Stillwater Creek 2015 Summary Report

Watershed Features	
Area	23.48 square kilometres 0.55% of the Rideau Valley watershed
Land Use	33% forest 23% urban 19% agriculture 19% wetland 6% rural
Surficial Geology	35% clay 35% Paleozoic bedrock 14% organic deposits 12% diamicton 2% gravel 2% sand
Watercourse Type	*Watercourse Type:* 83% natural 17% channelized *Flow Type:* 96% permanent 4% intermittent
Invasive Species	There were twelve invasive species observed in 2015: purple loosestrife, common buckthorn, Manitoba maple, Himalayan balsam, flowering rush, wild parsnip, European frogbit, glossy buckthorn, garlic mustard, honey suckle, Japanese knotweed, yellow iris
Fish Community	41 fish species have been captured in Stillwater Creek historically including eight game fish species

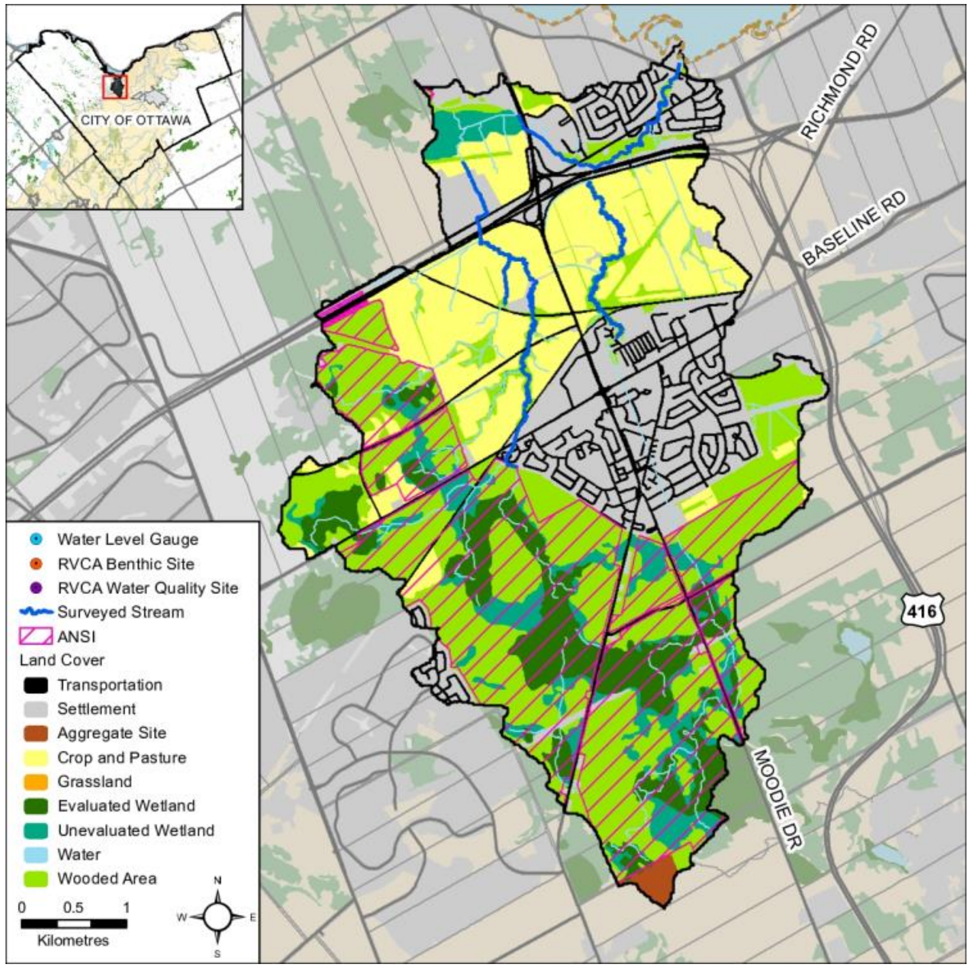


Figure 1 Land cover in the Stillwater Creek catchment

Woodlot Cover		
Size Category	**Number of Woodlots**	**% of Woodlot Cover**
10-30 ha	10	12
>30 ha	7	8

Wetland Cover
19% of the catchment is wetland

Wetland vegetation along Stillwater Creek

The Rideau Valley Conservation Authority, in partnership with seven other agencies in Ottawa (City of Ottawa, Heron Park Community Association, Ottawa Flyfishers Society, Ottawa Stewardship Council, Rideau Roundtable, National Defence HQ - Fish and Game Club, and the National Capital Commission) form the 2015 City Stream Watch collaborative.

Introduction

The headwaters of Stillwater Creek begin in the National Capital Commission's (NCC) Stony Swamp. Stony Swamp is almost 2000 hectares in size, and is a mix of woodland, wetland and regenerating fields. Over 700 plant species have been recorded in the conservation area. From Stony Swamp, Stillwater Creek runs through a heavily channelized and impacted area adjacent to Roberston Road. The creek returns to its natural morphology downstream of Robertson Road until the Highway 417 crossing. It then becomes channelized again, as it runs through the Wesley Clover Park on Corkstown Road. The creek flows through another large wetland before the Moodie Drive crossing, and from there runs parallel between Highway 417 and Corkstown Road until it turns north flowing through residential neighborhoods before emptying into the Ottawa River between the Nepean Sailing Club and Andrew Haydon Park.

Although large sections of Stillwater Creek are quite natural, it still has many impacts, including urbanization and agricultural pressures which have contributed to diminished water quality, loss of riparian cover/aquatic habitat, and shoreline destabilization (RVCA, 2013). The section of Stillwater Creek that flows between Corkstown Road and Highway 417 was designated a Life Science Site by the Ontario Ministry of Natural Resources containing regionally uncommon and regionally significant species (Ecoplans, DRAFT, 2009). Construction of a transitway expansion is planned for the area between Corkstown Road and Highway 417 which may cause impacts to this significant reach of Stillwater Creek, appropriate measures should be taken to ensure this area is not negatively impacted by future developments.

In 2015, 100 sections (10 km) of Stillwater Creek including it's tributaries were surveyed as part of the City Stream Watch monitoring activities. The following is a summary of observations made by staff and volunteers.

Stillwater Creek Overbank Zone

Riparian Buffer Width Evaluation

The riparian or shoreline zone is that special area where the land meets the water. Well-vegetated shorelines are critically important in protecting water quality and creating healthy aquatic habitats, lakes and rivers. Natural shorelines intercept sediments and contaminants that could impact water quality conditions and harm fish habitat in streams. Well established buffers protect the banks against erosion, improve habitat for fish by shading and cooling the water and provide protection for birds and other wildlife that feed and rear young near water. A recommended target (from Environment Canada's Guideline: How Much Habitat is Enough?) is to maintain a minimum 30 meter wide vegetated buffer along at least 75 percent of the length of both sides of rivers, creeks and streams. Stillwater Creek does not meet the target above as it has a buffer of greater than 30 meters along 40 percent of the right bank and 41 percent of the left bank. Figure 2 demonstrates the buffer conditions of the left and right banks separately.

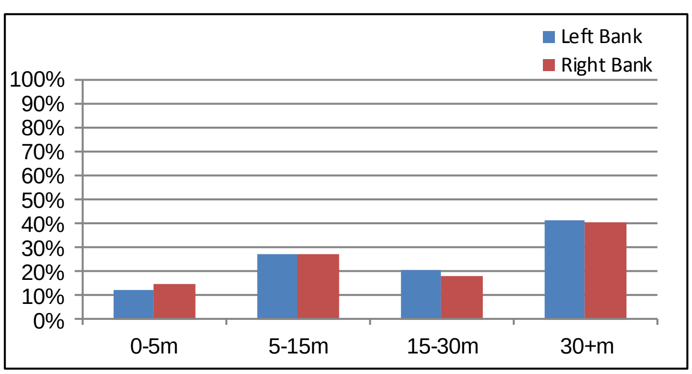


Figure 2 Vegetated buffer width along Stillwater Creek

Adjacent Land Use

The RVCA's City Stream Watch Program identifies 10 different land uses beside Stillwater Creek (Figure 3). Surrounding land use is considered from the beginning to end of each survey section (100m) and up to 100m on each side of the creek. Land use outside of this area is not considered for the surveys but is nonetheless part of the subwatershed and will influence the creek. Natural areas made up 36 percent of the surveyed stream, characterized by forest, scrubland, meadow and wetland. Thirty three percent of the land use along the surveyed sections of the stream was made up of agriculture and pasture. The remaining 31 percent of the land use surveyed was composed of residential, recreational and infrastructure uses at nine percent each, as well as industrial/commercial which was recorded as four percent of the land use.

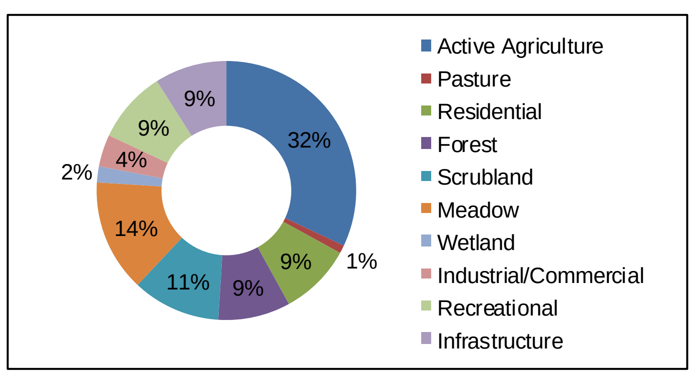


Figure 3 Land use along Stillwater Creek

Stillwater Creek Shoreline Zone

Erosion

Erosion is a normal, important stream process and may not affect actual bank stability; however, excessive erosion and deposition of sediment within a stream can have a detrimental effect on important fish and wildlife habitat. Poor bank stability can greatly contribute to the amount of sediment carried in a waterbody as well as loss of bank vegetation due to bank failure, resulting in trees falling into the stream and the potential to impact instream migration. Figure 4 shows low to moderate levels of bank erosion were observed along many sections of Stillwater Creek. Most of the areas where erosion was observed were in the agricultural lands south of Highway 417 on the main channel of the creek and its tributary. Shoreline stability in this area could be improved by increasing the vegetated buffer width along the creek.

Undercut Stream Banks

Undercut banks are a normal and natural part of stream function and can provide excellent refuge areas for fish. Figure 5 shows that the bank undercutting on Stillwater Creek varied considerably. Much of the creek had low levels of bank undercutting but these were interspersed with areas of moderate to high level undercutting. The highest levels of undercutting were observed where highway 417 crosses Stillwater Creek. The bank and substrate composition in this area is dominated by clay and the riparian vegetation is predominantly grasses so there is a possibility that the bank undercutting in section of the creek may lead to bank failure over time.

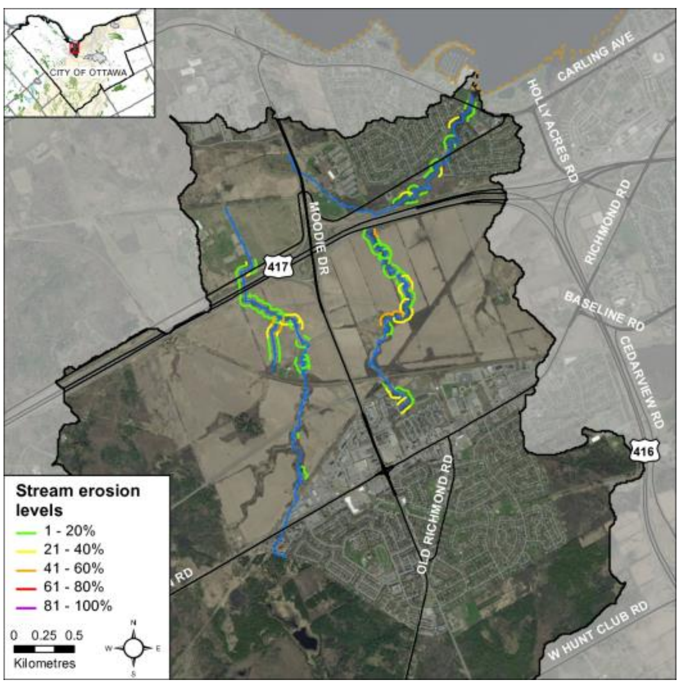


Figure 4 Erosion along Stillwater Creek

Stream bank erosion along Stillwater Creek

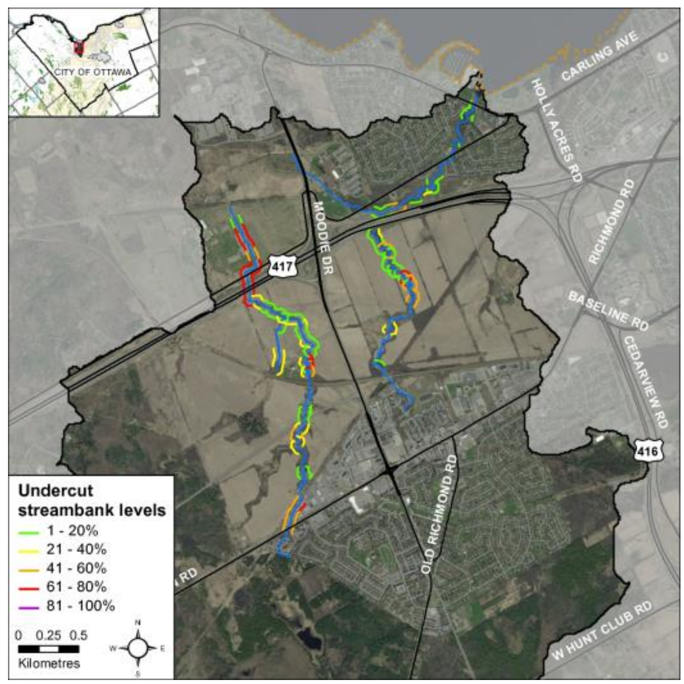


Figure 5 Undercut stream banks along Stillwater Creek

Section downstream of Hwy 417 with high levels of undercutting

Stream Shading

Grasses, shrubs and trees all contribute towards shading a stream. Shade is important in moderating stream temperature, contributing to food supply and helping with nutrient reduction within a stream. Figure 6 shows stream shading along Stillwater Creek. High levels of shading were seen along most of the creek with some sections having more moderate shading. In areas where trees and shrubs were not present in the buffer zone, tall overhanging grasses serve to shade the sections of Stillwater Creek with narrow stream width.

Instream Woody Debris

Figure 7 shows that overall, the surveyed sections along Stillwater Creek had moderate levels of instream woody debris in the form of branches and trees. Instream woody debris is important for fish and benthic habitat, by providing refuge and feeding areas.

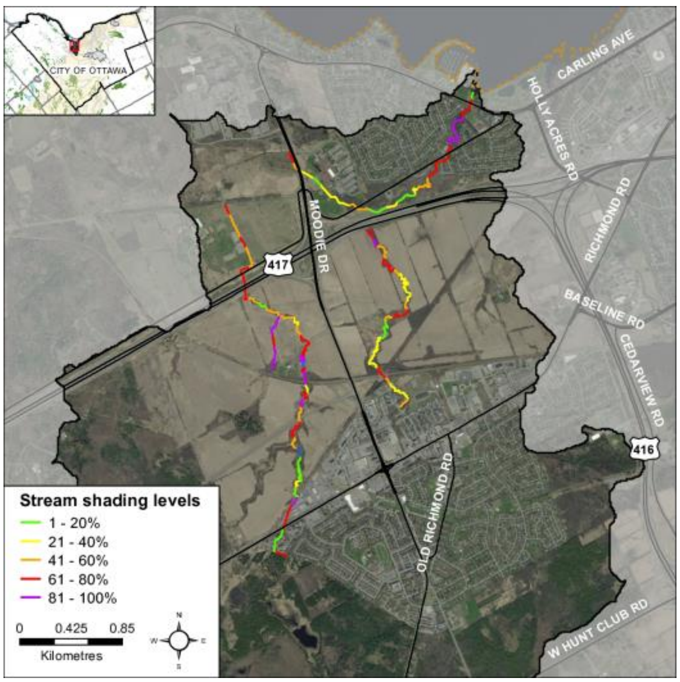


Figure 6 Stream shading along Stillwater Creek

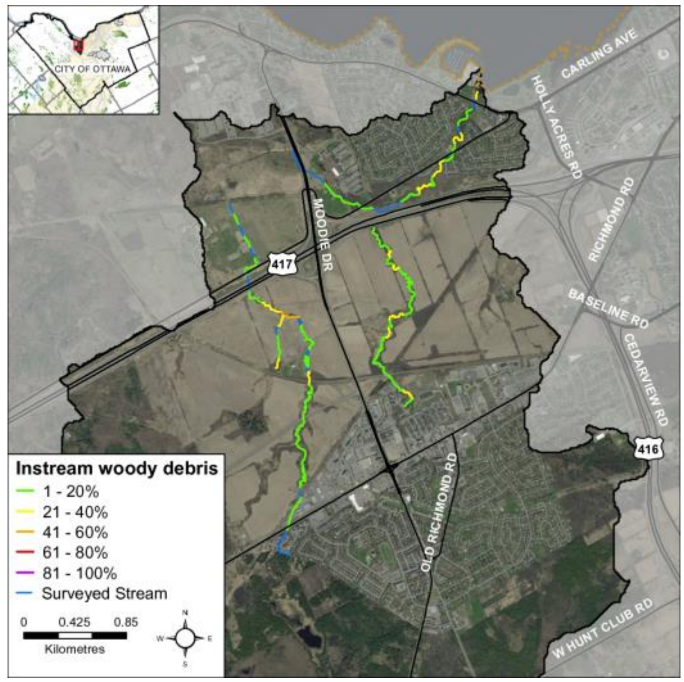
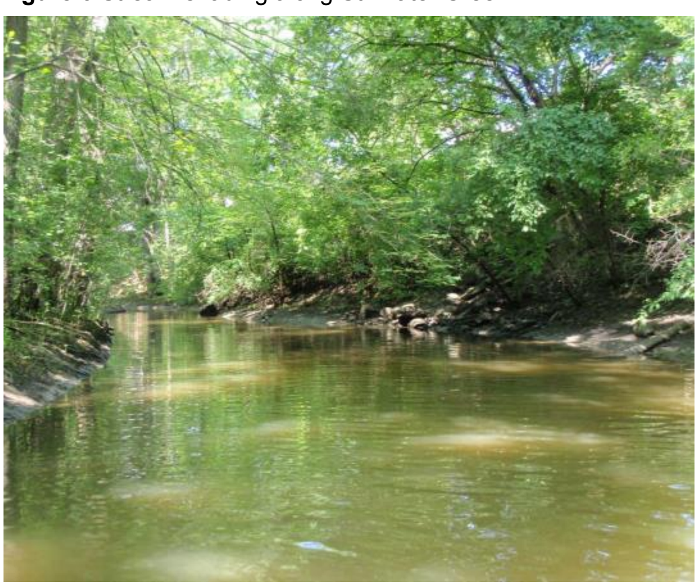


Figure 7 Instream woody debris along Stillwater Creek



Stream shade along Stillwater Creek

Instream woody debris along Stillwater Creek

Overhanging Trees and Branches

Figure 8 shows that Stillwater Creek had highly variable levels of overhanging branches and trees ranging from low to high levels. Trees and branches that are less than one meter from the surface of the water are defined as overhanging. At this proximity to the water branches and trees provide a food source, nutrients and shade which helps to moderate instream water temperatures.

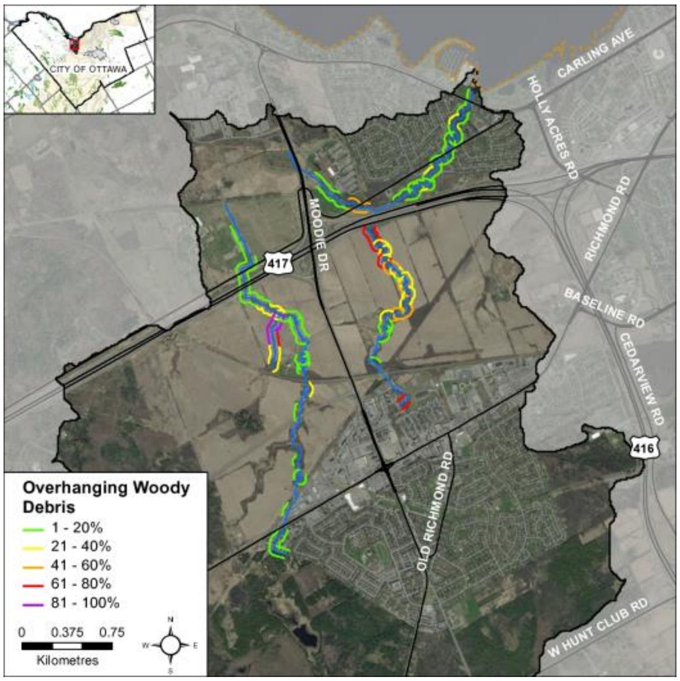


Figure 8 Overhanging trees and branches

Overhanging trees and branches on Stillwater Creek

Anthropogenic Alterations

Figure 9 demonstrates that 63 percent of the sections on Stillwater Creek remain “unaltered” or "natural". Sections considered "altered" account for 23 percent of the stream, while 14 percent of the sections sampled were considered “highly altered”. The highly altered sections of Stillwater Creek refer to those that are channelized as well as those that run through a culvert or road crossing with associated instream and shoreline modifications.

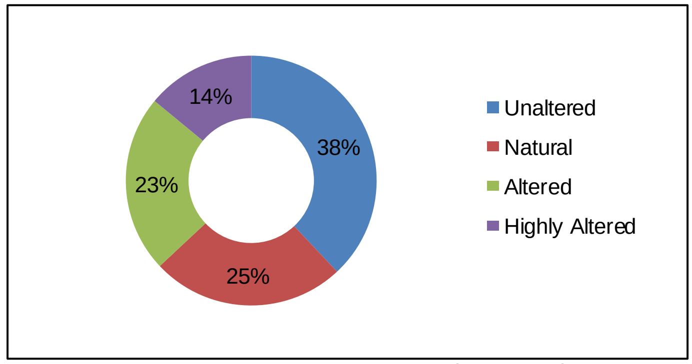


Figure 9 Anthropogenic alterations along Stillwater Creek

A highly altered section of Stillwater Creek at the Corkstown Road crossing

Stillwater Creek Instream Aquatic Habitat

Habitat Complexity

Streams are naturally meandering systems that move over time with varying degrees of habitat complexity. Examples of habitat complexity include habitat types such as pools and riffles as well as substrate variability and woody debris structure. A high percentage of habitat complexity (heterogeneity) typically increases the biodiversity of aquatic organisms within a system. The complexity of Stillwater Creek was high as demonstrated by the fact that 83 percent of the system was considered heterogeneous. Homogeneous areas were not extensive, typically lasting for only a section of two before becoming heterogeneous again. Overall, homogeneous sections made up 17 percent of the system.

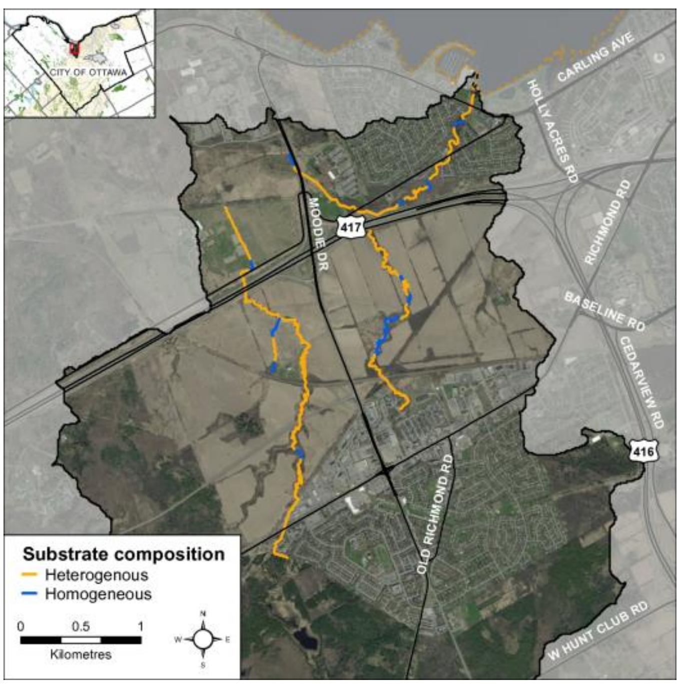


Figure 10 Instream habitat complexity in Stillwater Creek

Habitat complexity observed on Stillwater Creek

Instream Substrate

Diverse substrate is important for fish and benthic invertebrate habitat because some species have specific substrate requirements and, for example, will only reproduce on certain types of substrate. Figure 11 shows that the substrate composition of Stillwater Creek was very diverse. Thirty three percent of the instream substrate observed on Stillwater Creek was clay. Thirty two percent of the substrate was recorded as silt and sand. Twenty one percent was cobble and boulder, while eight percent was gravel. The remaining six percent was made up of bedrock. Figure 12 shows the distribution of the dominant substrate types along the system. Clay was recorded most often as the dominant substrate, with outcroppings of bedrock between Corkstown Road and Highway 417 as well as near Robertson Road. A significant amount of silt substrate was also recorded between Corkstown Road and Moodie Drive.

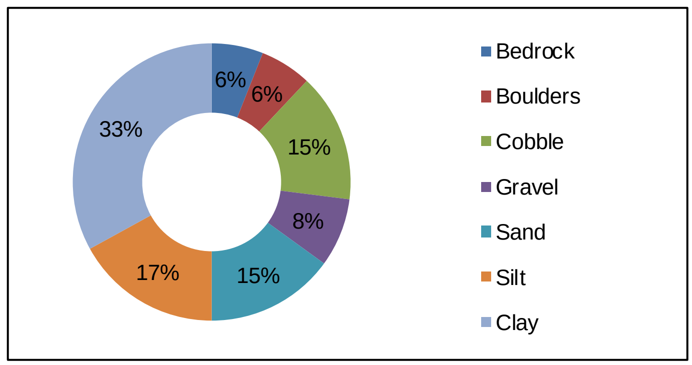


Figure 11 Instream substrate along Stillwater Creek

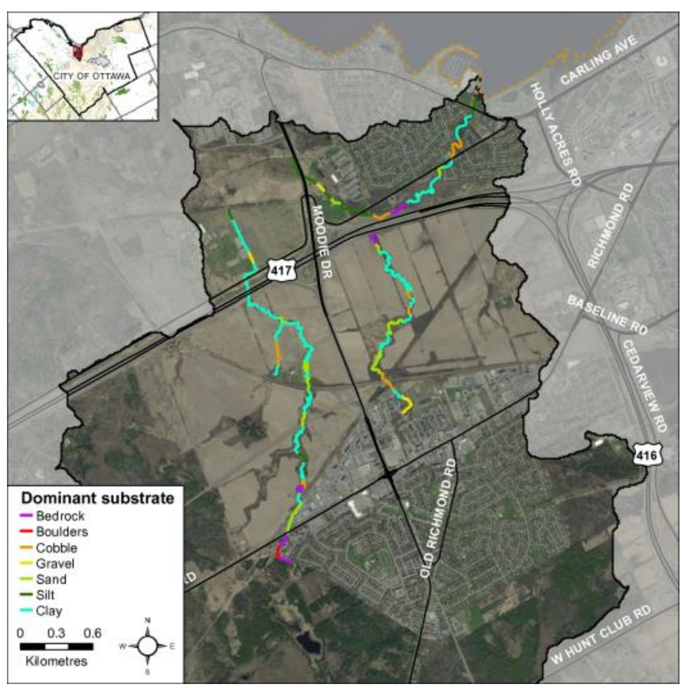


Figure 12 Dominant instream substrate in Stillwater Creek

Cobble and Boulder Habitat

Boulders create instream cover and back eddies for large fish to hide and/or rest out of the current. Cobble provides important over-wintering and/or spawning habitat for small or juvenile fish. Cobble can also provide habitat conditions for benthic invertebrates that are a key food source for many fish and wildlife species. Figure 13 shows the distribution of cobble and boulder habitat along Stillwater Creek. Areas of cobble and boulder habitat are well distribution along the entire length of the creek.

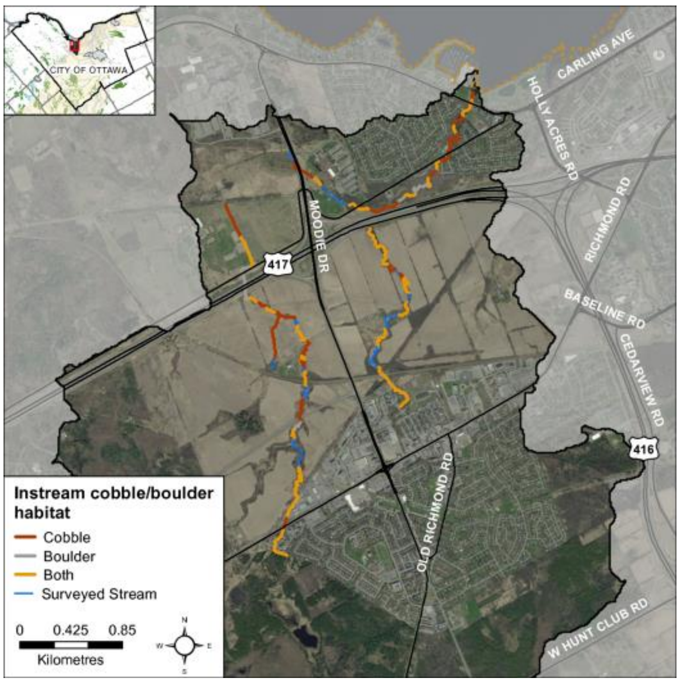


Figure 13 Cobble and boulder habitat in Stillwater Creek

Cobble and boulder habitat observed along Stillwater Creek upstream of Highway 417

Instream Morphology

Pools and riffles are important habitat features for fish. Riffles are areas of agitated water and they contribute higher dissolved oxygen to the stream and act as spawning substrate for some species of fish, such as sauger and walleye. Pools provide shelter for fish and can be refuge areas in the summer if water levels drop and water temperature in the creek increases. Pools also provide important over-wintering areas for fish. Runs are usually moderately shallow, with unagitated surfaces of water and areas where the thalweg (deepest part of the channel) is in the center of the channel.

Figure 14 shows that Stillwater Creek has good variability in instream morphology; 55 percent consists of runs, 40 percent consists of pools and five percent consists of riffles. Figure 15 shows where areas of riffle habitat was observed in Stillwater Creek. Although the riffle habitat was only five percent it was dispersed well across most of the creek.

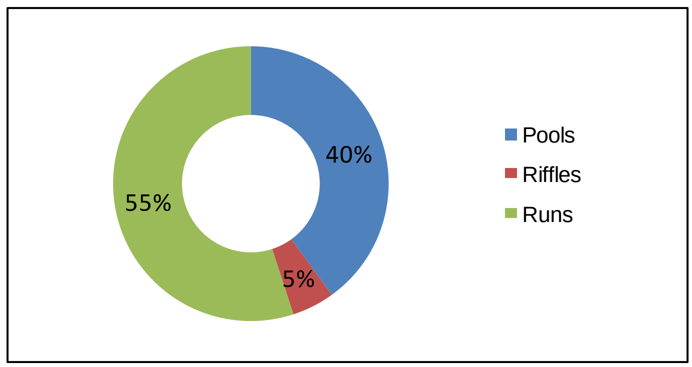


Figure 14 Instream morphology along Stillwater Creek

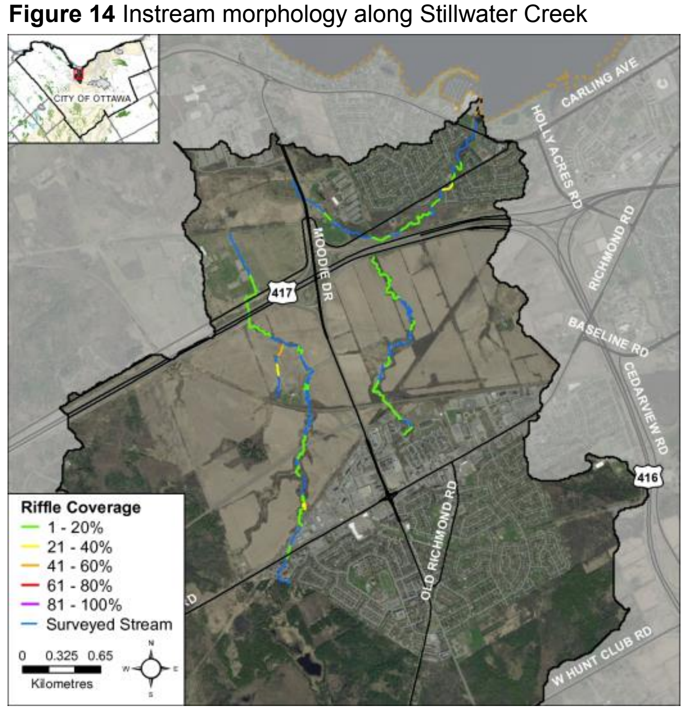


Figure 15 Riffle coverage in Stillwater Creek

Vegetation Type

Instream vegetation provides a variety of functions and is a critical component of the aquatic ecosystem. For example, emergent plants along the shoreline can provide shoreline protection from wave action and important rearing habitat for species of waterfowl. Submerged plants provide habitat for fish to find shelter from predator fish while they feed. Floating plants such as water lilies shade the water and can keep temperatures cool while reducing algae growth. Figure 16 depicts the high diversity of plant community structure in Stillwater Creek. Even though the diversity was high in most stream sections, areas with no vegetation were recorded most often, at 37 percent. Areas with no vegetation were dominated by bedrock and clay substrates where plants have difficulty establishing. Algae, submerged plants and narrow-leaved emergents were also recorded in high percentage at 28 percent, 13 percent and 10 percent respectively.

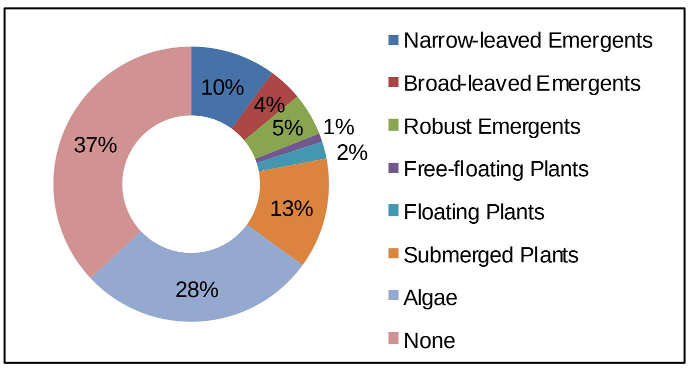


Figure 16 Vegetation types along Stillwater Creek

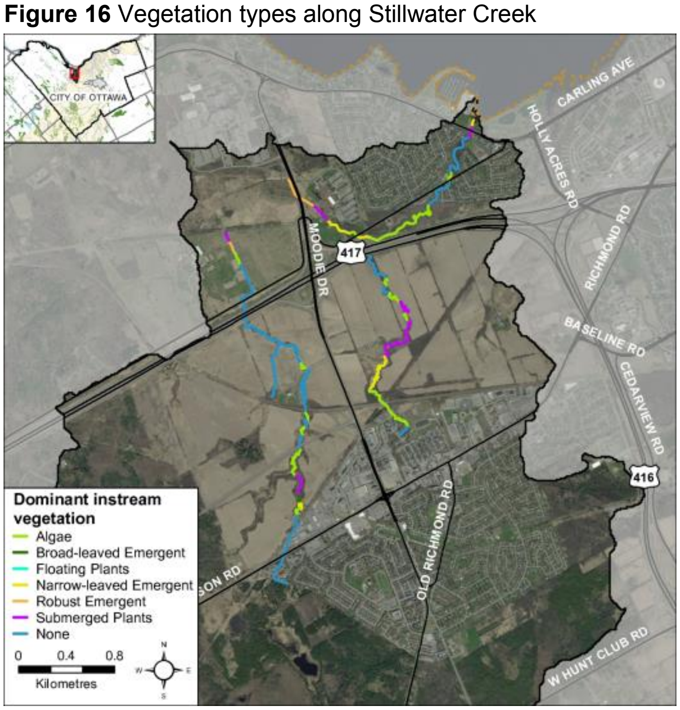


Figure 17 Dominant instream vegetation types

Instream Vegetation Abundance

Instream vegetation is an important factor for a healthy stream ecosystem. Vegetation helps to remove contaminants from the water, contributes oxygen to the stream, and provides habitat for fish and wildlife. Too much vegetation can also be detrimental. Figure 18 demonstrates that the vegetation abundance of Stillwater Creek varied considerably from extensive to rare and no vegetation. Rare and low levels were recorded most often and accounted for 58 percent, normal levels accounted for 21 percent, common levels accounted for seven percent and extensive levels accounted for 10 percent. The remaining four percent were areas with no vegetation. The vegetation levels varied considerably depending on the substrate types which were highly variable along Stillwater Creek. Areas with rare and low levels of vegetation were dominated by high flows as well as clay and bedrock substrates. Most types of vegetation have difficulty establishing in these conditions.

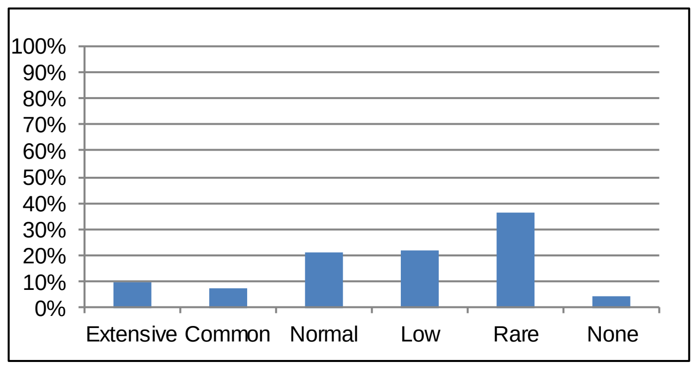


Figure 18 Instream vegetation abundance in Stillwater Creek

Bedrock substrate with instream low vegetation abundance

Stillwater Creek Stream Health

Invasive Species

Invasive species can have major implications on streams and species diversity. Invasive species are one of the largest threats to ecosystems throughout Ontario and can outcompete native species, having negative effects on local wildlife, fish and plant populations. Invasive species were observed along 94 percent of the sections surveyed along Stillwater Creek (Figure 19). Figure 20 shows the variety of invasive species observed along Stillwater Creek. The invasive species that were observed most often were purple loosestrife (*Lythrum salicaria),* common buckthorn (*Rhamnus cathartica*), and Manitoba maple (*Acer negundo*). Most of the sections where invasive species were present had more than one invasive species recorded.

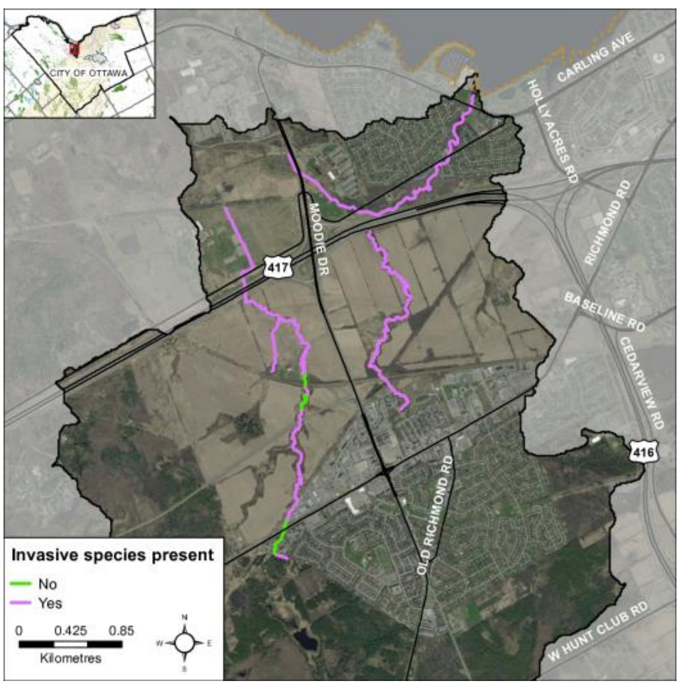


Figure 19 Presence of invasive species along Stillwater Creek

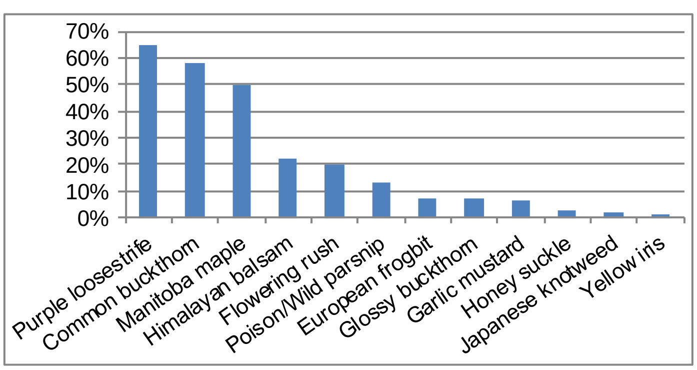


Figure 20 Invasive species observed along Stillwater Creek

Pollution

Figure 21 demonstrates the incidence of pollution/ garbage in Stillwater Creek. Thirty six percent of the sections surveyed did not have any observable garbage. Forty two percent had garbage on the stream bottom and 41 percent had floating garbage. Many of the sections had both garbage on the stream bottom and floating garbage. These areas were located near road crossings or in the developed areas near Robertson Road and Corkstown Road.

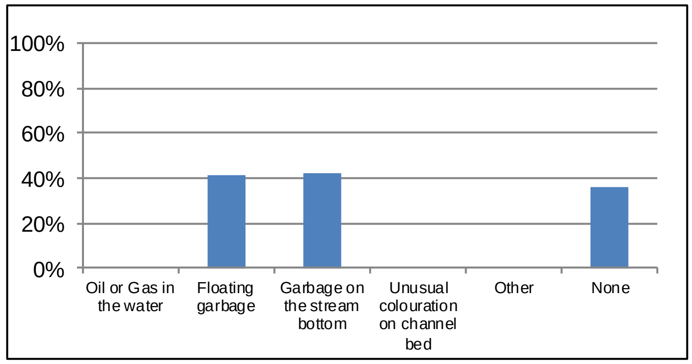


Figure 21 Pollution observed along Stillwater Creek

Wildlife

The diversity of fish and wildlife populations can be an indicator of water quality and overall stream health.

Wildlife	Observed
Birds	mallard, great blue heron, black-crowned night heron, american crow, american goldfinch, northern cardinal, gray catbird, american yellow warbler, field sparrow, sparrow spp., red-winged black bird, killdeer, american robin, mourning dove, starling, woodpecker spp., barn swallow, tree swallow, grackle, phoebe, Canada goose
Mammals	white tailed deer, north american beaver, coyote, chipmunk, raccoon, red squirrel, black squirrel, grey squirrel
Reptiles Amphibians	green frog, tadpoles, bull frog, leopard frog, american toad
Aquatic Insects	freshwater mussel, water strider, crayfish spp., leech, chironomidae, isopods, water boatmen
Other	ebony jewelwing, dragonfly exuvia, dragonfly spp., cabbage white butterfly, yellow sulfer butterfly, mosquito, grasshopper spp., bumblebee, cicada, crane fly, spider spp., beetle spp., snail, dock spider

Table 1 Wildlife observed along Stillwater Creek

Stillwater Creek Water Chemistry

Water Chemistry Measurement

During the stream characterization survey, a YSI probe is used to collect water chemistry information. Dissolved oxygen, conductivity and pH are measured at the start and end of each section.

A volunteer measuring water chemistry using a YSI

Dissolved Oxygen

Dissolved oxygen is a measure of the amount of oxygen dissolved in water. The Canadian Environmental Quality Guidelines of the Canadian Council of Ministers of the Environment (CCME) suggest that for the protection of aquatic life the lowest acceptable dissolved oxygen concentration should be 6 mg/L for warmwater biota (red line in Figure 22) and 9.5 mg/L for coldwater biota (blue line in Figure 22) (CCME, 1999). Figure 22 shows that most of the stretches of Stillwater Creek meet the standard for warmwater biota. With an average dissolved oxygen level of 3.8 mg/L, the stretch of creek between Corkstown Road and Moodie Drive had much lower average dissolved oxygen compared to other stretches of the creek. This section is influenced by a weir and doesn't meet standard of 6 mg/L for warmwater biota.

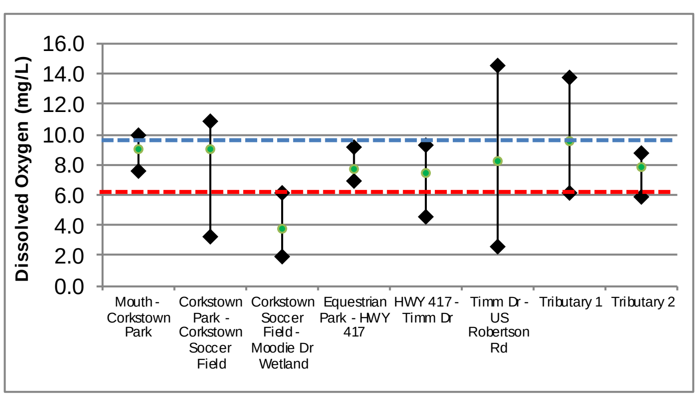


Figure 22 Dissolved oxygen ranges in Stillwater Creek

Conductivity

Conductivity in streams is primarily influenced by the geology of the surrounding environment, but can vary drastically as a function of surface water runoff. Currently there are no CCME guideline standards for stream conductivity, however readings which are outside the normal range observed within the system are often an indication of unmitigated discharge and/or stormwater input. The average specific conductivity observed within Stillwater Creek was 1309 µs/cm. Figure 23 shows that the conductivity readings varied moderately along the course of the creek. The lowest average specific conductivity reading at 717 µs/cm, was observed on the tributary of Stillwater Creek surveyed to the west of Moodie Drive. There is a significant spike in conductivity in the tributary east of Moodie Drive where the average recorded conductivity was 1813 µs/cm. The tributary east of Moodie Drive conveys flow from the highly developed area of Bells Corners around Robertson Road. As a result, the water chemistry of the tributary is significantly influenced by stormwater runoff.

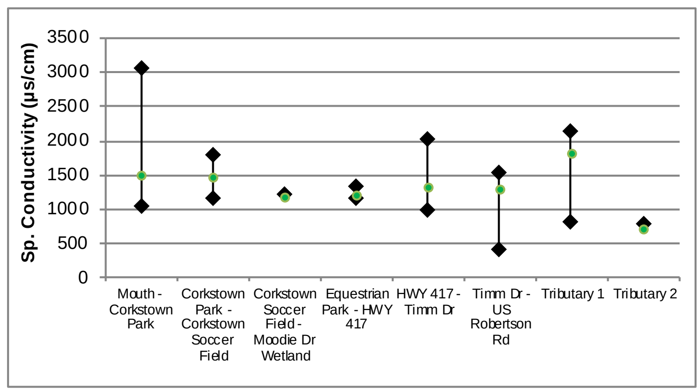


Figure 23 Conductivity ranges in Stillwater Creek

pH

Based on the PWQO for pH, a range of 6.5 to 8.5 should be maintained for the protection of aquatic life. Average pH values for Stillwater Creek ranged between 7.7 and 8.1, thereby meeting the provincial standard.

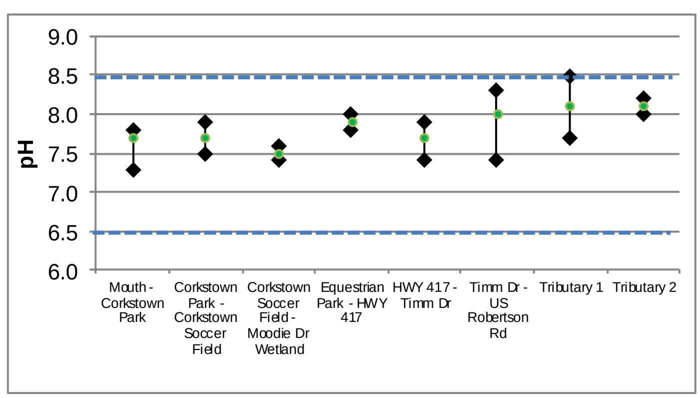


Figure 24 pH ranges in Stillwater Creek

Stillwater Creek Thermal Classification

Thermal Classification

Many factors can influence fluctuations in stream temperature, including springs, tributaries, precipitation runoff, discharge pipes and stream shading from riparian vegetation. Seven temperature loggers were deployed in late April to monitor water temperature in Stillwater Creek. Water temperature is used along with the maximum air temperature (using a revised Stoneman and Jones method) to classify sampling reaches into one of five categories that correspond to the thermal preferences of local fish communities (figure 27). Figure 25 shows the locations where temperature loggers were installed on Stillwater Creek.

Analysis of the data collected indicates that the thermal classification of Stillwater Creek is cool water with a cool-warm water reach towards Robertson Road. (Figure 27). The site of logger 3 between Corkstown Road and Moodie Drive represents a colder reach of the creek and is likely influenced by groundwater input.

Groundwater

Groundwater discharge areas can influence stream temperature, contribute nutrients, and provide important stream habitat for fish and other biota. During stream surveys, indicators of groundwater discharge are noted when observed. Figure 26 shows areas where one or more groundwater indicators were observed during stream surveys on Stillwater Creek. Most of the groundwater indicators were observed downstream of Moodie Drive and in the tributary surveyed east of Moodie Drive.

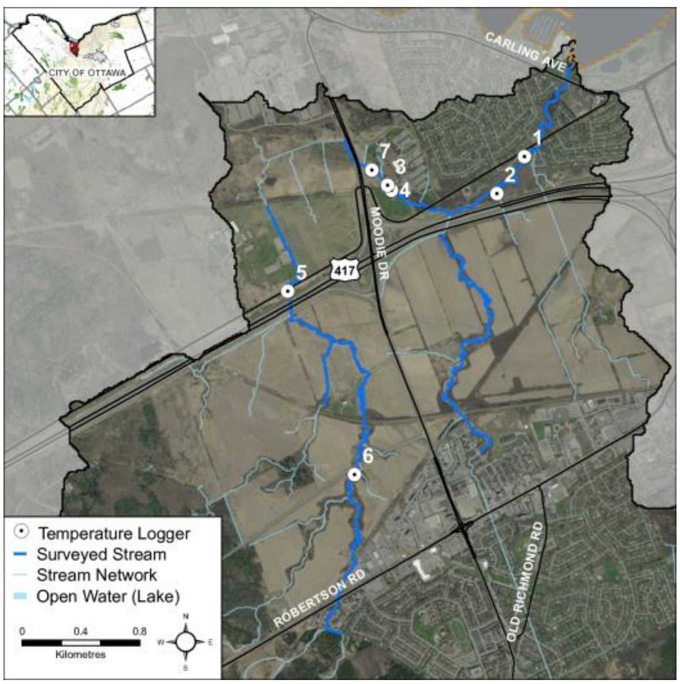


Figure 25 Temperature loggers along Stillwater Creek

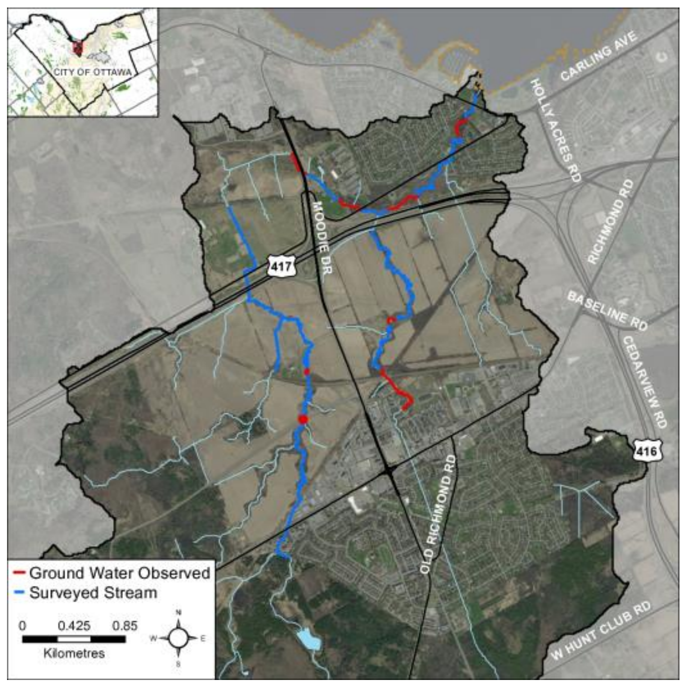


Figure 26 Groundwater indicators observed

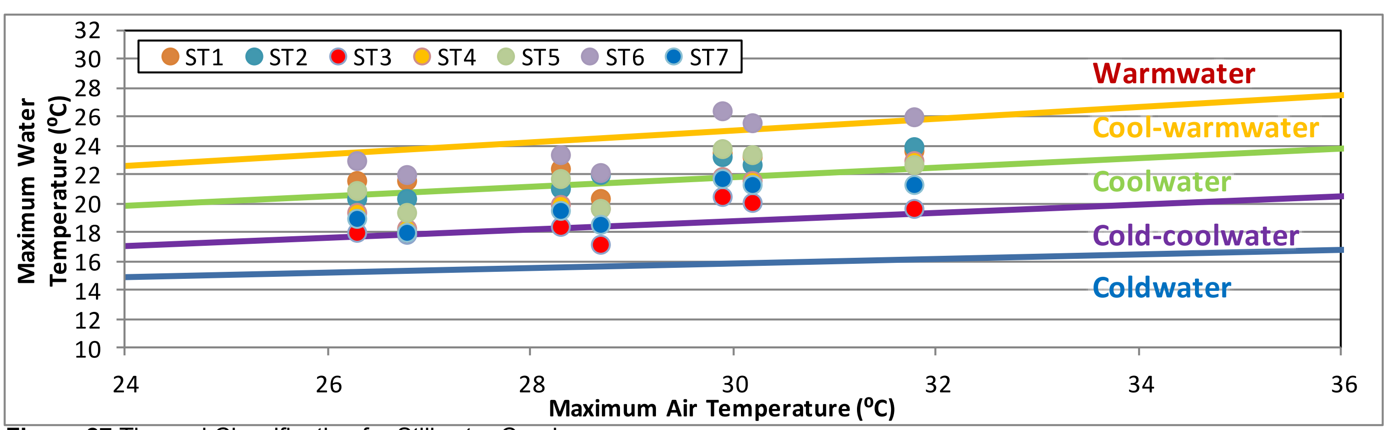


Figure 27 Thermal Classification for Stillwater Creek

Stillwater Creek Fish Community

Fish Community

Fish sampling sites located along Stillwater Creek are shown in Figure 28. The provincial fish codes shown in Figure 28 are listed (in Table 2) beside the common name of those fish species identified in Stillwater Creek. The thermal classification of Stillwater Creek is cool water, with 41 fish species having been observed historically including eight game fish species.

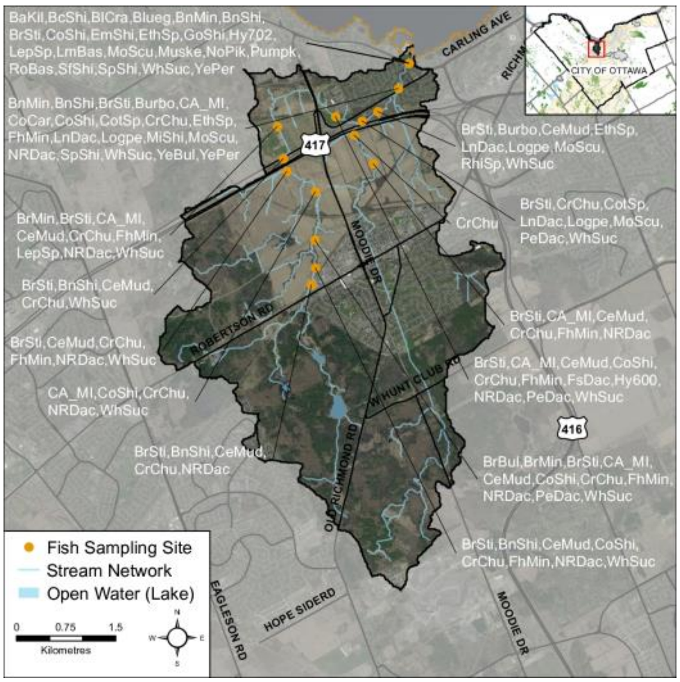


Figure 28 Stillwater Creek fish community

Fyke net set at the mouth of Stillwater Creek near the Ottawa River

Species observed in Stillwater Creek (with fish code)			
banded killifish.......	BaKil	largemouth bass.......	LmBas
black crappie.........	BlCra	Lepomis sp.............	LepSp
blackchin shiner.....	BcShi	logperch.................	LogPe
blacknose shiner....	BnShi	longnose dace.........	LnDac
bluegill................	Blueg	mimic shiner............	MiShi
bluntnose minnow..	BnMin	minnow hybrid.........	Hy600
brassy minnow......	BrMin	mottled sculpin.........	MoScu
brook stickleback...	BrSti	muskellunge............	Muske
brown bullhead.......	BrBul	northern pearl dace....	PeDac
burbot.................	Burbo	northern pike...........	NoPik
carps and minnows.	CA_MI	northern redbelly dace	NRDac
central mudminnow.	CeMud	pumpkinseed...........	Pumpk
common carp........	CoCar	pumpkinseed x bluegil	Hy702
common shiner......	CoShi	Rhinichthys sp..........	RhiSp
Cottus sp............	CotSp	rock bass...............	RoBas
creek chub...........	CrChu	spotfin shiner...........	SfShi
emerald shiner.......	EmShi	spottail shiner..........	SpShi
Etheostoma sp......	EthSp	white sucker............	WhSuc
fathead minnow......	FhMin	yellow bullhead.........	YeBul
finescale dace.......	FsDac	yellow perch............	YePer
golden shiner.........	GoShi		

Table 2 Fish species observed in Stillwater Creek

Burbot captured on Stillwater Creek

Northern pearl dace captured on Stillwater Creek

Migratory Obstructions

It is important to know locations of migratory obstructions because these can prevent fish from accessing important spawning and rearing habitat. Migratory obstructions can be natural or manmade, and they can be permanent or seasonal. Figure 29 shows that along Stillwater Creek, two perched culverts, two debris dams, one grade barrier and one weir were observed. Fish migration is currently being impacted by the weir near Moodie Drive and the perched culverts identified on the main channel of the creek at Timm Drive and the tributary east of Moodie Drive at the old railway line.

Beaver Dams

Beaver dams can also act as obstructions to fish migration. Figure 30 shows that a number of active, abandoned and breached beaver dams were observed on Stillwater Creek. Most of the beaver activity was observed between Highway 417 and Robertson Road as well as on the tributary east of Moodie Drive. The head, or difference between the water level up and down stream, of the beaver dams ranged from 0 cm to 60 cm.

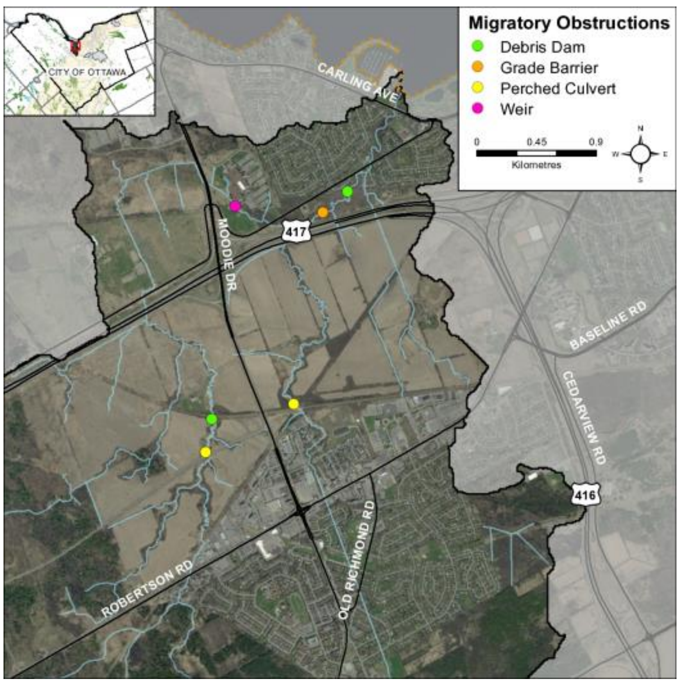


Figure 29 Stillwater Creek migratory obstructions

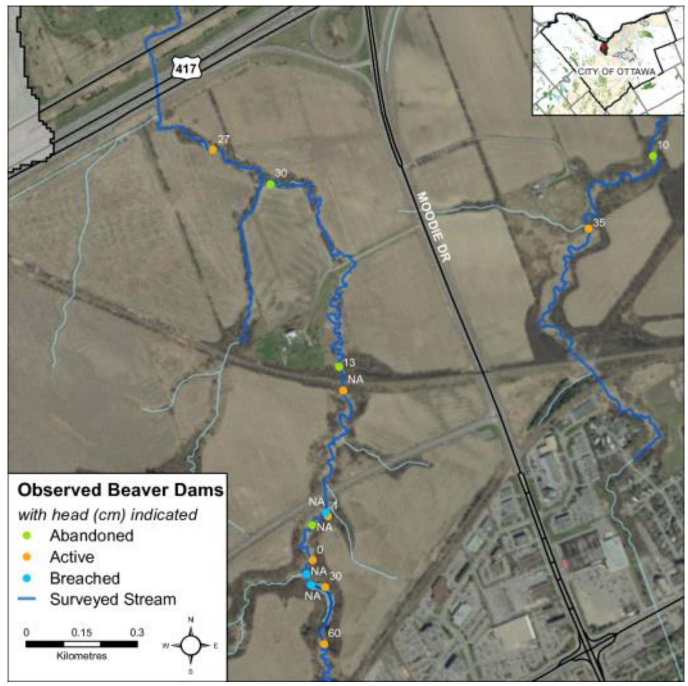


Figure 30 Beaver dams observed on Stillwater Creek

A perched culvert observed along a tributary of Stillwater Creek

A large beaver dam observed on Stillwater Creek

Headwater Drainage Feature Assessment

Headwaters Sampling

The RVCA City Stream Watch program assessed Headwater Drainage Features for Barrhaven Creek, Bilberry Creek, Mosquito Creek and Stillwater Creek in 2015. This protocol measures zero, first and second order headwater drainage features (HDF). It is a rapid assessment method characterizing the amount of water, sediment transport, and storage capacity within headwater drainage features (HDF). RVCA is working with other Conservation Authorities and the Ministry of Natural Resources and Forestry to implement the protocol with the goal of providing standard datasets to support science development and monitoring of headwater drainage features. An HDF is a depression in the land that conveys surface flow. Additionally, this module provides a means of characterizing the connectivity, form and unique features associated with each HDF (OSAP Protocol, 2013). In 2015 the program sampled 13 sites in the Stillwater Creek catchment area. Figure 31 demonstrates the 2015 Stillwater Creek sampling locations.

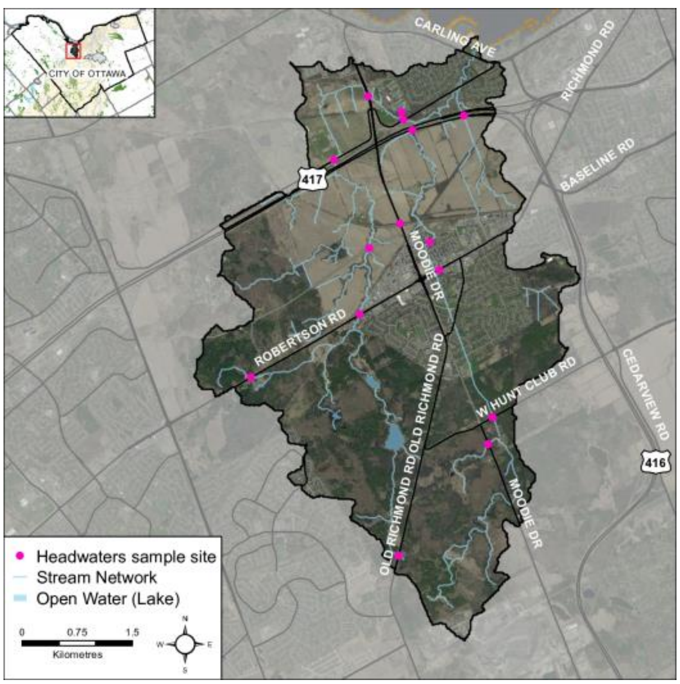


Figure 31 Stillwater Creek HDF sampling sites

Feature Type

The headwater sampling protocol assesses the feature type in order to understand the function of each feature. The evaluation includes the following classifications: defined natural channel, channelized or constrained, multi-thread, no defined feature, tiled, wetland, swale, roadside ditch and pond outlet. By assessing the values associated with the headwater drainage features in the catchment area we can understand the ecosystem services that they provide to the watershed in the form of hydrology, sediment transport, and aquatic and terrestrial functions. The Stillwater Creek catchment is dominated by natural channel and wetland headwater drainage feature types with two channelized sites and one tiled site. Figure 32 shows the feature type of the primary feature at the sampling locations on Stillwater Creek.

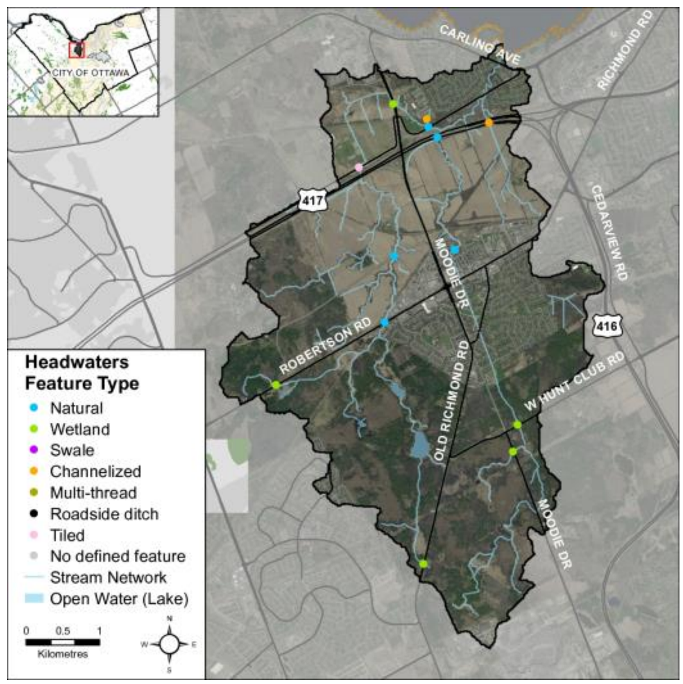


Figure 32 Stillwater Creek HDF feature types

Wetland feature type observed along Moodie Drive

Headwater Feature Flow

The observed flow condition within headwater drainage features can be highly variable depending on timing relative to the spring freshet, recent rainfall, soil moisture, etc. Flow conditions are assessed in the spring and in the summer to determine if features are perennial and flow year round, if they are intermittent and dry up during the summer months or if they are ephemeral systems that do not flow regularly and generally respond to specific rainstorm events or snowmelt. Flow conditions in headwater systems can change from year to year depending on local precipitation patterns. Figure 33 shows the observed flow conditions at the sampling locations in the Stillwater Creek catchment.

Feature Channel Modifications

Channel modifications were assessed at each headwater drainage feature sampling location. Modifications include channelization, dredging, hardening and realignments. Land use in the Stillwater Creek catchment varies widely from developed land to agriculture and natural forested and wetland areas. The majority of the sampling locations for the Stillwater Creek catchment area had no channel modifications but one site had mixed modifications, one site had channel hardening and one site had dredging. Figure 34 shows the channel modifications observed at the sampling locations for Stillwater Creek.

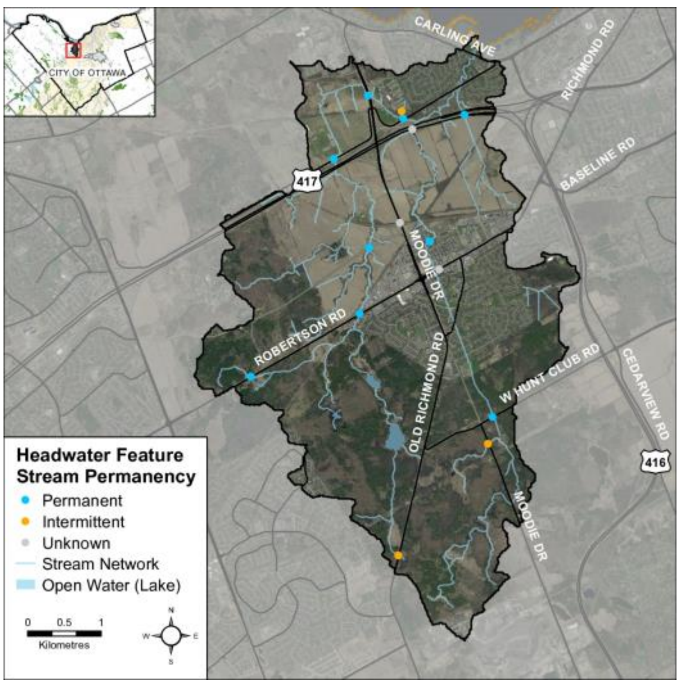


Figure 33 Stillwater Creek HDF flow conditions

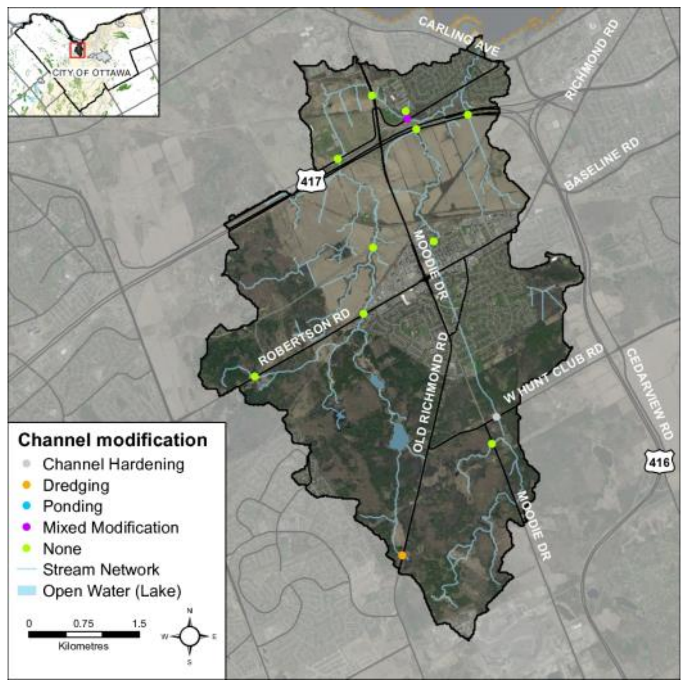


Figure 34 Mosquito Creek HDF channel modifications

Permanent HDF sampling site along Robertson Road

Channel hardening at an HDF site along Corkstown Road

Headwater Feature Vegetation

Headwater feature vegetation evaluates the type of vegetation that is found within the drainage feature. The type of vegetation within the channel influences the aquatic and terrestrial ecosystem values that the feature provides. For some types of headwater features the vegetation within the feature plays a very important role in flow and sediment movement and provides wildlife habitat. The following classifications are evaluated no vegetation, lawn, wetland, meadow, scrubland and forest. Headwaters features in the Stillwater Creek catchment were dominated by meadow, wetland and scrubland vegetation. Figure 35 depicts the dominant vegetation observed at the sampled headwater sites in the Stillwater Creek catchment.

Headwater Feature Riparian Vegetation

Headwater riparian vegetation evaluates the type of vegetation that is found along the headwater drainage feature. The type of vegetation within the riparian corridor influences the aquatic and terrestrial ecosystem values that the feature provides to the watershed. All of the sample locations in the Stillwater Creek catchment area were dominated by natural vegetation in the form of scrubland, meadow, wetland and forest. Figure 36 depicts the type of riparian vegetation observed at the sampled headwater sites in the Stillwater Creek catchment.

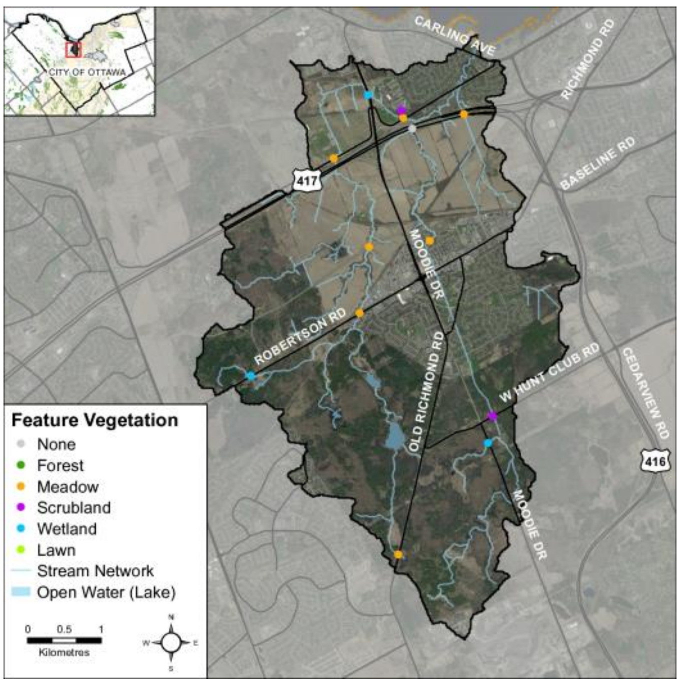


Figure 35 Stillwater Creek HDF feature vegetation

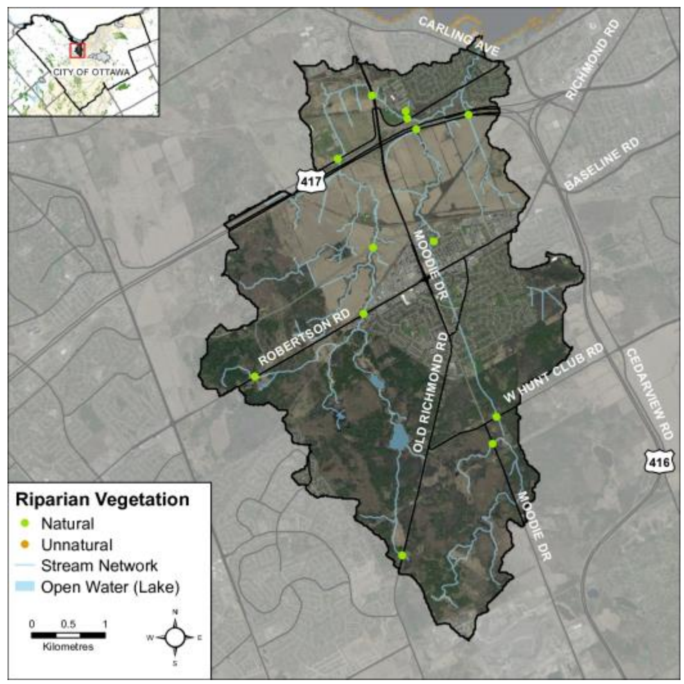


Figure 36 Stillwater Creek HDF riparian vegetation

Wetland feature vegetation observed at Robertson Road

A natural forested riparian buffer upstream of Highway 417

Headwater Feature Sediment Deposition

Assessing the amount of recent sediment deposited in a channel provides an index of the degree to which the feature could be transporting sediment to downstream reaches (OSAP, 2013). Evidence of excessive sediment deposition might indicate the requirement to follow up with more detailed targeted assessments upstream of the site location to identify potential best management practices to be implemented. Conditions ranged from no deposition observed to moderate levels of sediment deposition observed. Overall, most sites had minimal or moderate levels of sediment deposition. Figure 37 depicts the degree of sediment deposition observed at the sampled headwater sites in the Stillwater Creek catchment.

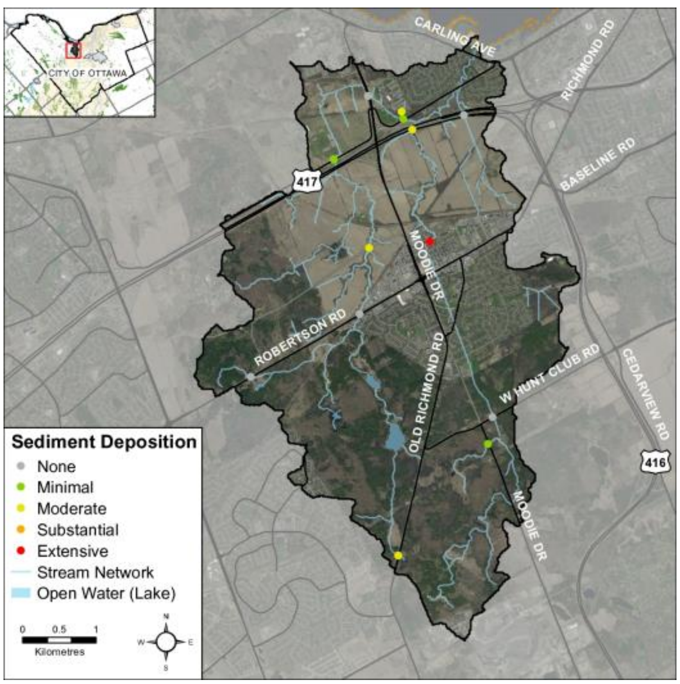


Figure 37 Stillwater Creek HDF sediment deposition

Spring conditions at a sampling site along Robertson Rd

Headwater Feature Upstream Roughness

Feature roughness will provide a measure of the amount of materials within the bankfull channel that could slow down the velocity of water flowing within the headwater feature (OSAP, 2013). Materials on the channel bottom that provide roughness include vegetation, woody debris and boulders/cobble substrates. Roughness can provide benefits in mitigating downstream erosion on the headwater drainage feature and the receiving watercourse by reducing velocities. Roughness also provides important habitat conditions to aquatic organisms. Most of the feature roughness of the sample locations in the Stillwater Creek catchment were classified as either moderate or extreme levels. Figure 38 shows the feature roughness conditions at the sampling locations in the Stillwater Creek catchment.

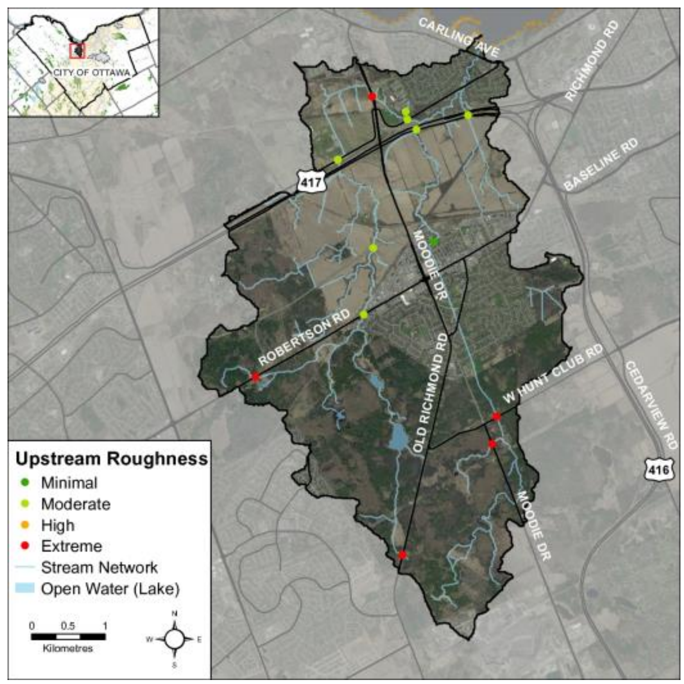


Figure 38 Stillwater Creek HDF feature roughness

Summer conditions at the same site along Robertson Rd

Stream Comparison Between 2009 and 2015

The following tables provide a comparison of observations on Stillwater Creek between the 2009 and 2015 survey years. Stillwater Creek was also surveyed in 2004, but the surveying protocol has changed significantly since that time so data from 2004 cannot be compared to data from 2009 and 2015. In order to accurately represent current and historical information, the site data was only compared for those locations which were surveyed in both reporting periods. In some instances, this resulted in changes to our overall summary information. This information is therefore only a comparative evaluation and does not represent the entirety of our assessment.

Anthropogenic Changes

Table 3 shows that between 2009 and 2015 anthropogenic alterations along Stillwater Creek have decreased. In 2009, 20 percent of the sections had no anthropogenic alterations, in 2015 that number has increased to 37 percent. This change many be caused by changes in the stream survey protocol. In 2010 anthropogenic alterations were further defined in the protocol, which has caused some land uses to shift categories.

Anthropogenic Alterations	2009 (%)	2015 (%)
No anthropogenic alterations	20	37
"Natural" conditions with minor human alterations	26	25
"Altered" with considerable human impact but significant natural portions	33	22
"Highly altered" by humans with few natural portions	21	16

Table 3 Comparison of anthropogenic alterations along Stillwater Creek between 2009 and 2015

A weir constructed along Stillwater Creek downstream of Moodie Drive that was observed in 2009 and 2015

Bank Stability Changes

According to observations bank stability on Stillwater Creek has improved overall since 2009. In 2009, 89 percent of the left and right bank were considered stable. In 2015, 96 percent of the left and right bank were stable.

Bank Stability	2009 (%) Left Bank	2009 (%) Right Bank	2015 (%) Left Bank	2015 (%) Right Bank
Stable	89	89	96	96
Unstable	11	11	4	4

Table 4 Comparison of bank stability along Stillwater Creek between 2009 and 2015

Changes in Instream Vegetation

Figure 39 shows that there has been a decrease in instream vegetation in Stillwater Creek since 2009. The amount of areas with no vegetation and rare levels of vegetation totaled 30 percent in 2009, and that number has increased to 43 percent in 2015. Low levels have remained the same at 20 percent in both 2009 and 2015. Normal levels of vegetation have decreased from 22 percent in 2009 to 14 percent in 2015. Finally, the number of areas classified as having common and extensive levels of vegetation has decreased from 28 percent in 2009 to 23 percent in 2015. The decrease in instream vegetation may be in part attributed to increased sedimentation in the system but vegetation growth is also dependent on climatic variables as well as the stage of the growing season when observations took place.

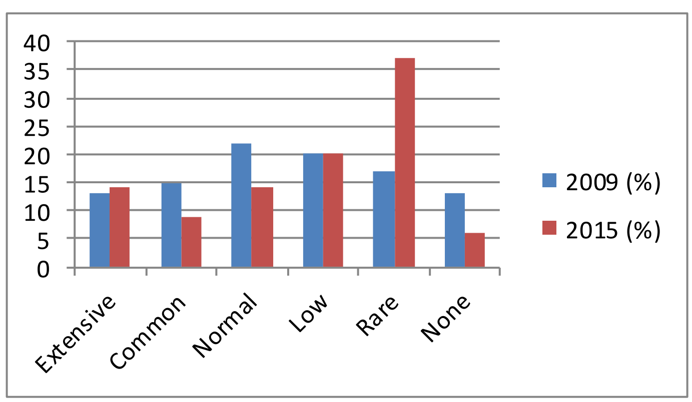


Figure 39 Comparison of instream vegetation levels between 2009 and 2015

Changes in Pollution and Garbage

Overall the amount of pollution and garbage in Stillwater Creek has decreased since 2009. Table 5 shows that the number of sections surveyed that were free from garbage has increased from 14 to 38 percent since 2009.

Pollution/Garbage	2009 (%)	2015 (%)
None	14	38
Floating garbage	66	38
Garbage on stream bottom	41	32
Oil or gas trails	1	0
Discoloration of channel bed	0	0

Table 5 Comparison of pollution/garbage levels between 2009 and 2015

Fish Community

Fish sampling was conducted on Stillwater Creek by the City Stream Watch program in 2004, 2009 and 2015. In total, 35 species of fish have been captured through City Stream Watch fish sampling efforts.

In 2004, 17 species were captured in five sampling sessions using a seine net downstream of Carling Avenue. In 2009, fish sampling effort was significantly increased sampling 4 sites downstream of Corkstown Road using a variety of methods (seine net, electrofisher, fyke net, windemere trap) resulting in 18 species caught. In 2015, 24 species were caught using a variety of methods (electrofishing, seining, fyke nets) at 10 sites throughout the system.

Five species caught in 2009 were not found in 2015. This does not mean the species have disappeared from Stillwater Creek but could be influenced by location, weather conditions, time of sampling and sampling method.

Mottled sculpin captured on Stillwater Creek

Species	Code	2004	2009	2015
banded killifish………	BaKil	X	X	X
black crappie………..	BlCra	X		
blackchin shiner…….	BcShi	X	X	
blacknose shiner……	BnShi		X	
bluegill………………..	Blueg	X		
bluntnose minnow…..	BnMin	X		X
brassy minnow……..	BrMin			X
brook stickleback…..	BrSti	X	X	X
burbot………………..	Burbo			X
carps and minnows…	CA_MI		X	X
central mudminnow..	CeMud		X	X
common shiner……..	CoShi	X	X	X
creek chub……………	CrChu		X	X
emerald shiner………	EmShi	X		X
Etheostoma sp……..	EthSp	X	X	X
fathead minnow……..	FhMin		X	X
finescale dace……….	FsDac			X
golden shiner……….	GoShi	X		
largemouth bass……..	LmBas	X		
Lepomis sp…………..	LepSp		X	X
logperch………………	LogPe			X
longnose dace……….	LnDac			X
mottled sculpin……….	MoScu		X	X
muskellunge………….	Muske	X		
northern pearl dace…..	PeDac			X
northern pike………….	NoPik		X	
northern redbelly dace	NRDac		X	X
pumpkinseed………….	Pumpk	X		X
pumpkinseed x bluegill	Hy702		X	
Rhinichthys sp……….	RhiSp			X
rock bass……………..	RoBas	X		
spotfin shiner………….	SfShi	X	X	
spottail shiner…………	SpShi			X
white sucker………….	WhSuc	X	X	X
yellow perch………….	YePer	X	X	X
Total Species		**17**	**18**	**24**

Table 6 Comparison of fish species caught in 2004, 2009 and 2015

Monitoring and Restoration

Monitoring and Restoration Projects on Stillwater Creek

Table 7 below highlights the monitoring and restoration work that has been done on Stillwater Creek to date by the Rideau Valley Conservation Authority. Potential restoration opportunities are listed on the following page.

Accomplishment	Year	Description
City Stream Watch Stream Characterization Monitoring	2004	65 stream surveys were completed on Stillwater Creek
	2009	79 stream surveys were completed on Stillwater Creek
	2015	100 stream surveys were completed on Stillwater Creek
City Stream Watch Fish Sampling	2004	Five sites were sampled on Stillwater Creek
	2009	Four sites were sampled on Stillwater Creek
	2015	Ten sites were sampled on Stillwater Creek
City Stream Watch Thermal Classification	2004	Two temperature loggers were deployed
	2009	Four temperature loggers were deployed
	2015	Seven temperature loggers were deployed
City Stream Watch Headwater Drainage Feature Sampling	2015	13 headwater drainage feature sites were sampled in the Stillwater Creek catchment
City Stream Watch Stream Cleanup	2009	City Stream Watch volunteers removed debris of human origin from the mouth of Stillwater Creek
Shoreline Naturalization Program Planting	2011	City Stream Watch volunteers planted native trees and shrubs along Stillwater Creek at the Nepean Equestrian Park and Robertson Road
	2013	City Stream Watch volunteers planted native trees and shrubs at the mouth of Stillwater Creek in Andrew Haydon Park
	2013, 2015	Shoreline Naturalization Program staff and volunteers planted shrubs and trees along Stillwater Creek at Abbot-Point-of-Care
City Stream Watch Invasive Species Removal	2010, 2011, 2012, 2013	Volunteers removed invasive yellow iris from the mouth of Stillwater Creek, returning each year to remove any new growth

Table 7 Monitoring and Restoration on Stillwater Creek

Volunteers performing stream surveys on Stillwater Creek

Volunteers planting trees along Stillwater Creek at Abbott-Point-of-Care

Potential Riparian Restoration Opportunities

Figure 40 depicts the locations where City Stream Watch staff and volunteers observed areas where the riparian zone could be restored or enhanced using one or more of the following techniques: riparian planting, erosion control, invasive species control and wildlife habitat creation.
The majority of the opportunities listed were riparian planting and invasive species control. Himalayan balsam is prolific along the tributary east of Moodie Drive and numerous riparian planting opportunities were observed along the main channel of the creek and the tributaries surveyed.

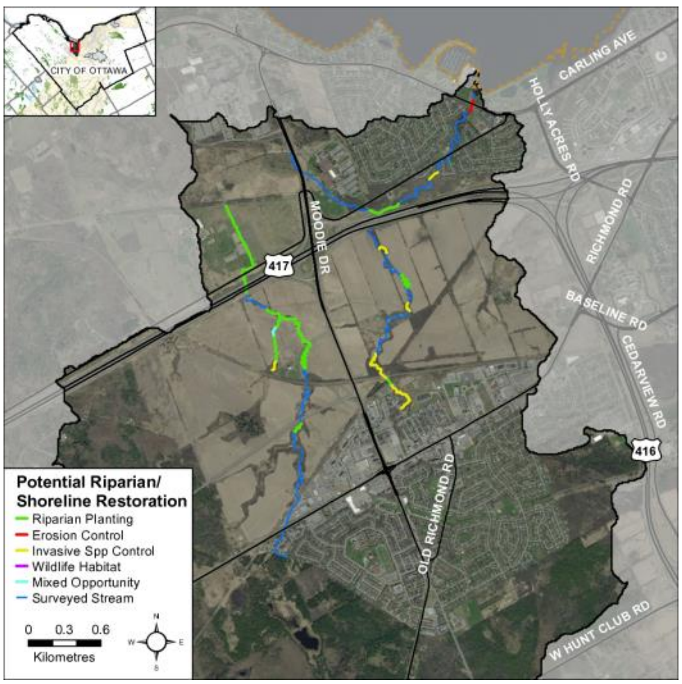
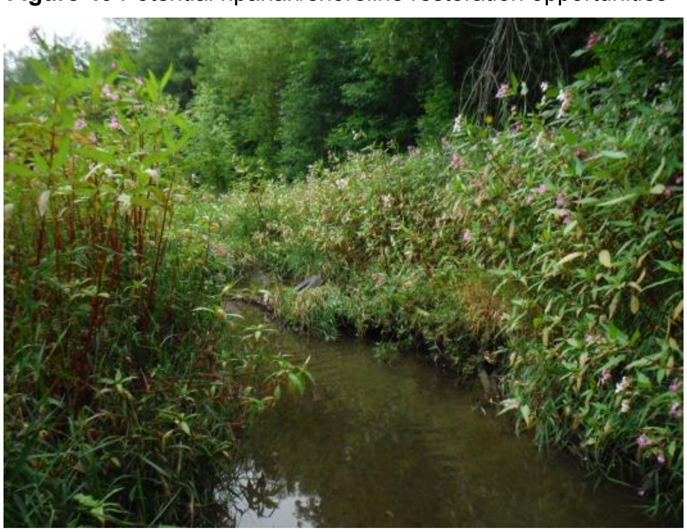


Figure 40 Potential riparian/shoreline restoration opportunities



Dense stands of Himalayan balsam observed on the tributary east of Moodie Drive

Potential Instream Restoration Opportunities

Figure 41 depicts the locations where City Stream Watch staff and volunteers made note of areas where there were one or more of the following instream restoration opportunities: fish habitat enhancement, garbage cleanup and channel modification.
Three areas were identified for stream cleanups, all near road crossings in the developed areas of Stillwater Creek. In addition, two locations where stream channelization had occurred were identified for channel modifications. An additional opportunity exists to remove the weir located downstream of Moodie Drive.

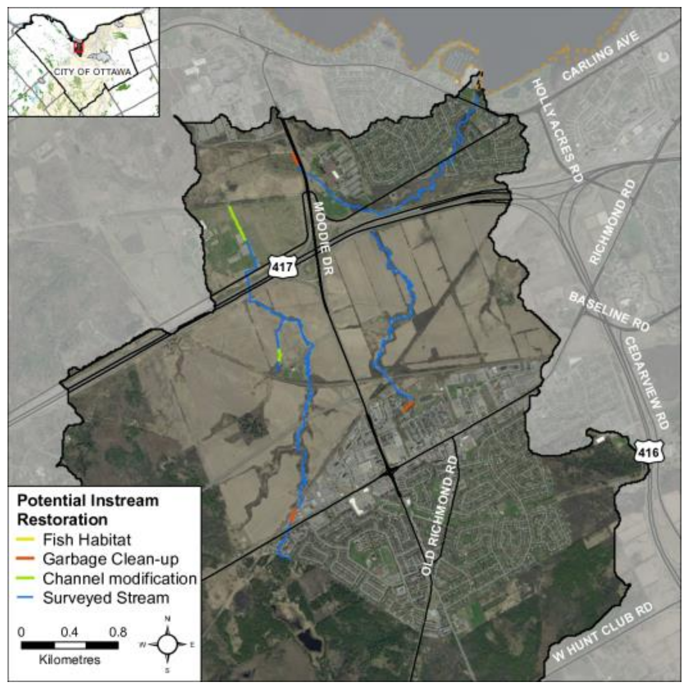


Figure 41 Potential instream restoration opportunities

Location where channel modification opportunity was identified on Stillwater Creek



References

1. Canadian Council of Ministers of the Environment (CCME), 1999. *Canadian Environmental Quality Guidelines and Summary Table* Retrieved From: http://www.ccme.ca/pulicatioins/ceqg_rcqe.html
2. Canadian Wildlife Service (CWS), Environment Canada. 2013. *How Much Habitat Is Enough? Third Edition* Retrieved from: http://www.ec.gc.ca/nature/E33B007C-5C69-4980-8F7B-3AD02B030D8C/894_How_much_habitat_is_enough_E_WEB_05.pdf
3. Chu, C., N.E. Jones, A.R. Piggot and J.M. Buttle. 2009. 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: 1605-1619
4. 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.
5. Ecoplans, Limited. September 2009. *West Transitway Expansion Bayshore to Moodie Drive: Preliminary Characterization of Existing Natural Environmental Conditions.* **DRAFT**.
6. Rideau Valley Conservation Authority (RVCA). 2009. *City Stream Watch Annual Report.* Manotick, ON: Julia Sutton
7. Rideau Valley Conservation Authority (RVCA). 2013. *Existing Habitat Condition, Channel Structure, Thermal Stability and Opportunities for Restoration for Stillwater Creek.* Manotick, ON: Justin Robert
8. Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada Bulletin 184: 966 pages
9. Stanfield, L. (editor). 2013. Ontario Stream Assessment Protocol. Version 9.0. Fisheries Policy Section. Ontario Ministry of Natural Resources. Peterborough, Ontario. 505 Pages
10. Stoneman, C.L. and M.L. Jones. 1996. *A Simple Method to Evaluate the Thermal Stability of Trout Streams*

For more information on the overall 2015 City Stream Watch Program and the volunteer activities, please refer to the City Stream Watch 2015 Summary Report.