Stevens Creek 2017 Catchment Report

Watershed Features	
Area	165.5 Square kilometres 3.9% of the Rideau Valley watershed
Land Use	35.17% agriculture 2.64% urban 29.80% forest 2.40% meadow 0.08% rural 0.22% waterbody 25.63% wetland
Surficial Geology	24.82% clay 19.72% diamicton 1.88% gravel 25.81% organic deposits 26.92% Paleozoic bedrock 0.85% sand
Watercourse Type	2017 thermal conditions cool-warm water system
Invasive Species	Fourteen invasive species were identified in 2017: banded mystery snail, common carp, common and glossy buckthorn, curly leaf pondweed, Eurasian milfoil, European frog-bit, flowering rush, non-native honeysuckle, Manitoba maple, Norway maple, poison/wild parsnip, purple loosestrife, rusty crayfish and zebra mussel.
Fish Community	27 species of fish have been observed from 2006-2017. Game fish species include: brown bullhead, largemouth bass, northern pike, rock bass, smallmouth bass, tadpole madtom, yellow perch, and white sucker.

Wetland Catchment Cover
20.47% evaluated wetland
5.16% unevaluated wetland

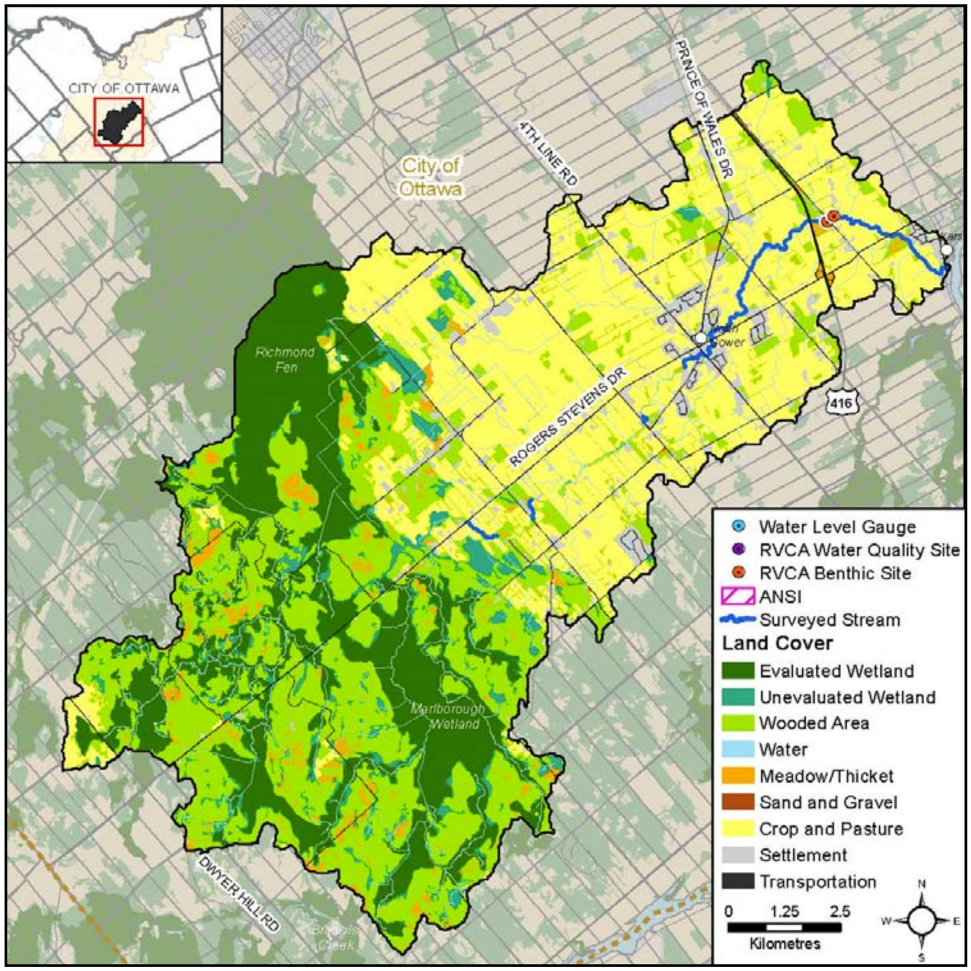
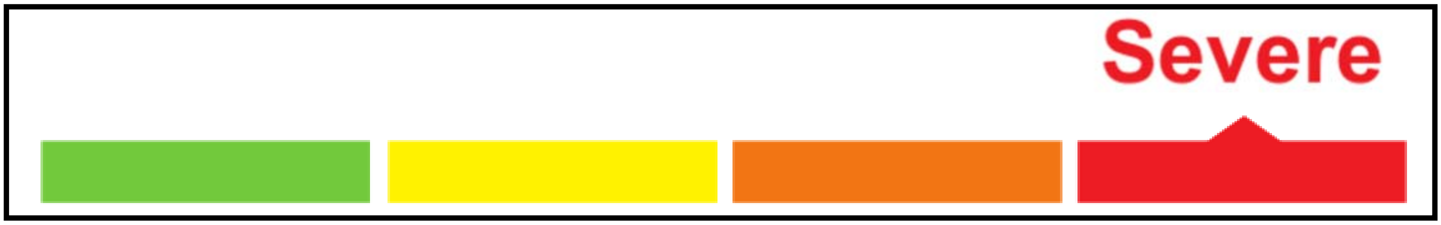


Figure 1 Land cover in the Stevens Creek catchment

Section of Stevens Creek between Roger Stevens Road and Second Line Road

The Rideau Valley Conservation Authority, in partnership with six other agencies in Ottawa: City of Ottawa, Ottawa Flyfishers Society, Ottawa Stewardship Council, Rideau Roundtable, Canadian Forces Fish and Game Club, and the National Capital Commission form the 2017 City Stream Watch Collaborative.

Flood Conditions - Rideau Valley Watershed



Flood Conditions

Heavy rains throughout the summer and into the fall made 2017 the wettest year in Ottawa in recorded history. This year we observed prolonged and significant flooding in parts of the Rideau River Watershed. RVCA monitors areas along the Rideau River, by mid-April the first flood message was sent and by May 1st the message was upgraded to a Flood Warning.

The Rideau River peaked on April 8th, with a level of 456 cubic meters per second, a 1:4 year event (RVCA, 2017 a). In July 24th, North Gower at the south end of Ottawa, experienced a 100-year flood level (as much as 62 centimeters), with 100-year precipitation amounts of 123 millimetres in one day; this day, Stevens Creek received 35 percent more rain than average causing unprecedented floods in the area (RVCA, 2017 b). This year was quite a contrast to 2016, when the city experienced moderate to severe drought conditions throughout most of the year.

Flooded road section in the Stevens Creek catchment near the Rideau River

Flooded section of Pinecrest Creek near the Ottawa River

Flooded agricultural field in the Becketts Creek catchment

Introduction

Stevens Creek is a tributary of the Rideau River located in the South end of the City of Ottawa. The 33 kilometer stream flows from the Marlborough Forest, Southwest of Pierces Corners, through North Gower on to its confluence with the Rideau River to the East in Kars. The sub-watershed of Stevens Creek drains 165.5 squared kilometers of land, comprised of mainly wetlands, forest, and agricultural/rural land uses. The vegetation cover is comprised of 53.76 percent wooded areas and 46.24 percent wetland; of the woodlots in the catchment, 51 percent are less than one hectare in size, 43 percent are one to 30 hectares, and six percent have an area over 30 hectares. The majority of the headwaters of this catchment, located in the Marlborough Forest, is a class one Provincially Significant Wetland and also has locally important recreational value.

The Marlborough Forest itself is comprised of 1,344 hectares of coniferous trees and mixed hardwoods. Historically this wetland forest was paramount for the local forestry economy with Stevens Creek as a log driving channel (Walker and Walker, 1968). Today, this forest still has incredible recreational value, used for hiking, snowmobile, and ski trails; by hunters; and importantly as a wildlife refuge for deer, moose, beaver, waterfowl, birds, turtles and frogs.

In 2017 the City Stream Watch program surveyed 104 sections (10.4 km) of the main stem of Stevens Creek; eight sites were sampled for fish community composition; five temperature loggers were deployed; and 60 headwater drainage feature sites were assessed. Areas that were not surveyed lacked private property access permission. The surveyed sections of the main branch include portions from the mouth to North Gower, sections near McCordick Road, and a portion from Malakoff Road to Roger Stevens Road. The following is a summary of our observations and assessment.

Stevens Creek Overbank Zone

Riparian Buffer Width Evaluation

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

Figure 2 demonstrates buffer conditions along the left and right banks of the surveyed sections of Stevens Creek. Buffers greater than 30 meters were present along 28 percent of the left bank and 32 percent of the right bank. A 15 to 30 meter buffer was present along 15 percent of the left bank and 12 percent of the right bank; five to 15 meter buffers were observed along 30 percent of the left bank and 26 percent of the right bank. A five meter buffer or less was present along 27 percent of the left banks and 30 percent of the right bank.

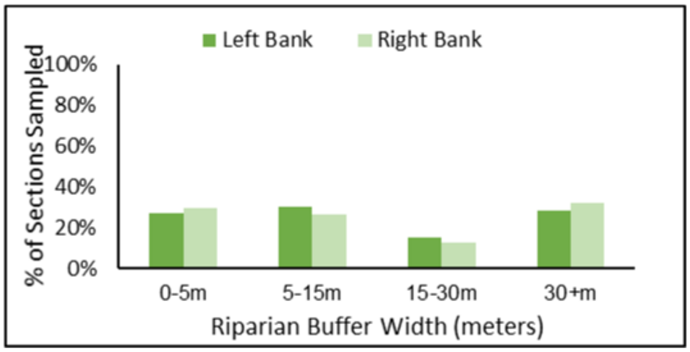


Figure 2 Vegetated buffer width along Stevens Creek

Improvements of buffer are needed, particularly in the agricultural areas and near roadway intersections where buffers are lower than the recommended guidelines.

Riparian Buffer Alterations

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

Stevens Creek riparian zones have some natural vegetative communities; alterations are associated with municipal infrastructure, including roadways, and agricultural land uses.

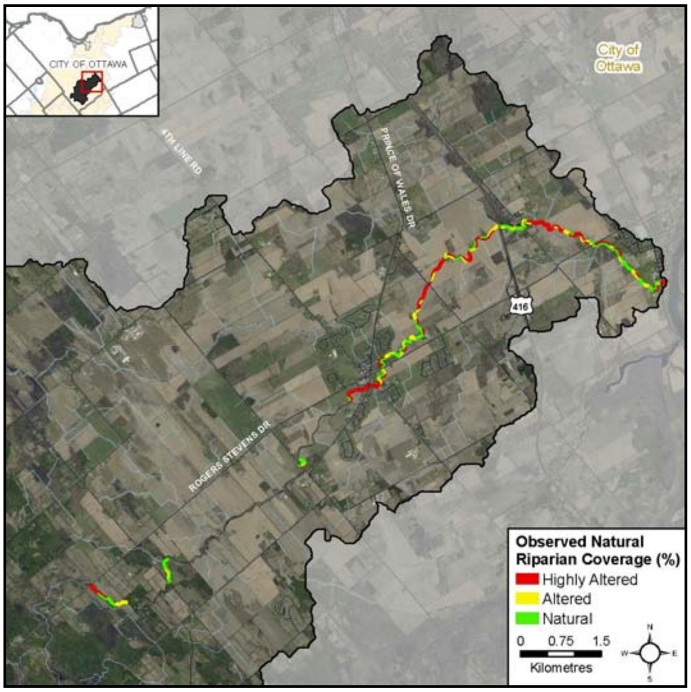


Figure 3 Riparian buffer alterations in Stevens Creek

Adjacent Land Use

Surrounding land use is considered from the beginning to the end of the survey section (100 m) and up to 100 meters on each side of the river. Land use outside of this area is not considered for the surveys but is nonetheless part of the subwatershed and will influence the creek. Figure 4 shows the percent of surveyed sections that contain each type of land use.

Forest and meadows were present in 77 percent and 42 percent of the sections surveyed, being the most common land use found. Scrubland was present in 40 percent of the surveyed areas, and wetland was present in 15 percent of sections.

Aside from the natural areas, the most common land use in the catchment was agricultural, with 72 percent of the sections containing active agriculture, 11 percent of the sections had pasture land present and one percent abandoned agriculture. Other uses observed included 18 percent of surveyed areas with infrastructure (such as roads); residential areas were observed in 34 percent; seven percent had recreational uses; and industrial or commercial use was identified in six percent of the adjacent lands.

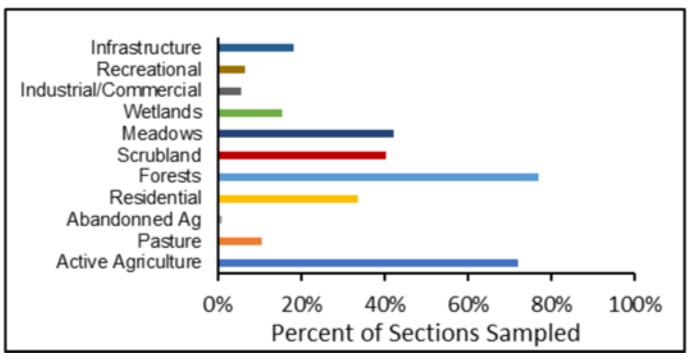


Figure 4 Adjacent land use 100 meters from each shoreline and percentage of presence along Stevens Creek

Section along Stevens Creek with reduced riparian buffer

Stevens Creek Shoreline Zone

Anthropogenic Alterations

Stream alterations are classified based on specific functional criteria associated with the flow conditions, the riparian buffer and potential human influences.

Figure 5 shows the level of anthropogenic alterations for the 104 sections surveyed in Stevens Creek, with only ten percent remaining without any human alteration. Of the sections surveyed, 22 percent fall in the classification of natural. Natural sections have not been straightened or diverted, have a riparian buffer greater than 15 meters, contain few lawns, ornamental gardens, beaches, rip rap or constructed wooden structures.

Altered sections account for 48 percent of surveyed areas, they may contain diverted or straightened sections and riparian buffers of five to 15 meters. Shoreline alterations also include concrete. One or two storm water outlets could also be present.

Highly altered sections (20% of sections) have the highest proportion of alterations. Including riparian buffers less than five meters, shoreline alterations are found on most of the section, and portions of the stream may flow through culverts.

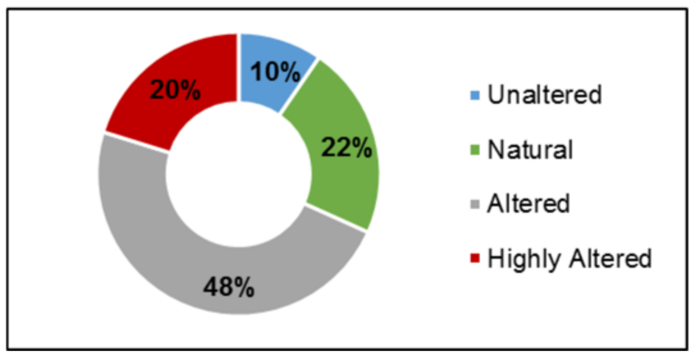


Figure 5 Anthropogenic alterations along Stevens Creek

Road crossing altering a section of Stevens Creek

Erosion

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

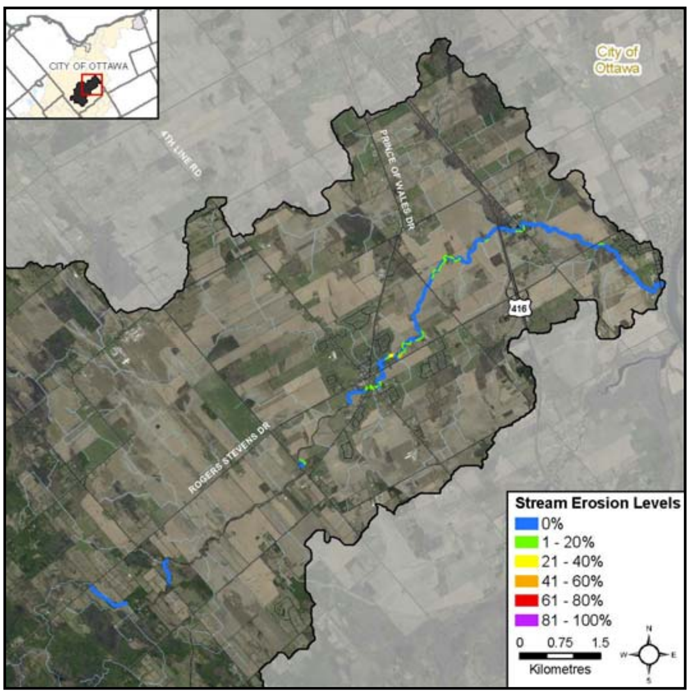


Figure 6 Erosion levels along Stevens Creek

Bank erosion along Stevens Creek

Stevens Creek is a stream emerging from wetlands, and retains wetland riverine conditions throughout. This type of system has flood storage capacity via hydric soils which results in lower erosion levels.

Undercut Stream Banks

Wooden retaining wall along Stevens Creek

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

Figure 7 shows that undercut banks were not present in the majority of the sections surveyed in Stevens Creek, 13 percent of the sections had undercutting in the left bank and six percent of the right bank.

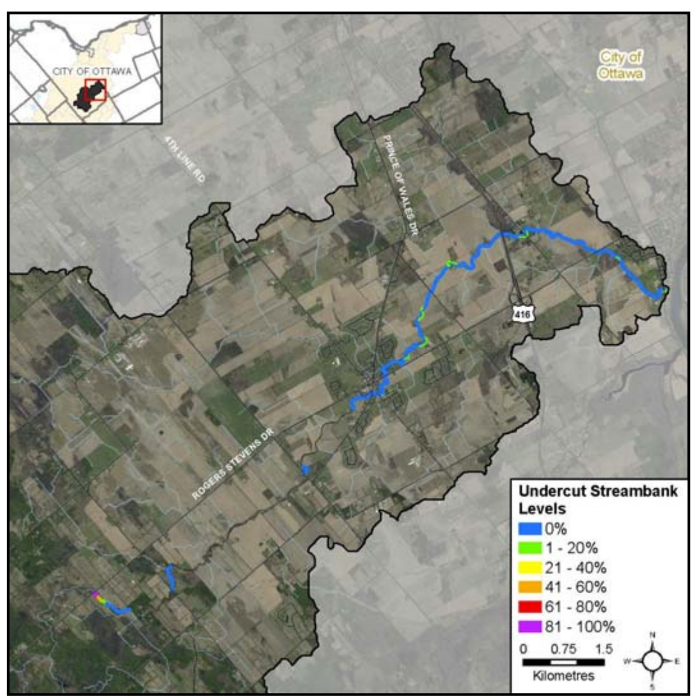


Figure 7 Undercut stream banks along Stevens Creek

Stream Shading

Grasses, shrubs and trees all contribute towards shading a stream. Shade is important in moderating stream temperature, contributing to food supply and helping with nutrient reduction within a stream. Stream cover is assessed as the total coverage area in each section that is shaded by overhanging trees/grasses and tree canopy, at greater than one meter above the water surface.

Figure 8 shows the percentage of sections surveyed with various levels stream shading. The majority of sections (61%) had a shade cover of one to 20 percent. The highest shading of 81 to 100 percent was observed in four percent of the sections. Cover of 41 to 60 percent was present in eight percent of the sections; 21 percent of the sections had 21 to 40 percent coverage; and five percent had 61 to 80 percent cover. No cover was observed in only two percent of the sections. Figure 9 shows the distribution of these shading levels along Stevens Creek.

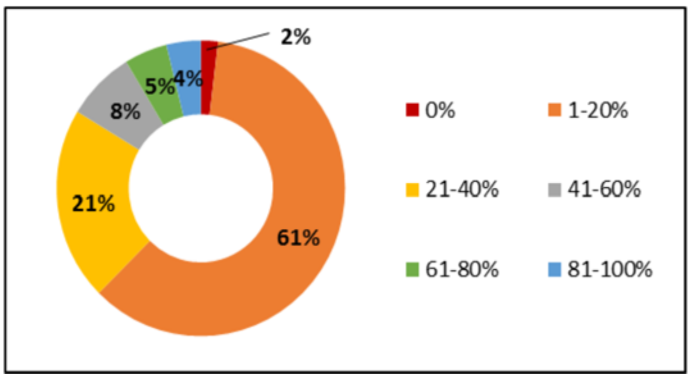


Figure 8 Stream shading along Stevens Creek

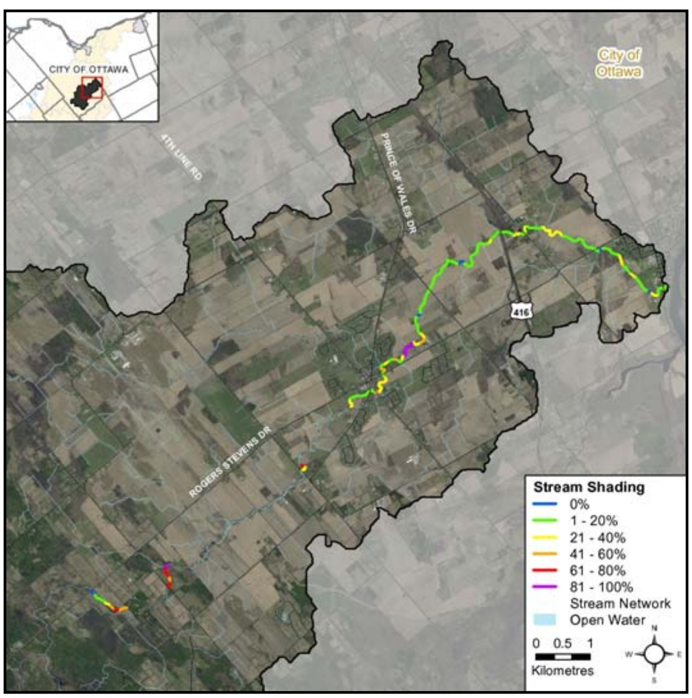


Figure 9 Stream shading along Stevens Creek

A mix of trees and plants comprised the majority of shading. Overhanging plants, mainly broad leaved emergent plants and rushes were seen in 53 percent of the left bank and 52 percent of the right bank.

Overhanging Trees and Branches

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

Figure 10 shows the presence of overhanging trees and branches that were observed along Stevens Creek. In the surveyed portions, 87 percent of the sections had overhanging trees and branches on the left bank, and 72 percent of the sections had overhanging trees on the right banks.

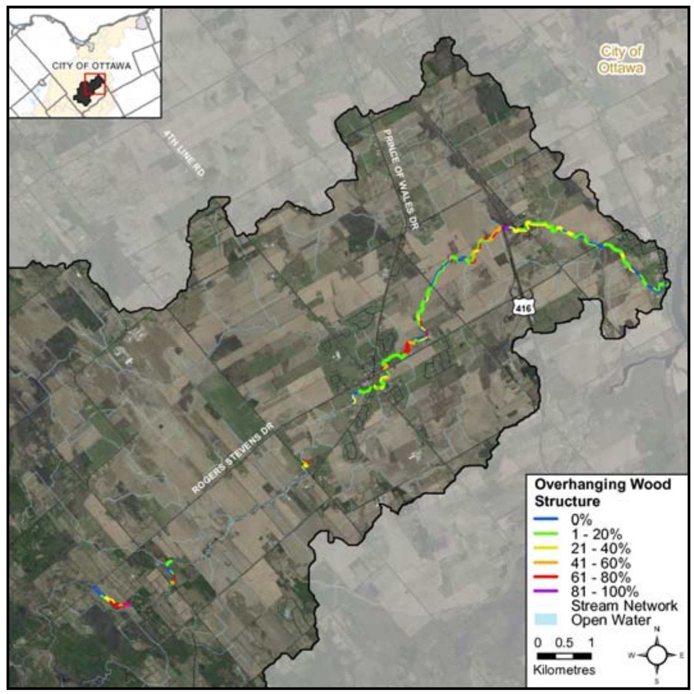
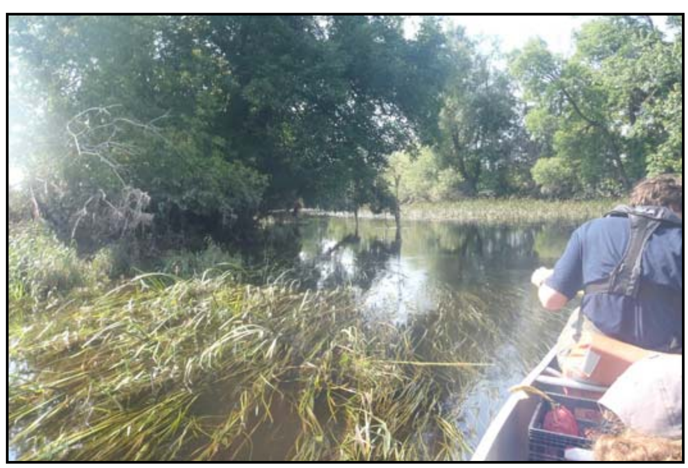


Figure 10 Overhanging trees and branches along Stevens Creek



Overhanging trees and branches on Stevens Creek

Stevens Creek Instream Aquatic Habitat

Habitat Complexity

Habitat complexity is a measure of the overall diversity of habitat types and features within a stream. Streams with high habitat complexity support a greater variety of species niches, and therefore contribute to greater diversity. Factors such as substrate, flow conditions (pools, riffles) and cover material (vegetation, wood structure, etc.) all provide crucial habitat to aquatic life. Habitat complexity is assessed based on the presence of boulder, cobble and gravel substrates, as well as the presence of instream woody material. A higher score shows greater complexity where a variety of species can be supported. Figure 11 shows habitat complexity of the sections surveyed: 12 percent had no complexity; 38 percent had a score of one; 13 percent scored two; 19 percent scored three; and 18 percent had the highest habitat diversity.

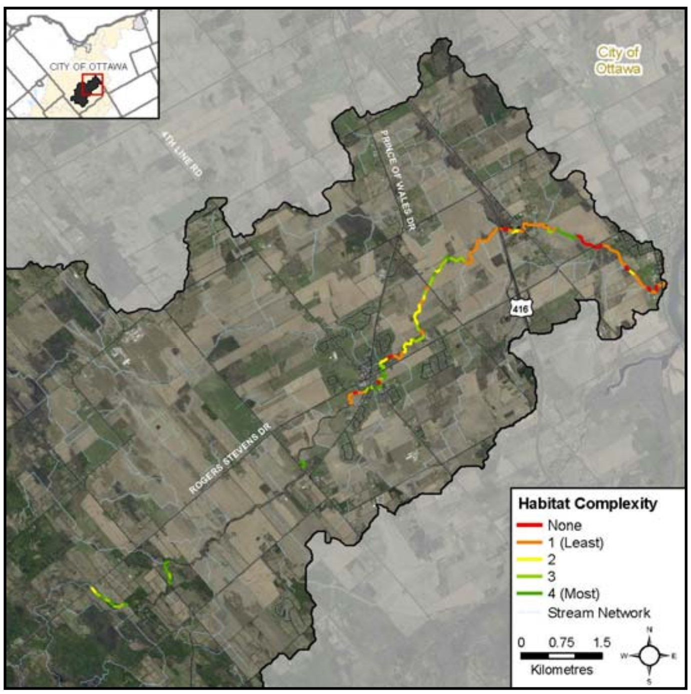


Figure 11 Instream habitat complexity along Stevens Creek

Section of Stevens Creek featuring riffle, run, and pool habitat

Instream Substrate

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

Figure 12 shows the substrates present in the sections surveyed of Stevens Creek. It is a system dominated by silt, with 88 percent of sections containing this type of substrate. It also has clay and sand portions, some areas with gravel, cobble and boulders.

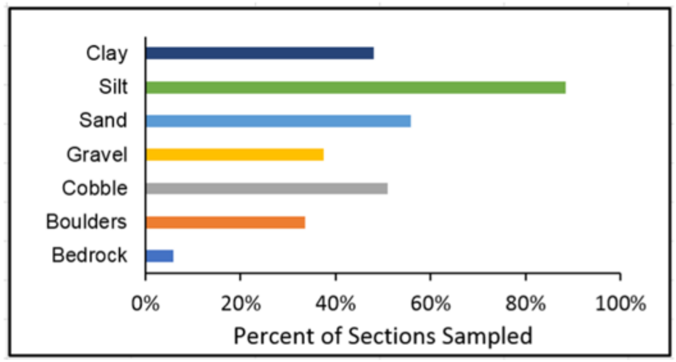


Figure 12 Instream substrate along Stevens Creek

Figure 13 shows the dominant substrates along the creek. From the areas that were assessed, silt was the dominant substrate type in 42 percent of sections and clay in 32 percent. Gravel and cobble were identified as dominant in 11 percent of all surveyed sections; sand dominated 11 percent; and bedrock was dominant in five percent of sections.

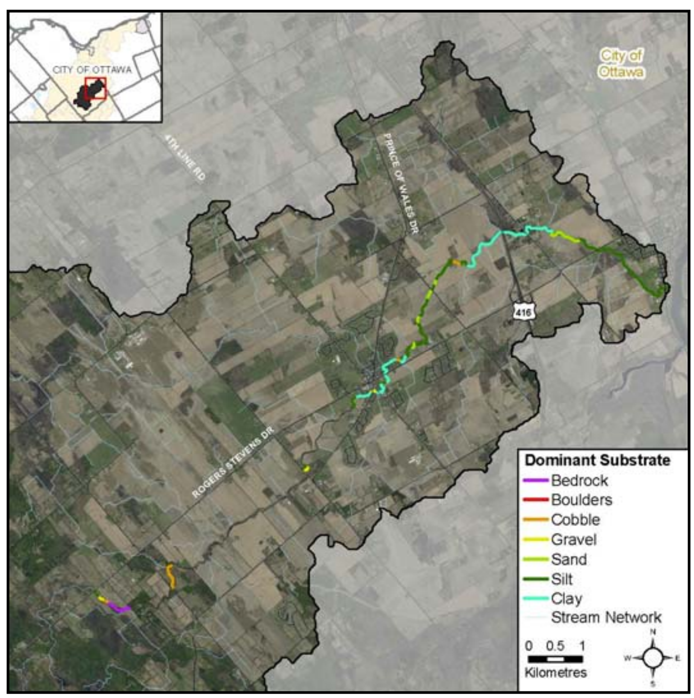


Figure 13 Dominant instream substrate along Stevens Creek

Instream Morphology

Pools and riffles are important habitat features for aquatic life. Riffles are fast flowing areas characterized by agitation and overturn of the water surface. Riffles thereby play a crucial role in contributing to dissolved oxygen conditions and directly support spawning for some fish species. They are also areas that support high benthic invertebrate populations which are an important food source for many aquatic species. Pools are characterized by minimal flows, with relatively deep water and winter and summer refuge habitat for aquatic species. Runs are moderately shallow, with unagitated surfaces of water and areas where the thalweg (deepest part of the channel) is in the center of the channel.

Figure 14 shows that Stevens Creek has a diversity of morphological conditions, suitable for a variety of aquatic species and life stages; 67 percent of sections contained pools, 18 percent contained riffles and the majority, 95 percent, contained runs. Figure 15 shows the locations of riffle habitat along Stevens Creek.

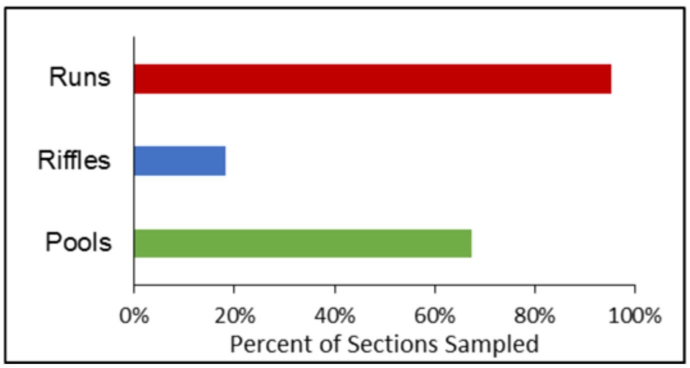


Figure 14 Instream morphology along Stevens Creek

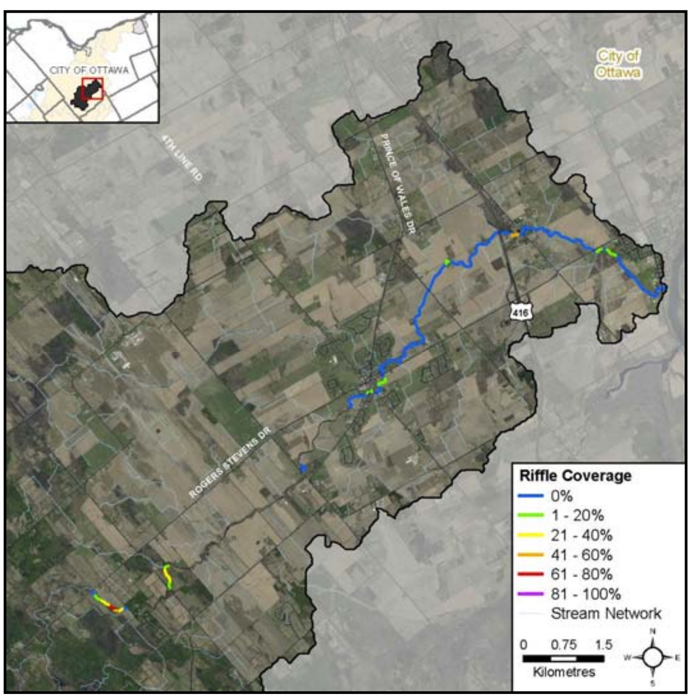


Figure 15 Riffle habitat locations along Stevens Creek

Instream Wood Structure

Figure 16 shows that the majority of Stevens Creek had low levels of instream wood material in the form of branches and trees. Instream wood structure is important for fish and wildlife habitat, by providing refuge and feeding areas. Excessive amounts can create migration barriers.

Instream wood structures found along Stevens Creek

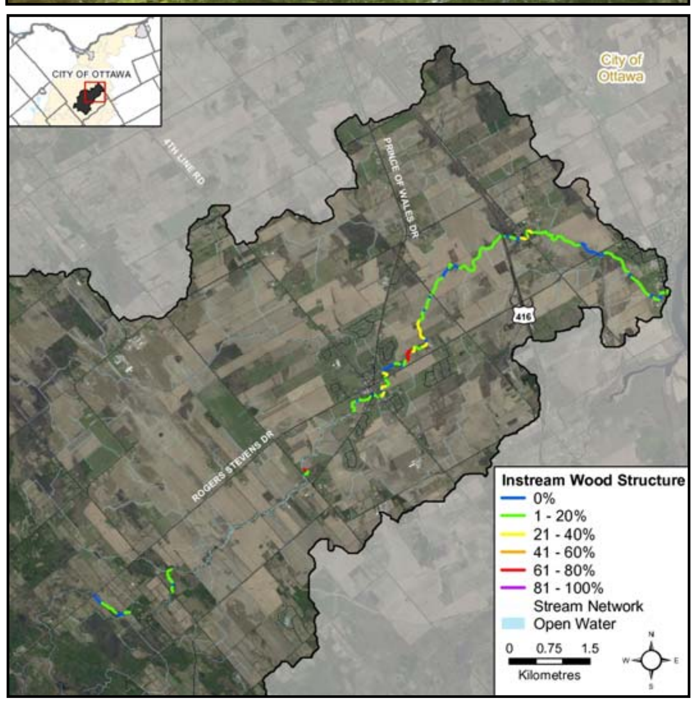


Figure 16 Instream wood structures along Stevens Creek

Instream Aquatic Vegetation Type

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

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

Figure 17 shows the aquatic vegetation community structure. The two types commonly present along Stevens Creek were narrowed-leaved vegetation, present in 81 percent of sections; and submerged vegetation present along 81% of sections surveyed.

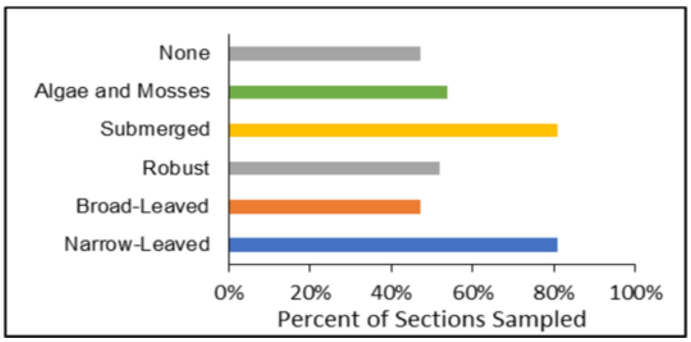


Figure 17 Aquatic vegetation presence along Stevens Creek

Stevens Creek has a large diversity of instream aquatic vegetation, with only 17 percent of sections having no vegetation as the dominant type (Figure 18). Submerged vegetation was the most dominant type across 50 percent of all sections. Narrow leaved was dominant in 18 percent, Robust in 13 percent and algae was dominant in only two percent of sections.

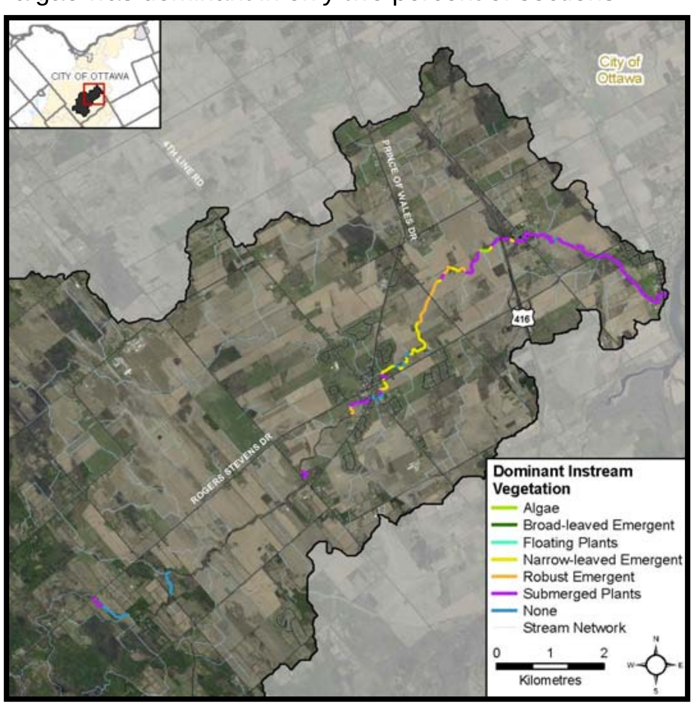


Figure 18 Dominant instream vegetation in Stevens Creek

Instream Vegetation Abundance

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

As seen in Figure 19, 71 percent of Stevens Creek sections had common levels of vegetation, 42 percent had normal, and 37 percent had extensive vegetation. Low abundance levels were observed in 21 percent of sections surveyed and rare abundance in 15 percent. No vegetation was found along 27 percent of sections.

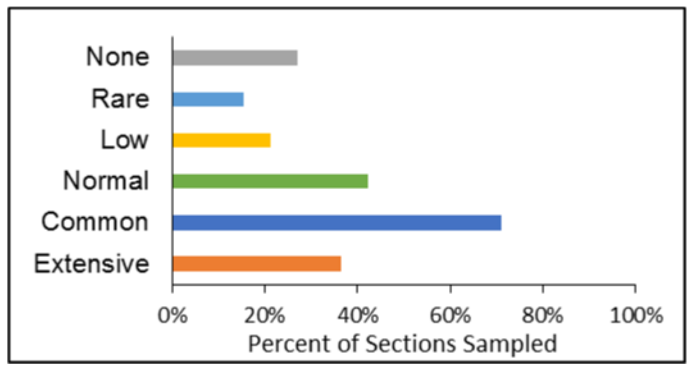


Figure 19 Instream vegetation abundance along Stevens Creek

Cattails found along Stevens Creek are instream robust emergent vegetation, typically found in wetlands

Section of Stevens Creek with extensive aquatic vegetation

Stevens Creek Stream Health

Invasive Species

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

Figure 20 shows abundance of species observed per section. Fourteen invasive species observed in 2017:

- banded mystery snail (*Viviparus georgianus)*
- common & glossy buckthorn (*Rhamnus cathartica* & *R. frangula*)
- common carp (*Cyprinus carpio)*
- curly-leaf pondweed (*Potamogeton crispus*)
- Eurasian milfoil (*Myriophyllum spicatum*)
- European frog-bit (*Hydrocharis morsus-ranae*)
- flowering rush (*Butomus umbellatus*)
- non-native honey suckle (*Lonicera spp.*)
- Manitoba maple (*Acer negundo*)
- Norway maple (*Acer platanoides*)
- poison/wild parsnip (*Pastinaca sativa*)
- purple loosestrife (*Lythrum salicaria*)
- rusty crayfish (*Orconectes rusticus*)
- zebra mussel (*Dreissena polymorpha*)

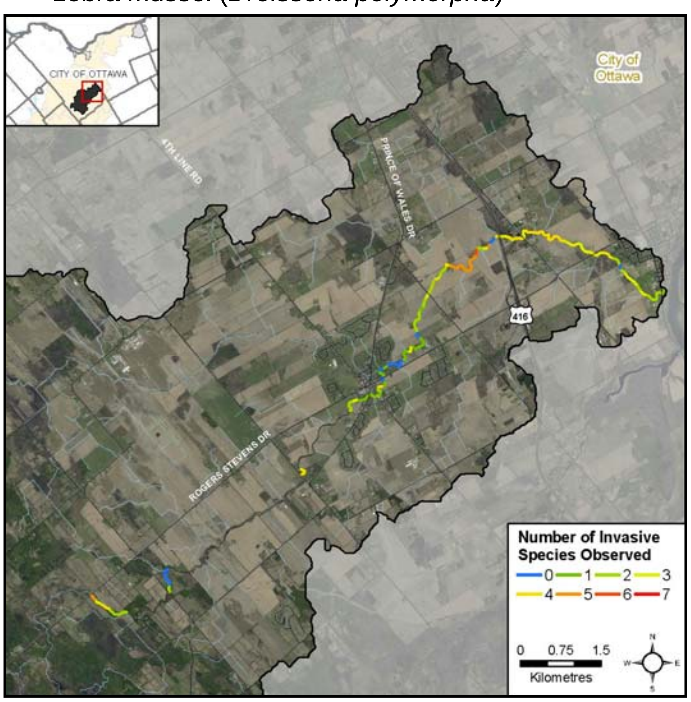


Figure 20 Invasive species abundance along Stevens Creek

Invasive species found along Stevens Creek, curly leaf pond-weed and Eurasian milfoil invading instream (top) and purple loosestrife found along the shorelines (below)

To report and find information about invasive species visit

http://www.invadingspecies.com

Managed by the Ontario Federation of Anglers and Hunters

Pollution

Figure 21 shows the types of pollution observed in Stevens Creek. The levels of garbage found in the main portion of the stream were low, with 72 percent of sections surveyed containing no garbage. Twenty two percent of sections had floating garbage, five percent had garbage on the stream bottom and six percent had other forms of pollution.

In the headwater portions of the catchment garbage was also observed.

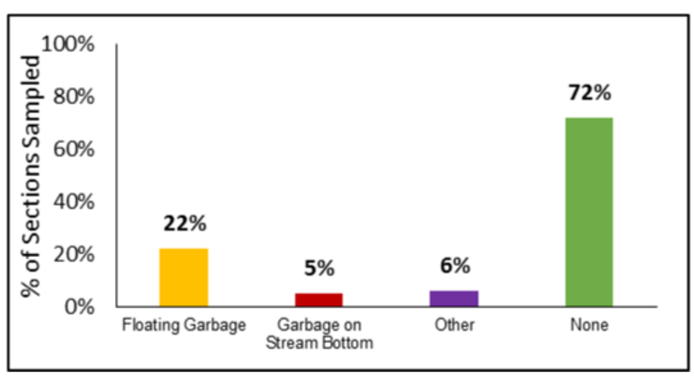


Figure 21 Pollution observed along Stevens Creek

Wildlife

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

Osprey nesting near the confluence with the Rideau River (above) and an adult northern pike hiding within aquatic vegetation in the headwater reaches (below) of Stevens Creek

Butterflies found along Stevens Creek, an endangered monarch caterpillar (above) and a giant swallowtail (below)

Table 1 Wildlife observed along Creek in 2017

Birds	American crow, American goldfinch, American pekin, American robin, barn swallow, belted kingfisher, black-capped chickadee, blue jay, Canada goose, ducks, finches, gray catbird, killdeer, great blue heron, mallard, mourning dove, osprey, red-winged blackbird, sandpipers, song sparrow, sparrows, swallows, turkey vulture, woodpeckers, yellow warbler
Reptiles & Amphibians	American bullfrog, green frog, northern leopard frog, northern water snake, midland painted turtle, pickerel frog, snapping turtle
Mammals	American red squirrel, chipmunks, eastern grey squirrel, mice, muskrat
Aquatic Insects & Benthic Invertebrates	amphipods, banded mystery snails, caddisflies, crayfishes, eastern elliptio, eastern lampmussel, fingernail clams, gyrinid beetle, mayflies, snails, odonates, rusty crayfish, unionid mussels, water strider, whirligig beetle, zebra mussel
Other	aphids, beetles, black flies, blue-eyed darner, butterflies, cicadas, crickets, damselflies, dragonflies, ebony jewelwing, giant swallowtail, monarch butterfly, mosquitoes, moths,, spiders, snails, widow skimmer

Painted turtle basking (above) and snapping turtle nesting (below) near the shorelines of Stevens Creek

Stevens Creek Water Chemistry

Water Chemistry Assessment

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

Collecting water chemistry measurements with a YSI probe in the Stevens Creek catchment

Dissolved Oxygen

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

Figure 22 shows the concentration levels found in the surveyed portions of Stevens Creek. The two dashed lines depicted represent the Canadian water quality guidelines. Most of the surveyed portions had adequate oxygen levels to support warm-water aquatic life. Levels below the Canadian water quality guideline were found in agricultural areas and at road crossings (sec. 21-26, 51-55, 80-85, 101-104). Average levels across the system were 6.9 milligrams per liter.

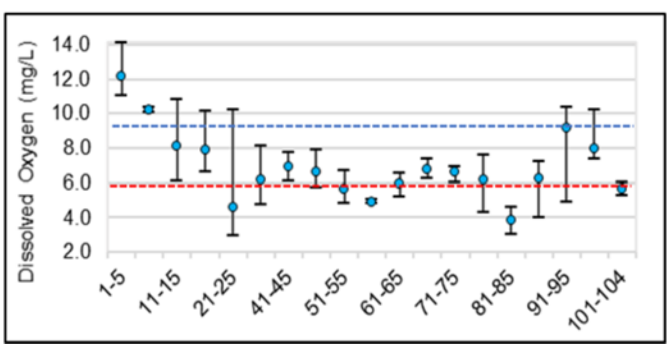


Figure 22 Dissolved oxygen ranges along surveyed sections of Stevens Creek

Conductivity

Conductivity is a measure of water's capacity to conduct electrical flow. This capacity is dictated by the presence of conductive ions that originate from inorganic materials and dissolved salts. Water conductivity in natural environments is typically dictated by the geology of the area, however anthropogenic inputs also have a profound effect. Currently there is no existing guideline for stream conductivity levels, however conductivity measurements outside of normal range across a system are good indicators of anthropogenic inputs including unmitigated discharges and storm water input.

Figure 23 shows specific conductivity levels in Stevens Creek, the average level is depicted by the dashed line (462 µS/cm). Notable variability was observed at the mouth, (sec. 1-5) likely influenced by the Rideau River; and by drainage in agricultural zones and runoff from roadway crossings (sec. 86-90, 91-95, 100).

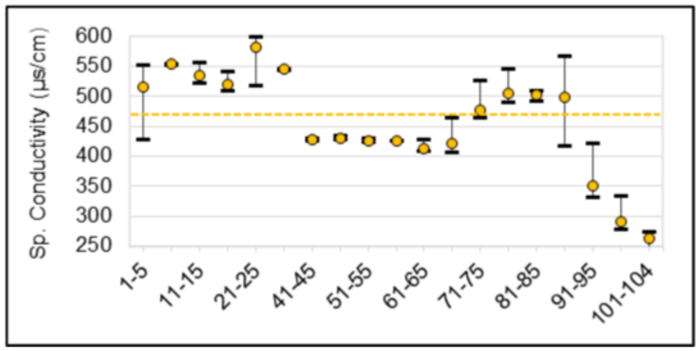


Figure 23 Conductivity ranges along surveyed sections of Stevens Creek

pH

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

Figure 24 shows Stevens Creek had pH levels that meet the PWQO, depicted by the dashed line. Average levels across the system were pH 7.71.

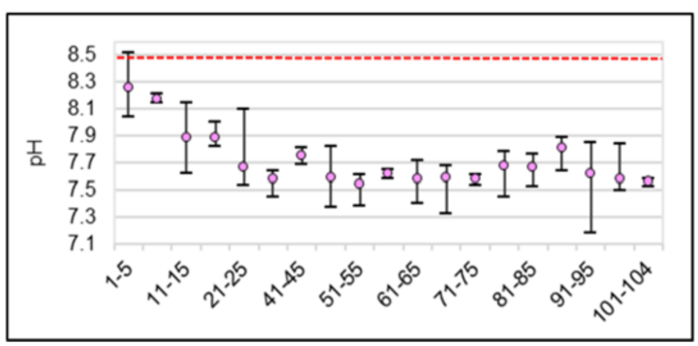


Figure 24 pH ranges along surveyed sections of Stevens Creek

Oxygen Saturation (%)

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

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

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

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

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

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

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

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

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

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

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

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

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

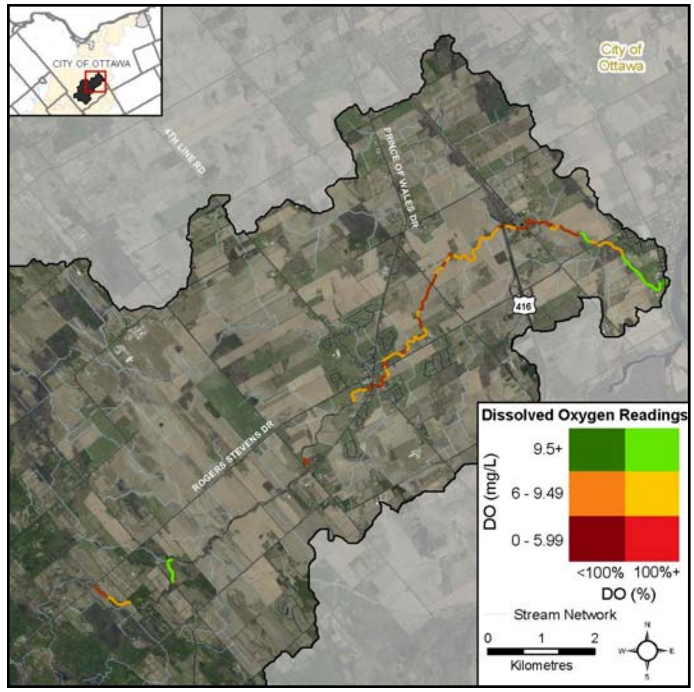


Figure 25 Bivariate assessment of dissolved oxygen concentration (mg/L) and saturation (%) along Stevens Creek

Figure 25 shows the oxygen conditions across the areas that were surveyed in 2017. Overall dissolved oxygen conditions in Stevens Creek are sufficient to sustain warm-water biota in areas near the confluence to the Rideau River. Sections upstream of the first crossing of Roger Stevens Drive, shown in dark red and orange in Figure 25, have significant levels of impairment both in concentration and percent saturation. These areas have wetland features that have naturally lower oxygen levels, however these can be further limited by extensive vegetation growth of invasive species, and anthropogenic nutrient input.

There are forested areas in the upper reaches near Malakoff Road were optimal conditions ocur for warm-water and cold-water biota observed near agricultural areas and road crossings. These areas are shaded and contain riffle habitat that is conducive to oxygenation.

Site on Stevens Creek with **impaired** oxygen conditions (Dissolved oxygen levels of 4.75 mg/L and 53.1% saturation)

Site on Stevens Creek with **optimal** oxygen conditions (Dissolved oxygen levels of 10.17 mg/L and 100.6% saturation)

Specific Conductivity Assessment

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

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

Average levels of conductivity in Stevens Creek (462 µS/cm) are within guidelines (500 µS/cm) used for the Canadian Environmental Performance Index (Environment Canada 2011). Figure 26 shows relative specific conductivity levels in Stevens Creek. Normal levels were maintained for most of the surveyed portions. Moderately elevated conditions were observed near the confluence with the Rideau River, where wetland features can have an increased level of conducting ions being discharged from groundwater. Highly elevated conditions were present near the third crossing of Roger Stevens Drive. This area receives upstream wetland discharge, has road runoff influences, and agricultural land uses adjacent; all of these factors can lead to elevated conductivity levels.

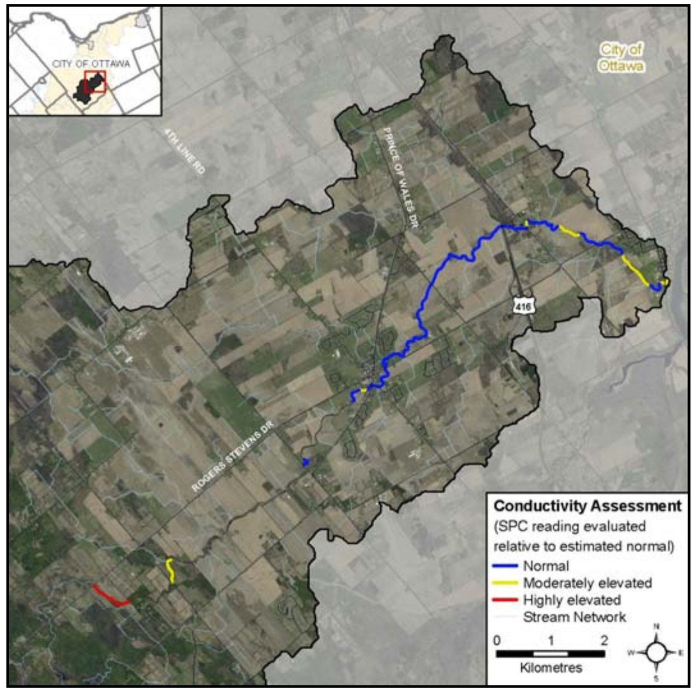


Figure 26 Relative specific conductivity levels along Stevens Creek

Section of Stevens Creek near Roger Stevens Drive with highly elevated levels of specific conductivity

Section of Stevens Creek upstream of highway 416 with moderately elevated levels of specific conductivity

Stevens Creek Thermal Classification

Thermal Classification

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

Figure 27 shows where thermal sampling sites were located. Analysis of data from five loggers (using the Stoneman and Jones, 1996, method adapted by Chu et al., 2009), Stevens Creek is classified as **Cool-warm water** (Figure 28).

Within those three sites, cold-cool, cool, cool-warm water and warm water fish species were present, with fish thermal preferences indicated by Cocker at al. (2001).

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. Indicators include: springs/ seeps, watercress, iron staining, significant temperature change and rainbow mineral film. Figure 29 shows areas were one or more groundwater indicators were observed during stream surveys and headwater assessments.

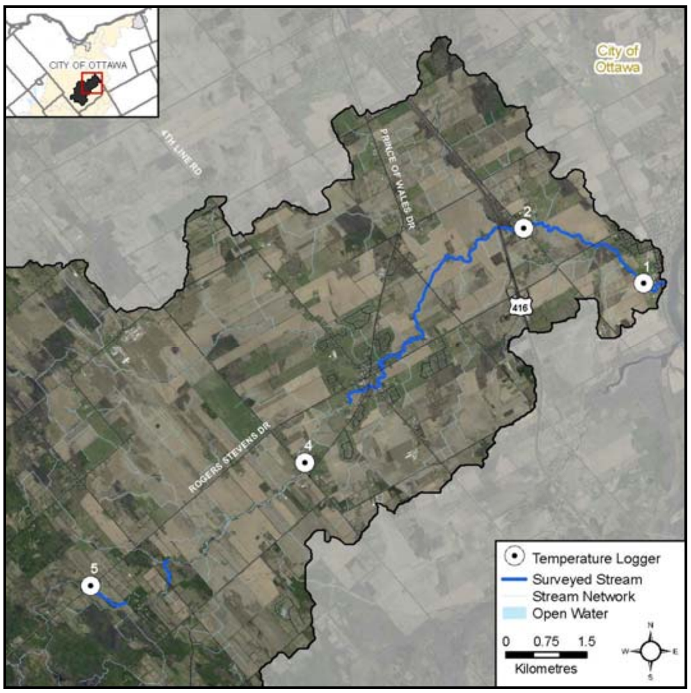


Figure 27 Temperature logger locations on Stevens Creek

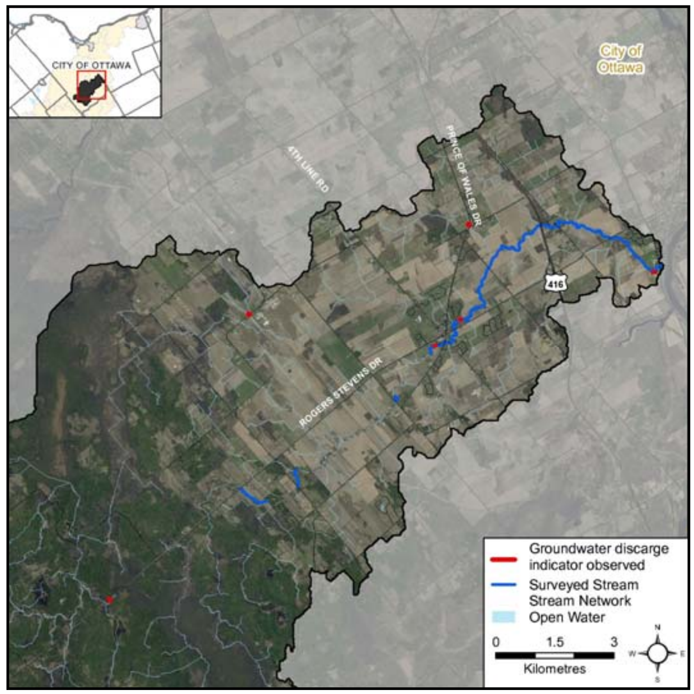


Figure 29 Groundwater indicators observed in Stevens Creek

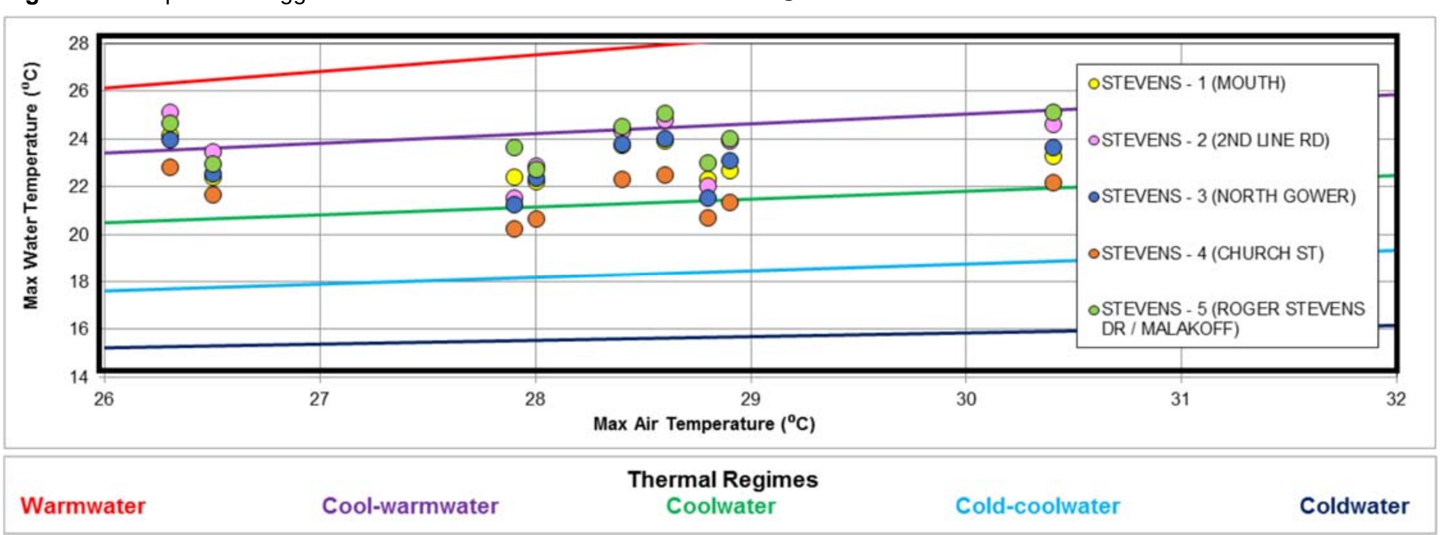


Figure 28 Thermal Classification for Stevens Creek with the five thermal regimes adapted from Stoneman and Jones (1996) by Chu et al. (2009): **cool-warm water** category for all five sites sampled on Stevens Creek

Stevens Creek Fish Community

Fish Community Summary

Eight fish sampling sites were evaluated between May and July 2017. The following site locations were sampled daily for four days with a large fyke net: near the confluence with the Rideau River, at Roger Stevens Drive, at Second Line road and at Third Line Road. One site in North Gower was sampled by backpack electrofishing. Three most upstream sites near Church Street, McCordick Road, and Roger Stevens Drive were sampled with a seine net.

Table 2 Fish species observed in Stevens Creek

Species	Thermal Class	MNR Species Code
banded killifish *Fundulus diaphanus*	Cool	BaKil
blacknose shiner *Notropis heterolepis*	Cool-warm	BnShi
bluegill *Lepomis macrochirus*	Warm	Blueg
bluntnose minnow *Pimephales notatus*	Warm	BnMin
central mudminnow *Umbra limi*	Cool-warm	CeMud
common shiner *Luxilus cornutus*	Cool	CoShi
creek chub *Semotilus atromaculatus*	Cool	CrChu
johnny/tessalated darter *Etheostoma spp.*	Cool	EthSp
golden shiner *Notemigonus crysoleucas*	Cool	GoShi
largemouth bass *Micropterus salmoides*	Warm	LmBas
Lepomis Spp.	Warm	LepSp
northern pike *Esox lucius*	Cool	NoPik
pumpkinseed *Lepomis gibbosus*	Warm	Pumpk
rock bass *Ambloplites rupestris*	Cold-cool	RoBass
smallmouth bass *Micropterus dolomieu*	Warm	SmBas
spottail shiner *Notropis hudsonius*	Cold-cool	SpShi
white sucker *Catostomus commersonii*	Cool	WhSuc
yellow perch *Perca flavescens*	Cool	YePer
Total Species		**18**

Eighteen species were captured in 2017, they are listed in Table 2 along with their thermal classification preferences (Coker et al., 2001) and MNR species codes. Stevens Creek has a mixed fish community ranging from cold-cool to warm water species. The sampling locations where these species were observed, as well as RVCA historical sites, are depicted in Figure 30. The codes used in the figure are the MNR codes provided in Table 2. For comparisons across sampling years and a complete list of RVCA historical fish records from Stevens Creek refer to page 22 of this report.

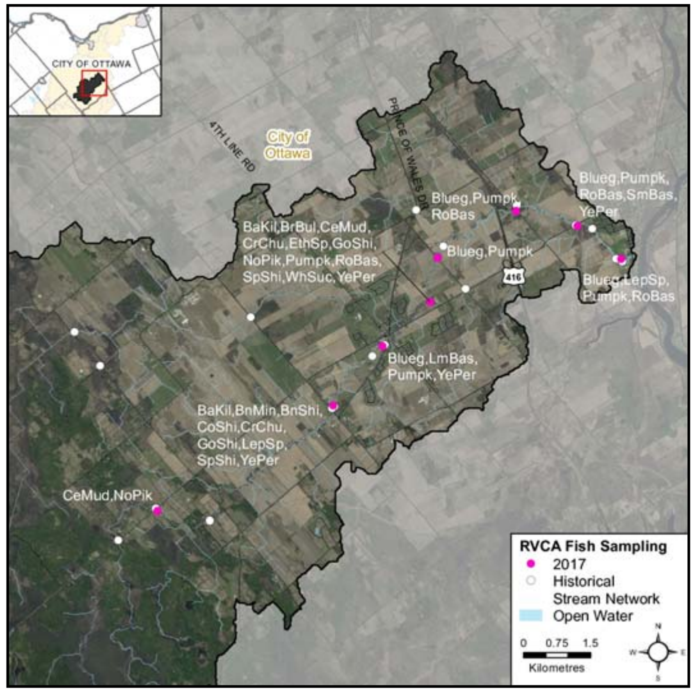


Figure 30 Stevens Creek fish sampling locations and 2017 fish species observations

Back pack electrofishing (above) and a juvenile northern pike captured (below) in Stevens Creek near North Gower

Migratory Obstructions

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

There is a weir located in North Gower and one debris dam was observed upstream of highway 416. This debris accumulated from naturally fallen trees and branches. The locations of migratory obstructions observed during headwater drainage feature assessment and stream surveys in 2017 are shown in Figure 31.

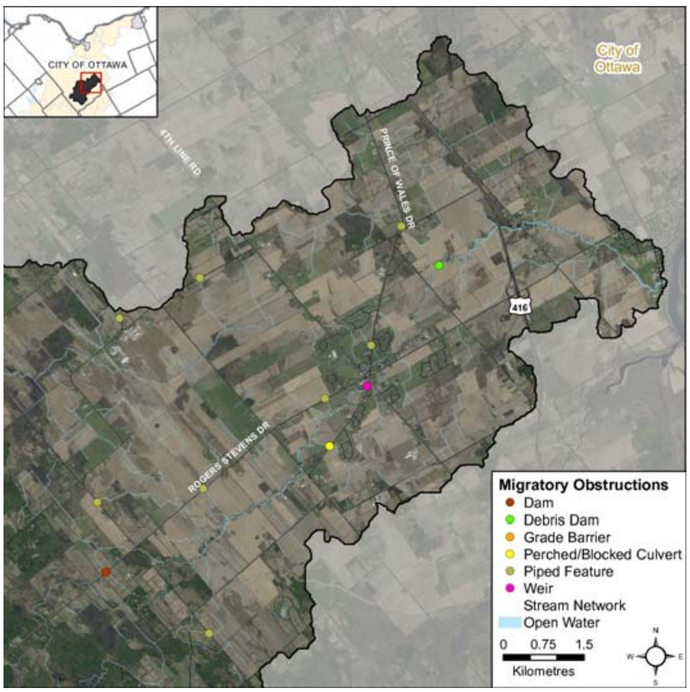


Figure 31 Locations of migratory obstructions along Stevens Creek

Debris dam observed along Stevens Creek

Weir observed along Stevens Creek

Tiling and other entombments of headwater drainage features can also cause migratory obstructions in the headwater reaches of the catchment. These obstructions lead to loss of important habitat and seasonal spawning grounds for many fish species, including northern pike.

Tiling of headwater drainage features creates fish migratory obstructions and loss of seasonal aquatic habitat

Beaver Dams

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

No active dams were identified on the surveyed portions of Stevens Creek in 2017. In past City Stream Watch monitoring years beaver dams have been identified.

Headwater Drainage Feature Assessment

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

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

Headwaters Sampling

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

Features are evaluated as per the Ontario Stream Assessment Protocol (OSAP, 2017). This protocol measures zero, first and second order headwater drainage features. It is a rapid assessment method characterizing the amount of water, sediment transport, and storage capacity within headwater drainage features. In 2017 the City Stream Watch program assessed 60 HDF sites in the Stevens Creek Catchment (Figure 32).

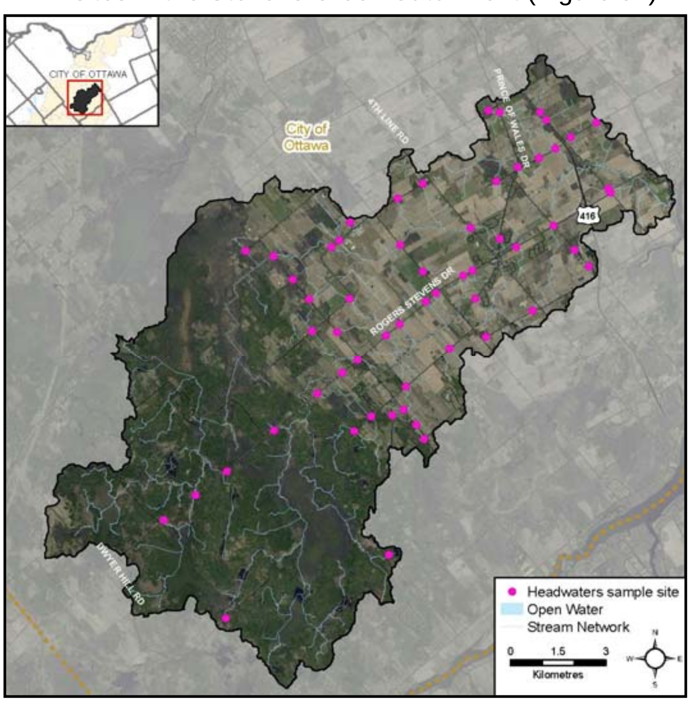


Figure 32 Location of HDF sampling sites in the Stevens Creek catchment

Feature Type

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

Figure 33 shows the feature type of the primary feature at the sampling locations. Channelized features were overall dominant, observed in 34 sites. Three features were roadside ditches, and nine were tiled. The natural features present included four natural channels, eight wetlands, one swale and one no defined feature.

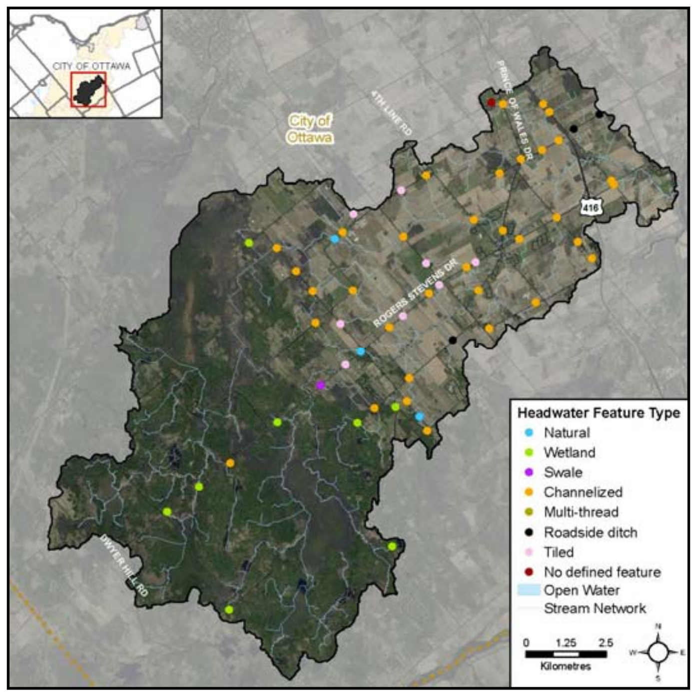


Figure 33 Map of Stevens Creek HDF feature types

Channelized drainage feature on Phelan Road West

Headwater Feature Flow

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

Flow conditions in the Stevens Creek catchment area are shown in Figure 34.

Intermittent feature with spring and summer conditions on Roger Stevens Drive

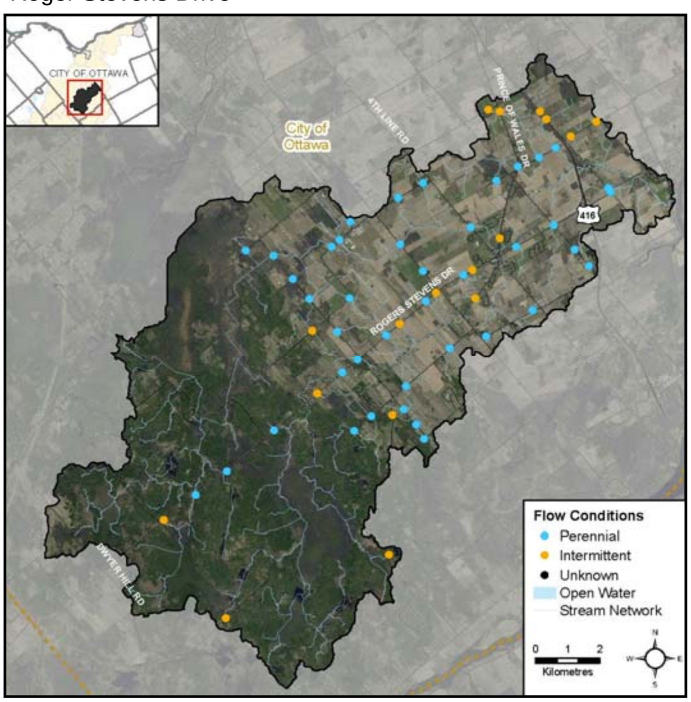


Figure 34 Headwater feature flow conditions in the Stevens Creek catchment

Feature Channel Modifications

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

Figure 35 shows channel modifications observed in Stevens Creek headwater drainage features. Most modifications in this catchment for headwater drainage features are dredging or straightening.

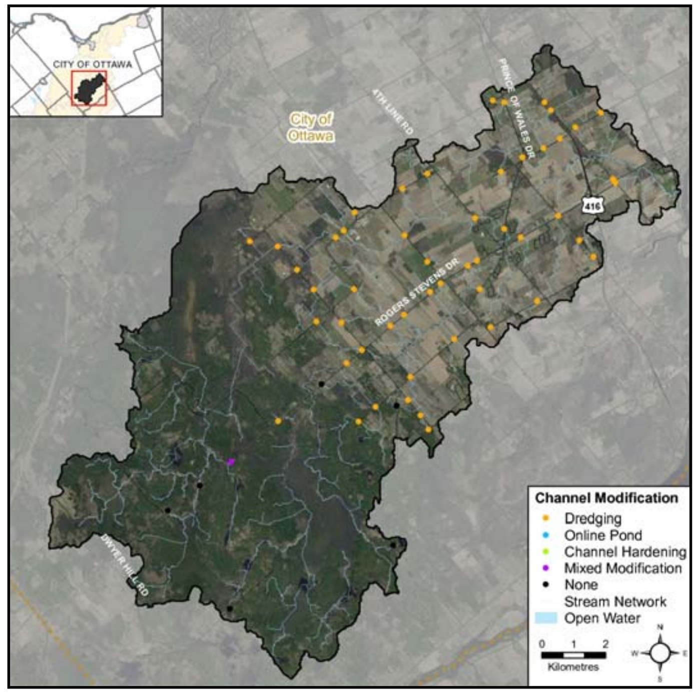


Figure 35 Headwater feature channel modifications in the

An example of mixed modifications: channel dredging and hardening with rip rap along channel on Roger Stevens Drive

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, sediment movement and provides wildlife habitat. The following classifications are evaluated: no vegetation, lawn, wetland, meadow, scrubland and forest.

Figure 36 depicts the dominant vegetation observed at the sampled sites in the Stevens Creek catchment. Wetland vegetation was the most common type (22 features); followed by no vegetation in the spring time (18 features) where flows and sediment transport are unmitigated by the lack of vegetative material. Of the remaining features, 17 were dominated by meadow, one by scrubland, one by forest, and one feature had no defined channel with cropped land as its vegetation type.

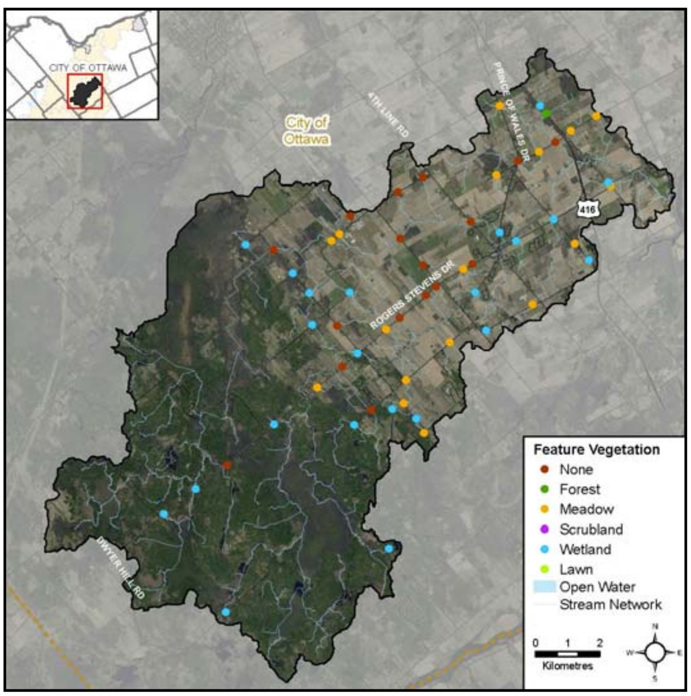


Figure 36 Headwater feature vegetation in the Stevens Creek

Wetland feature vegetation in HDF on Harnett Road

Headwater Feature Riparian Vegetation

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

Figure 37 shows the type of riparian vegetation observed at the sampled headwater sites in the Stevens Creek catchment. These riparian zones have anthropogenic influences from agricultural areas as well as road infrastructure.

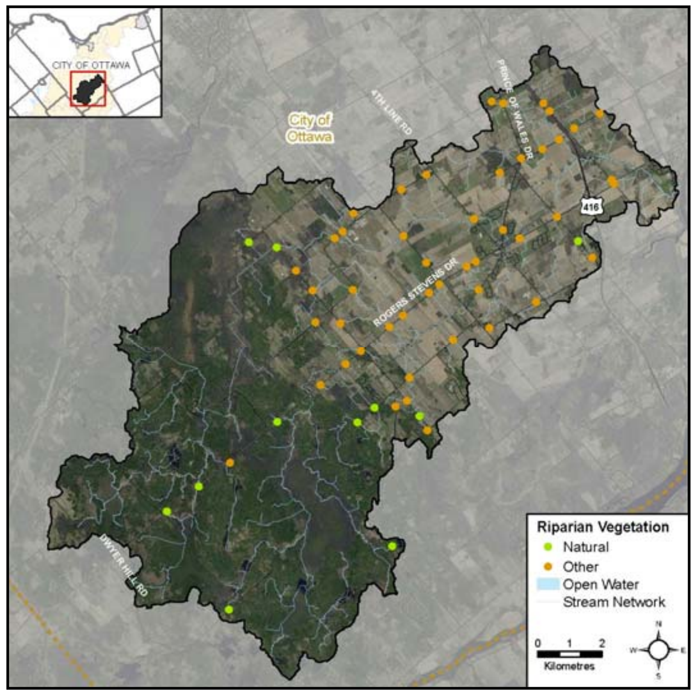


Figure 37 Riparian vegetation types along headwater features in the Stevens Creek catchment

HDF with other, non-natural cropped, riparian vegetation on Malakoff Road

Headwater Feature Sediment Deposition

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

From the upstream features assessed, sediment deposition ranged from none to extensive. Three features had evidence of extensive deposition and two had substantial levels. Seven features had moderate amounts of deposits, 19 had minimal levels and 29 had no evidence of sediment deposition. Figure 38 shows the levels of sediment deposition in the catchment.

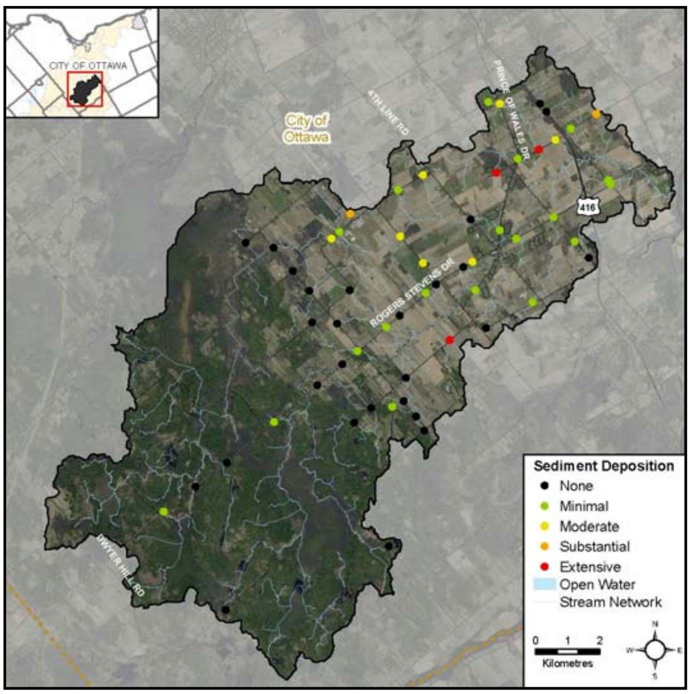


Figure 38 Headwater feature sediment deposition in the Stevens Creek catchment

Substantial sediment deposition observed on Malakoff Road

Headwater Feature Upstream Roughness

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

This parameter is categorized depending on the amount of roughness coverage in a channel: minimal (less than 10 %), moderate (10-40 %), high (40-60 %), and extreme (more than 60 %). In the Stevens Creek catchment, 25 of the sites had minimal roughness, 16 had moderate, eight had high, and 11 had extreme coverage. Figure 39 shows the various feature roughness across the area.

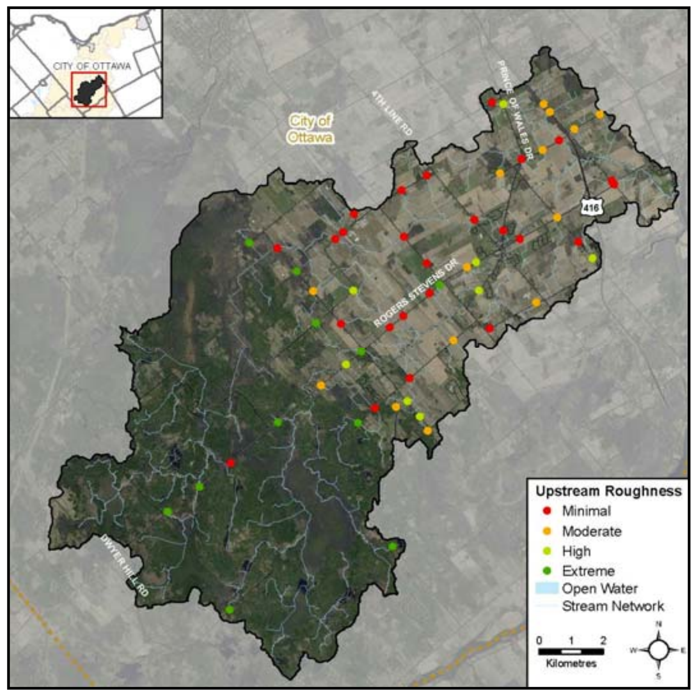


Figure 39 Headwater feature roughness in the Stevens Creek catchment

High feature roughness in springtime provided by cattails within feature on Third Line Road South

Stream Comparison Between 2005, 2011 and 2017

The following tables provide a comparison of observations on Stevens Creek between the 2005, 2011 and 2017 survey years (RVCA 2005, RVCA 2011). Monitoring protocols from 2005 were modified and enhanced, so data from that year cannot be compared to the later years (there are some exceptions). In order to accurately represent current and historical information, the site data was only compared for those sections which were surveyed in both reporting periods. This resulted in changes to our overall summary information, averages presented here differ from ones in this report. This information is therefore only a comparative evaluation and does not represent the entirety of our assessment.

Water Chemistry

Water chemistry parameters are collected throughout all the sections surveyed in the stream. This criteria reflects the overall conditions and changes in the environment. Variation in these conditions can be attributed to environmental and ecological changes. Some can be in part due to natural variability within the system from various weather, seasonal, and annual conditions.

Table 3 shows a comparison of these parameters between 2011 and 2017. Average summer water temperatures range from cooler water in 2017 (20.0°C) to warmer values in 2011 (22.6°C), with 2.6 degrees centigrade of variation. In 2017 cooler temperatures than the previous reporting year are possibly due to cooler air temperatures and higher precipitation experienced in 2017. Aside from these general temperature observations, loggers provide a detailed summary of stream thermal conditions.

Standardizing stream temperature accounts for climatic factors including air temperatures and precipitation. With the data collected from temperature loggers, standardized stream temperatures are calculated and summarized in Table 3. These values decreased by 0.06°C for every degree of air temperature from 2011 to 2017.

Average dissolved oxygen levels were found to be increasing by 1.1 milligrams per liter from 2011 to 2017. These changes can also be attributed to weather patterns and cooler temperatures which are conducive to the stream's ability to hold more oxygen.

Average specific conductivity decreased from 2011 to 2017 by 75.8 µS/cm and pH decreased by 0.14 units from 2011 to 2017. These slight changes may be indicative of increased anthropogenic input, specifically ionic compounds including road salts and fertilizers.

Table 3 Water chemistry comparison (2011/2017)

Water Chemistry (2011—2017)				
YEAR	**PARAMETER**	**UNIT**	**AVERAGE**	**STND ERROR**
2011	pH	-	7.85	± 0.03
2017	pH	-	7.71	± 0.02
2011	Sp. Conductivity	us/cm	538.2	± 14.0
2017	Sp. Conductivity	us/cm	462.4	± 8.2
2011	Dissolved Oxygen	mg/L	5.80	± 0.30
2017	Dissolved Oxygen	mg/L	6.90	± 0.21
2011	Water Temperature	ºC	22.6	± 0.1
2017	Water Temperature	ºC	20.0	± 0.4
2011	Standardized Stream Temperature[1]	ºC Water /	0.86	± 0.02
2017	Standardized Stream Temperature[1]	ºC Water /	0.82	± 0.01

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

- Daily maximum air temperatures must exceed 24.5 ºC
- No precipitation for 3 days preceding measurement
- Measurements to be taken between 4:00PM—6:00PM
- All temperatures points to be collected in July/August
- Logger must be deployed in flowing waters

Invasive Species

The overall percentage of sections surveyed where invasive species were observed had a reduction of seven percent (Table 4). Purple loosestrife had a reduction of observations by 43 percent, this decline may be associated to management efforts (OMNR 2012). European frog-bit also decreased, likely due to higher than average water levels in 2017. Manitoba maple and flowering rush had decreased observations likely due to surveyors missing sightings. Other invasive species have expanded their range, most notably poison parsnip. There are also seven invasive species newly reported in 2017.

Table 4 Invasive species presence observed in 2011 and 2017

Invasive Species	2011	2017	+/-
banded mystery snail	14%	26%	▲
common & glossy buckthorn	NR	15%	▲
common carp	NR	1%	▲
curly leaf pondweed	25%	26%	▲
Eurasian milfoil	5%	36%	▲
European frog-bit	80%	53%	▼
flowering rush	55%	35%	▼
garlic mustard	1%	NR	▼
honey suckle	NR	5%	▲
Manitoba maple	43%	13%	▼
Norway maple	NR	1%	▲
poison/wild parsnip	NR	7%	▲
purple loosestrife	61%	18%	▼
rusty crayfish	NR	2%	▲
zebra mussel	NR	2%	▲
Total	**95%**	**88%**	▼

Pollution

Garbage accumulation on Stevens Creek was found to increase from 2005 to 2011 and then decreased by 2017. Frequent precipitation events in 2017 may have flushed garbage downstream. In 2017 the polluted sections contained garbage, such as plastics, packaging, and included other large items (boats, furniture and old tiling pipes).

Table 5 Pollution levels (presence in % of sections)

Pollution/Garbage	2005	2011	2017	+/-
floating garbage	9%	28%	22%	▼
garbage on stream bottom	10%	14%	5%	▼
other	N/A	31%	6%	▼
Total	**22%**	**38%**	**28%**	▼

Instream Aquatic Vegetation

Table 6 shows instream aquatic vegetation decreases from 2011-2017. Narrow-leaved emergent plants (e.g. sedges), robust emergent plants (e.g. cattails), and submerged plants (e.g. pondweed) had lower observations in the number of sections surveyed. Drastic declines seen in broad leaved emergent plants (e.g. arrowhead), free-floating plants (e.g. frog-bit), floating plants (e.g. water lilies), and algae are possibly associated to heavy rainfall and higher water levels.

Table 6 Instream aquatic vegetation (presence in % of sections)

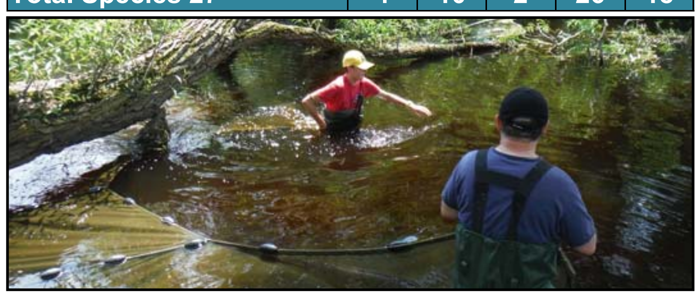
Instream Vegetation	2011	2017	+/-
narrow-leaved emergent plants	91%	81%	▼
broad-leaved emergent plants	88%	47%	▼
robust emergent plants	73%	52%	▼
free-floating plants	88%	56%	▼
floating plants	93%	70%	▼
submerged plants	88%	81%	▼
algae	99%	54%	▼

Fish Community

Fish sampling was carried out by the City Stream Watch program in 2005, 2011 and 2017 to evaluate fish community composition in Stevens Creek (see Table 7). Other fish sampling observations made by RVCA (in 2003 and 2010) are also included in this table. In total 27 species have been observed in Stevens Creek. In 2005 ten species were captured at one site; 26 species were found at 14 sites in 2011; and18 species were observed in eight sites in 2017. Deep water levels due to significant precipitation events in 2017 limited the type and effort of sampling. The majority of species observed in 2017 had been captured in previous years, with the smallmouth bass as a new record. It is also important to note one species at risk, the bridle shiner, and one invasive species (Scott and Crossman 1998), the common carp, which was incidentally observed in 2017 during stream surveys.

Table 7 Comparison of fish species caught between 2003-2017

Species	2003	2005	2010	2011	2017
banded killifish *Fundulus diaphanus*				X	X
blacknose shiner *Notropis heterolepis*				X	X
bluegill *Lepomis macrochirus*			X	X	X
bluntnose minnow *Pimephales notatus*			X	X	X
brassy minnow *Hybognathus hankinsoni*				X	
bridle shiner *Notropis bifrenatus*				X	
brook stickleback *Culaea inconstans*	X			X	
brown bullhead *Ameiurus nebulosus*		X		X	
central mudminnow *Umbra limi*	X	X		X	X
common shiner *Luxilus cornutus*				X	X
creek chub *Semotilus atromaculatus*	X			X	X
Cyprinid *spp.*		X		X	
Etheostoma spp.				X	X
golden shiner *Notemigonus crysoleucas*				X	X
largemouth bass *Micropterus salmoides*		X		X	X
Lepomis Spp.		X		X	X
logperch *Percina caprodes*				X	
northern pike *Esox Lucius*	X	X		X	X
northern redbelly dace *Chrosomus eos*				X	
pumpkinseed *Lepomis gibbosus*		X		X	X
rock bass *Ambloplites rupestris*		X		X	X
rosyface shiner *Notropis rubellus*				X	
smallmouth bass *Micropterus dolomieu*					X
spottail shiner *Notropis hudsonius*		X		X	X
tadpole madtom *Noturus gyrinus*				X	
white sucker *Catostomus commersonii*				X	X
yellow perch *Perca flavescens*		X		X	X
Total Species 27	**4**	**10**	**2**	**26**	**18**



CSW volunteers pulling a seine net on Stevens Creek

Monitoring and Restoration

Monitoring and Restoration Projects on Stevens Creek

Table 8 highlights recent and past monitoring that has been done on Stevens Creek by the City Stream Watch program. Monitoring activities and efforts have changed over the years. Potential restoration opportunities are listed on the following page.

Table 8 City Stream Watch monitoring and restoration on Stevens Creek

Accomplishment	Year	Description
City Stream Watch Stream Monitoring	2011	14.0 km of stream was surveyed
	2017	10.4 km of stream was surveyed
City Stream Watch Fish Sampling	2005	one fish community sites was sampled
	2011	14 fish community sites were sampled
	2017	eight fish community sites were sampled
City Stream Watch Thermal Classification	2011	five temperature probes were deployed
	2017	five temperature probes were deployed
City Stream Watch Headwater Drainage Feature Assessment	2017	60 headwater drainage feature sites were sampled in the Stevens Creek catchment
City Stream Watch Riparian Planting	2012	900 trees and shrubs were planted by volunteers
City Stream Watch Invasive Species Removals	2013	two square meters of stream was cleared of invasive yellow iris

Volunteers assisting with headwater monitoring in the Stevens Creek catchment

Temperature probe installation in Stevens Creek near the confluence with the Rideau River

Tile Outlet Control

Due to the high agricultural land use in the Stevens Creek catchment, many areas could benefit from tile outlet control. This involves placing structures at the head of tile drains to retain water and nutrients in the field during growing season. It has been demonstrated through research that water quality and crop yields increase with the use of these structures. On average fields of corn see a three percent yield increase and soy can have up to four percent (Agriculture & Agri-food Canada, 2011).

Headwater drainage feature that could benefit from tile outlet control in the Stevens Creek catchment

Potential Riparian Restoration Opportunities

Riparian restoration opportunities were assessed in the field and include potential enhancement through riparian planting, erosion control, invasive species management and/or wildlife habitat creation (Figure 40).

Riparian Planting

Various sections of Stevens Creek riparian area can benefit from riparian planting. Many sections had riparian buffers of limited size and low plant diversity. Additional planting would increase shading, enhance wildlife habitat, reduce soil erosion and mitigate negative impacts from runoff and anthropogenic input.

Invasive Species Control

Invasive species management is needed in areas where invasive instream aquatic vegetation is beginning to establish.

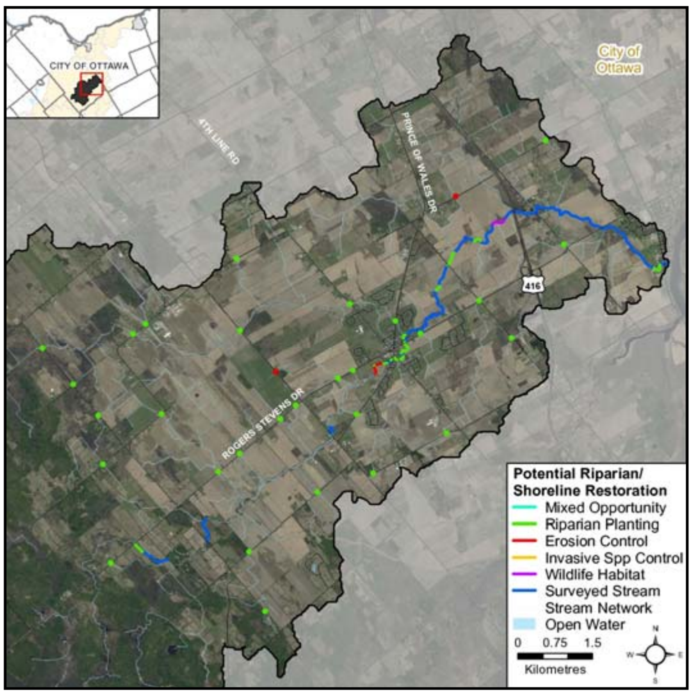


Figure 40 Potential riparian/shoreline restoration opportunities along Stevens Creek

Exposed shoreline that could benefit from riparian planting along Stevens Creek.

Potential Instream Restoration Opportunities

Garbage clean up

Stevens Creek would benefit from a garbage clean up in a small area shown in Figure 41. After significant precipitation in 2017, garbage accumulated heavily in this section, including small items such as Styrofoam and plastic, as well as large items such as floating docks.

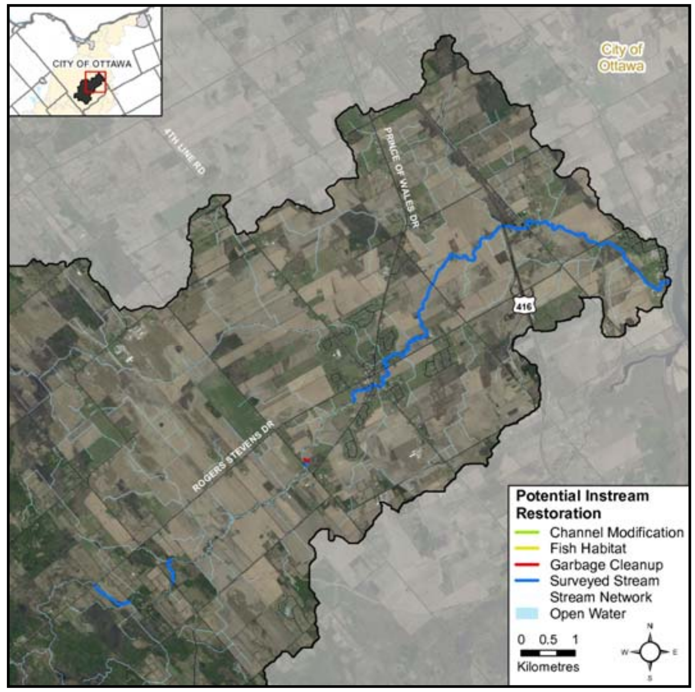


Figure 41 Potential instream restoration opportunities in Stevens Creek

Area with accumulation of large debris, could benefit from a stream clean up.



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For more information on the overall 2017 City Stream Watch Program and the volunteer activities, please refer to the City Stream Watch 2017 Summary Report: https://www.rvca.ca/rvca-publications/city-stream-watch-reports

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