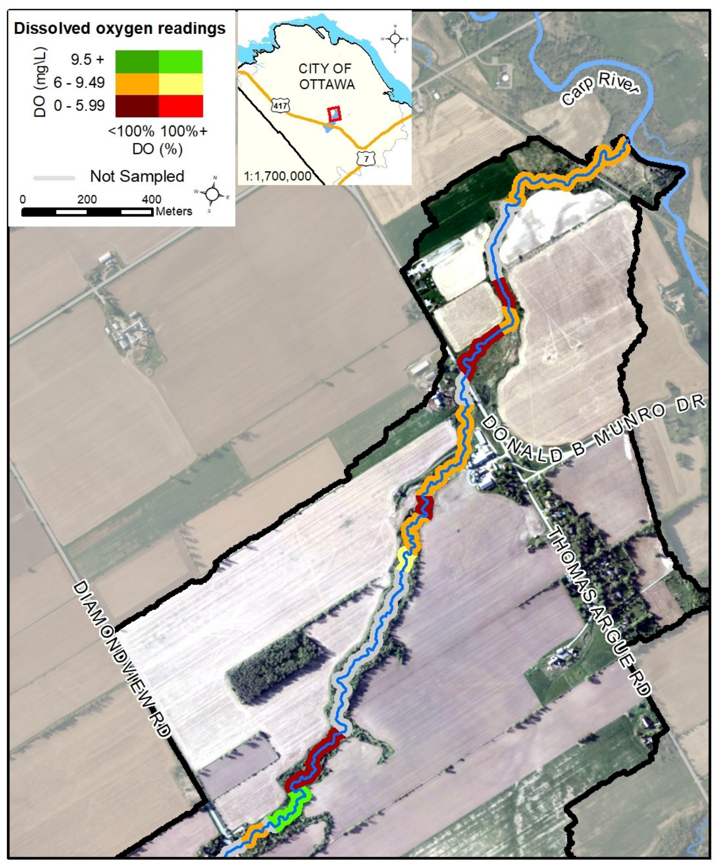


Figure 22: *Dissolved oxygen concentration and saturation results for Carp C.*

Areas of Water Quality Concern (AOC)

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 water quality concern.

As shown on page 12, Carp C had one low pH value of 6.38. This slightly below ideal range value combined with a low dissolved oxygen score resulted in this site receiving a moderate AOC classification.

Conductivity values were fairly consistent between 700 and 900 µs/cm for the majority of the surveyed reaches. 500 m of the Carp C tributary downstream of Diamondview Road had distinctly higher conductivity readings which averaged 1525 µs/cm. This combined with the poor oxygen scores for that 500 m reach (seen in Figure 22) gave the area a poor score.

Oxygen concentration levels were low with 9 sections having low oxygen concentration and 13 more sites with low saturation levels as shown in Figure 22. This indicates that some reaches have less than ideal conditions for aquatic organisms.

The nine poor scores shown in Figure 23 reflect areas where lower oxygen concentration and saturation scores combine with higher than average conductivity readings.

The 13 sections with good scores had moderate to low conductivity readings and moderate dissolved oxygen and low concentration values.

The two sections receiving an excellent score reflect the areas that had high oxygen concentration and saturation scores combined with an average conductivity score for the site near Thomas Argue Road, and an above average conductivity score near Diamondview Road.

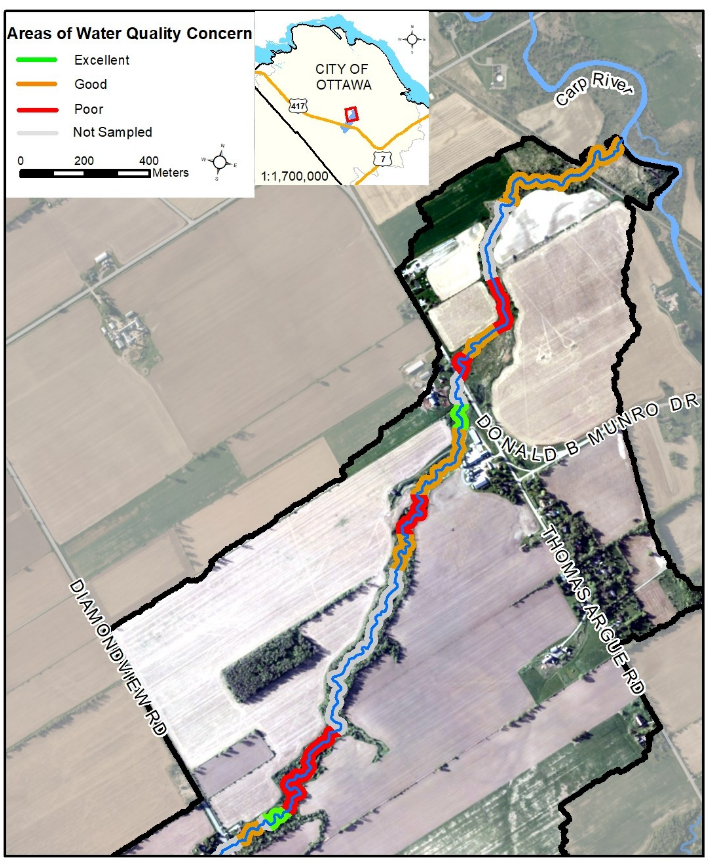


Figure 23: *Areas of Water Quality Concern in Carp C.*

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 temperature datalogger was deployed in Carp C from May to October 2019 to give 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 Carp C for 2019.

Unfortunately, due to an equipment malfunction data was only collected from the downstream logger in 2019. Analysis of the data collected indicates that Carp C should be classified as a cold-cool water stream. These results confirm the conclusions made in the 2016 survey, which indicates there is likely a groundwater spring between the two sites.

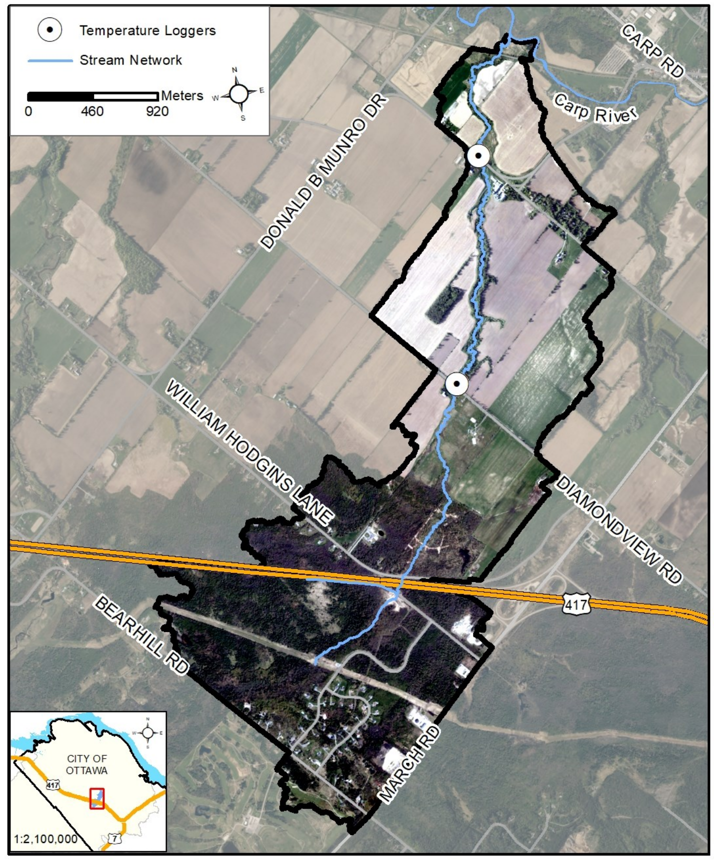


Figure 24: *Location of the temperature logger site on Carp C.*

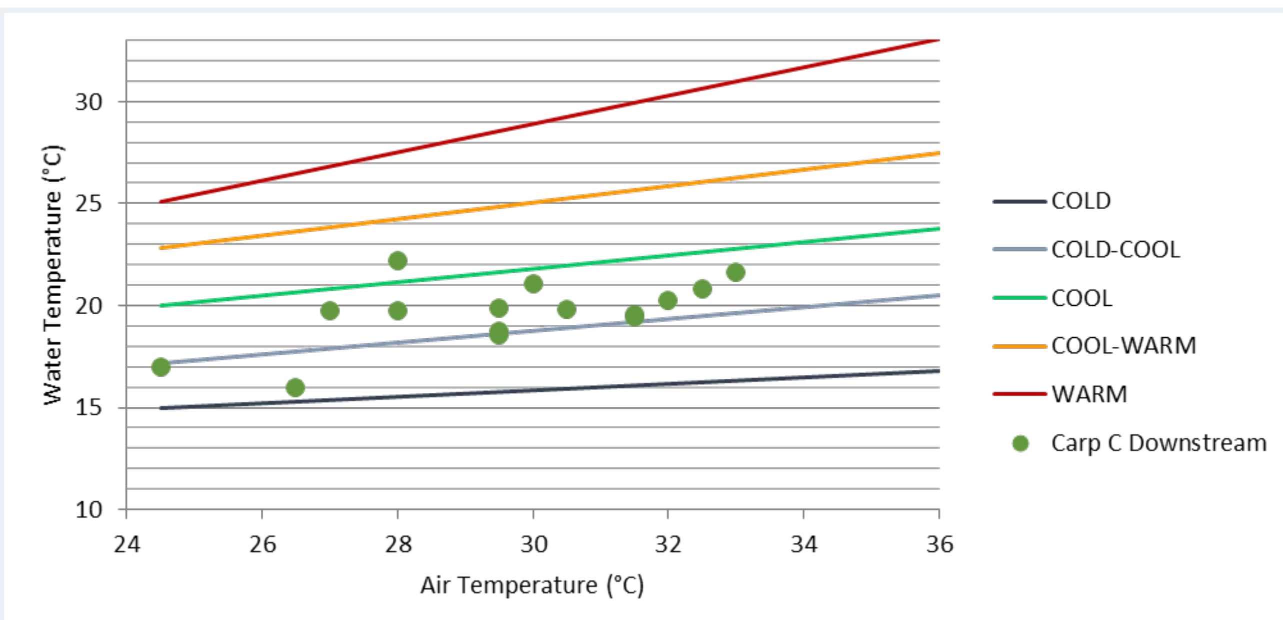


Figure 25: *Thermal classification of Carp C.*

Each point on the graph represents a water temperature that was taken under all 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; and
- Water temperature at 4:00 pm.

Fish Sampling

Unfortunately MVCA was unable to perform a fish survey on Carp C in 2019. However, MVCA has records of past fish sampling efforts in Carp C and has been able to compile the fish species list shown in Table 4 (Thermal classes from Coker, 2001).

Table 4: Fish Species Found In Carp C

Species Common Name	Thermal Class
Brassy Minnow	Cool
Brook stickleback	Cool
Central Mudminnow	Cool
Creek Chub	Cool
Dace sp.	Cool
Eastern Blacknose Dace	Cool
Fathead Minnow	Warm
Pearl Dace	Cool
White Sucker	Cool

Beaver Activity

Within the surveyed sections of the Carp C Tributary, 1 beaver lodge was noted and 5 dams were observed.

The shoreline vegetation in these areas showed low to common levels of tree cropping.

Migratory Obstructions

Migratory obstructions are features in a water way that prevent fish from freely swimming up and downstream. This can negatively affect 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 Carp C revealed that there are 14 migratory obstructions. Of those there are 5 beaver dams, 7 debris dams and 2 perched culverts.

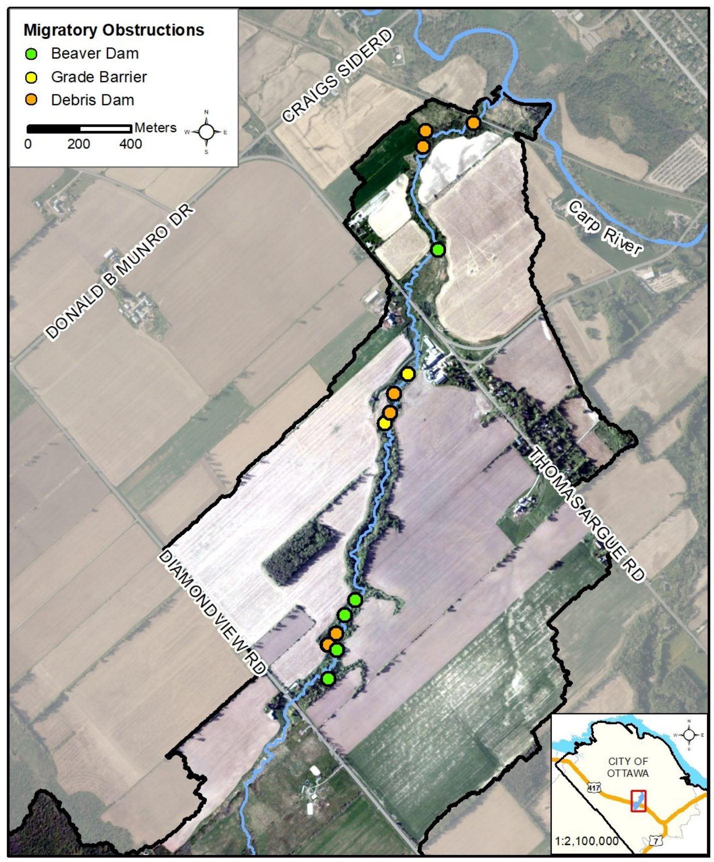
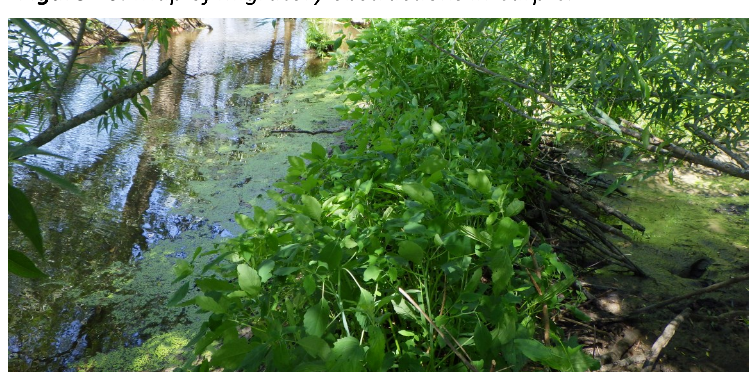


Figure 26: *Map of migratory obstructions in Carp C.*



Wildlife Observed

There were many species of wildlife observed during this assessment of Carp C. Of note was the wide variety of birds heard or encountered. A complete list of species observed during the 2019 survey is shown in Table 5.

Table 5: Carp C Wildlife Observed	
Birds	Cedar waxwing, Crow, Goldfinch, Harry Woodpecker, Great-blue Heron, Hummingbird, Kingbird, Kingfisher, Raven, Red-tailed Hawk, Red-winged Blackbird, Song Sparrow, other sparrows, Spotted Sandpiper, Starling, Yellow Warblers, Wood Duck, and other unidentified birds.
Mammals	Deer, Deer tracks, Racoon, muskrat tracks, beaver tracks
Reptiles and Amphibians	Green Frogs, other frogs, Snapping Turtle
Insects	Back swimmer, beetles, crayfish, damselflies, dragonflies, Isopods, leeches, Monarch, Mosquitos, snails, Stonefly, Viceroy Butterfly, Water Strider as well as other unidentified butterflies and moths

Pollution

Pollution in the form of litter, such as plastic, steel, oil and antifreeze containers, a plastic table etc. were occasionally found in Carp C, however other forms of visible pollution were rarely observed in the surveyed sections (Figure 27). 63% of the surveyed sections of Carp C had no visible pollution, this is a very beneficial attribute of the creek.

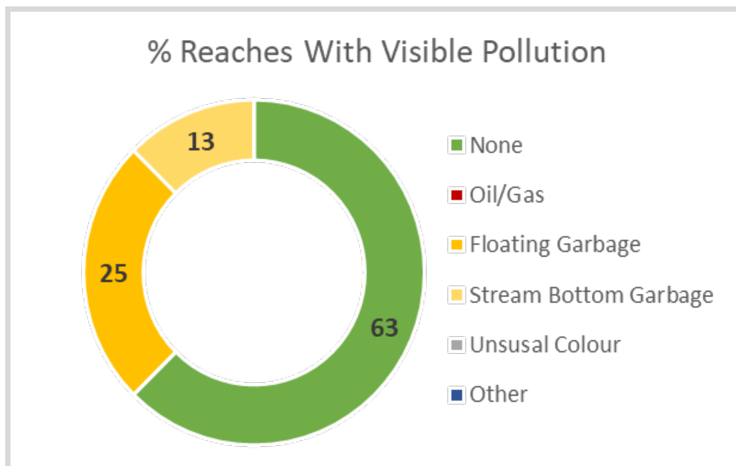


Figure 27: *Percentage of reaches with visible pollution in Carp C.*

Agricultural Impacts

Agricultural land uses represent 41% of the Carp C Tributary watershed, and as such had an important role to play in the health of the creek.

Cattle access

As part of the CSW protocol, the level of livestock (predominantly cattle) access within each 100 m section was classified as either low (<10 m of access), moderate (10-20 m of access) or extreme (>20 m of access).

None of the reaches surveyed were found to have signs of livestock access to the tributary.

Field erosion

Livestock access to the banks of a watercourse is a risk for erosion as foot traffic along the banks as well as the close grazing of the vegetation can make it hard for the plants to grow deep strong root systems. These roots are beneficial as they hold the predominately clay soils together during high water level or flow events.

Tilling too close to the top of the bank can also have a similar impact on bank erosion risk by disrupting the presence of deep rooting vegetation.

Of the 24 reaches surveyed none had notable amounts of field erosion along the banks. However, tilled fields were quite close to the top of bank in a few reaches.

Potential Stewardship Opportunities

Naturally vegetated shorelines help reduce erosion, filter pollutants before water runoff enters the watercourse and assist in flood control while also providing food and habitat for a variety of wildlife.

69% of left bank and 74% of the right bank of the surveyed reaches had less than a 30 m vegetated buffer. 10% of left bank and 12% of right bank reaches have less than a 5 m buffer. Additionally, 17% of the stream surveyed has less than 20% shade cover.

Stewardship activities can include but are not limited to; restoring eroded banks and enhancing stream shading by planting trees within 5 meters of the top of bank (particularly the east or south banks to increase shade), or widening and improving riparian buffers through reduced tilling near the top of bank and planting the area with native species of trees, shrubs, grasses or wild flowers.

The next steps will be to contact landowners in these areas and explore the potential for collaboration with them on a voluntary basis to enhance their shorelines.

City of Ottawa programs such as the Rural Clean Water Program and the Green Acres fund are available to help financially support some of these undertakings. Information about these programs is available from the Stewardship Coordinator at MVCA.

Photo Above: The purple flower is Dames Rocket

Photo Below: Purple Loosestrife

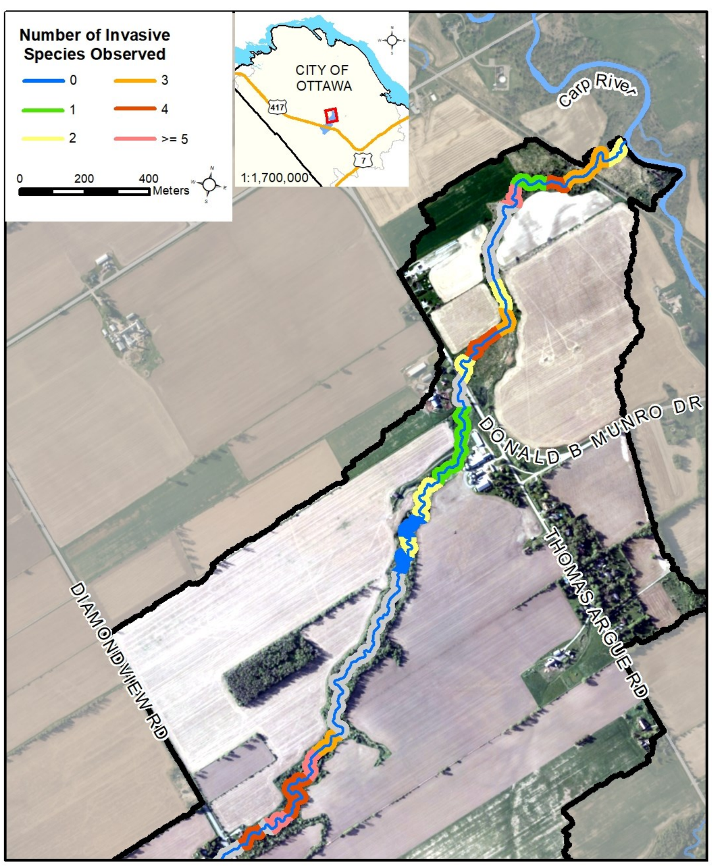


Figure 28: *Abundance of identified invasive species along Carp C.*

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 13 identified invasive species in the Carp C Corridor, there are a large number of sections with one or fewer invasive species identified adjacent to the creek.

Invasive species identified while surveying Carp C are: Common Bittersweet Nightshade, Bull Thistle, Common Buckthorn, Dames Rocket, Dog-strangling Vine, Garlic Mustard, Hawthorn, Honey Suckle, Manitoba Maple, Poison Parsnip, Purple Loosestrife, Rusty Crayfish and Vetch.

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.

Photo above: A Bull Thistle leaning over the tributary.

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

Headwater Drainage Features

The City Stream Watch program assessed three Headwater Drainage Features in the Carp C subwatershed in 2019 (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 three headwater sites surveyed in the Carp C watershed consist of the following 4 feature types; defined natural channels, channelized features, wetlands and roadside ditches.

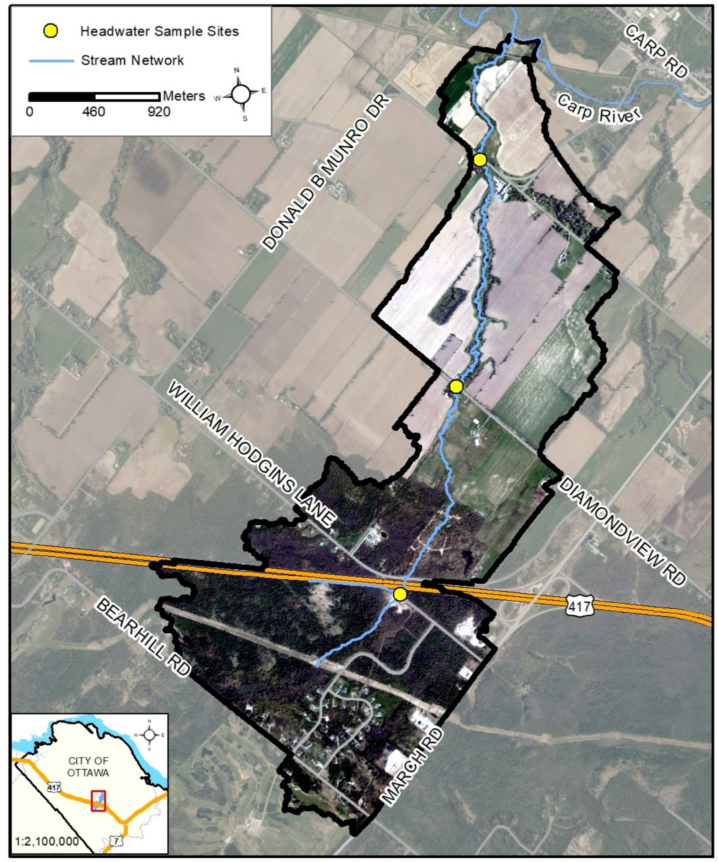


Figure 29: *Headwater drainage feature sampling sites in the Carp C watershed.*

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.

Surface flows were considered minimal for two sites during both visits, and the third was completely dry. During the July visit.

HDF Channel Modifications

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

Channel modifications noted at the Carp C 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 distance zones from the shoreline of each headwater feature (0-1.5 m, 1.5-10 m and 10-30m).

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

Meadow and wetland were the dominant feature vegetation types. Meadow, scrubland and wetland were the dominant riparian vegetation types.

Land Owners & Volunteers

A big **"Thank You!"** needs to go out to the landowners as well as dedicated volunteers, three summer students and one co-op student who came out in 2019 and helped make this monitoring program happen.

Water Chemistry Comparison Between 2016 and 2019

Water chemistry parameters are tracked throughout the entire surveyed system and reflect the general conditions of the surrounding environment. Shifts in these conditions can be indicative of general ecological changes within the environment. However due to the limited number of sampling years and sampling sites 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 2016 and 2019. MVCA surveyed Carp C with the City Stream Watch protocol in 2016 (4 reaches) and in 2019 (24 reaches) with only 2 reaches being done in both years. Both summers experienced hot dry conditions, however Carp C was severely impacted by the drought in 2016 limiting the number of reaches surveyed in that year. Due to differences in the monitoring schedules and weather patterns, the other 2 reaches done in 2016 were not revisited in 2019.

T-Tests were run on the data from the 2 reaches that were sampled in both 2016 and 2019 to determine the significance of the differences found. The results are summarized in Table 7. Water temperature, dissolved oxygen and specific conductivity results at those two locations were found to be significantly different between the two sampling years. Water depth values at those two sites were found to not be significantly different between the years. Two sampling events at two monitoring sites is not a sufficient amount of data to run statistics on and thus these are not conclusive results.

The difference in the weather conditions between the sampling years as well as the difference in the number of successfully surveyed reaches highlights the need for a longer term and more robust data set created through repeated visits to CSW catchments. Gathering more data will help clarify the interpretation of the results collected in 2016 and 2019.

Table 7: Comparison of Water Quality Parameters in Carp C					
	2016 Mean Results	**2016 Variance**	**2019 Mean Results**	**2019 Variance**	**Significant Difference?**
Water Temperature (°C)	23.35	0.07	19.95	1.39	Yes
pH	n/a	n/a	7.6	0.08	n/a
Dissolved Oxygen (mg/L)	0.465	0.07	15.3	28.69	Yes
Specific Conductivity (µS/cm)	918	14536	1447	2062	Yes
Water Depth (m)	0.47	0.06	0.36	0.01	No

Report Summary

The results in Table 6 are a summary of the highlights from each of the report sections. The surveyed portions of the Carp C Tributary have high amounts of natural shoreline vegetation and more than 50% shade coverage. The stream is classified as cold-cool water fish habitat. 45% of the sections have moderate to high habitat complexity which increases the habitat diversity available for benthic organisms, fish and other aquatic animals that call Carp C home. However, nine of the 24 reaches received a poor areas of concern score.

The main cause of the water quality concern rating is that nine of the monitored sections have lower than 6 mg/L dissolved oxygen. This combined with poor oxygen saturation levels makes these reaches less than ideal habitat for aquatic organisms. The source of this stress is unclear, however near-by agricultural land uses may have an impact. Further assessment for trends and potential causes will have to be done on a variety of water chemistry variables as MVCA continues to monitor Carp C.

Table 6: Summary Of City Stream Watch Results for Carp C in 2019

Sample Variable	Results Summary
Number of Sections Surveyed	24
Average Stream Width (m)	4.1
Average Stream Depth (m)	.042
Average Hydraulic Head (mm)	0.4
Average Water Temperature (˚C)	18.3
Average Conductivity (µS/cm)	953
Average pH	7.69
Average Dissolved Oxygen Concentration (mg/L)	6.93
Average Dissolved Oxygen Saturation (%)	71.1
# of Areas of Water Quality Concern with a Poor Score	5
Dominant Adjacent Land Uses	Active Agriculture
% Channel Alterations	8% Altered
% Vegetated Riparian Buffer Width (>30 m)	31% Left Bank, 26% Right Bank
% Overhanging Trees & Branches >40% Section Coverage	8% Left Bank, 13% Right Bank
% Stream Shading >40% Section Coverage	58%
% of Undercut Banks >60% Section Coverage	8% Left Bank, 4% Right Bank
Dominant Substrate Type	Clay
Sub-Dominant Substrate Type	Cobble
# Sections with a Habitat Complexity Score ≥3 variables	11
Dominant In-stream Morphology	82% Runs
Dominant In-stream Vegetation Types	Algae
Dominant Amount of In-stream Vegetation	Rare
Thermal Class	Cold-cool
Migratory Obstructions	14
# of Identified Invasive Species	13
Potential Stewardship Activities	Shoreline planting
# Head Water Drainage Features Sampled	2

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

References

Brooks, A.P., Gehrke, P.C., Jansen, J.D., Abbe, T.B. " Experimental reintroduction of woody debris on the Williams river, NSW: Geomorphic and Ecological responses". *River Research and Applications.* (2004). 513-536 Online

Canada. Environment Canada. "How Much habitat is Enough? A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern". *Minister of Public Works and Government Services Canada.* (2004). Print.

Canadian Council of Ministers of the Environment. "Canadian water quality guidelines for the protection of aquatic life: Dissolved oxygen (freshwater)". *Canadian Council of Ministers of the Environment.* (1999).

Castelle A.J., Johnson, A. W., Conolly, C. "Wetland and Stream Buffer Size Requirements—A Review". *Journal of Environmental Quality.* 23 (1994): 878-882. Print.

Chu, C., Jones, N.E., Piggott, A.R. and Buttle, J.M. "Evaluation of a Simple Method to Classify the Thermal Characteristics of Streams Using a Nomogram of Daily Maximum Air and Water Temperatures." *North American Journal of Fisheries Management* 29. (2009). 1605-1619, Online.

Coker, G.A, C.B. Portt, and C.K. Minns. 2001. Morphological and Ecological Characteristics of Canadian Freshwater Fishes. Can. MS Rpt. Fish. Aquat. Sci. 2554: iv+89p.

Environment Canada, 2011. Canada's Freshwater Quality in a Global Context Indicator. Data sources and methods. ISBN: 978-1-100-17978-0 . Available online: http://publications.gc.ca/collections/collection_2011/ec/En4-144-3-2011-eng.pdf

Stanfield, L. W., Kilgour, B.W. "How Proximity of Land Use Affects Stream Fish and Habitat." *River Research and Application*. Wiley Online Library. (2012). Online.

Stanfield, L. (editor). 2017. Ontario Stream Assessment Protocol. Version 10. Section 4: Module 10. Ontario Ministry of Natural Resources. Peterborough, Ontario. 548 Pages.

Vannote, R.L., Minshall, G.W., Cummins, K.W., Sedell, J.R. and Cushing, C.E. "The River Continuum". *Canadian Journal of Fisheries and Aquatic Sciences* 37. (1980): 130-137. Print.

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.