Cody 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 CSW 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 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 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 the MVCA staff and the volunteers, 109 sections in two catchments were assessed in 2018.

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

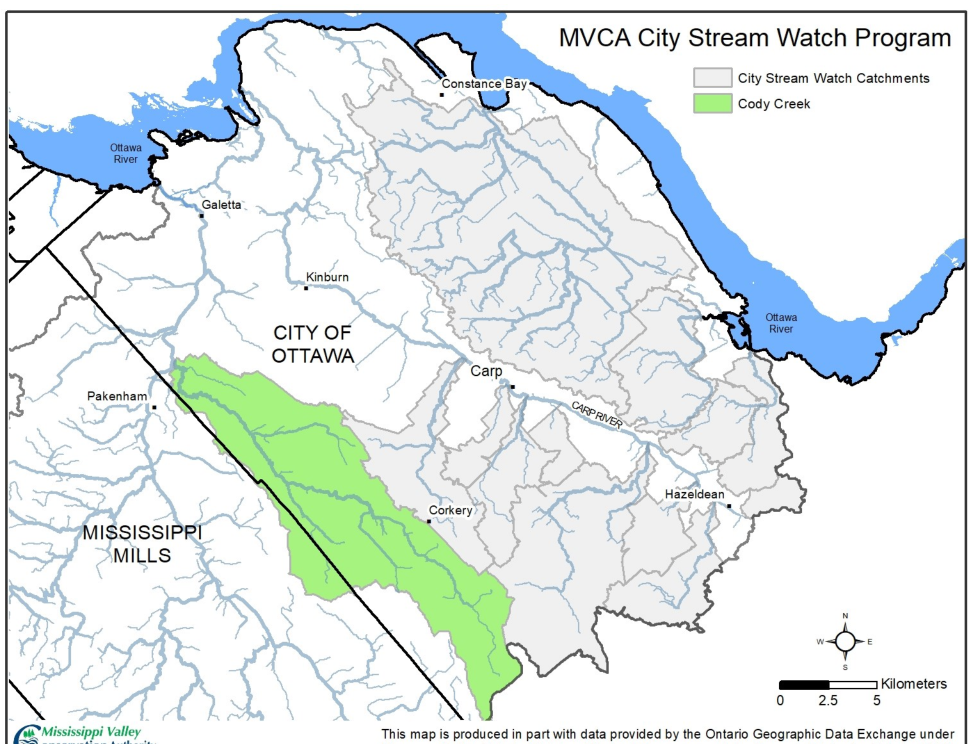


***Figure 1:** MVCA's City Stream Watch area highlighting the location of the Cody Creek subwatershed.*

Cody Creek

Located along the western edge of the City of Ottawa, Cody Creek is a tributary to the Mississippi River. With a length of 36 kilometers (km) and draining an area of 103 km^2, it is a large contributor of flow, sediment and nutrients to the Lower Mississippi River.

Cody Creek's headwaters originate in the Manion Corners Provincially Significant Wetland Complex located north of Highway 7 and east of Upper Dwyer Hill Road. It flows north and west through agricultural lands to the Mississippi River downstream of Pakenham. Table 1 presents a summary of some key features of the Cody Creek Subwatershed.

Table 1: Subwatershed Features	
Area	103 Square Kilometers
Length	36 Kilometers
Type	100% Permanent
	Cool-warm water habitat
	92% Natural
	8% Channelized
Land Use	44.7% Agriculture
	1.5% Aggregate sites
	30% Wooded area
	4.2% Rural land-use
	15.9% Wetlands
	1.4% Grassland
	2.2% Roads
	0.2% Water
Surficial Geology	31.6% Clay
	2.3% Diamicton
	15.9% Organic deposits
	42.2% Bedrock
	6.3% Sand
	1.7% Gravel

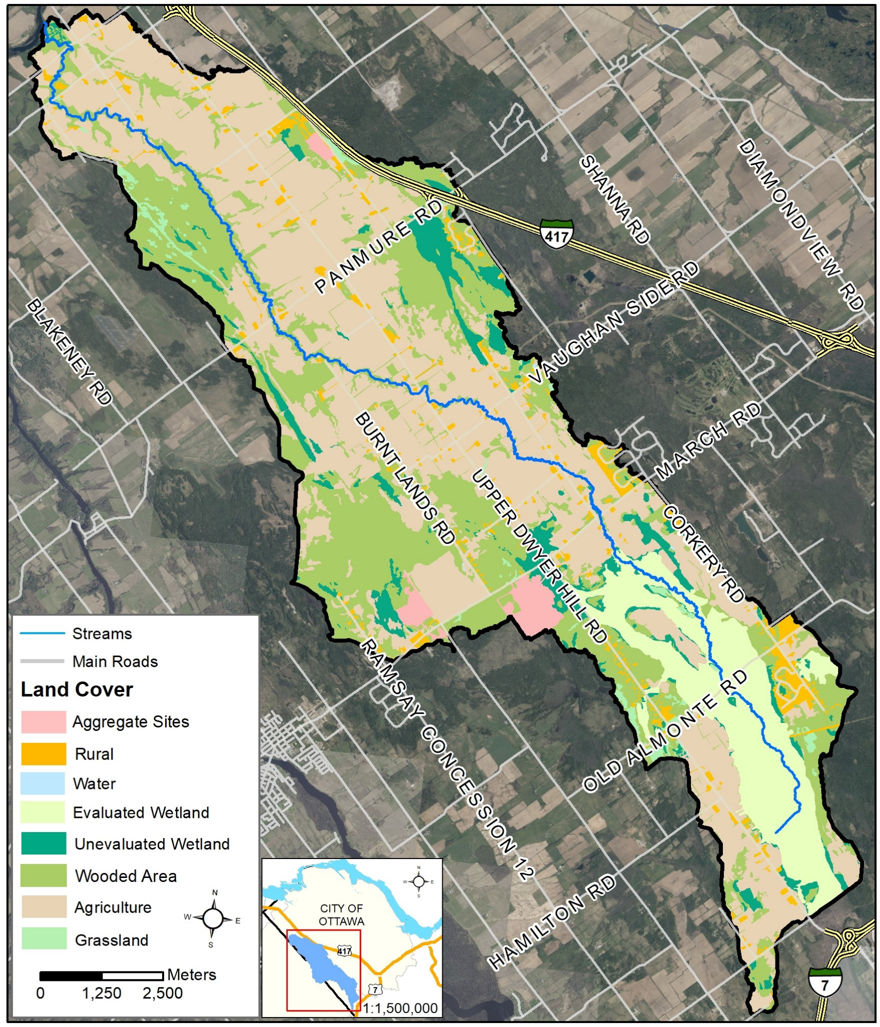
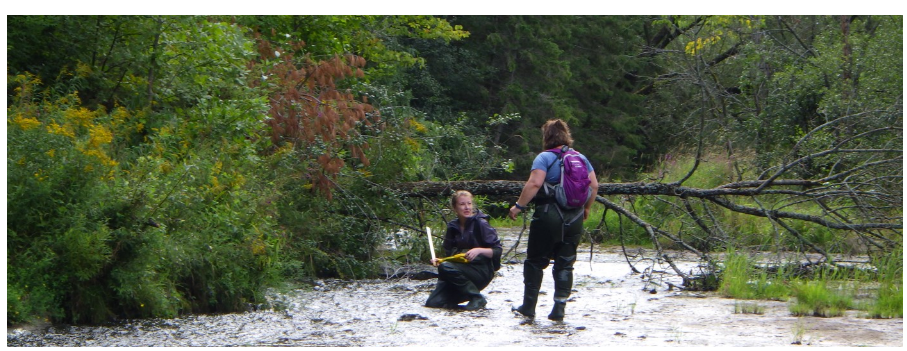


Figure 2: Land Use in the Cody Creek subwatershed.

The Cody Creek Subwatershed

As shown in Figure 2, the Cody Creek 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 (30%) and wetlands (15.9%).

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 2018 survey.



Monitoring in Cody Creek

In 2018, permission was granted to survey 56 sections of Cody Creek, shown on Figure 3, which cover approximately 5.6 km of the main creek.

While these sections provide a good representation of the overall condition of Cody Creek, 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 Cody Creek. The surveyed sections had an average stream width of 7.8 meters (m), an average depth of 0.6 m, an average hydraulic head of 2 millimeters (mm), which is an indicator of surface water velocity.

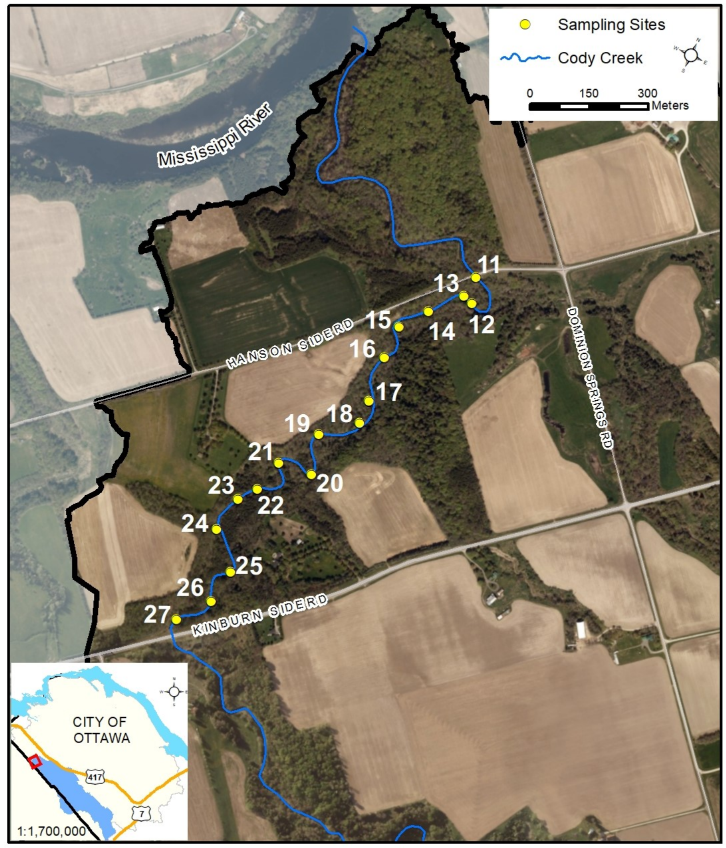
Table 2: Cody Creek Assessment Facts

	Minimum	Maximum	Average
Stream Wetted Width (m)	3.20	30.00	7.8
Stream Depth (m)	0.0	2.0	0.6
Hydraulic Head (mm)	0	25	2

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 un-wadeable, 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.

NORTH CODY CREEK SAMPLE SITES



SOUTH CODY CREEK SAMPLE SITES

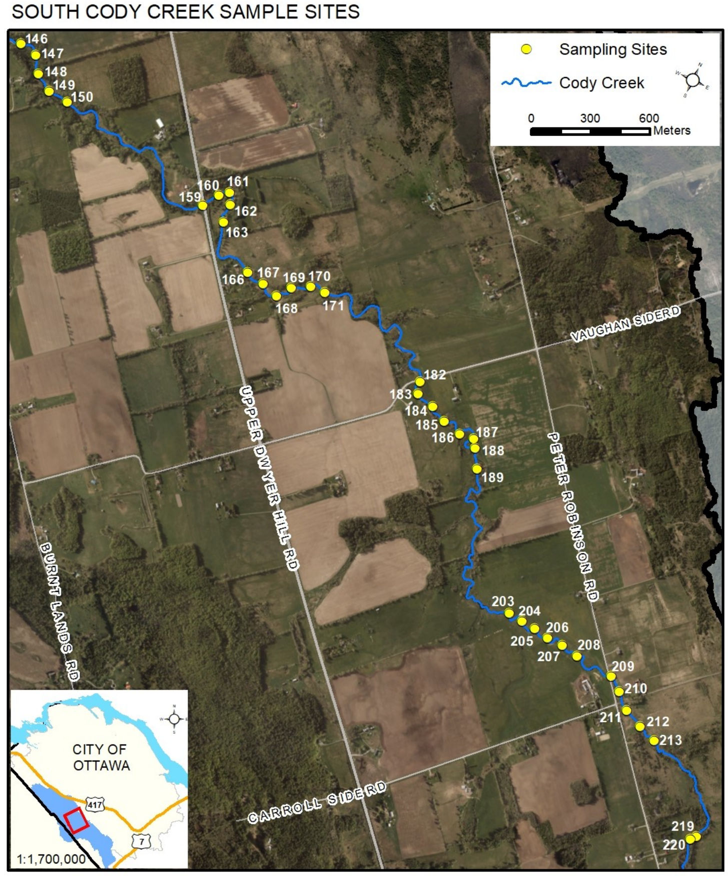


***Figure 3:** Locations of the monitoring sites along Cody Creek.*

General Land Use Adjacent to Cody Creek

General land use along each surveyed section of Cody 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 Cody Creek.

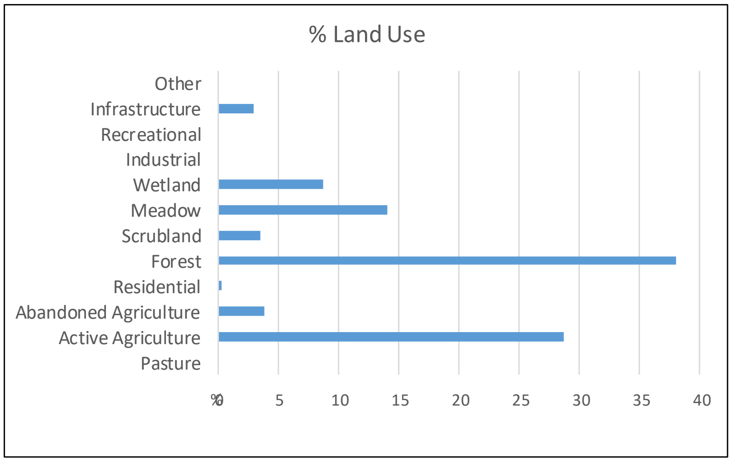


Figure 4: *Land use alongside Cody Creek.*

Of the eleven categories, industrial and recreational were not found to be present along surveyed sections. At 38%, forest represents the most prominent category of land use followed by active agriculture at 29%, and meadow at 14%.

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 (29% active, 4% abandoned). However, the land use observed directly adjacent to the creek is dominated by forest (38%). This is a benefit to the creek as well as the surrounding landscape as this forest cover provides shade, habitat and food for a wide variety of animals, cools the water and protects the banks from erosion. Meadow (14%) and wetland habitat (9%) round out the diversity of habitats on the landscape and contribute to erosion mitigation.

Human Alterations to Cody 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 meandering pattern of flowing water. As seen in Figure 5, 63% of Cody Creek was found to be completely unaltered, 29% was natural (with minor alterations), and 8% was altered (with considerable human impact). No surveyed sections were considered highly altered.

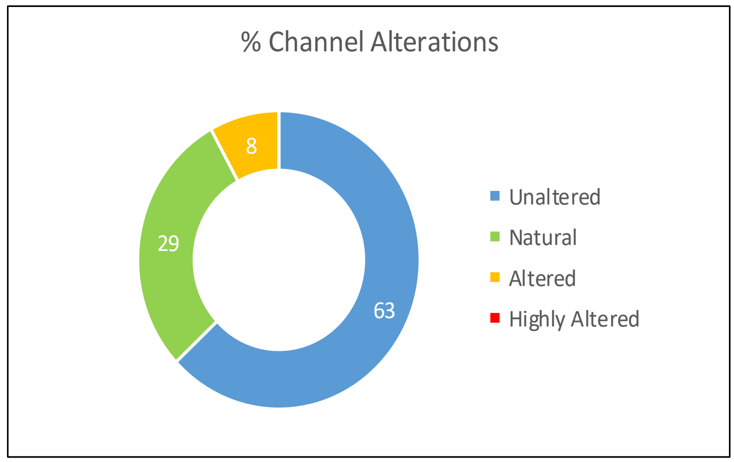
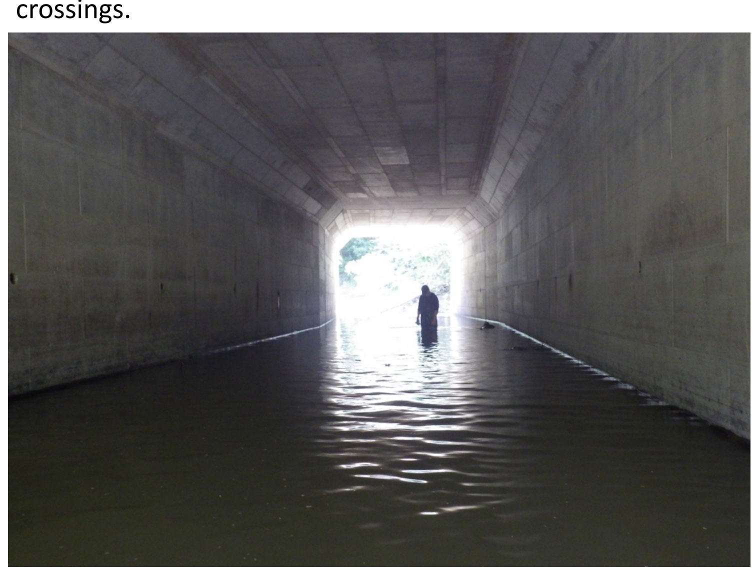
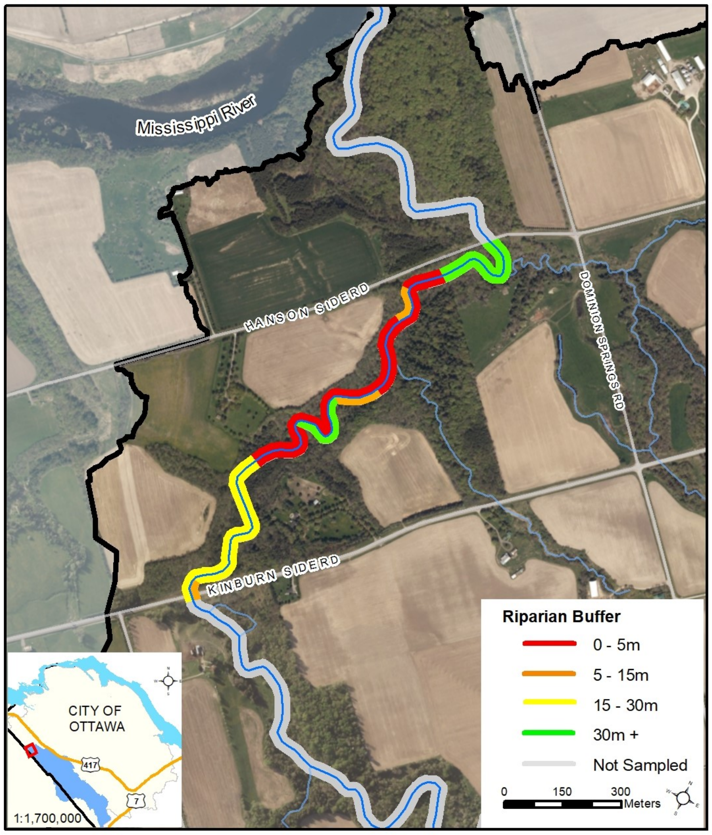


Figure 5: *Extent of human alterations to the shoreline of Cody Creek.*

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 crossings.



NORTH CODY CREEK SAMPLE SITES



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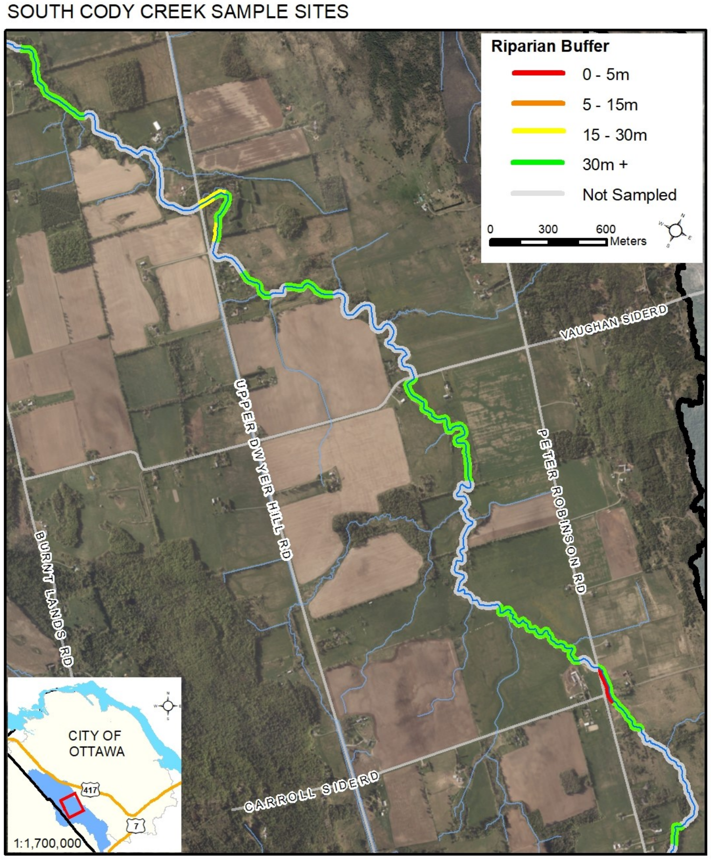


***Figure 7:** Vegetated buffer widths along Cody Creek.*

Riparian Buffer along Cody 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).

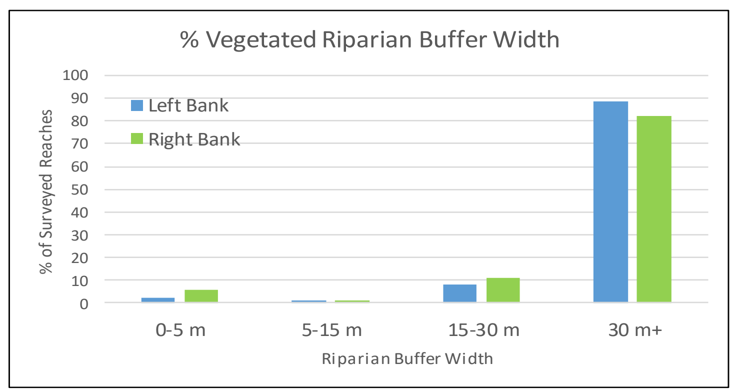


***Figure 6:** Riparian buffer widths along Cody Creek.*

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, most of the surveyed sections of Cody Creek have a sufficiently wide riparian buffer. Results for surveyed sections are very positive with 89% of the left bank and 82% of the right bank having a buffer width greater than 30 meters. Only 4% of sections on the left bank and 7% of sections on the right bank have a buffer of 15 m or less.

Figure 7 shows the differences in riparian buffer widths along the surveyed reaches of Cody Creek. The few reaches with smaller buffers were found in the agricultural areas and near the roads.

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, Cody Creek has a low percent coverage of overhanging trees and branches, as seen in Figure 8 with 75% of the reaches 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, 45% of the 56 surveyed stream sections were classified as having zero overhanging trees and branches along the left bank, and 43% on the right. 25% of the surveyed stream was found to have greater than 41% overhanging branches providing nutrients and shade to the creek.

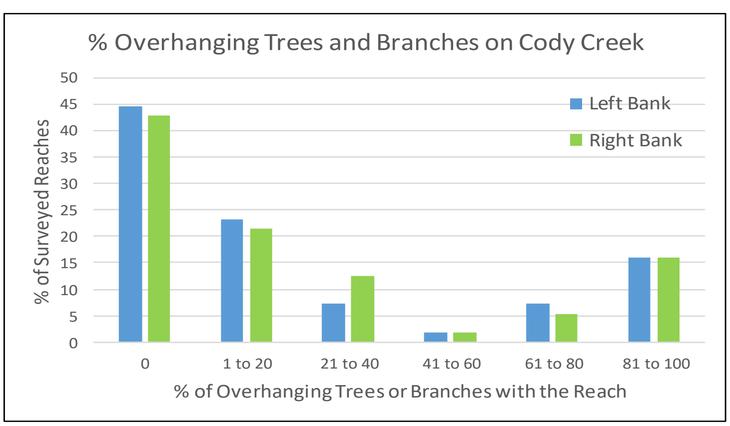
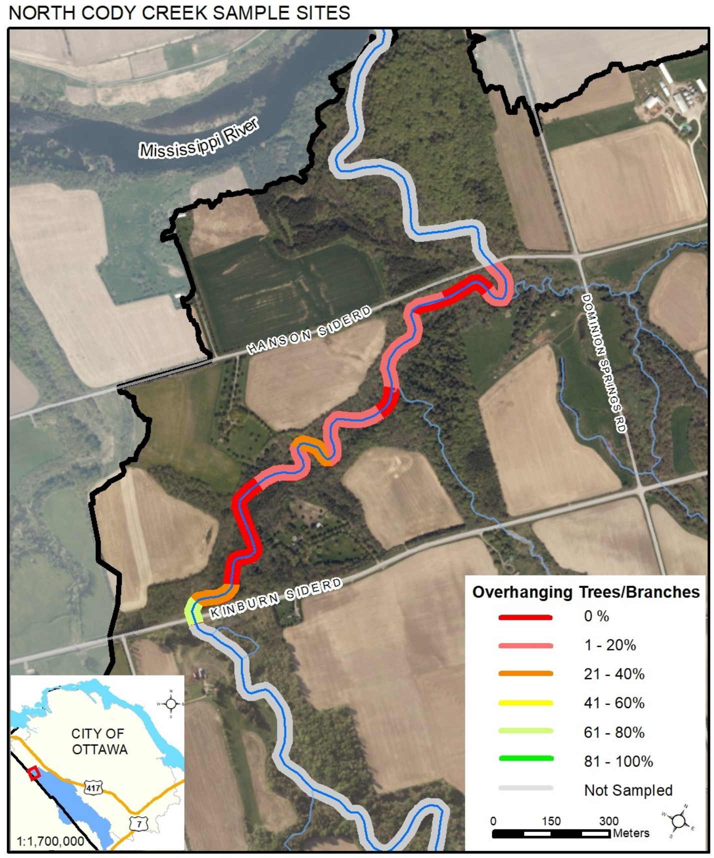


Figure 8: *Percentage of each surveyed section of Cody Creek with overhanging trees and branches.*



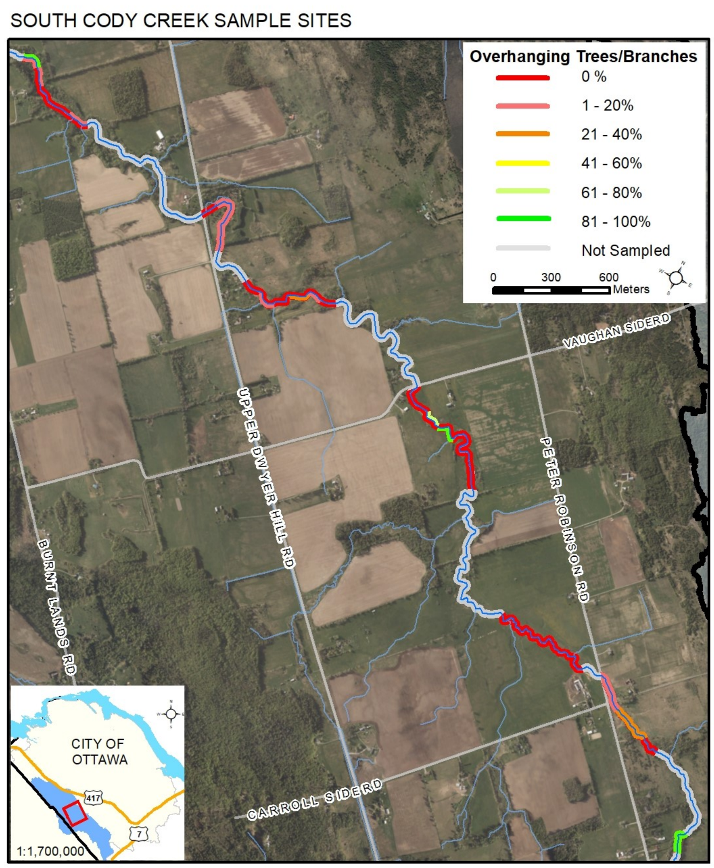
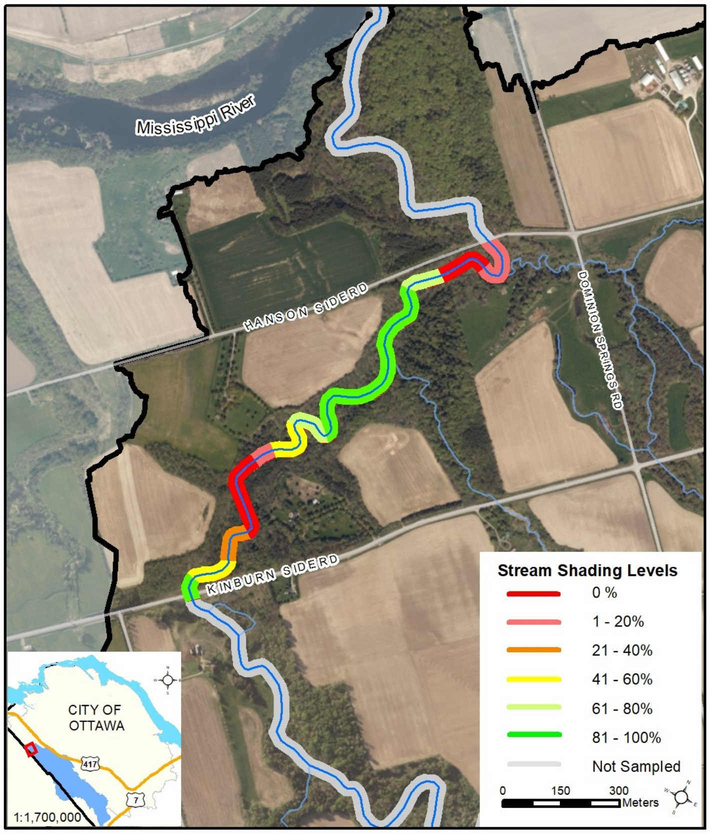


Figure 9: *Overhanging trees and branches along Cody Creek.*

NORTH CODY CREEK SAMPLE SITES



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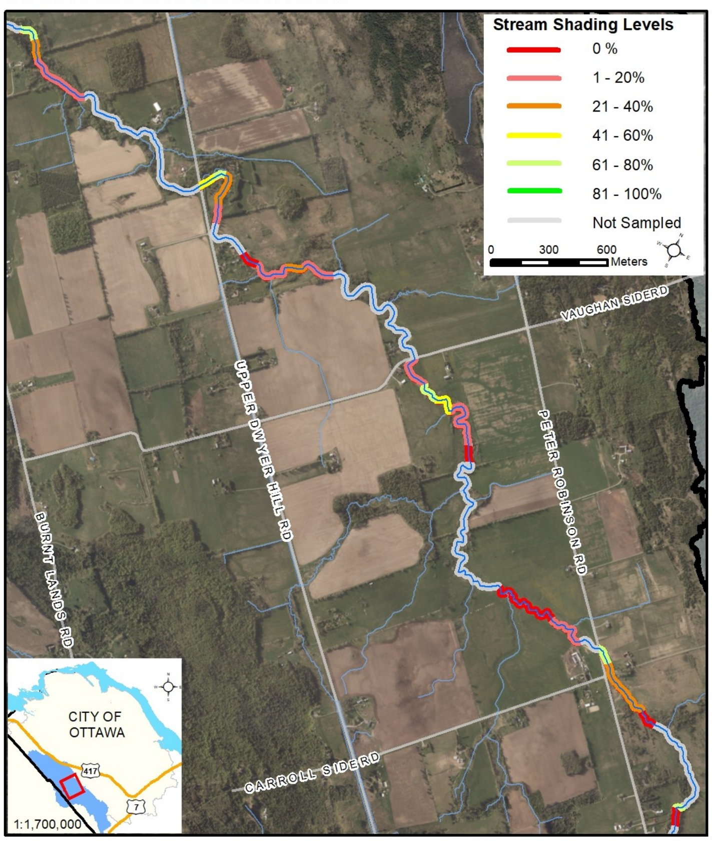


Figure 10: *Stream Shading along Cody Creek.*

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 Cody Creek. 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 scrub land interspersed with areas of dense forest. Cody Creek is also fairly wide in certain areas and well forested banks can not provide 100% shade coverage.

Figure 11 shows the data quantified as the percent of creek sections classified according to the various levels of shading. For example, 13% of the 56 stream sections that were surveyed were classified as having 0% shading, and more than half of the surveyed reaches have less than 41% shading.

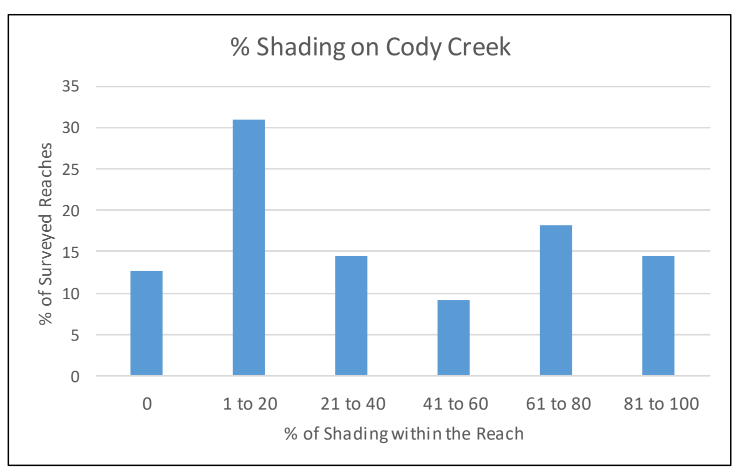


Figure 11: *Shading along Cody Creek.*

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.

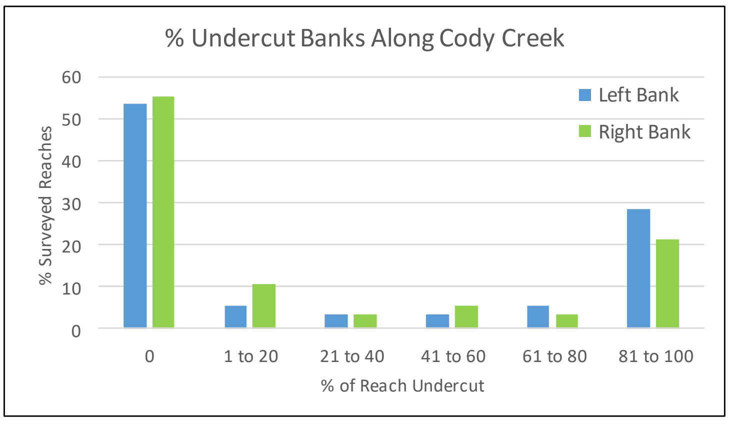
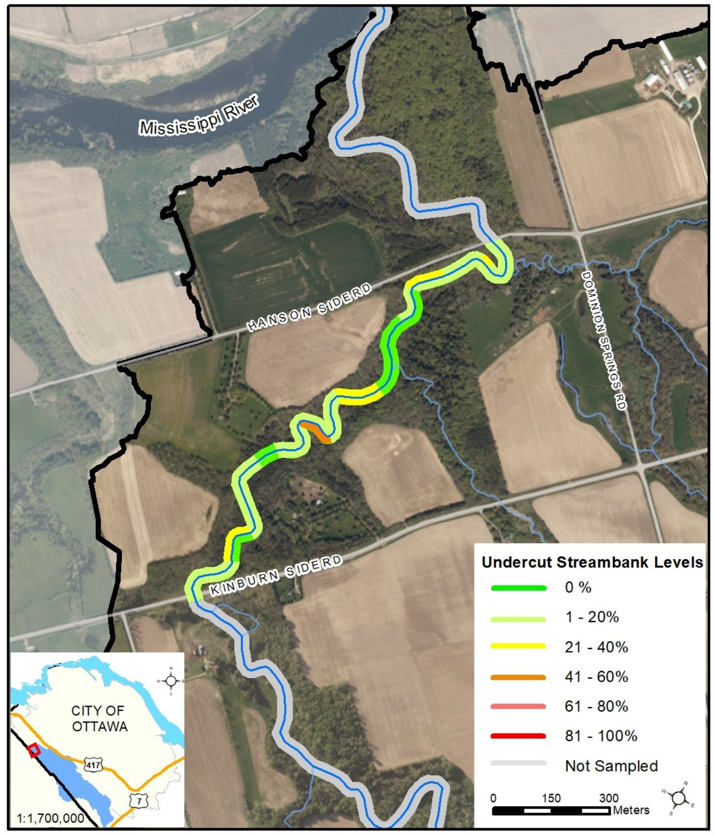


Figure 12: *Percent undercut stream banks along Cody Creek.*

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 Cody Creek. Overall, the sections of Cody Creek that were surveyed were found to have very little undercutting. However, 29% of the left bank and 21% of the right have a high degree undercutting. Other shoreline erosion types such as slumping and landslide locations were also noted during the surveys.

NORTH CODY CREEK SAMPLE SITES



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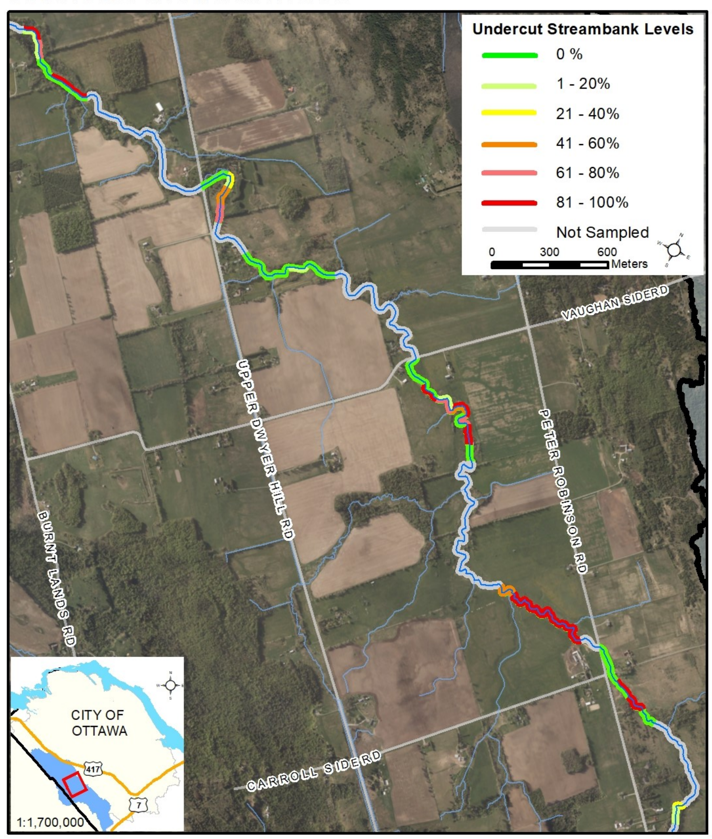
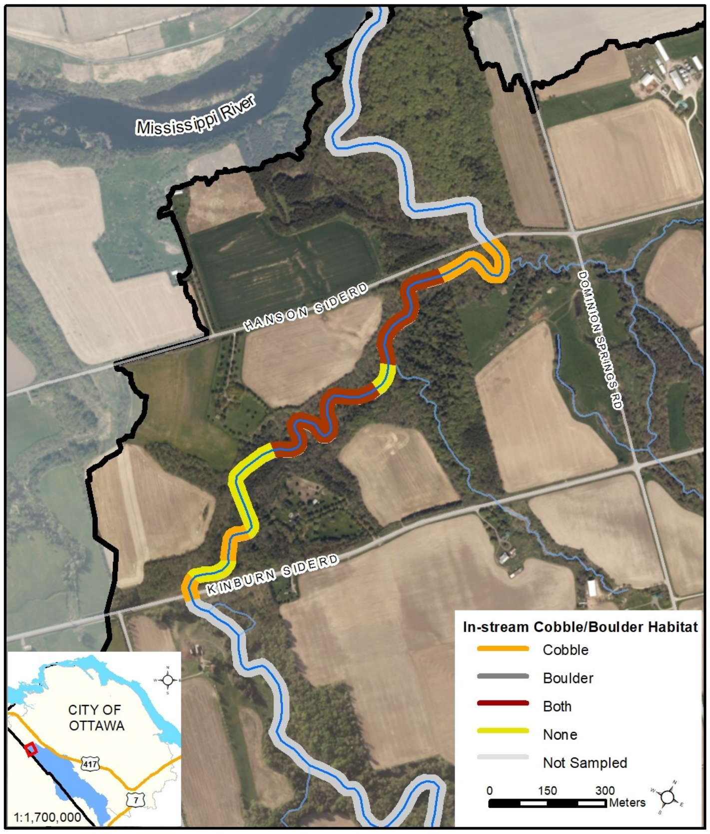


Figure 13: *Map of undercut banks in Cody Creek.*

NORTH CODY CREEK SAMPLE SITES



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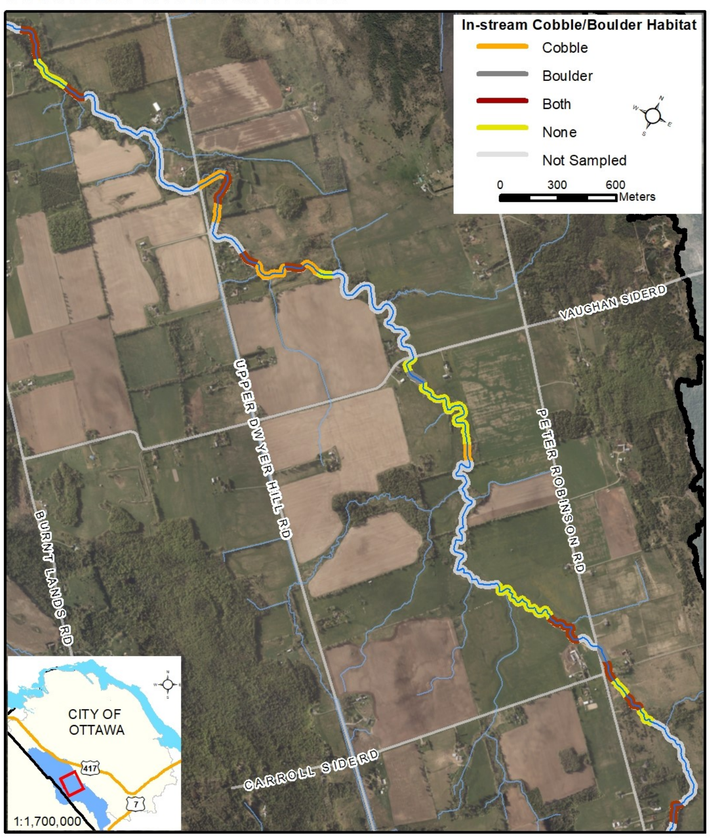


Figure 14: *Cobble and boulder habitat along Cody Creek.*

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 15 summarizes the different types of substrate which make up the bed of Cody Creek.

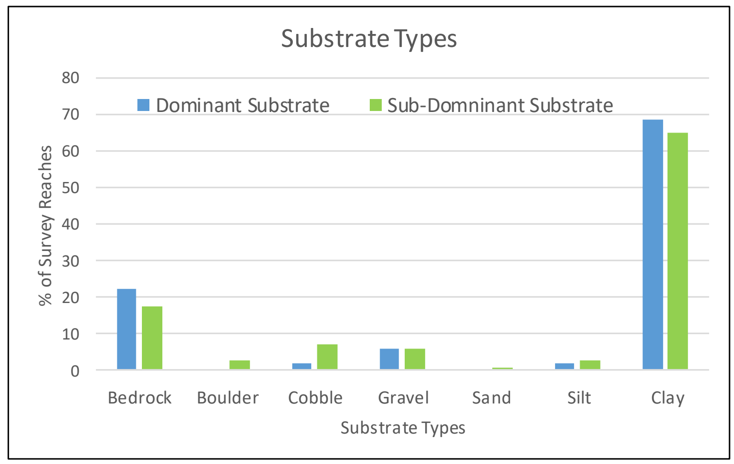


Figure 15: *Percentages of in-stream substrate types in Cody Creek.*

Cody Creek is composed of high percentages of clay, with smaller percentages of bedrock, gravel and cobble. Clay, which makes up 69% of the dominant and 65% of the sub-dominant in-stream substrate, is prone to disturbance and erosion. Cobble and gravel which make up 8% of Cody Creek's dominant and 13% 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 make up only 2% of Cody Creek's sub-dominant in-stream substrate, create cover and back eddies for larger fish to hide and to rest out of the current.

Cobble and Boulder Habitat

As discussed above, cobble and boulders both provide important fish habitat. Figure 14 shows the sections of Cody Creek where cobble and boulders were found to either be present or not present on the stream bed and shows that the creek has a healthy distribution of cobble and boulder substrates with a number of sections distributed along the creek 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, Cody Creek was found to consist of 84% runs, 9% riffles and 8% pools. Stewardship efforts could be focused at creating more in-stream pool/riffle sequences to enhance fish habitat.

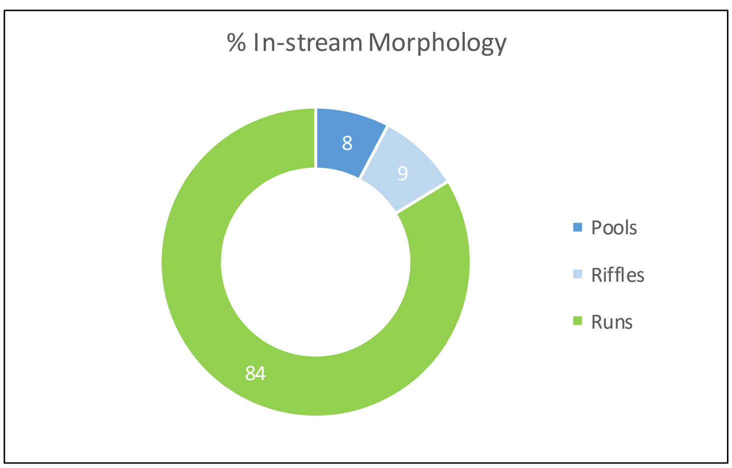


Figure 16: *In-stream morphology along Cody Creek.*

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 or vegetative material in each surveyed reach of Cody 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.

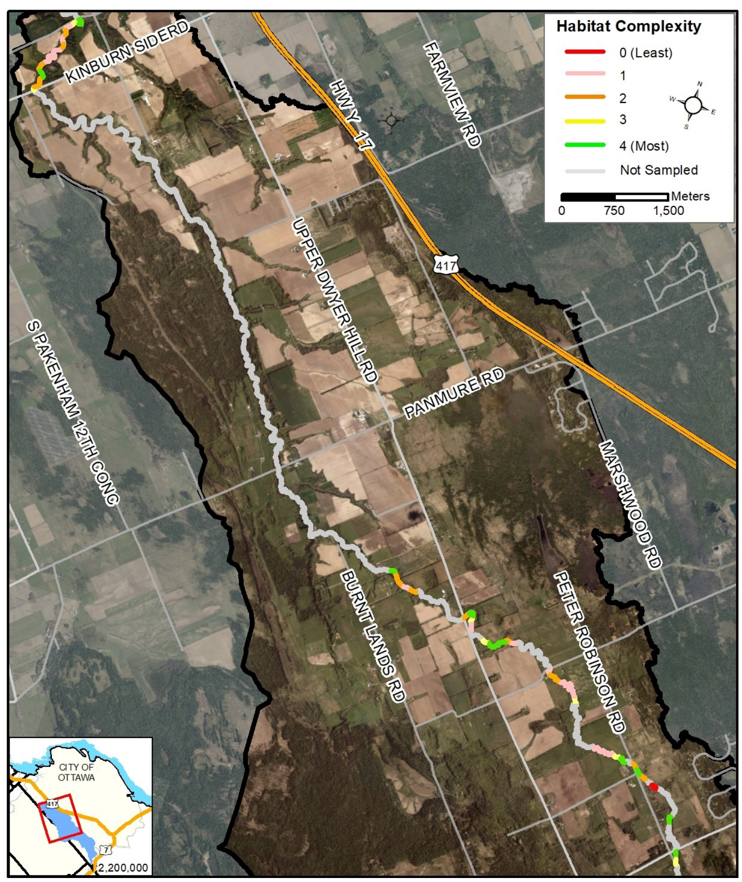


Figure 17: *Habitat Complexity Scores for Cody Creek.*

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 by type into eight categories; narrow-leaved emergent, broad-leaved emergent, robust emergent, free floating plants, floating plants, submerged plants, algae and no plants. Narrow-leaved emergents (58%) was the most prominent in-stream vegetation in Cody 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 in-stream vegetation in Cody Creek. 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 high density vegetation, with 35% common abundance and 9% extensive abundance.

Low in-stream vegetation levels in Cody Creek are likely due to substrate type. For example, areas near the lower end of the system were deep and had a 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.

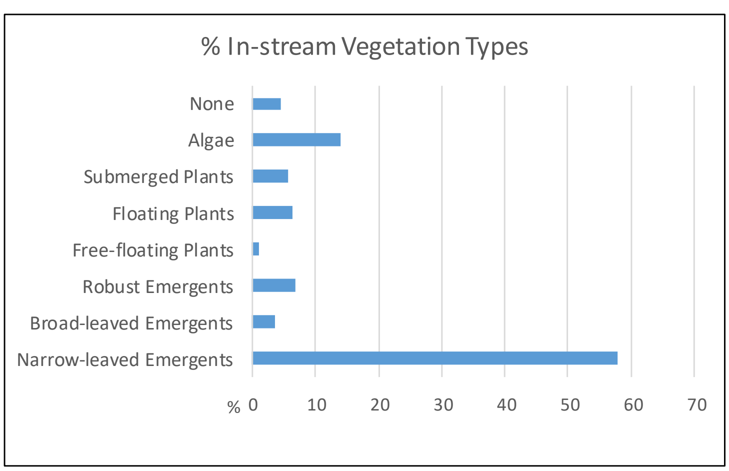


Figure 18: *Types of in-stream vegetation in Cody Creek.*

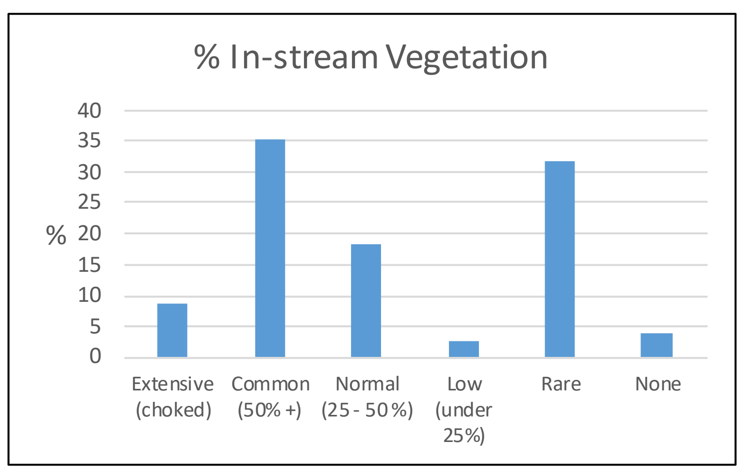


Figure 19: *Abundances of in-stream vegetation in Cody Creek.*

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 Cody Creek is 487 µS/cm, putting it just below the target level.

Since background conductivity can vary between systems, the 2018 results have been compared to the surveyed average for Cody 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 Cody Creek stay within this ideal range. The average pH of Cody Creek is 7.5, a nearly neutral condition, which is ideal for many species of fish to thrive.

Table 3: Cody Creek Water Quality Data			
	Minimum	**Maximum**	**Average**
Water Temperature (˚C)	19.4	25.4	21.7
Specific Conductivity (µS/cm)	352.6	726.0	487.0
pH	6.45	8.10	7.50
Dissolved Oxygen Concentration (mg/L)	0.83	11.00	5.50

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 Cody Creek measured at 5.50 mg/L, indicating that large reaches of the creek do not have adequate dissolved oxygen levels for most warm water fish to thrive. This indicates a potentially stressed environment in these locations, which will be discussed further on the following pages. 29 of the sections surveyed fall within the dissolved oxygen range required to support warm water fish. There is only 1 section that has suitable concentrations for supporting warm and cold water fish as seen Figure 21.

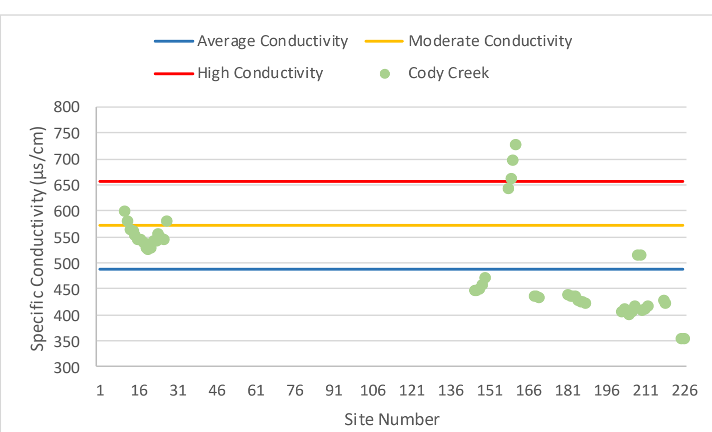


Figure 20: *Specific conductivity results from Cody Creek.*

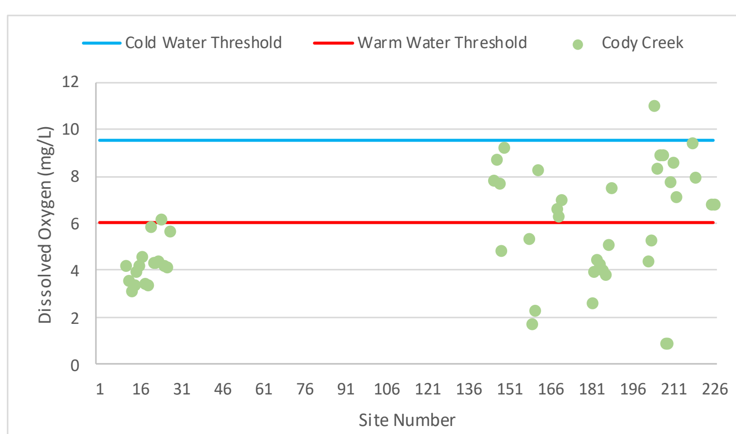


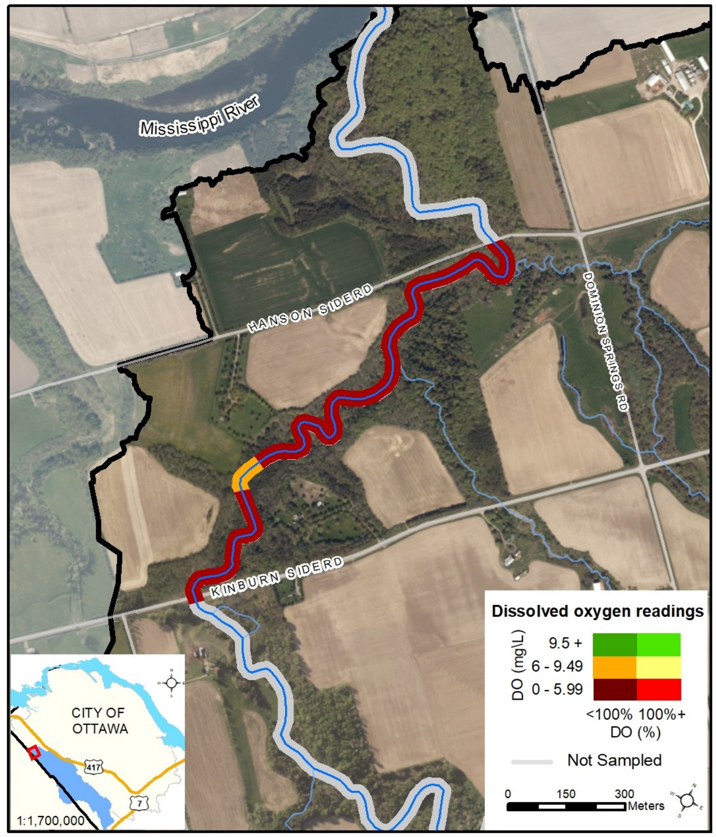
Figure 21: *Dissolved oxygen concentration results from Cody Creek.*

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.

NORTH CODY CREEK SAMPLE SITES



SOUTH CODY CREEK SAMPLE SITES

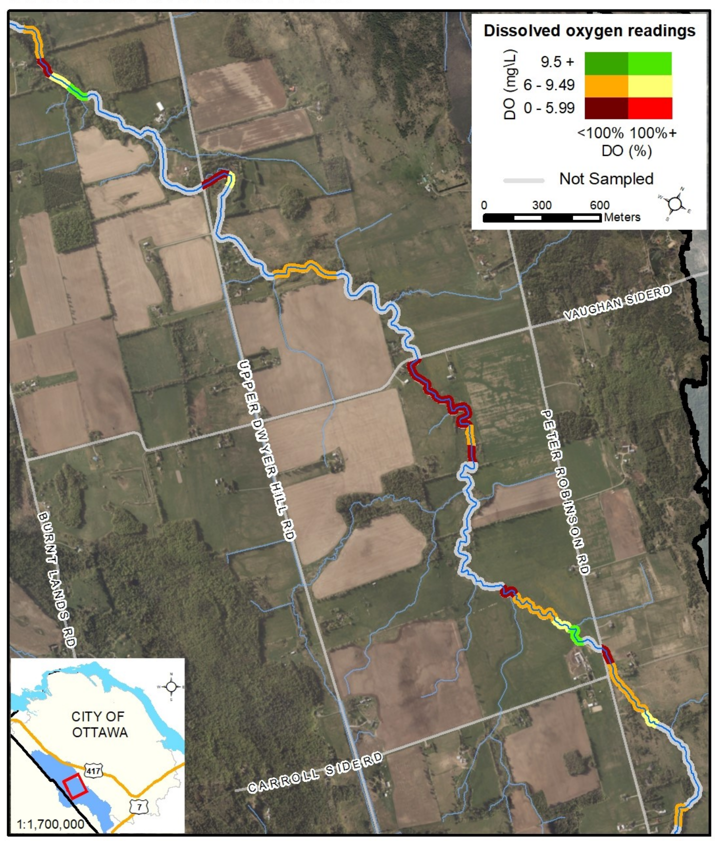
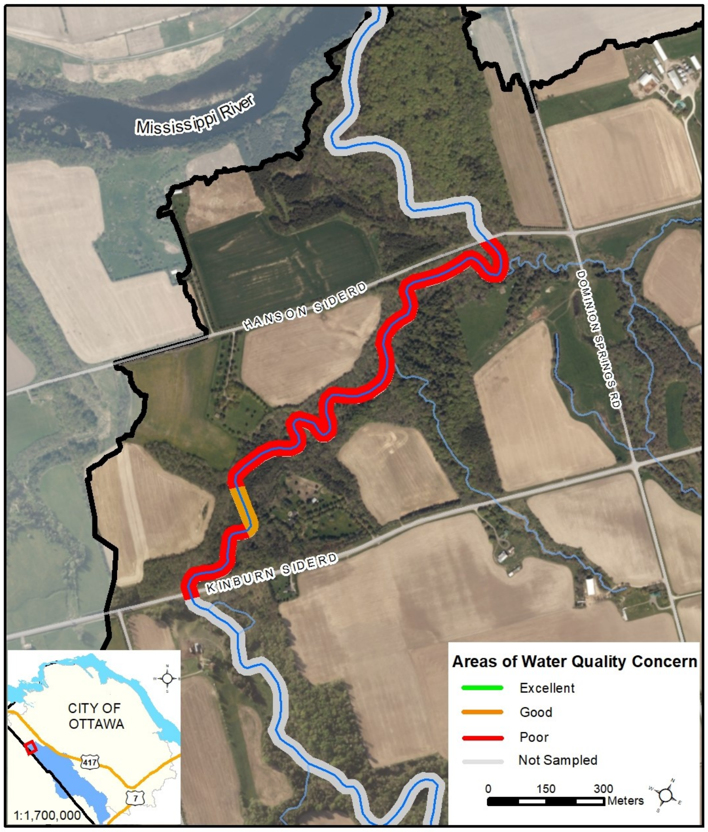


***Figure 22:** Dissolved oxygen concentration and saturation results for Cody Creek.*

NORTH CODY CREEK SAMPLE SITES



SOUTH CODY CREEK SAMPLE SITES

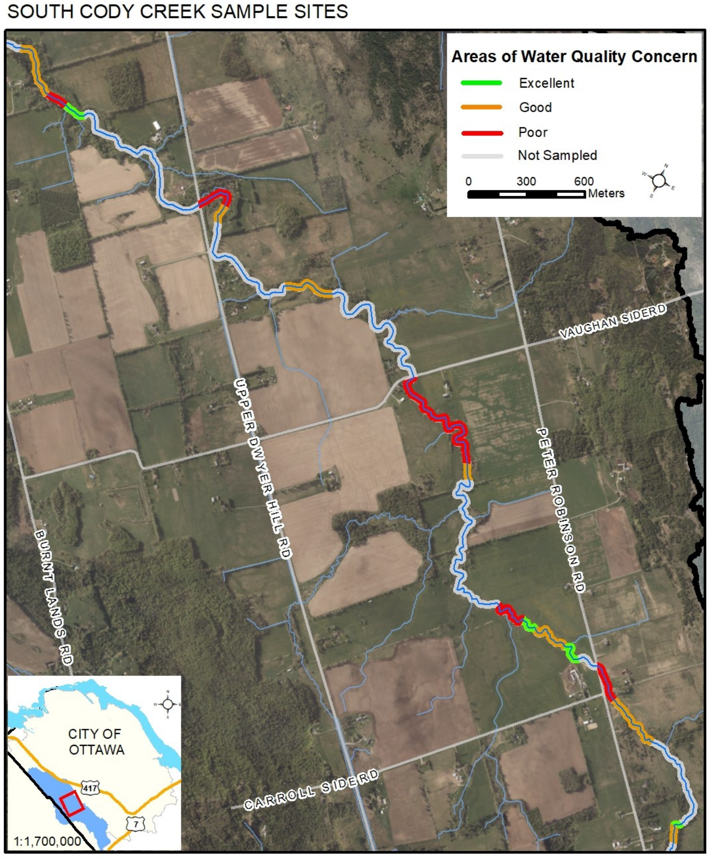


Figure 23: *Areas of Water Quality Concern in Cody Creek.*

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 water quality concern.

As shown on page 12, Cody Creek's pH values did not exceed the ideal range and therefore don't impact the ranking for Areas of Concern. Conductivity values were fairly low throughout the creek with values increasing near Upper Dwyer Hill Road and near the outlet. Oxygen concentration levels were variable with 29 sections having low oxygen concentration and saturation results throughout the system as shown on page 13. This indicates that some reaches have less than ideal conditions for aquatic organisms.

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

The sections receiving a good score reflect the areas that had low to 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 two temperature dataloggers were deployed in Cody Creek from May to October 2018 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 Cody Creek for 2018.

Analysis of the data collected indicates that Cody Creek should be classified as a cool-warm water stream, with slightly cooler waters upstream of March Road.

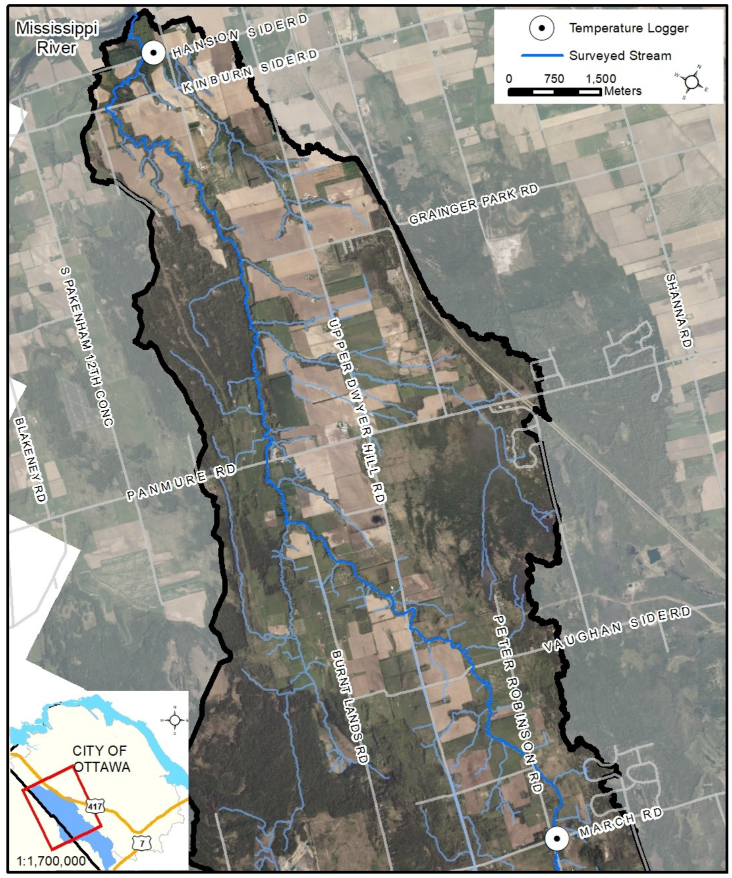


Figure 24: *Location of the temperature logger sites on Cody Creek.*

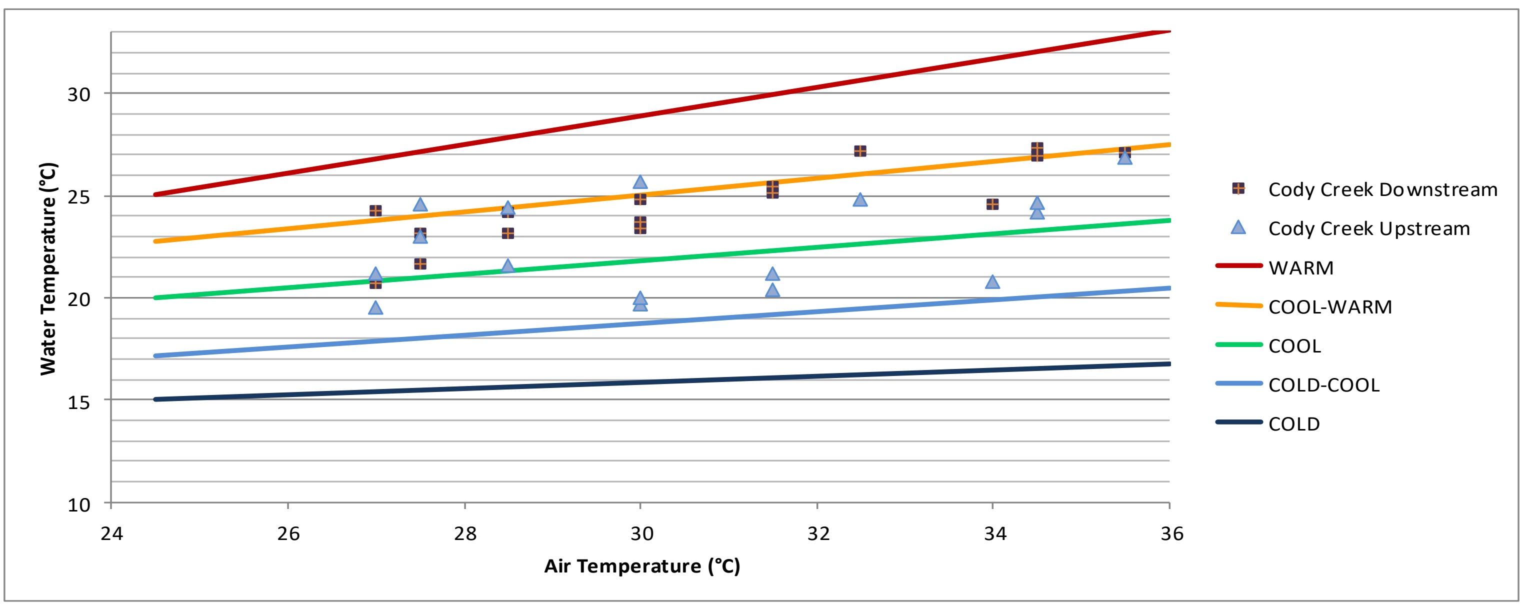


Figure 25: *Thermal classification of Cody Creek.*

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

Unfortunately MVCA was unable to perform a fish survey on Cody Creek in 2018. However, some fish species were observed and identified during the stream survey work. Additionally, MVCA has records of past fish sampling efforts along Cody Creek and has been able to compile a fish species list shown in Table 4. (Species marked with an "*" were observed in 2018 by MVCA's crew)

The known species list for Cody Creek can be found in Table 4 below. (Thermal classes from Coker, 2001)

Table 4: Fish Species Found In Cody Creek

Species Common Name	Thermal Class
Brook Stickleback	Cool
Catfish species*	Warm
Central Mudminnow	Cool
Creek Chub*	Cool
Darter species*	
Fathead Minnow	Warm
Finescale Dace	Cool
Mottled Sculpin*	Cool
Northern Redbelly Dace	Cool
Various cyprinids*	

Migratory Obstructions

Migratory obstructions are features in a water way that prevent fish from freely swimming up and downstream. This can negatively effect 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 Cody Creek revealed that there are 2 debris jams and 1 beaver dam acting as migratory obstructions. In addition to these types of obstructions, there were other less complete blockages to flow caused by landslides and downed trees.

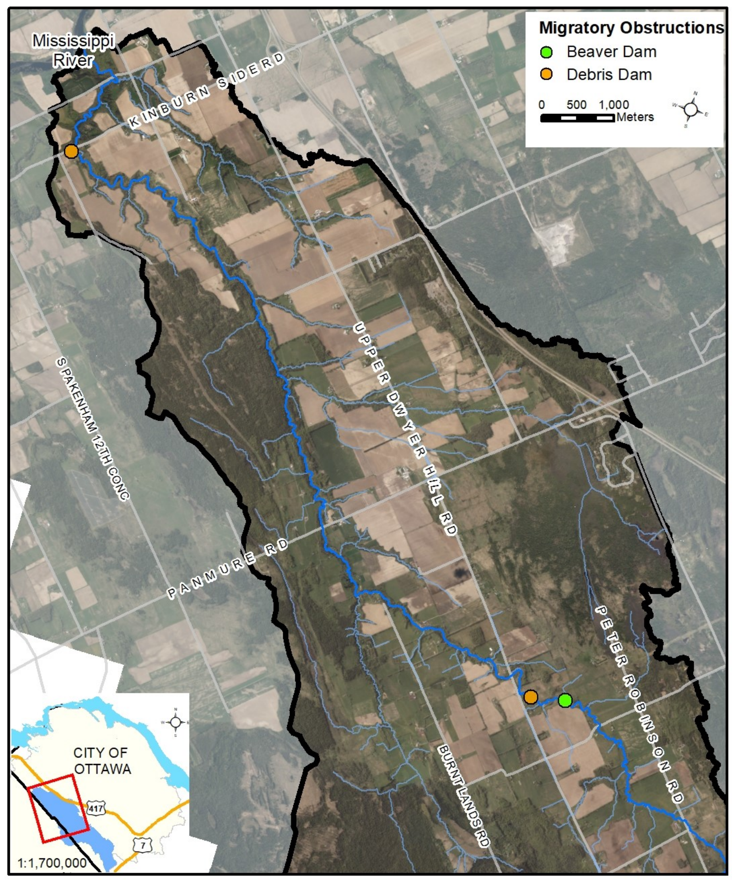


Figure 26: *Map of migratory obstructions in Cody Creek.*

Wildlife Observed

There were many species of wildlife observed during this assessment of Cody Creek. This being a very rural catchment within the City of Ottawa signs of animals not typically seen in other CSW surveys were observed; such as the tracks for a black bear. A complete list of species observed during the 2018 survey is shown in Table 5.

Table 5: Cody Creek Wildlife Observed	
Birds	Kingfisher, Blue Heron, Blue Jay, Cedar Waxwing, Crow, Gold Finch, Grackle, Mourning Dove, Red-tailed Hawk, Sand Piper, Sap Sucker, song birds, Wood Duck
Mammals	Black Bear tracks, Beaver, Cattle, Coyote tracks, Fox, Muskrat, Raccoon, Squirrel, White-tailed Deer
Reptiles and Amphibians	Bull Frog, Green Frog, Leopard Frog, Painted Turtle, Pickerel Frog, Snapping Turtle
Aquatic Insects	Caddisfly, Coleoptera, Crayfish, Damselflies, Diving Beetle, Dragonflies, Hempitera, Leeches, Monarch, Tiger Swallowtail, Water Scorpion, Water Strider, Yellow Skipper
Other	Bees, Deerflies, Fingernail Clams, flies, Mosquitos, snails, spiders

Pollution

Pollution in the form of litter, such as cans, plastic, and tires was occasionally found in Cody Creek, however other forms of visible pollution were rarely observed in the surveyed sections (Figure 27). 91% of the surveyed sections of Cody Creek had no visible pollution; this is a very beneficial attribute of the creek.

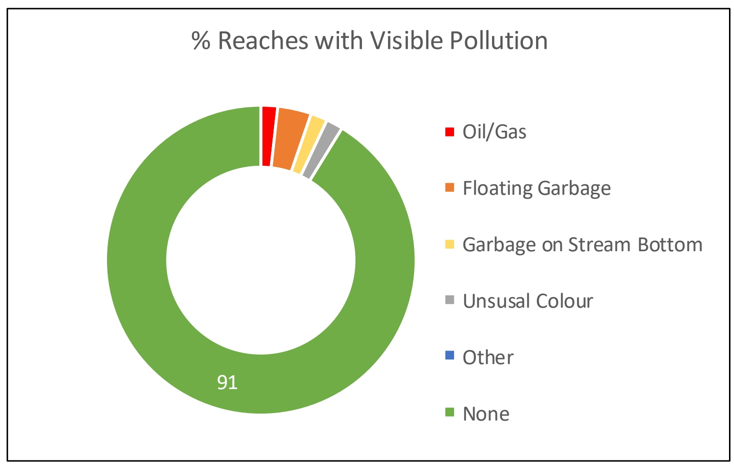


Figure 27: *Percentage of reaches with visible pollution from Cody Creek.*

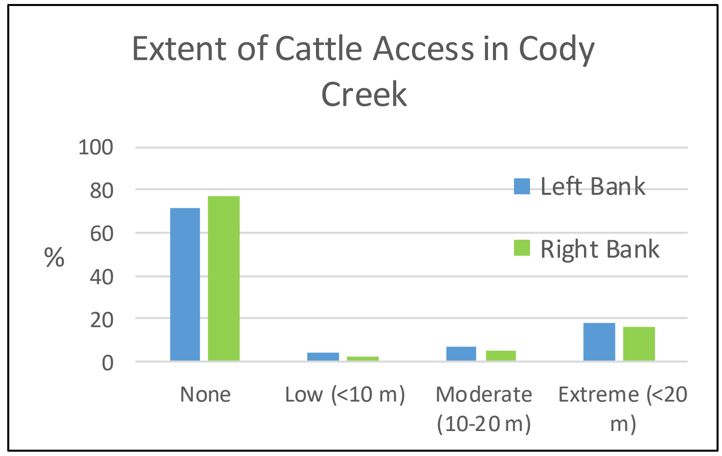


***Figure 28:** Extent of cattle access in the surveyed sections of Cody Creek.*

Agricultural impacts

Agricultural land uses represent 44.7% of the Cody Creek 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).

As shown in Figure 28, of the 56 sections surveyed, 13 (23%) of the right bank and 16 (29%) of the left bank sections had some level direct access to the creek by cattle. 18% of the left bank and 16% of the right bank were classified as having greater than 20 m of access to the creek's shoreline by cattle.

Field erosion

Of the 16 reaches where cattle access to the creek was observed, 12 reaches had notable field erosion along the banks. Foot traffic along the banks as well as the close grazing of the vegetation makes it hard for the plants to grow deep strong root systems that would help hold the predominately clay soils together during high water level or flow events.

Potential Stewardship Opportunities

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

11% of left bank and 18% of the right bank of surveyed reaches has less than a 30 m vegetated buffer. 3% of left bank and 7% of right bank reaches has less than a 15 m buffer. Additionally, 44% of the stream surveyed has less than 20% shade cover.

Stewardship activities can include but are not limited to; restoring eroded banks and riparian buffers through planting native species of trees and shrubs, planting trees on east or south banks to increase shade and reducing livestock access to the creek.

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. If you are interested in more information about these programs, please contact the Stewardship Coordinator at MVCA.

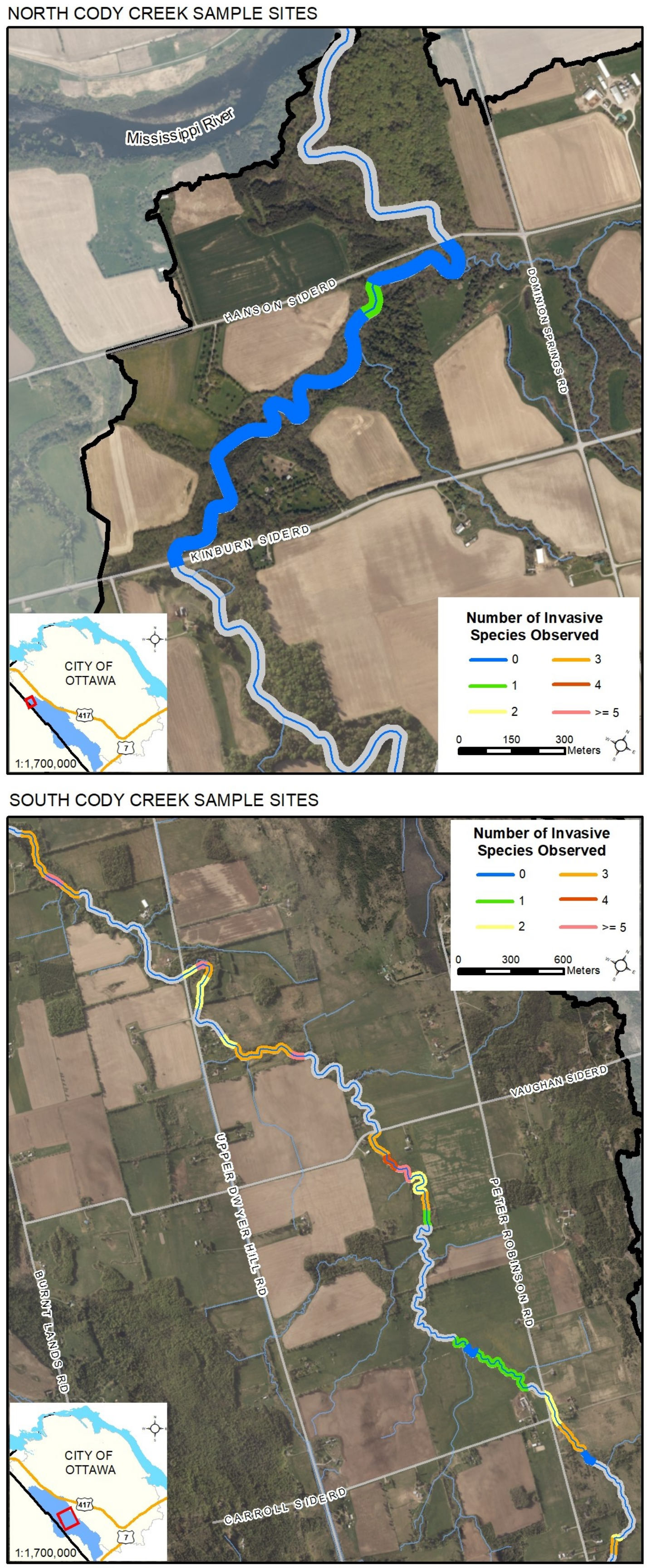


Figure 29: *Abundance of identified invasive species along Cody Creek.*

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 29 shows that although there are 13 identified invasive species in the Cody Creek Corridor, there are a large number of sections with one or fewer invasive species identified adjacent to the creek.

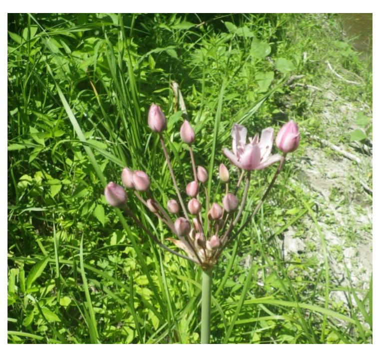
Invasive species identified while surveying Cody Creek are: Common Buckthorn, Curly Leaf Pondweed, European Black Alder, Flowering Rush, Glossy Buckthorn, Himalayan Balsam, English Ivy, Manitoba Maple, Norway Maple, Poison Parsnip, Purple Loosestrife, and Yellow Iris.

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.

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 12 Headwater Drainage Features in the Cody 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 12 headwater sites surveyed in the Cody Creek watershed consist of 5 of the 9 feature types. The top three feature types are defined natural channels, roadside ditches and channelized features making up 87% of the total features.

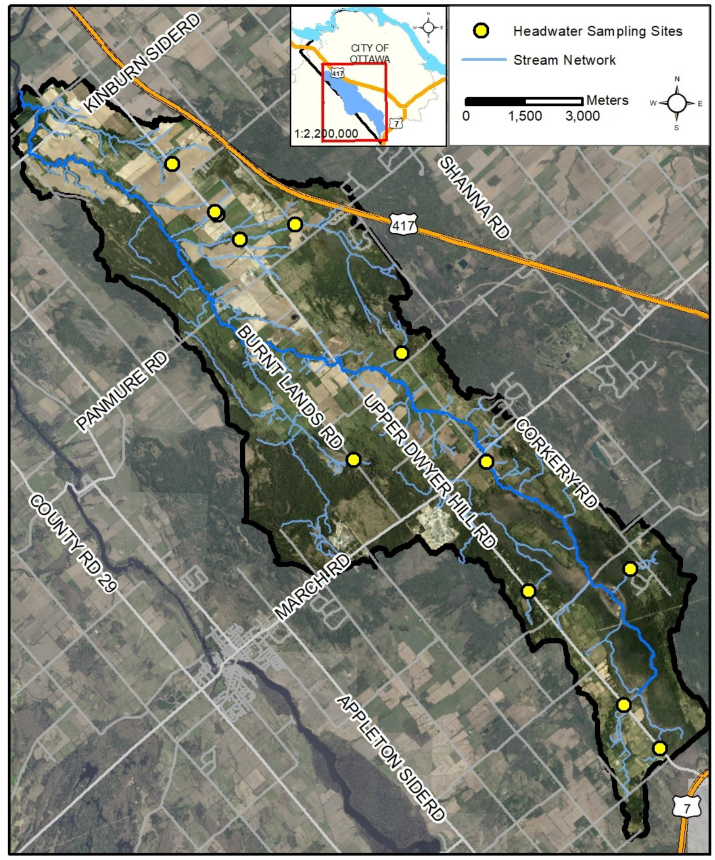


Figure 29: *Headwater drainage feature sampling sites in the Cody Creek watershed.*

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.

There were drought conditions in the summer of 2018, however only 3 of the monitored headwater features were dry in August.

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 Cody 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 10-30m).

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

Meadow and Scrubland were the dominant feature vegetation types. Cropped Land, Scrubland and Lawn were the dominant riparian vegetation types. Examples of crops and lawns near two features assessed can be seen in the photos above and 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 6 are a summary of the highlights from each of the report sections. Cody Creek has high amounts of natural shoreline vegetation and good shade coverage. The stream is classified as cool-warm water fish habitat. 39% of the 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 Cody Creek home. However, more than half of the areas received a poor areas of concern score.

The main cause of the water quality concern rating is that 31 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, agricultural impacts such as livestock access and shoreline erosion 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 Cody Creek.

Table 6: Summary Of City Stream Watch Results for Cody Creek 2018

Sample Variable	Results Summary
Number of Sections Surveyed	56
Average Stream Width (m)	7.8
Average Stream Depth (m)	0.6
Average Hydraulic Head (mm)	2.0
Average Water Temperature (˚C)	21.7
Average Conductivity (µS/cm)	487
Average pH	7.50
Average Dissolved Oxygen Concentration (mg/L)	5.50
Average Dissolved Oxygen Saturation (%)	61.3
# of Areas of Water Quality Concern with a Poor Score	31
Dominant Adjacent Land Uses	Agriculture, Forest, and Wetland
% Channel Alterations	8
% Vegetated Riparian Buffer Width (>30 m)	Left bank 89%, Right bank 82%
% Overhanging Trees & Branches >40% Section Coverage	Left Bank 25%, Right bank 23%
% Stream Shading >40% Section Coverage	42%
% of Undercut Banks >60% Section Coverage	Left Bank 34%, Right Bank 25%
Dominant Substrate Type	Clay, Bedrock
Sub-Dominant Substrate Type	Clay, Bedrock
# Sections with a Habitat Complexity Score ≥3 variables	22
Dominant In-stream Morphology	Runs
Dominant In-stream Vegetation Types	Narrow-leaved Emergent
Dominant Amount of In-stream Vegetation	Common, Rare
Thermal Class	Cool-Warm
Migratory Obstructions	2 log jams, 1 beaver dam
# of Identified Invasive Species	13
Potential Stewardship Activities	Shoreline buffer and erosion prevention improvements
# Head Water Drainage Features Sampled	12

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.