Hunt Club Creek 2019 Catchment Report

Catchment Features

Area	2.93 square kilometres 0.07% of the Rideau Valley watershed
Land Use	80.51% urban 16.66% forest 2.83% meadow 0% wetland
Surficial Geology	5.36% diamicton 24.78% gravel 1.21% organic deposits 2.30% Paleozoic bedrock 66.35% sand
Watercourse Type	2019 thermal conditions **Cool water**
Invasive Species	Nine invasive species were identified in 2019: common & glossy buckthorn, forget-me-not, garlic mustard, non-native honeysuckles, Manitoba maple, Norway maple, purple loosestrife, yellow iris
Fish Community	Three species of fish have been observed from 2007-2019: bluegill, brook stickleback, pumpkinseed

Wetland Cover

0% of the watershed are wetlands

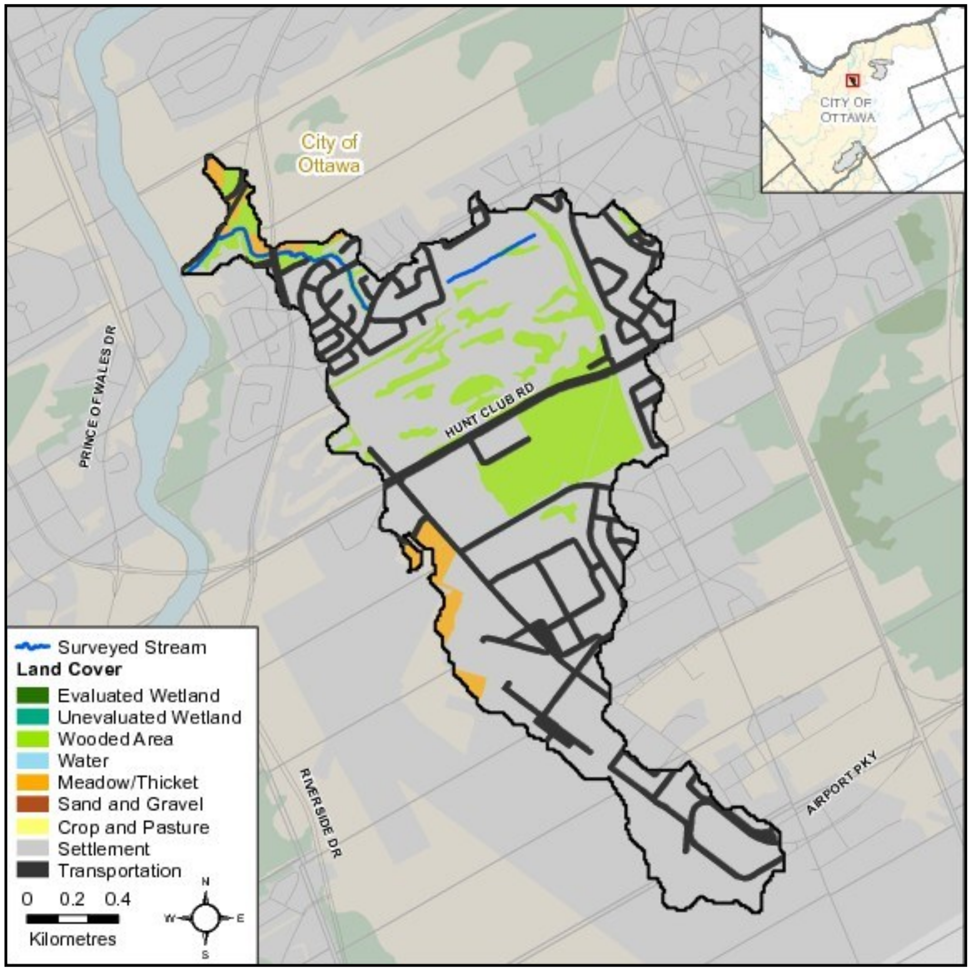


Figure 1 Land cover in the Hunt Club Creek catchment

Vegetation Cover

Type	Hectares	Percent of Cover
Wooded Areas:	**49**	**100%**
Hedgerow	0.29	0.60%
Plantation	10.38	21.24%
Treed	38.20	78.16%
Wetlands*	**0**	**0%**
Total Cover	**49**	**100%**

*Includes treed swamps

Woodlot Analysis

Size Category	Number of Woodlots	Percent of Woodlots
1 Hectare	42	62.69%
1 to <10 Ha	18	26.87%
10 to <30 Ha	3	4.48%
>30 Ha	4	5.97%
Total Cover	**67**	**100%**

The Rideau Valley Conservation Authority in partnership with the City of Ottawa, National Capital Commission, Ottawa Flyfishers Society, Canadian Forces Ottawa Fish and Game Club, Ottawa Stewardship Council, Rideau Roundtable, South Nation Conservation and Mississippi Valley Conservation Authority form the City Stream Watch 2019 collaborative.

Introduction

Hunt Club Creek is a tributary of the Rideau River located in the Hunt Club area. The Hunt Club Creek catchment area measures 2.9 square kilometers and land use is highly urbanized. The approximately 2.8 kilometer stream has many portions piped underground, and flows into the Rideau River. The upper reaches of the catchment are piped underground in lands owned by the Ottawa International Airport and resurfaces at De Niverville Private through lands managed by the Department of National Defense. The creek is channelized through residential areas and passes through the Ottawa Hunt and Golf Club. From there the creek flows to the Rideau River through the McCarthy woods, a valued habitat by the National Capital Commission (NCC), who manages these lands. There is also the Hackett stormwater management pond near Riverside Drive, built by the City of Ottawa in 1984, that outlets into the creek upstream of the road crossing. The creek itself has undergone many transformations from its original form which connected to Sawmill Creek up until the late 1990's where the creek took the final shape it has today; for a more detailed account of the history of Hunt Club creek read John Sankey's Hunt Club Creek account (Sankey, 2013).

In 2019 the City Stream Watch program surveyed 16 sections (1.6 km) of the main stem of Hunt Club Creek. Two sites were sampled for fish community composition and data from one temperature logger was collected at one of these sites. One headwater drainage feature was assessed in the spring and in the summer. The following is a summary of our observations and assessment.

Low Water Conditions

After a cool and wet spring with significant flooding in certain areas, especially along the Ottawa River; hot dry weather with localized rainfall characterized the summer and early fall of 2019. In August, the climate stations in the watershed measured rainfall at 80 percent under normal levels for that time of year, passing the threshold for low water status. As of August 15, minor low water status in the Rideau Valley watershed was announced by the Rideau Valley Conservation Authority under the Ontario Low Water Response Program (RVCA, 2019). Water levels in lakes and large rivers were close to average for summer conditions however smaller creeks and streams, including headwater drainage features and wetlands, became dry under these drought conditions.

Several significant rainfall events in the last two weeks of October ended the drought conditions. The average 90-day rainfall measured were well above the 80 percent of normal for the time of year. As of October 30, the Rideau Valley watershed status retuned to normal water levels (RVCA, 2019). Water levels in the smaller rivers and streams across the watershed were restored from their prior below normal dry conditions.

Hunt Club Creek Overbank Zone

Riparian Buffer Width Evaluation

The riparian buffer is the adjacent land area surrounding a stream or river. Naturally vegetated buffers are important to protect the 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 Hunt Club Creek. Buffers greater than 30 meters were present along 35 percent of the left bank and 52 percent of the right bank. A 15 to 30 meter buffer was present along 13 percent of the left bank and nine percent of the right bank. A 5 to 15 meter buffer was present along 13 percent of the left bank and eight percent of the right bank. A five meter buffer or less was present along 47 percent of the left bank and 31 percent of the right bank. Less than half the buffer width evaluation on the sections surveyed of Hunt Club Creek are within guidelines. Improvements can be made in areas were buffers were less than the 30 meter guideline.

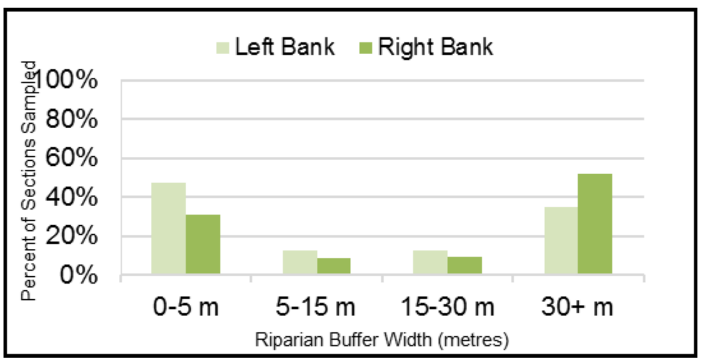


Figure 2 Vegetated buffer width along Hunt Club Creek

Vegetated buffer greater than 30 meters in width along Hunt Club Creek west of Riverside Drive

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 evaluation of anthropogenic alterations to the natural riparian cover are shown in Figure 3.

Hunt Club Creek surveyed riparian zones were primarily natural through the McCarthy woods, with 44 percent of the right bank and 31percent of the left bank having dominant natural riparian vegetative communities. Alterations to the riparian buffer accounted for 25 percent of the right bank and 31 percent of the left bank. Highly altered conditions were observed on 31 percent of the right bank and 38 percent of the left bank. These alterations were associated with residential land uses as well as municipal infrastructure, including roadways and railway.

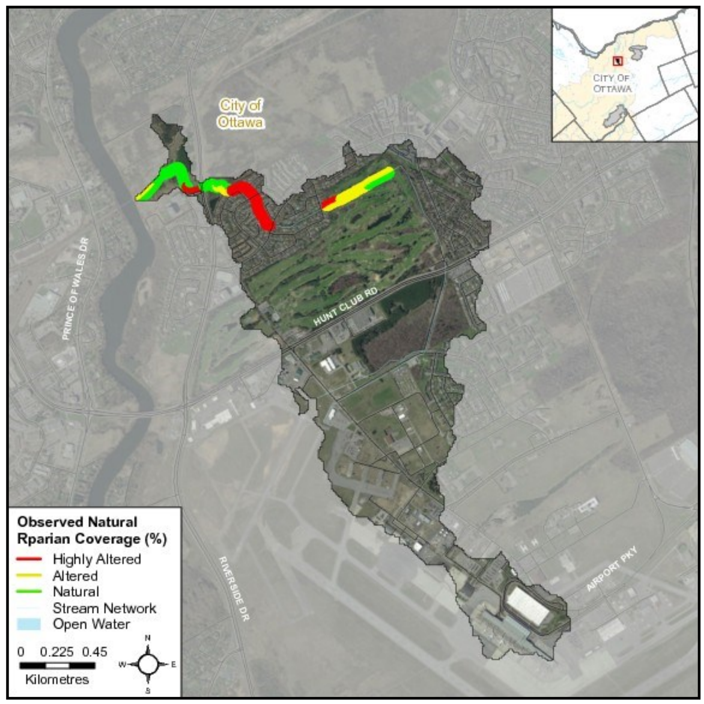


Figure 3 Riparian buffer alterations in Hunt Club Creek

Residential land use along Hunt Club Creek north of Gillespie Avenue

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, meadows and scrubland were present in 81 percent, 63 and 56 percent of the sections surveyed, being the most common land use observed. Wetlands were present in 13 percent of the surveyed areas.

Aside from the natural areas, the most common land uses in the catchment were residential and infrastructure, including roads, bridges, culverts and railway, with 31 percent of the sections each having this adjacent land use. Recreational land use was present in 25 percent of sections surveyed. Industrial and commercial land use was observed in six percent.

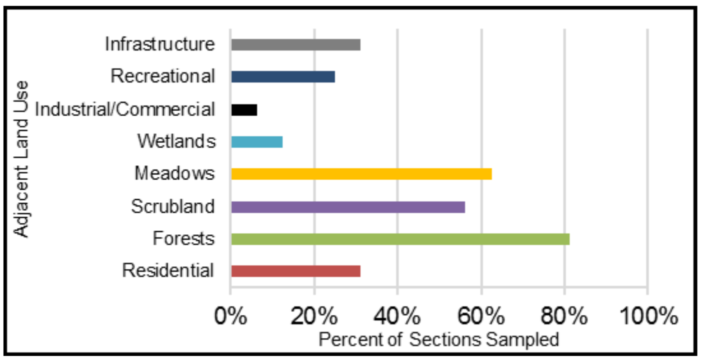


Figure 4 Adjacent land use 100 meters from each shoreline and percentage of presence along Hunt Club Creek

Section along Hunt Club Creek with forest, scrubland, meadow and railway infrastructure land uses west of Riverside Drive

Hunt Club Creek Shoreline Zone

Anthropogenic Alterations

Stream alterations were classified based on specific functional criteria associated with potential human influences on the riparian buffer, shoreline state, flow conditions and channel structure.

Figure 5 shows the level of anthropogenic alterations for the 16 sections surveyed in the Hunt Club Creek catchment, with one section remaining without any human alteration. Of the areas surveyed, three sections fell in the classification of natural. Natural sections had a riparian buffer greater than 15 meters in width, and had natural shorelines.

Two sections were classified as altered. They contained straightened sections and riparian buffers of five to 15 meters in width. Shoreline alterations included concrete bridges.

Ten of the sections surveyed were highly altered. The riparian buffers were less than five meters in width; shoreline alterations were found on most of the sections, including armourstone, storm water outlets were present and sections had been historically straightened.

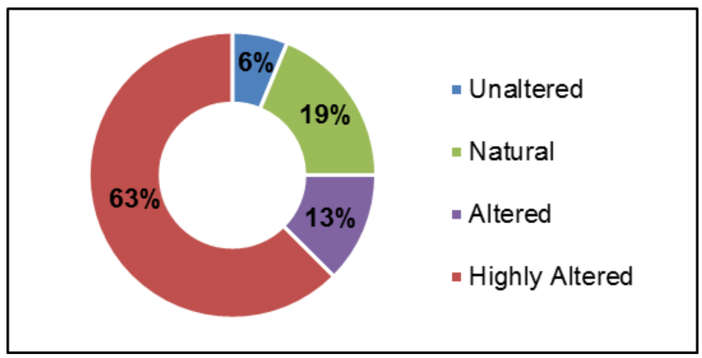
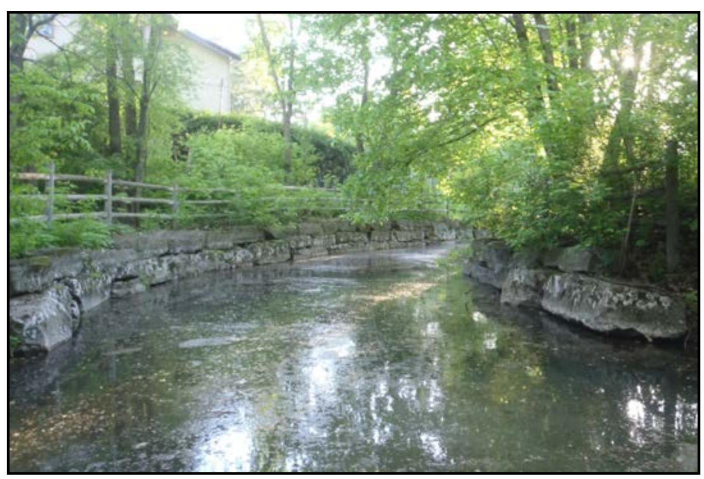


Figure 5 Anthropogenic alterations along Hunt Club Creek



A highly altered section with channelization, reduced riparian buffers and armourstone on the shoreline of Hunt Club Creek east of Riverside Drive

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 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 shows significant erosion was observed across the surveyed portions of the creek. Bank instability was observed in 56 percent each of the left and right banks of the sections surveyed.

Hunt Club Creek is prone to erosion due to increased flows from urbanization impacts. The lack of headwater drainage features diminishes the natural storage capacity of the system. Stormwater runoff from impervious surfaces and entombment can also increase flows, although the stormwater management pond mitigates the effects of paved surfaces.

Undercut Stream Banks

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 extent of each surveyed section with overhanging bank cover present.

Figure 7 shows where undercut banks were present and to what extent each section contained them in Hunt Club Creek. Undercut banks were observed in 25 percent each of the left and right banks of the sections surveyed.

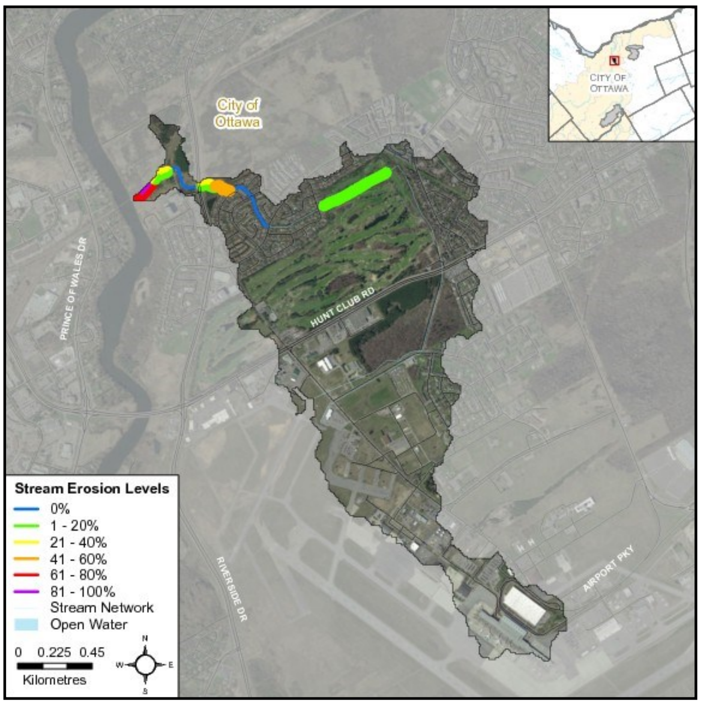


Figure 6 Erosion levels along Hunt Club Creek

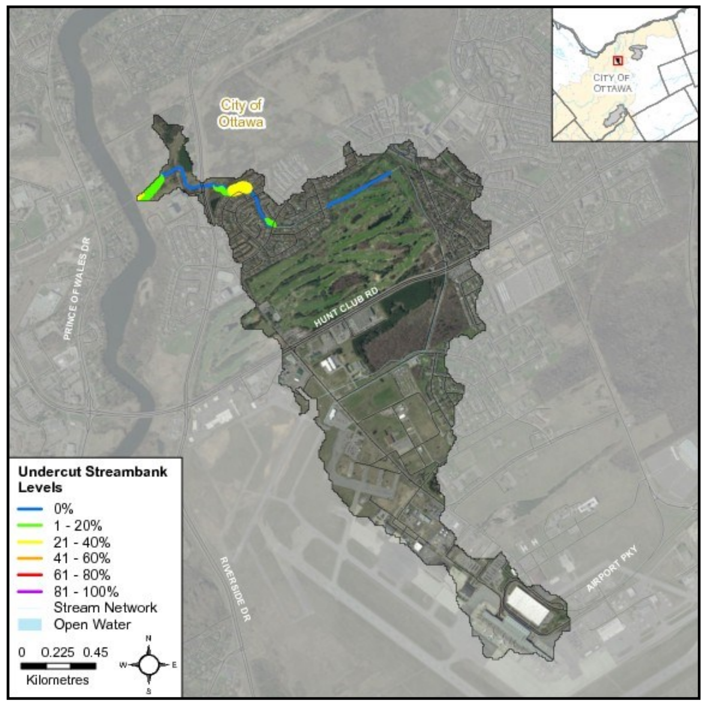


Figure 7 Undercut stream banks along Hunt Club Creek

Bank erosion along Hunt Club Creek east of Riverside Drive

Undercut banks along Hunt Club Creek east of Riverside Drive

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 of stream shading. The majority of sections, six of them, had shade cover of 81 to 100 percent. Out of the higher levels observed, five of sections had 61 to 80 percent shade cover; two sections had 41 to 60 percent shade cover. The lowest level, one to 20 percent of shading was observed in three of sections surveyed. Figure 9 shows the distribution of these shading levels as a percentage of sections surveyed along Hunt Club Creek.

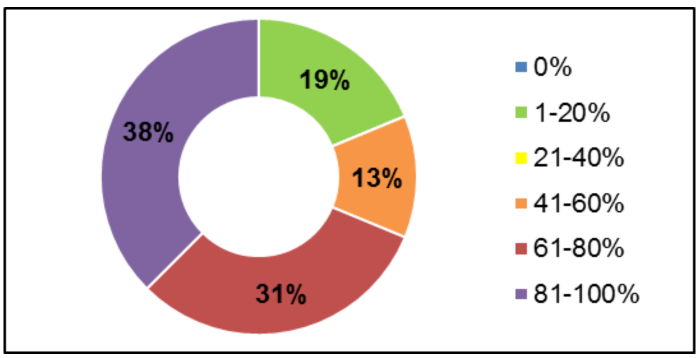


Figure 8 Stream shading along Hunt Club Creek

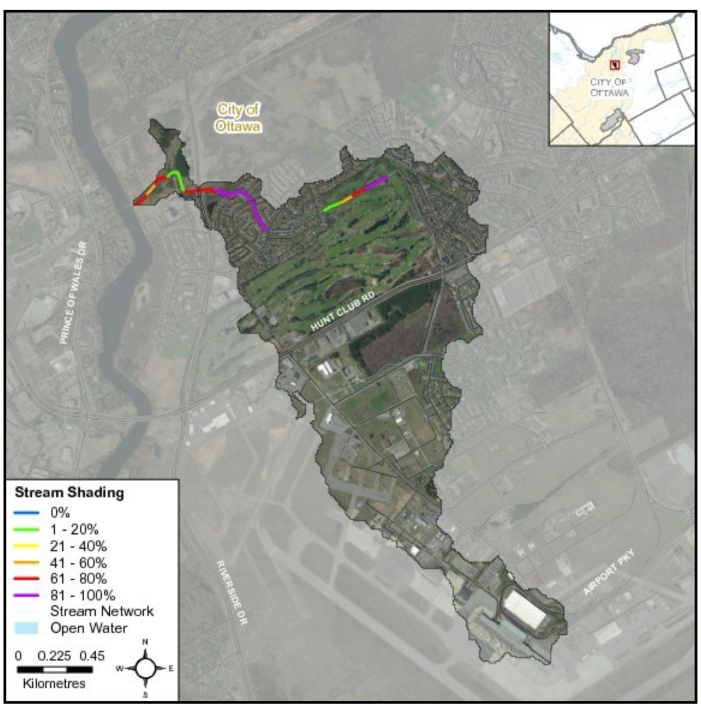


Figure 9 Stream shading along Hunt Club Creek

A mix of trees and plants comprised the majority of shading. Overhanging plants, mainly grasses and robust emergent plants, were seen in 50 percent of the left banks and 56 percent of the right banks.

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 and percentage within each section of overhanging trees and branches that were observed along Hunt Club Creek. Of the surveyed portions, 81 percent of the sections had overhanging trees and branches on the left bank, and 94 percent of the sections had overhanging trees on the right bank.

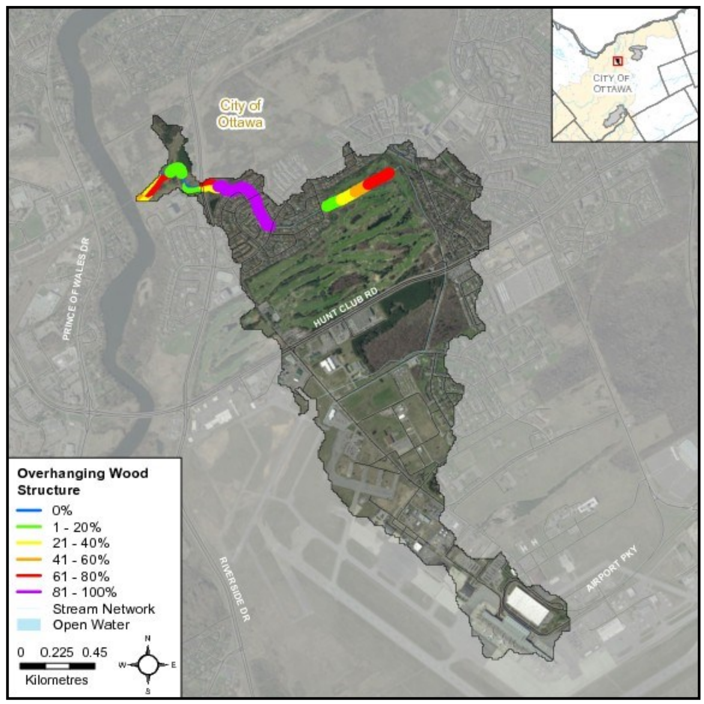


Figure 10 Overhanging trees and branches along Hunt Club Creek

Overhanging trees and branches provide shading west of Riv-erside Drive along Hunt Club Creek

Hunt Club Creek Instream Aquatic Habitat

Habitat Complexity

Habitat complexity is a measure of the 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, morphologic 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 wood structure. A higher score shows greater complexity where a variety of species can be supported. Figure 11 shows habitat complexity of the sections surveyed: six percent had no complexity; 19 percent had a score of one; 13 percent scored two; and 38 percent scored three; 25 percent of the sections surveyed scored four, the highest level.

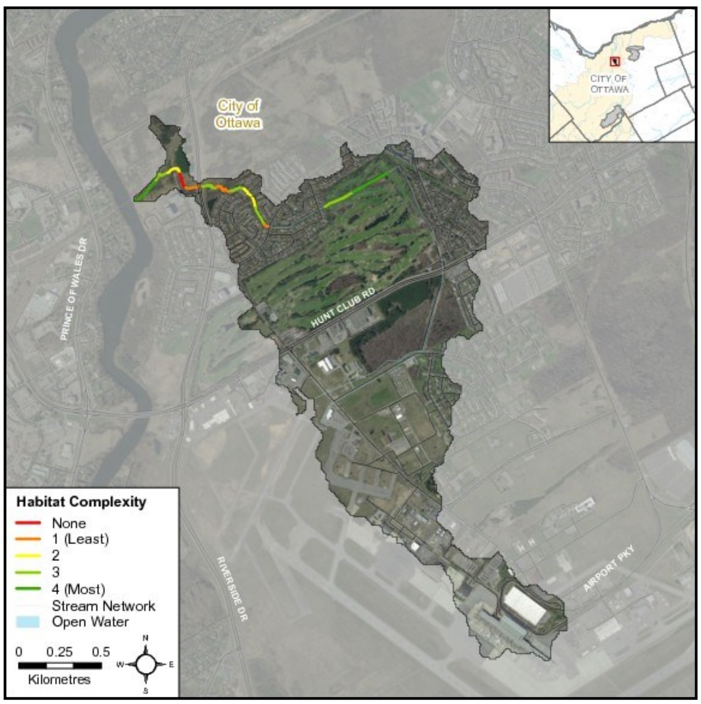


Figure 11 Instream habitat complexity along Hunt Club Creek

Section of Hunt Club Creek with complex habitat features including boulders, cobble, gravel and instream wood structure

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 diversity of species within a stream.

Substrate complexity along Hunt Club Creek was observed to be highly heterogenous in 94 percent of sections surveyed, and homogenous in the remaining six percent. Figure 12 shows the substrate types observed. It is a system dominated by cobble, with 88 percent of sections containing this type of substrate. Many sections surveyed, 63 percent, also contained silt. Other types of substrates observed included gravel, sand, clay, boulders and bedrock.

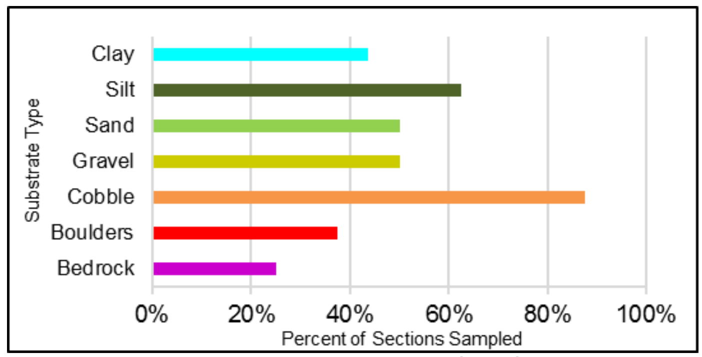


Figure 12 Instream substrate along Hunt Club Creek

Figure 13 shows the dominant substrate types along the creek. Cobble was the dominant substrate type in 38 percent of sections surveyed, silt was dominant in 25 percent, bedrock in 19 percent, clay in 13 percent and sand in six percent of sections.

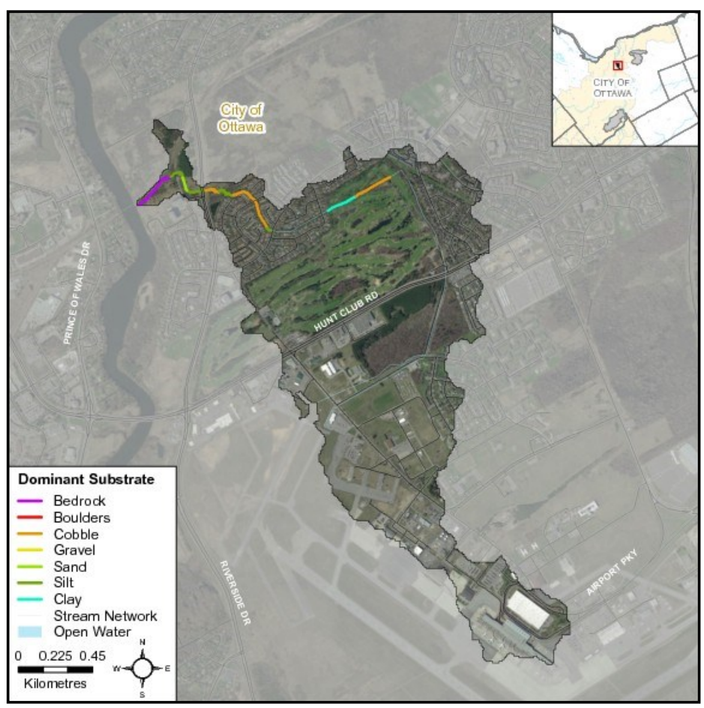


Figure 13 Dominant instream substrates along Hunt Club Creek

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 diverse 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 the surveyed portions of Hunt Club Creek has highly diverse morphological conditions, suitable for a variety of aquatic species and life stages; 56 percent of sections contained pools, 69 percent of sections contained riffles and 100 percent contained runs. Figure 15 shows the locations of sections surveyed which contained riffle habitat and the extent of presence within each section.

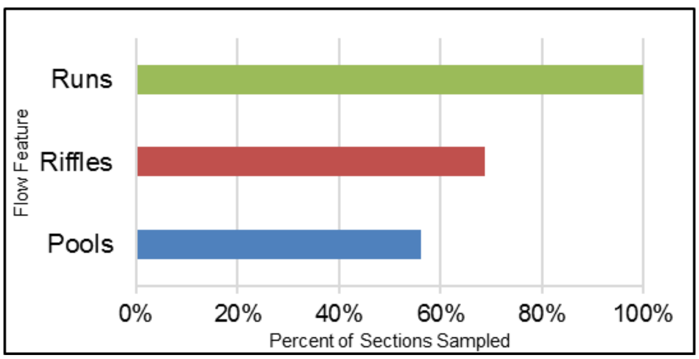


Figure 14 Instream morphology along Hunt Club Creek

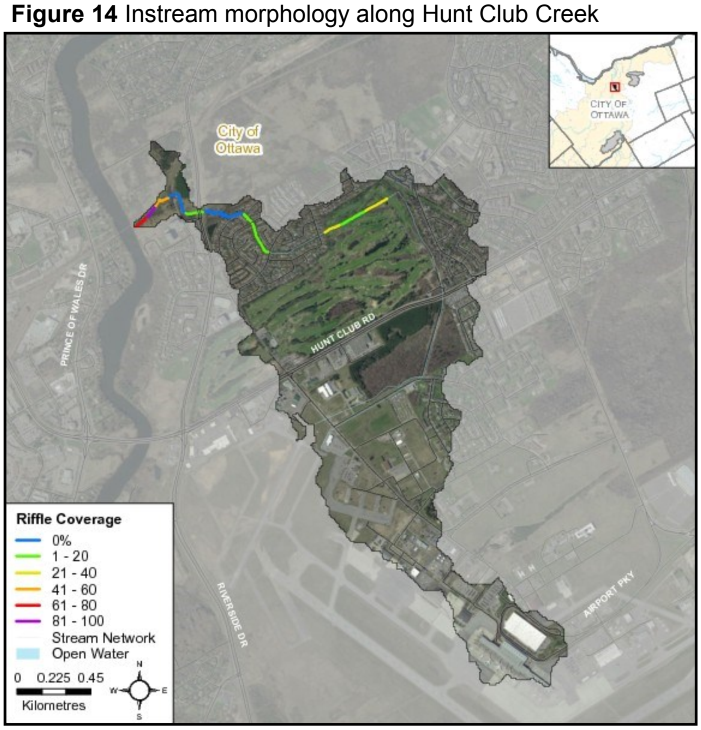


Figure 15 Riffle habitat locations along Hunt Club Creek

Instream Wood Structure

Figure 16 shows that a portion of Hunt Club Creek had low to high levels of instream wood structure 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 result in temporary seasonal migration barriers.

Instream wood structure found along Hunt Club Creek are important for fish and wildlife habitat

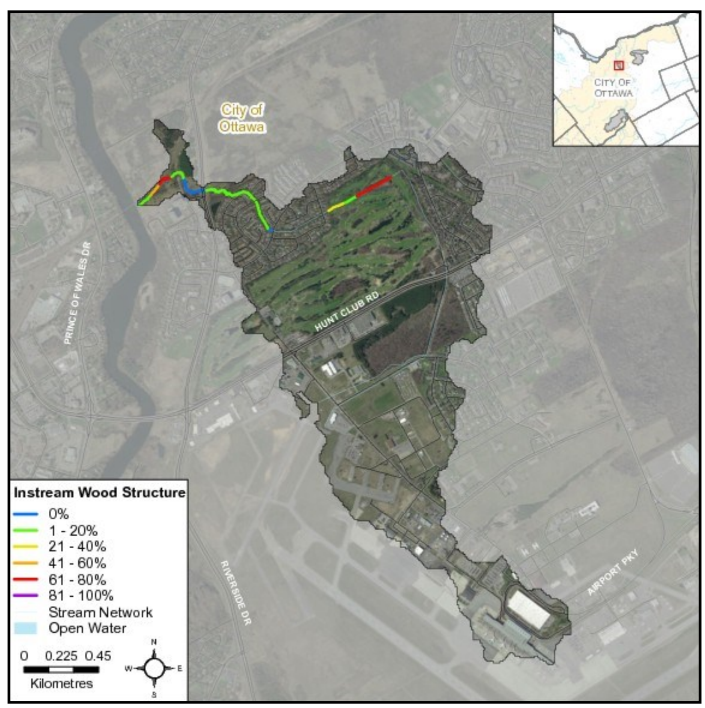


Figure 16 Instream wood structures along Hunt Club Creek

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 along Hunt Club Creek. Vegetation types included: submerged vegetation present in 56 percent of sections surveyed; robust emergent vegetation in 44 percent; narrow-leaved emergent vegetation present in 31 percent; broad-leaved emergent plants in 13 percent; and algae present in 44 percent of sections.

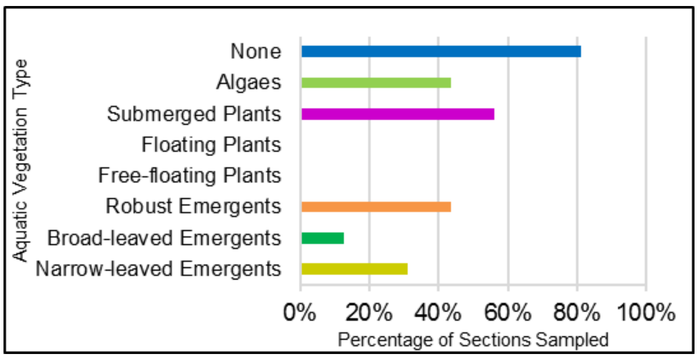


Figure 17 Aquatic vegetation presence along Hunt Club Creek

Figure 18 shows the dominant vegetation type observed in Hunt Club Creek. No vegetation was the most dominant type across 56 percent of sections, which is likely as a result of the flashy flows on the creek which can limit aquatic vegetation growth. Narrow-leaved emergent and submerged plants were each dominant in 19 percent of sections. Algae was the dominant vegetation in six percent of sections surveyed.

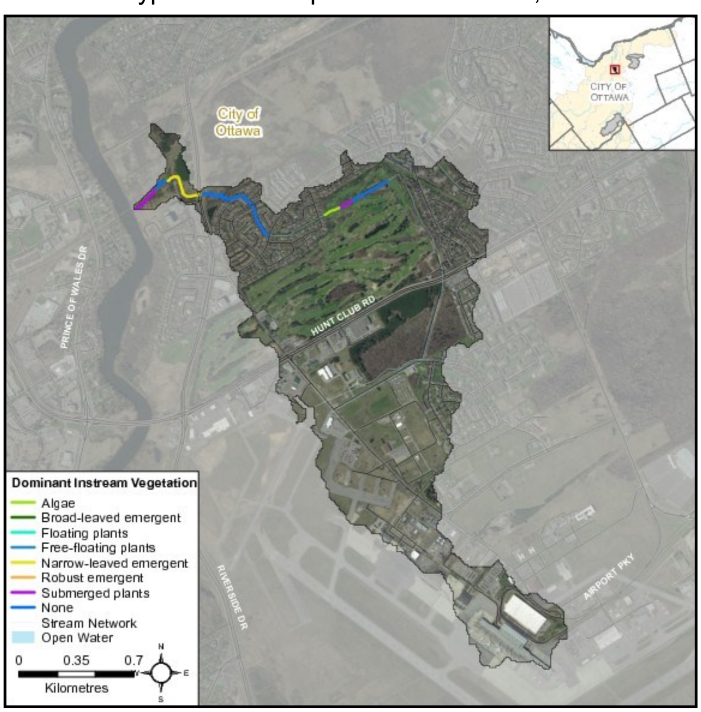


Figure 18 Dominant instream vegetation in Hunt Club Creek

Instream Vegetation Abundance

The abundance of instream vegetation is also crucial for 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.

Abundance of vegetation is classified by the amount of vegetation present along each section. Levels of vegetation are categorized based on the extent of coverage of a section from none and sparse to an entire section choked with vegetation. As seen in Figure 19, 81 percent of sections along Hunt Club Creek had no vegetation in part; 19 percent had rare abundance; 25 percent had low; 38 percent had normal levels; 50 percent had common levels; and extensive amounts were found in 19 percent of sections.

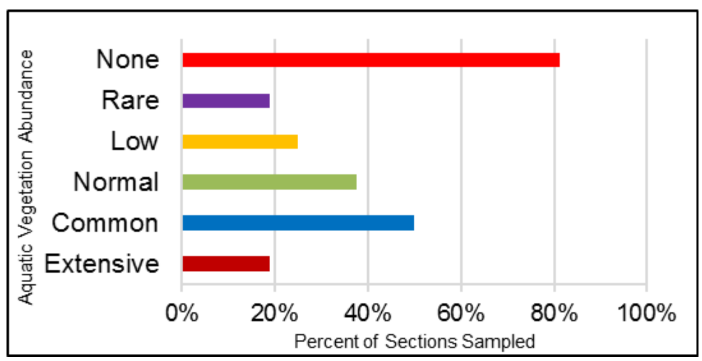


Figure 19 Instream vegetation abundance along Hunt Club Creek

Yellow buttercup are submergent aquatic plants observed along Hunt Club Creek west of Riverside Drive

Hunt Club 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.

Invasive species were observed in all sections surveyed along Hunt Club Creek, Figure 20 shows diversity of species observed per section surveyed.

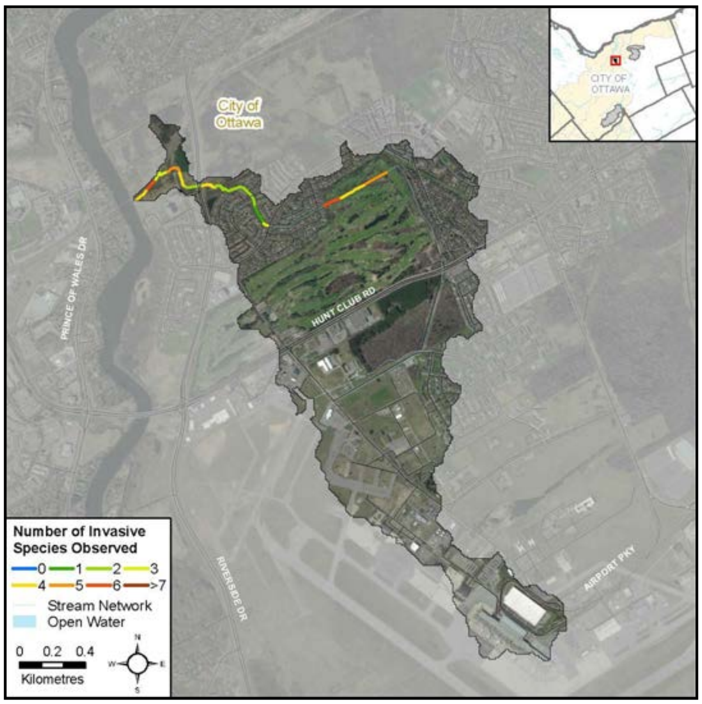


Figure 20 Invasive species diversity along Hunt Club Creek

The following are a list of species observed in 2019 in the surveyed portions of Hunt Club Creek:

- Common buckthorn (*Rhamnus cathartica*)
- forget-me-not (*Myosotis scorpioides*)
- garlic mustard (*Allaria petiolata*)
- non-native honeysuckles (*Lonicera spp.)*
- glossy buckthorn (*Rhamnus frangula*)
- Manitoba maple (*Acer negundo*)
- Norway maple (*Acer platanoides*)
- purple loosestrife (*Lythrum salicaria*)
- yellow iris (*Iris pseudacorus*)

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 where pollution was observed along Hunt Club Creek. Garbage on the stream bottom was found in 50 percent of sections; floating garbage was observed in six percent; and oil or gas trails were observed in one section. The types of garbage observed included tires, cans, drink bottles, plastic bags, small plastic fragments, tarps, metal furniture and a bicycle.

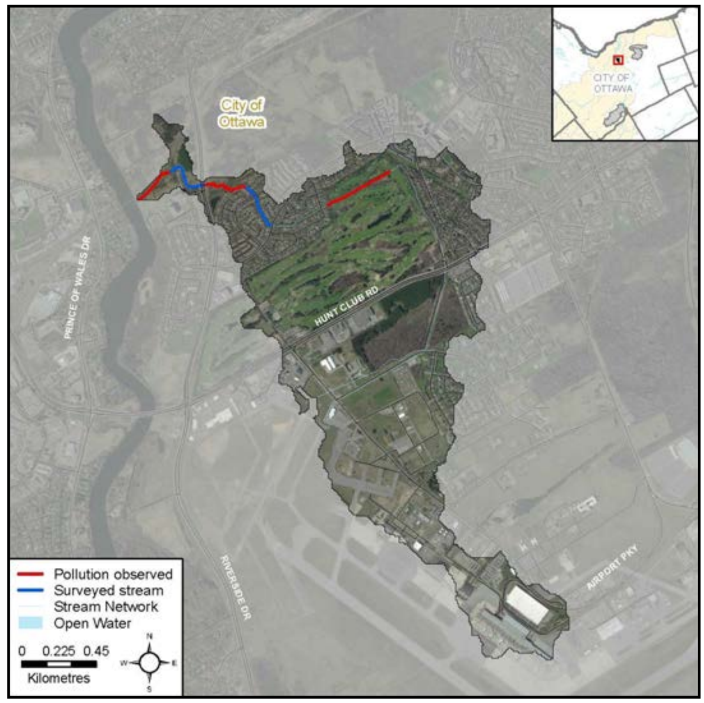


Figure 21 Pollution observed along Hunt Club Creek

Wildlife

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

Table 1 Wildlife observations along Hunt Club Creek in 2019

Birds	American crow, American redstart, American robin, black-capped chickadee, blue jay, chipping sparrow, common raven, mallard, red-winged blackbird, song sparrow, veery, yellow warbler
Reptiles & Amphibians	green frog, northern leopard frog, ring-necked snake, tadpoles
Mammals	chipmunk, eastern grey squirrel, North American raccoon, red fox
Aquatic Insects & Benthic Invertebrates	caddisfly larvae, dragonfly larvae, isopods, leeches, oligochaete worms, riffle beetle larvae, snails, whirligig beetle, water striders
Other	Bumblebees, midges, mosquitoes

Hunt Club 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.

Volunteer collecting water chemistry measurements with a multiparameter YSI probe

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 Hunt Club Creek. The two dashed lines depicted represent the Canadian water quality guidelines. Most of the surveyed portions were found to have oxygen levels within the Canadian water quality guidelines for warmwater above 20 degrees Celsius. Average concentration levels across the system were 8.7 milligrams per liter.

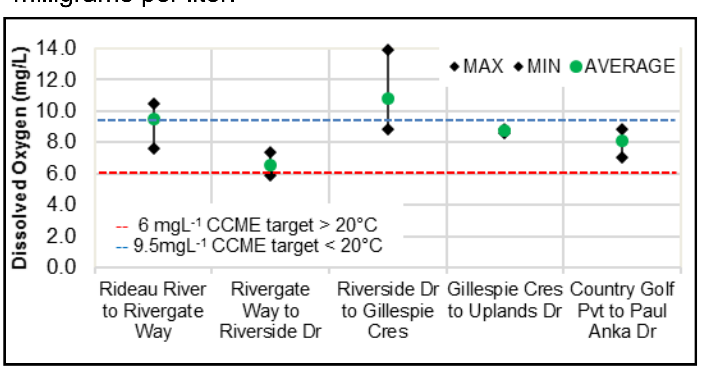


Figure 22 Dissolved oxygen ranges along surveyed sections of Hunt Club Creek

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 Hunt Club Creek, the average level is depicted by the dashed line (985.2 µS/cm). Conductivity levels are lower in areas approaching the confluence with the Rideau River. Higher levels were observed in the upper sections of the creek. An increase is observed from Riverside Drive to Gillespie Crescent, as land use changes from the McCarthy Woods to residential areas with unmitigated storm water.

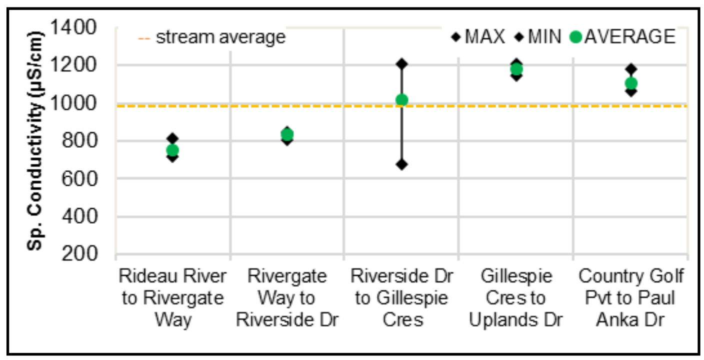


Figure 23 Specific Conductivity ranges along surveyed sections of Hunt Club Creek

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 Hunt Club Creek had mostly pH levels that meet the PWQO. Across the system average pH was 7.62.

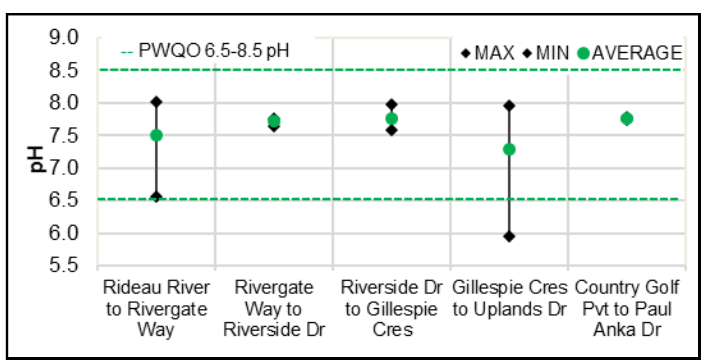


Figure 24 pH ranges along surveyed sections of Hunt Club Creek

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.

Section on Hunt Club Creek downstream of Riverside Drive with **impaired** oxygen conditions (Dissolved oxygen levels of 5.88 mg/L and 62.3 % saturation)

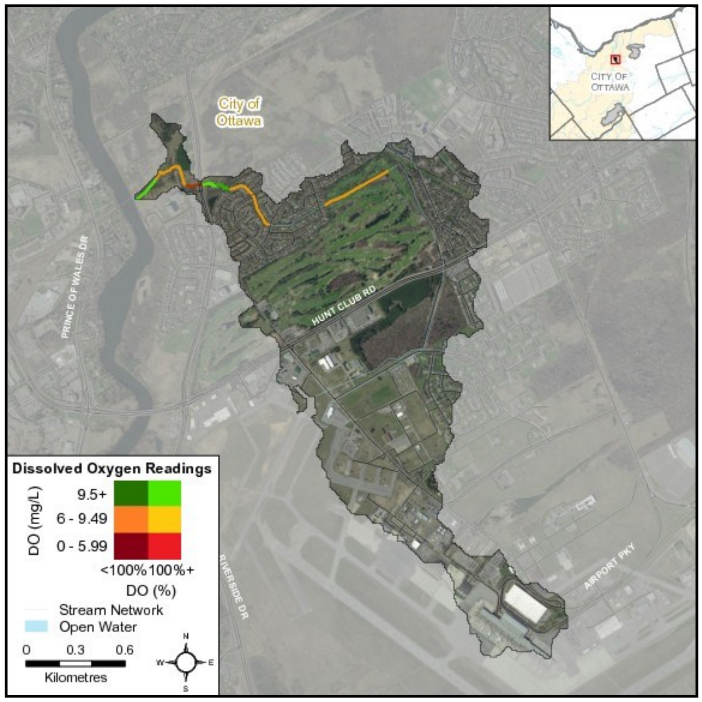


Figure 25 Bivariate assessment of dissolved oxygen concentration (mg/L) and saturation (%) along Hunt Club Creek

Figure 25 shows the oxygen conditions across the areas that were surveyed in 2019. Dissolved oxygen conditions in Hunt Club Creek were sufficient to sustain cold and warm-water biota. In areas near the confluence to the Rideau River, and just upstream of Riverside Drive, there were high levels of dissolved oxygen concentration and saturation. Near the confluence, there was a series of bedrock formations and waterfalls that allowed water to be well oxygenated. Sections shown in dark red and orange in Figure 25, had lower levels both in concentration and percent saturation. Some of these areas had wetland features that have naturally lower oxygen levels downstream of Riverside Drive. However dissolved oxygen levels can be further limited by anthropogenic input, as seen in residential areas and through the golf course.

Section on Hunt Club Creek at the confluence with the Rideau River with **optimal** oxygen conditions for cold-water biota (Dissolved oxygen levels of 10.5 mg/L and 100.0 % 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 stormwater, 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 specific conductivity measured in the surveyed portions of Hunt Club Creek (985.2 µS/cm) were above guidelines (500 µS/cm) used for the Canadian Environmental Performance Index (Environment Canada 2011).

Figure 26 shows relative specific conductivity levels in Hunt Club Creek. Normal levels were maintained for most of the surveyed portions. Moderately elevated conditions were observed from Uplands Road to Gillespie Crescent. This is area is highly urbanized and was upstream of the stormwater management pond. The creek receives unmitigated stormwater in this location. Treatment within the pond enables the system to regain a lower conductivity level downstream of Riverside Drive.

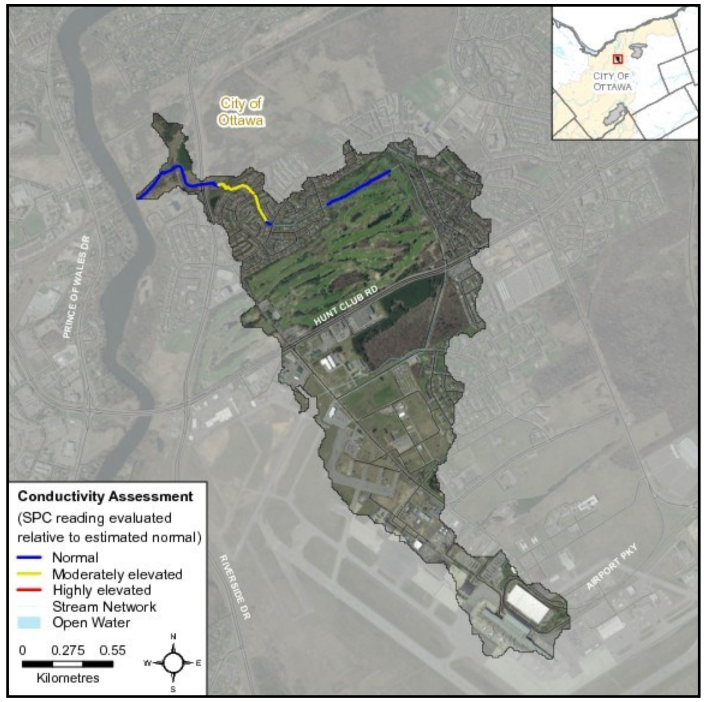


Figure 26 Relative specific conductivity levels along Hunt Club Creek

Section of Hunt Club Creek where unmitigated stormwater input elevates conductivity levels near Uplands Drive (above) and the stormwater pond outlets onto the creek upstream of Riverside Drive (below) lowering conductivity levels

Piped section of Hunt Club Creek that opens up at Uplands Road with moderately elevated conductivity levels

Hunt Club 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 Hunt Club Creek, two temperature loggers were placed in April and retrieved in early November.

Figure 27 shows where thermal sampling sites were located. Due to instrument malfunction, only data from one logger at Riverside Drive (#1) was retrieved. Analysis of data from one logger (using the Stoneman and Jones, 1996, method adapted by Chu et al., 2009), indicated Hunt Club Creek was classified as **coolwater** at the Riverside Drive location (Figure 28). Fish species observed in that area have thermal preferences from warm to cool as 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 and HDF assessments, indicators of groundwater discharge were noted when observed (Figure 29). Indicators included: springs/seeps, watercress, iron staining, significant temperature changes and rainbow mineral film.

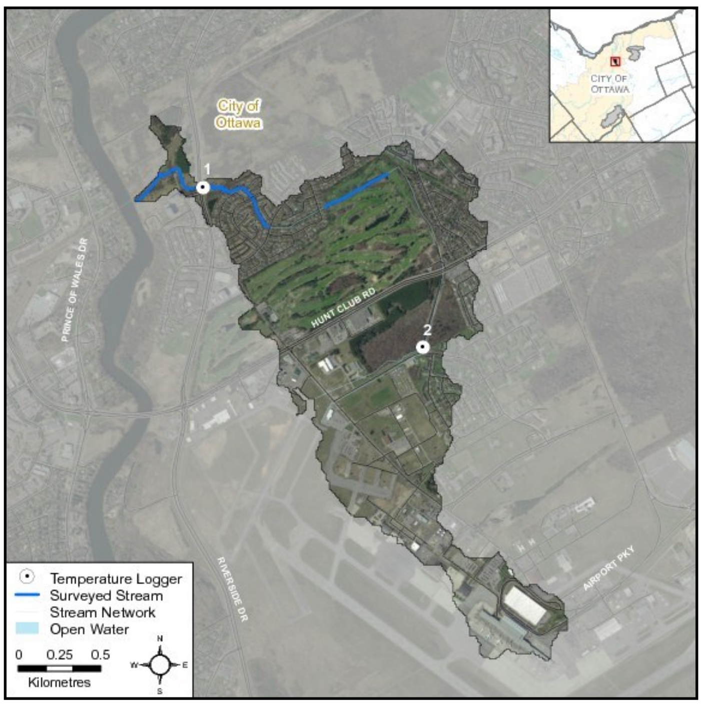


Figure 27 Temperature logger locations on Hunt Club Creek

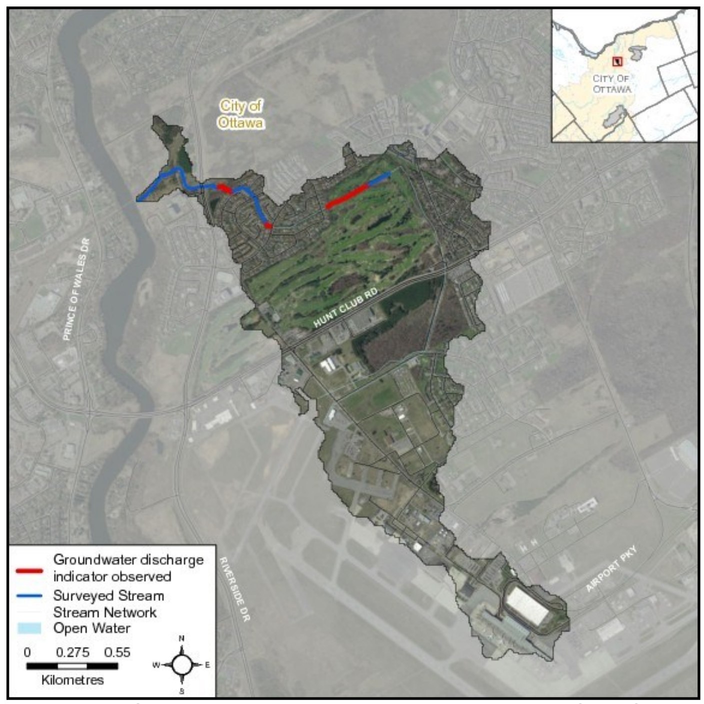


Figure 29 Groundwater indicators observed in Hunt Club Creek

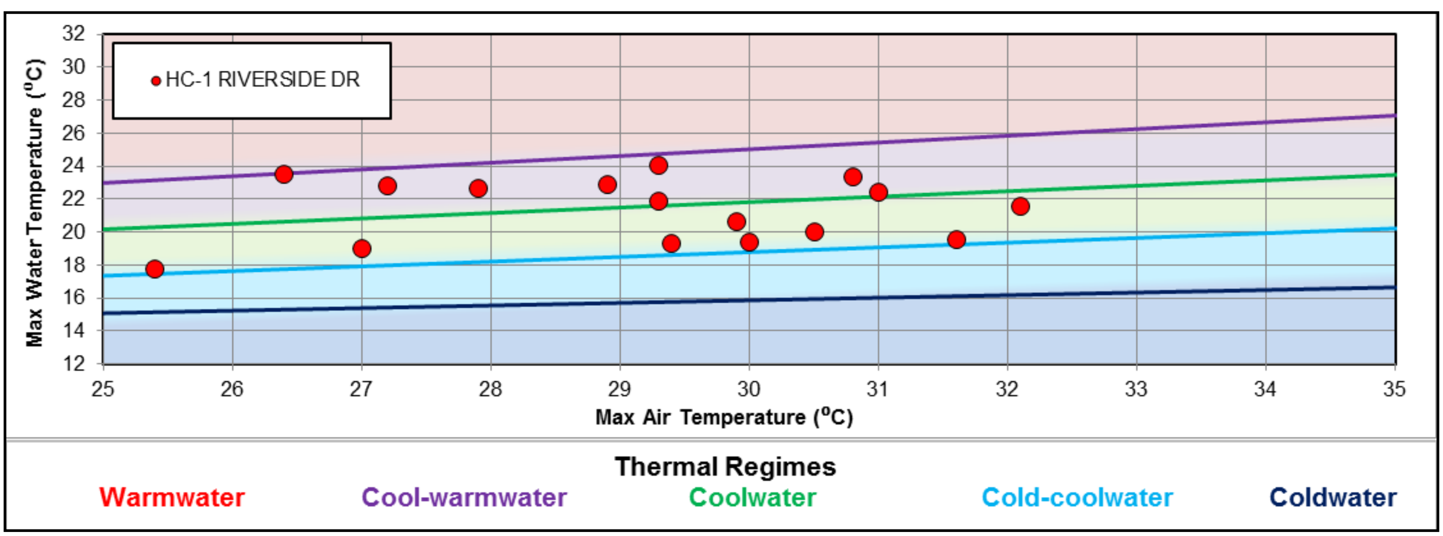


Figure 28 Thermal Classification for Hunt Club Creek with the five thermal regimes adapted from Stoneman and Jones (1996) by Chu et al. (2009): **coolwater** category for one site sampled on Hunt Club Creek

Hunt Club Creek Fish Community

Fish Community Summary

Two fish sampling sites were evaluated between May and July 2019. Both site locations were sampled with the use of a backpack electrofishing unit.

Three species were captured in 2019, they are listed in Table 2 along with their thermal classification preferences (Coker et al., 2001) and MNR species codes. Hunt Club Creek had a mixed fish community ranging from 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 species codes provided in Table 2. For comparisons across sampling years and a complete list of RVCA historical fish records from Hunt Club Creek refer to page 18 of this report.

Table 2 Fish species observed in Hunt Club Creek in 2019

Species	Thermal Class	MNR Species Code
bluegill *Lepomis macrochirus*	**Warm**	Blueg
brook stickleback *Culaea inconstans*	**Cool**	BrSti
pumpkinseed *Lepomis gibbosus*	**Warm**	Pumpk
Total Species		**3**

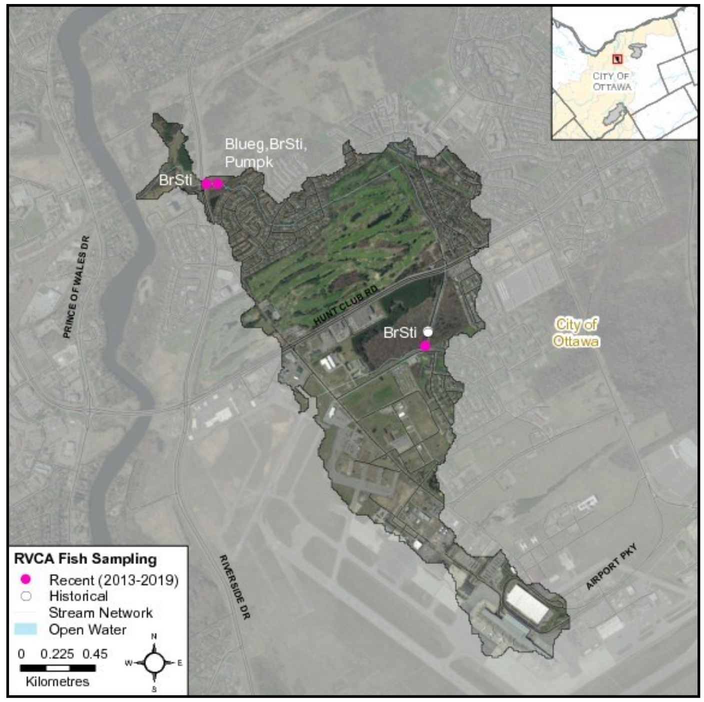
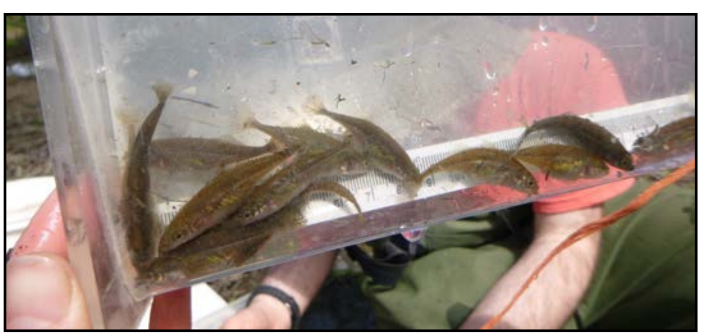


Figure 30 Hunt Club Creek fish sampling locations and fish species observations from 2013 - 2019

Pumpkinseed (above) and brook stickleback (below) observed in Hunt Club Creek



Fish community sampling by electrofishing (above) and RVCA staff and a volunteer process fish (below) in Hunt Club 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.

The locations of ten migratory obstructions observed in the surveyed portion of Hunt Club Creek are shown in Figure 31. Most of the obstructions on Hunt Club Creek are natural, they are grade barriers formed from bedrock. Upstream of Riverside Drive the obstructions are caused by anthropogenic changes in the features, including piping of headwater reaches and the weir in the main channel as part of the stormwater management facility.

This water control dam on Hunt Club Creek creates a permanent migration barrier to fish communities

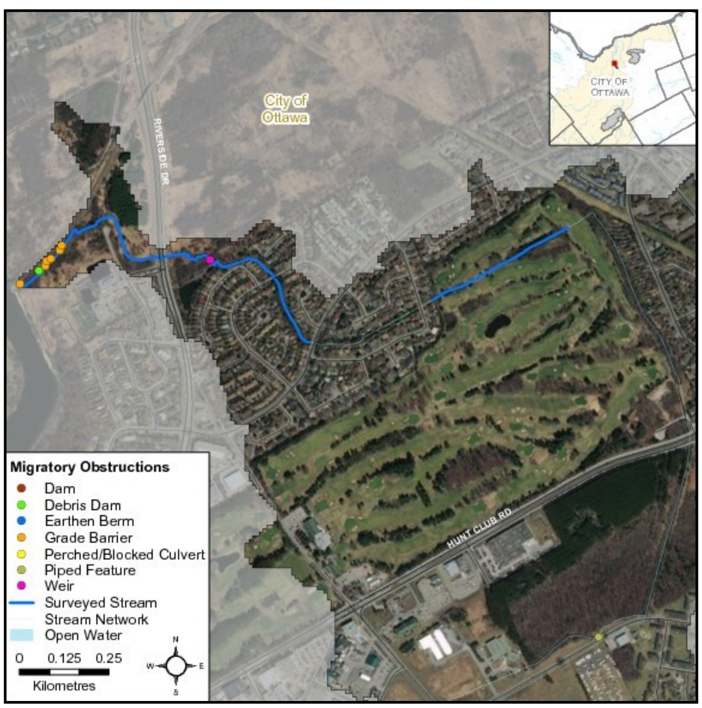


Figure 31 Locations of migratory obstructions along Hunt Club Creek catchment

Beaver Dams

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 wood material used in the dams which removes excess nutrient and toxins. Beaver dams may be seasonal barriers to fish migration.

In 2019 two beaver dams were identified on the surveyed portions of Hunt Club Creek and are shown in Figure 32.

An active beaver dam along Hunt Club Creek near Riverside Drive

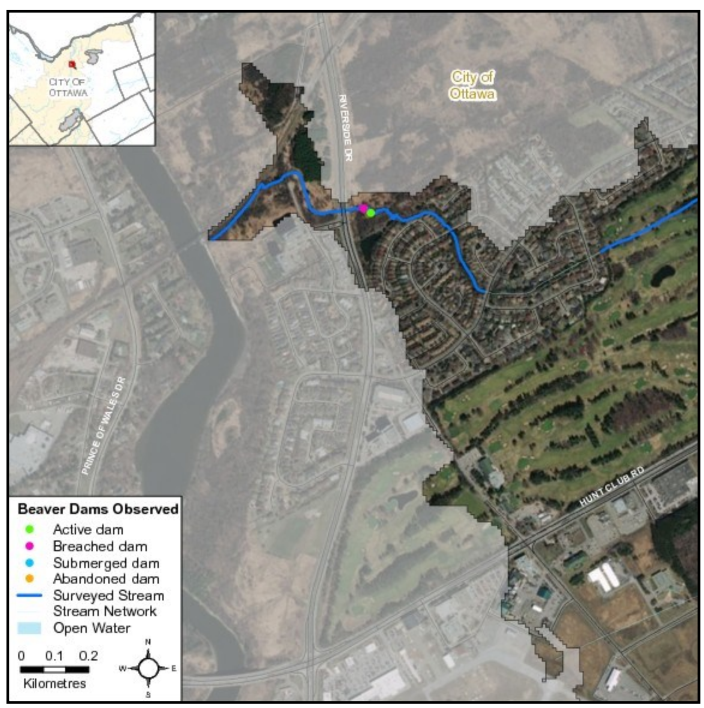


Figure 32 Locations of beaver dams along Hunt Club Creek

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, 2019):

- 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 were evaluated as per the Ontario Stream Assessment Protocol (OSAP, 2019). 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 2019 one HDF site was assessed in the Hunt Club Creek Catchment (Figure 33).

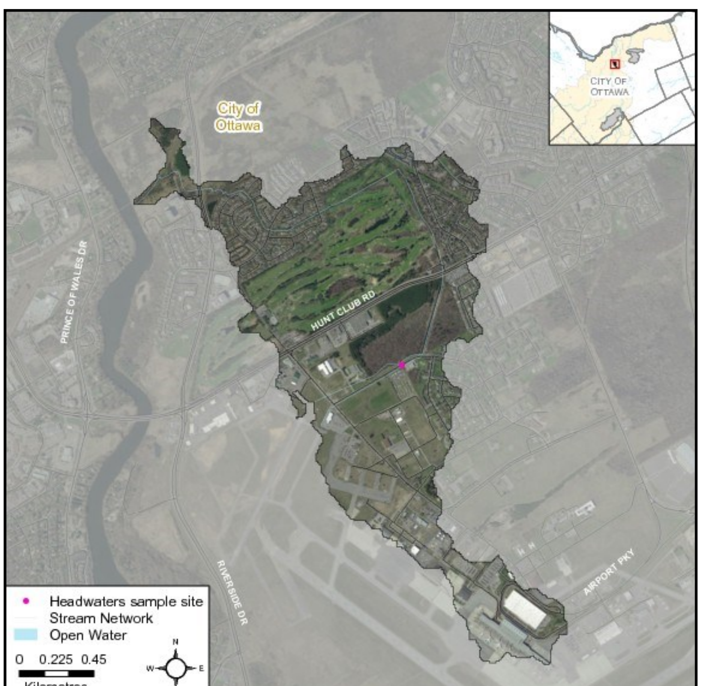


Figure 33 Location of headwater drainage feature sampling site in the Hunt Club Creek catchment

The headwater drainage features of Hunt Club Creek have been heavily modified throughout the urbanization process. The majority of the features are no longer present, as they have been transformed into stormwater drainage features. This upper feature has been piped and can no longer be surveyed using the OSAP protocol.

Piped headwater drainage feature on Hunt Club Creek, shows the upstream portion (above) buried and the downstream outlet remains open (below)

Stream Comparison Between 2013 and 2019

The following tables provide a comparison of observations on Hunt Club Creek between the 2013 and 2019 survey years (RVCA 2013). In order to accurately represent current and historical information, the data was only compared for those sections which were surveyed in both 2013 and 2019. This information is a comparative evaluation and doesn't 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 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 water chemistry parameters between 2013 and 2019.

Average pH decreased by 0.20 units from 2013 to 2019; specific conductivity increased by 413.8 µS/cm. The larger change observed is in specific conductivity, indicating more ions being present in 2019 compared to 2013. The increased levels of conductivity observed in 2019 show the increases are located in residential areas, where there is some unmitigated road and stormwater runoff. Average dissolved oxygen levels were found to be higher by 0.3 milligrams per liter in 2013. These levels are comparable across both cycle years with little difference.

Average summer water temperatures range from cooler water in 2019 (14.8°C) to warmer values in 2013 (15.8° C), with one degree centigrade of variation. Observations from 2013 were made from June to July, whereas observations in 2019 were made in June. Aside from these general temperature observations, loggers provide a detailed recording of stream thermal conditions. Standardized stream temperature assessments account for climatic factors including air temperatures and precipitation. With the data collected from temperature loggers at Riverside Drive, standardized stream temperature factors were calculated and summarized in Table 3. This factor increased by 0.12°C for every degree of air temperature from 2013 to 2019. In 2013 Hunt Club Creek at this site was classified as cold-cool water and in 2019 as cool water (methods from Chu et al., 2009).This difference may be accounted for by the difference in placement of the logger at this site; in 2013 it was influenced by the stormwater outlet and in 2019 the logger was placed outside the influence of the stormwater outlet.

Table 3 Water chemistry comparison (2013/2019)

Water Chemistry (2013/2019)				
Year	**Parameter**	**Unit**	**Average**	**STND Error**
2013	pH	-	7.82	± 0.05
2019	pH	-	7.62	± 0.13
2013	Sp. Conductivity	us/cm	571.4	± 121.8
2019	Sp. Conductivity	us/cm	985.2	± 50.1
2013	Dissolved Oxygen	mg/L	9.0	± 0.3
2019	Dissolved Oxygen	mg/L	8.7	± 0.5
2013	Water Temperature	ºC	15.8	± 0.3
2019	Water Temperature	ºC	14.8	± 0.4
2013	Standardized Stream Temperature[1]	ºC Water / 1ºC Air	0.62	± 0.09
2019	Standardized Stream Temperature[1]	ºC Water / 1ºC Air	0.74	± 0.16

[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
- Water temperature points collected from July 1st —September 10th
- Logger must be deployed in flowing waters

Invasive Species

The percentage of sections surveyed where invasive species were observed had a significant increase of 41 percent, these were observed in every section in 2019 (Table 4). Purple loosestrife had a reduction of observations. Dog Strangling vine was observed in 2013 in sections that were not surveyed in 2019, due to lack of access permission; however this species has not expanded its range on to further reaches. Other invasive species have expanded their range including buckthorn, Manitoba maple and yellow iris. There are also several species that were not previously reported, forget-me-not, garlic mustard, non native honeysuckle and Norway maple.

Table 4 Invasive species presence (% of sections) observed in 2013 and 2019 (NPR are Not Previously Reported species; RE are species Reported Elsewhere not surveyed in 2019)

Invasive Species	2013	2019	+/-
common & glossy buckthorn	12%	94%	▲
dog strangling vine	RE	0%	▼
Forget-me-not	NPR	13%	▲
garlic mustard	NPR	25%	▲
honey suckle (non-native)	NPR	19%	▲
Manitoba maple	6%	94%	▲
Norway maple	NPR	6%	▲
purple loosestrife	24%	19%	▼
yellow iris	41%	50%	▲
Total percent of sections invaded	**59%**	**100%**	▲

Pollution

Garbage accumulation on Hunt Club Creek was found to decrease from 2013 to 2019. The percentage of sections that were polluted was lower in 2019. All types of pollution were also found to decrease from the previous monitoring cycle. Table 5 shows pollution levels in both monitoring years.

Table 5 Pollution levels (presence in % of sections surveyed) comparison between 2013 and 2019

Pollution/Garbage	2013	2019	+/-
oil or gas trails	24%	6%	▼
floating garbage	41%	6%	▼
garbage on stream bottom	65%	50%	▼
unusual colouration	6%	0%	▼
Total polluted sections	**88%**	**56%**	▼

Instream Aquatic Vegetation

Table 6 shows decreases in instream aquatic vegetation from 2013-2019. Narrow-leaved emergent plants (e.g. sedges), broad leaved emergent plants (e.g. arrowhead) and robust emergent plants (e.g. cattails) were present in comparable abundance in both years. Free-floating plants (e.g. duckweed) and floating plants (e.g. water lilies) were not observed in the system in either monitoring year. Submerged plants (e.g. pondweed) were observed in more sections in 2019 and algae had lower observations which are both indicators of improved plant community composition.

Table 6 Instream aquatic vegetation (presence in % of sections) comparison between 2013a dn 2019

Instream Vegetation	2013	2019	+/-
narrow-leaved emergent plants	41%	31%	▼
broad-leaved emergent plants	6%	13%	▲
robust emergent plants	35%	44%	▲
free-floating plants	0%	0%	
floating plants	0%	0%	
submerged plants	24%	56%	▲
algae	100%	44%	▼

Narrow-leaved emergent, robust emergent and submerged plants present along Hunt Club Creek at Riverside Drive

Fish Community

Fish sampling was carried out by the City Stream Watch program in 2013 and 2019 to evaluate fish community composition in Hunt Club Creek (see Table 7). In total three species have been observed in Hunt Club Creek. In 2013, only one species was observed in two sites; and three species were observed in two sites in 2019. One sample location in 2019 was a replicate of a previously sampled site in 2013. The second site sampled in 2013 could not be re-sampled due to lack of property access. A new site was sampled in 2019 and yielded two more observations.

Brook stickleback observed in 2019 had been captured in 2013, with pumpkinseed and bluegill as new observations.

Table 7 Comparison of fish species caught between 2007-2019

Species	2013	2019
bluegill *Lepomis macrochirus*		x
brook stickleback *Culaea inconstans*	x	x
pumpkinseed *Lepomis gibbosus*		x
Total Species 3	**1**	**3**

Bluegill (above) observed upstream of Riverside Drive on Hunt Club Creek (below)

Monitoring and Restoration

Monitoring on Hunt Club Creek

Table 8 highlights recent and past monitoring that has been done on Hunt Club Creek by the Rideau Valley Conservation Authority's City Stream Watch program. Monitoring activities and efforts have changed overtime.

Table 8 City Stream Watch monitoring on Hunt Club Creek

Accomplishment	Year	Description
City Stream Watch Stream Monitoring	2013	2.8 km of stream was surveyed
	2019	1.6 km of stream was surveyed
City Stream Watch Fish Sampling	2013	Two fish community sites were sampled
	2019	Two fish community sites were sampled
City Stream Watch Thermal Classification	2013	Two temperature probes were deployed from June to September
	2019	One temperature probe was deployed from April to October
Headwater Drainage Feature Assessment	2013	Four headwater drainage feature sites were sampled in the catchment (included main stem of Hunt Club Creek)
	2019	One headwater drainage feature site was sampled in the catchment
City Stream Watch Invasive Species Removal	2013	Volunteers assisted in the removal of yellow iris at one removal session
	2019	Volunteers assisted in the removal of yellow iris at two removal sessions

Potential Riparian Restoration Opportunities

Riparian restoration opportunities include potential enhancement through invasive species management. Opportunities were identified along Hunt Club Creek surveyed areas (Figure 34).

Invasive Species Control

Invasive species management is recommended in the most upstream locations to reduce areas affected. Invasive yellow iris was observed in small clusters throughout, these plants may be effectively managed due to their isolated state. Some removal efforts were implemented in 2019, however isolated plants remain in the system and should be targeted in the future.

Invasive yellow iris is found throughout Hunt Club Creek

Students from John McCrae Secondary School (above) joining City Stream Watch volunteers and staff (below) at a yellow iris removal event along Hunt Club Creek at Riverside Drive

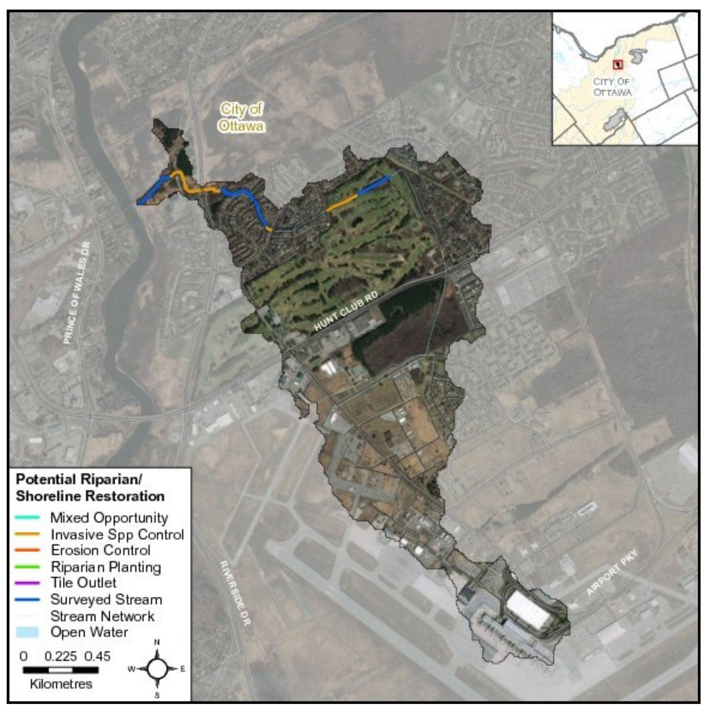
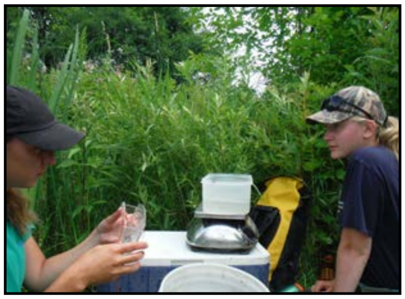


Figure 34 Potential riparian restoration opportunities along Hunt Club Creek and its headwater reaches



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For more information on the 2019 City Stream Watch Program and the volunteer activities, please refer to the City Stream Watch 2019 Summary Report:

https://www.rvca.ca/rvca-publications/city-stream-watch-reports

RVCA City Stream Watch would like to thank all the **volunteers** who assisted in the collection of information; as well as the many **landowners** who gave us property access to portions of the stream; and to our **City Stream Watch Collaborative members**: City of Ottawa, National Capital Commission, Ottawa Flyfishers Society, Canadian Forces Ottawa Fish and Game Club, Ottawa Stewardship Council, Rideau Roundtable, South Nation Conservation, Mississippi Valley Conservation Authority and Rideau Valley Conservation Authority