Nepean Creek 2018 Catchment Report

Watershed Features	
Area	10.71 square kilometres 0.25% of the Rideau River watershed
Land Use	0.84% agriculture 76.18% urban 15.48% forest 5.38% meadow 0.72% rural 0.59% waterbody 0.81% wetland
Surficial Geology	42.12% clay 25.75% diamicton 7.95% organic deposits 0.90% Paleozoic bedrock 23.28% sand
Watercourse Type	2018 thermal conditions **Cool-warmwater** to **warmwater** to **coolwater**
Invasive Species	Ten invasive species were identified in 2018: banded mystery snail, Chinese mystery snail, common buckthorn, flowering rush, Himalayan balsam, Manitoba maple, *Phragmites*, purple loosestrife, rusty crayfish, yellow iris
Fish Community	19 species of fish have been observed from 2007-2018. Game fish species include: brown bullhead, largemouth bass, pumpkinseed, smallmouth bass, rock bass

Wetland Catchment Cover
0.00% evaluated wetland
0.81% unevaluated wetland

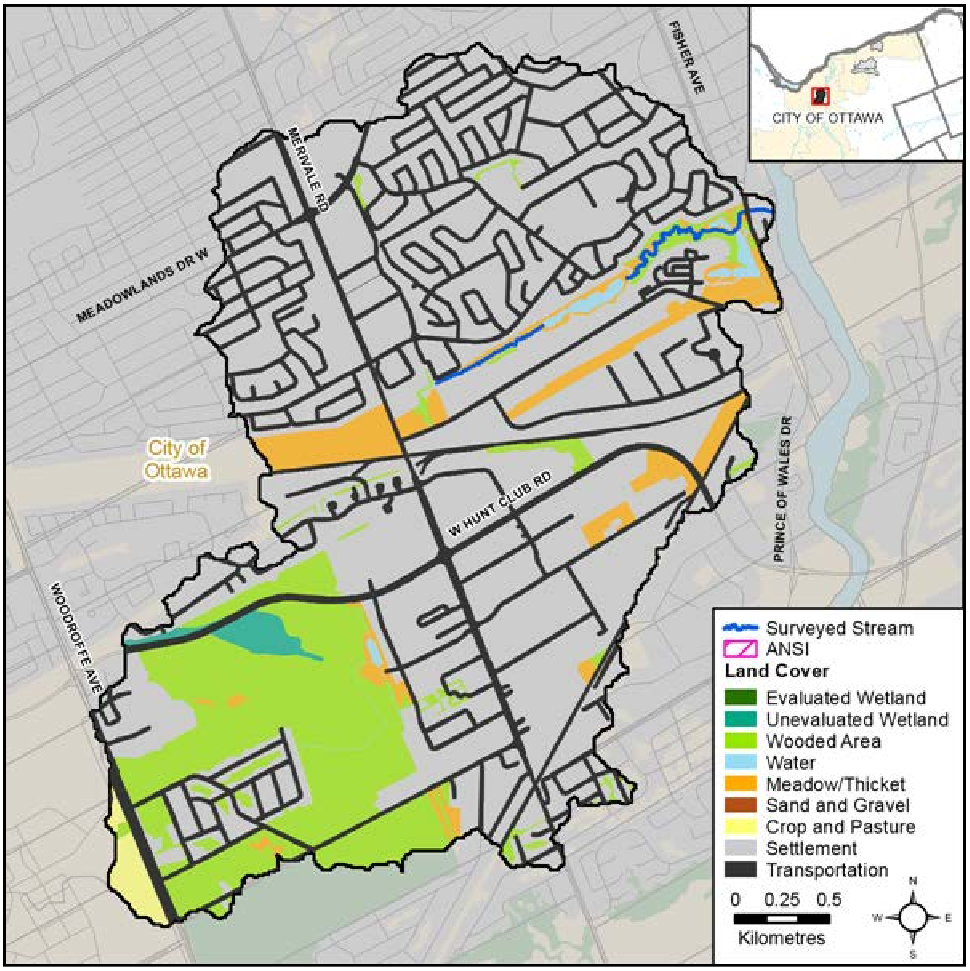

Figure 1 Land cover in the Nepean Creek catchment


Mouth of Nepean Creek at the Rideau River

The Rideau Valley Conservation Authority, in partnership with eight other agencies in Ottawa, form the 2018 City Stream Watch Collaborative: South Nation Conservation Authority, Mississippi Valley Conservation Authority, City of Ottawa, Ottawa Flyfishers Society, Ottawa Stewardship Council, Rideau Roundtable, Canadian Forces Fish and Game Club, and the National Capital Commission.

Introduction

Nepean Creek is approximately two kilometers long (excluding the stormwater ponds) and flows from Colonnade Business Park just east of Merivale Road to the Rideau River just south of the intersection of Prince of Wales Drive and Fisher Avenue. The headwater reaches of the creek are piped underground, out-letting just east of Howard Darwin Centennial Arena. From that point, Nepean Creek flows along the southern edge of a developed residential area. A naturalized buffer has been maintained between the development and the stream, and well used recreational pathways wind their way through the area crossing the creek multiple times and connecting to residential streets. Nepean Creek has one online stormwater pond and one offline stormwater settling pond located close to the Rideau River. The stormwater ponds were not included as part of the stream survey as they fall outside the guidelines of the stream assessment protocol.

In 2018, the City Stream Watch program surveyed eighteen 100 meter sections of Nepean Creek. Three sites were sampled for fish community composition.

Low Water Conditions - Rideau Valley Watershed

Low Water Conditions

Prolonged periods of hot dry weather punctuated by heavy rainfall events characterized 2018. The year began close to normal however March had less than normal precipitation. The spring freshet in early April was significant but the forecasted rain didn't materialize and peak flows were only slightly above average. The dry weather came on through May, continued through June and as of July 10th 2018, the conditions in the Rideau Valley Watershed were declared to be at the minor low water status. At this time, stream flows were below normal but still above critical thresholds. (RVCA, 2018) Twenty five days with temperatures above 30 degrees, 15 of those in July, contributed to the overall drought condition in the watershed. As of July 19th the status within the watershed reached moderate severity.

On August 2nd this status was reduced back to minor severity with significant rainfalls measured through eastern Ontario in late July. Rain in the lower reaches of the watershed continued through August and into September. As of September 27th 2018, the low water status in the lower Rideau River Watershed returned to normal.

Nepean 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 Nepean Creek. Buffers greater than 30 meters were present along 61 percent of the left bank and 62 percent of the right bank. A 15 to 30 meter buffer was present along 14 percent of the left bank and 19 percent of the right bank; five to 15 meter buffers were observed along five percent of the left bank and six percent of the right bank. A five meter buffer or less was present along 16 percent of the left banks and 14 percent of the right bank. Efforts have been made to maintain generous buffer widths when possible along this urban stormwater system.

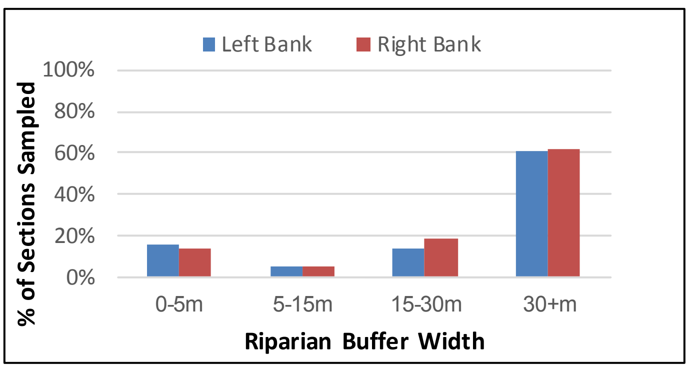

Figure 2 Vegetated buffer width along Nepean Creek

Vegetated buffer along Nepean Creek

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.

Nepean Creek riparian zones have primarily natural vegetative communities. Alterations upstream of the creek are mainly due to channel straightening as the system is eventually piped. Alterations are also associated with infrastructure, including roadways, and pedestrian pathway crossings.

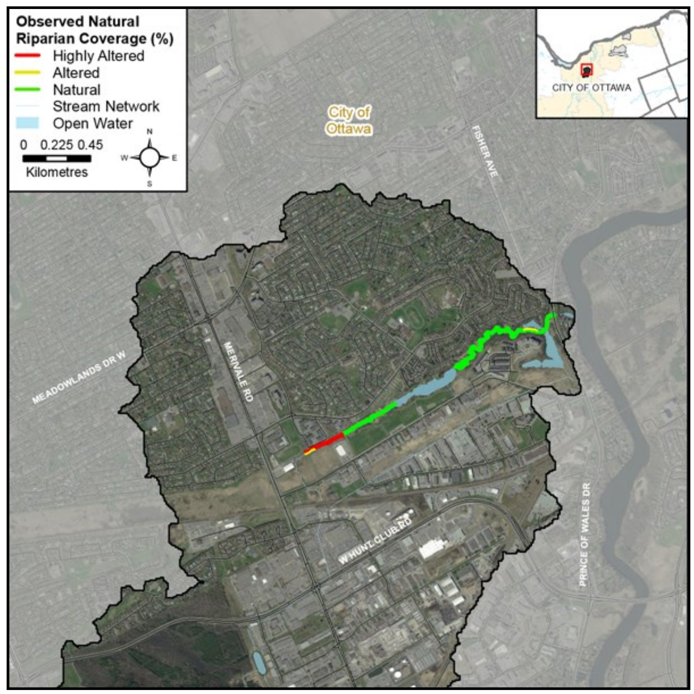

Figure 3 Riparian buffer alterations in Nepean Creek

Channel straightening along Nepean 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 stream. 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 83 percent and 72 percent of the sections surveyed, being the most common land uses found. Scrubland was present in 61 percent of the surveyed areas, and wetland was present in 33 percent of sections.

Aside from the natural areas, the most common land use in the catchment was infrastructure, with 17 percent of the sections containing elements of infrastructure in the form of roads and pedestrian pathways. Other uses observed included six percent of surveyed areas with industrial or commercial uses and six percent of sections with residential areas.

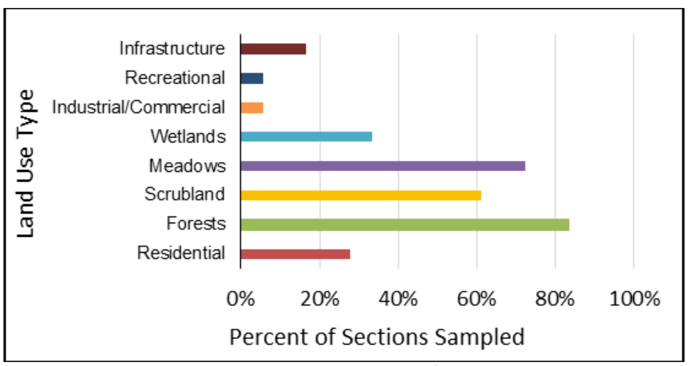

Figure 4 Adjacent land use 100 meters from each shoreline and percentage of presence along Nepean Creek

Section along Nepean Creek with meadow, scrubland and residential land uses

Nepean 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 surveyed sections in Nepean Creek, with 17 percent remaining without any human alteration. The majority of sections, 61 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 22 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.

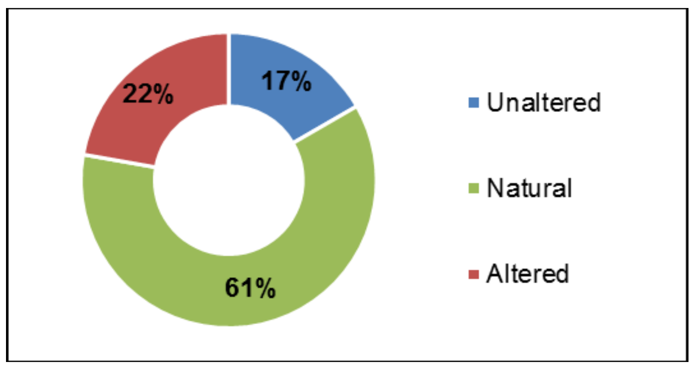

Figure 5 Anthropogenic alterations along Nepean Creek

Pedestrian pathway altering a section of Nepean 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 shows the levels of stream erosion observed across the surveyed portions of Nepean Creek.

Higher erosion levels were observed upstream of the online stormwater ponds. There are multiple stormwater outlets flowing into the creek from surrounding neighborhoods.

Undercut Stream Banks

Stream bank undercuts can provide important 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 present in over half of the sections surveyed in Nepean Creek, 67 percent of the sections had undercutting in the left bank and 56 percent of the right bank.

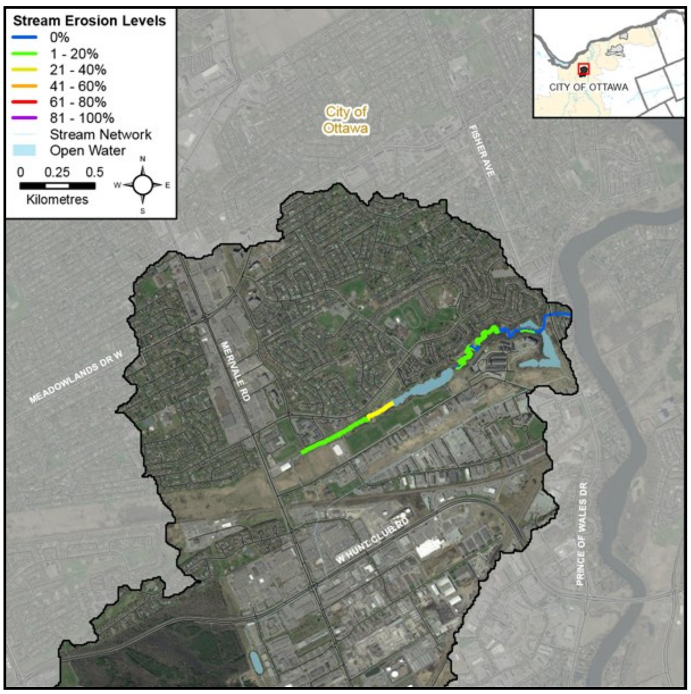

Figure 6 Erosion levels along Nepean Creek

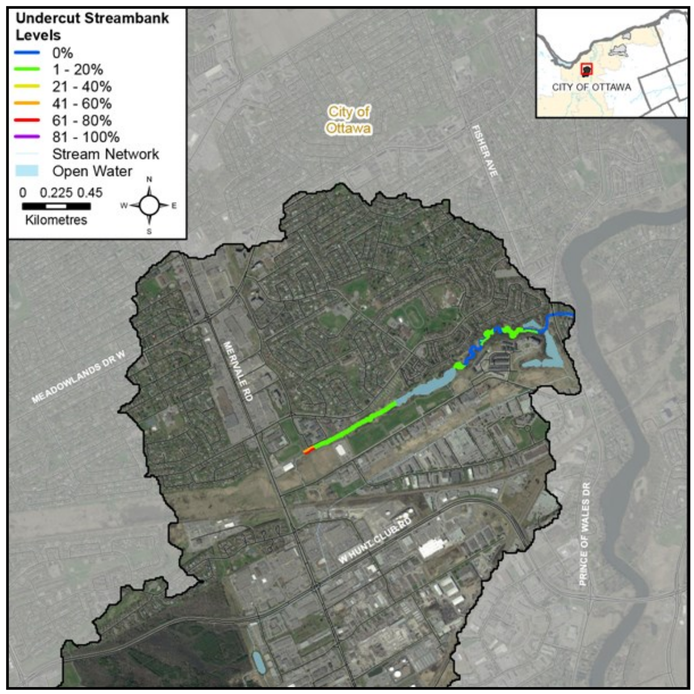

Figure 7 Undercut stream banks along Nepean Creek

Stormwater outlet on Nepean Creek

Exposed tree roots and bank undercutting along Nepean 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 shading 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 (50%) had a shade cover of one to 20 percent. The highest shading of 81 to 100 percent was not observed in any of the sections. Shading of 61 to 80 percent was present in 11 percent of the sections; 22 percent of the sections had 41 to 60 percent shading; 17 percent had 21 to 40 percent shading. Figure 9 shows the distribution of these shading levels along Nepean Creek.

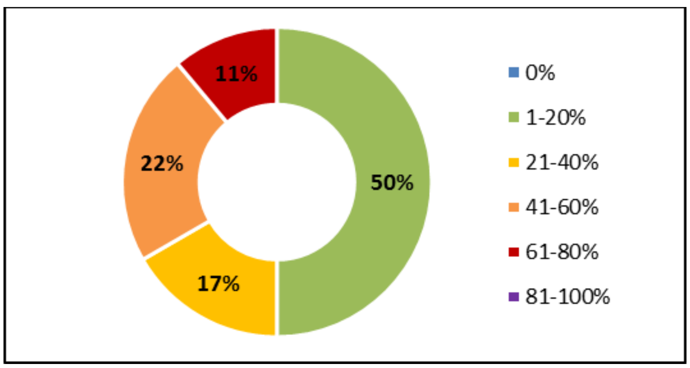

Figure 8 Stream shading along Nepean Creek

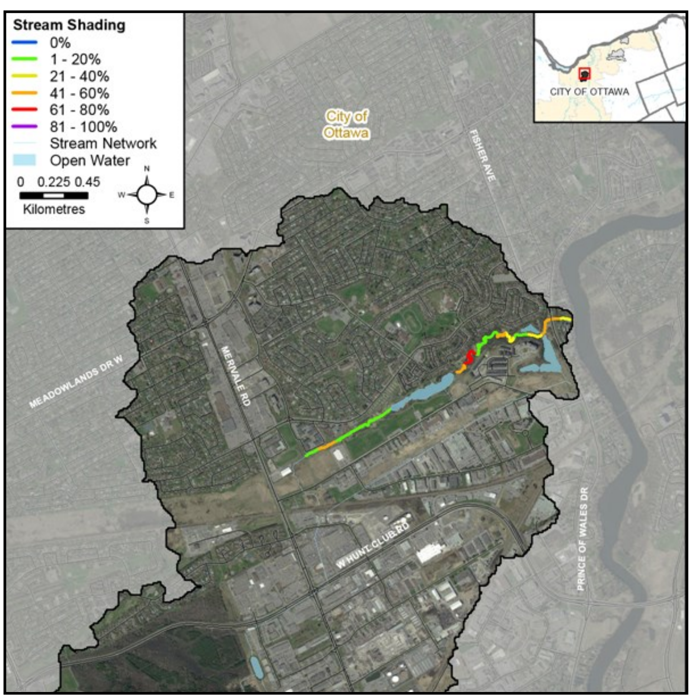

Figure 9 Stream shading levels along Nepean Creek

A mix of trees and plants comprised the majority of shading. Overhanging plants, mainly broad leaved emergent plants and grasses were seen in 78 percent of the left bank and 78 percent of the right bank.

Overhanging Wood Structure

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

Figure 10 shows the presence of overhanging wood structure observed along Nepean Creek. In the surveyed portions, 89 percent of the sections had overhanging trees and branches on the left bank, and 89 percent of the sections had overhanging trees on the right banks.

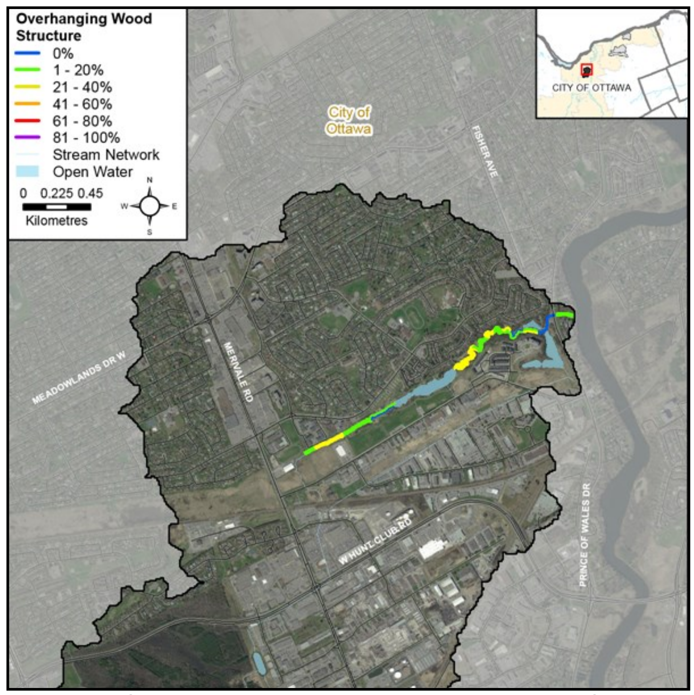

Figure 10 Overhanging wood structure along Nepean Creek

Overhanging trees and branches on Nepean Creek

Nepean 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 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: zero percent had no complexity; 6 percent had a score of one; 44 percent scored two; 28 percent scored three; and 22 percent had high habitat diversity.

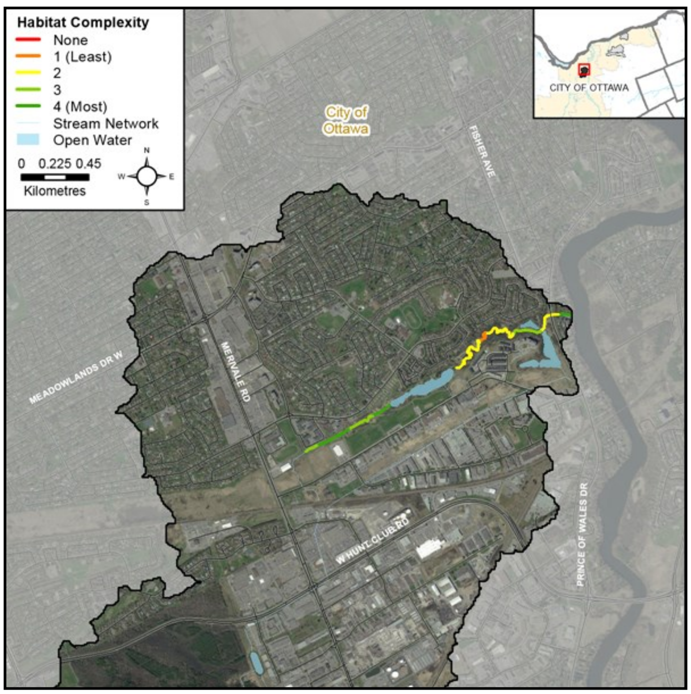

Figure 11 Instream habitat complexity along Nepean Creek

Section of Nepean Creek featuring riffle and run 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 Nepean Creek. It is a system dominated by silt, with 89 percent of sections containing this type of substrate. It also has cobble, clay and sand portions, some areas with boulders and gravel.

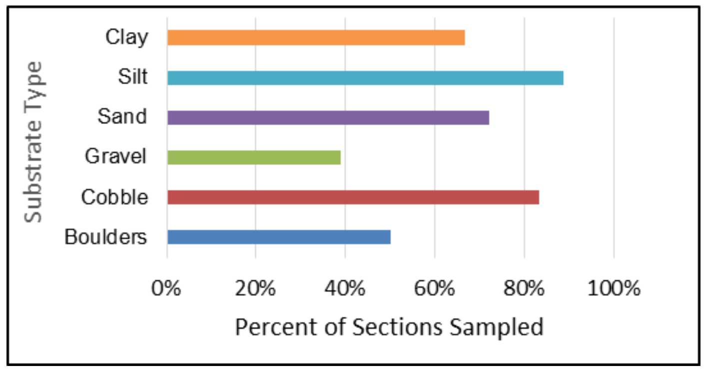

Figure 12 Instream substrate along Nepean Creek

Figure 13 shows the dominant substrates along the creek. From the areas that were assessed, silt was the dominant substrate type in 50 percent of sections. Cobble, gravel and clay were each identified as dominant in 17 percent of all surveyed sections.

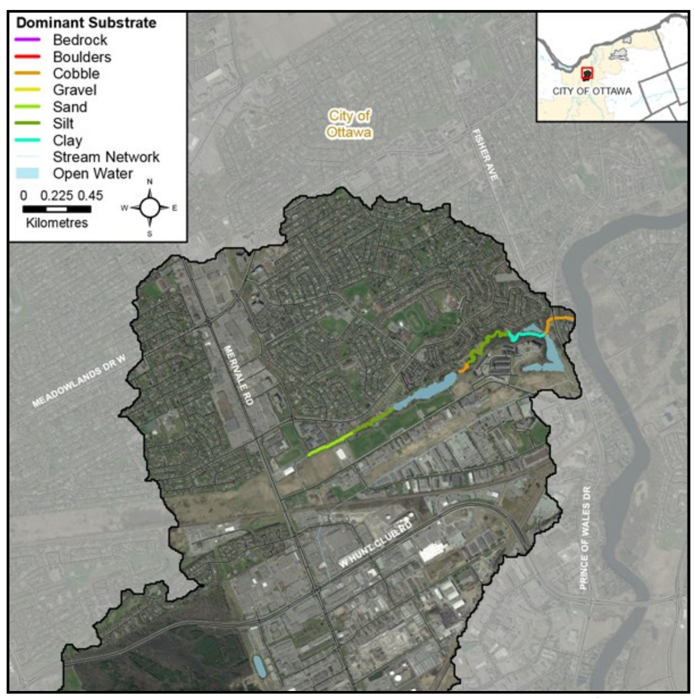

Figure 13 Dominant instream substrate along Nepean Creek

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 Nepean Creek has a diversity of morphological conditions, suitable for a variety of aquatic species and life stages; 83 percent of sections contained pools, 67 percent contained riffles and the majority, 100 percent, contained runs. Figure 15 shows the locations of riffle habitat along Nepean Creek.

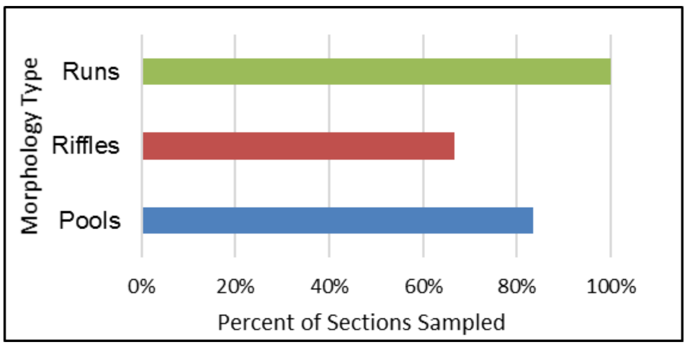

Figure 14 Instream morphology along Nepean Creek

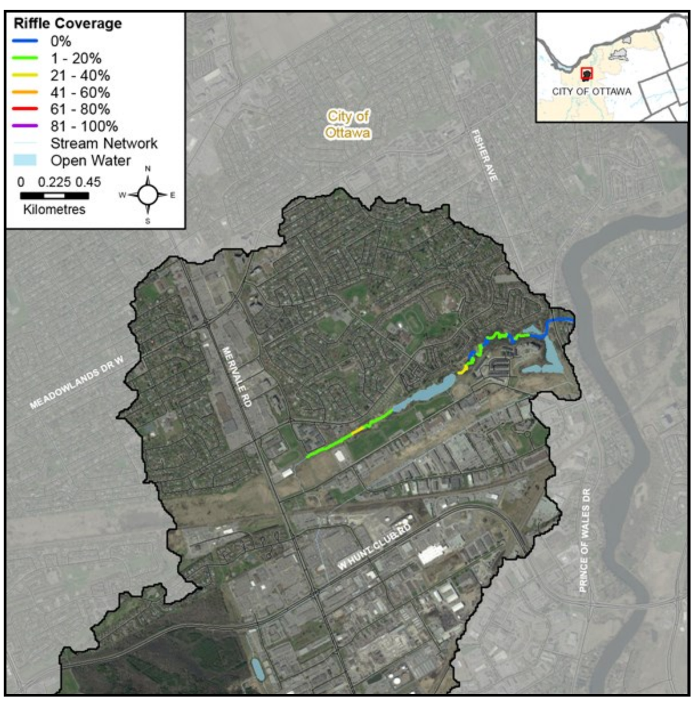

Figure 15 Riffle habitat locations along Nepean Creek

Instream Wood Structure

Figure 16 shows that the majority of Nepean Creek had low 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 create temporary migration barriers.

Instream wood structure found along Nepean Creek

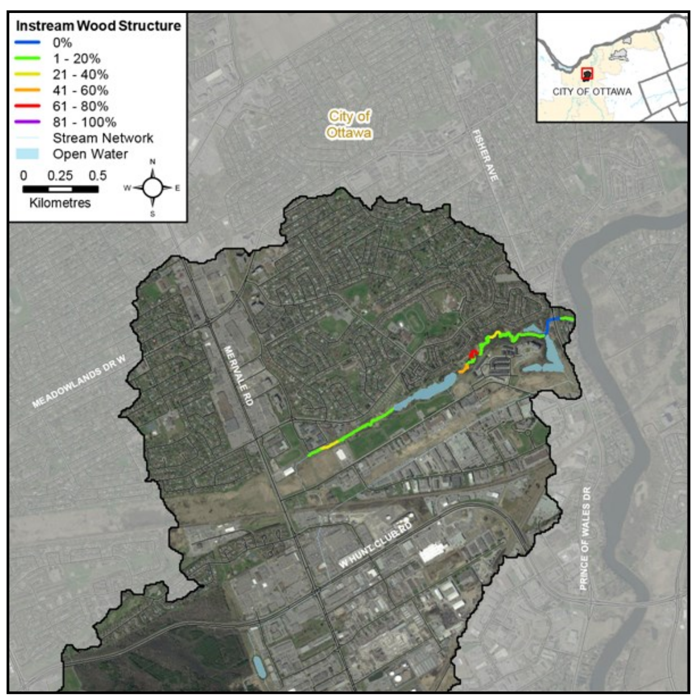

Figure 16 Instream wood structure along Nepean Creek

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 three types commonly present along Nepean Creek were algae (found in 72 percent of sections), submerged and broad leaved vegetation (each present in 67 percent of sections surveyed).

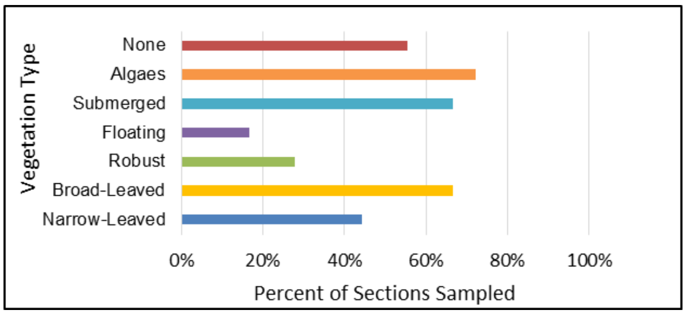

Figure 17 Aquatic vegetation presence along Nepean Creek

Nepean Creek does not have a large diversity of instream aquatic vegetation, with 39 percent of sections having no vegetation as the dominant type (Figure 18). Submerged vegetation was also the dominant type across 39 percent of all sections. Algae was dominant in 11 percent, robust and broad leaved were dominant in six percent of sections respectively.

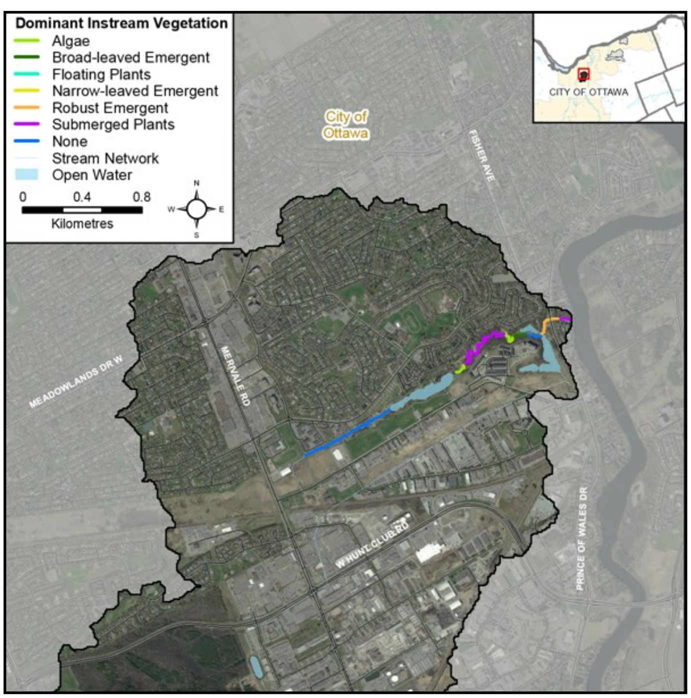

Figure 18 Dominant instream vegetation distribution in Nepean Creek

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, 50 percent of Nepean Creek sections had low levels of vegetation, 39 percent had normal levels. Common and rare levels of vegetation were each found in 17 percent of sections. No vegetation was found along 56 percent of sections surveyed.

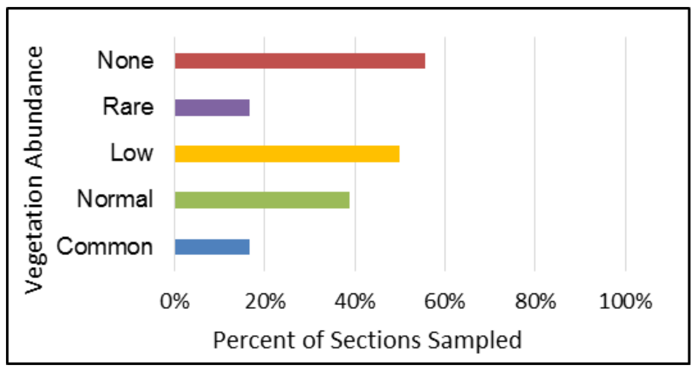

Figure 19 Instream vegetation abundance along Nepean Creek

Submerged vegetation found along Nepean Creek

Section of Nepean Creek with low levels of instream aquatic

Nepean Creek Stream Health

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 Nepean Creek catchment.

Table 1 Wildlife observed along Nepean Creek in 2018

Birds	American goldfinch, American robin, mallard ducks, finches, red-winged blackbird, song birds, sparrows, common grackle, European starling, Northern cardinal
Reptiles & Amphibians	frogs, green frog, American toad tadpoles, turtle egg
Mammals	common raccoon tracks, black squirrels
Benthic Invertebrates	water striders
Other	bumblebees, butterflies, deerflies, cyprinid sp., dragonflies, horseflies, mosquitoes, mussels,

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. Ten invasive species were observed in 2018:

- banded mystery snail (*Viviparus georgianus)*
- common buckthorn (*Rhamnus cathartica*)
- flowering rush (*Butomus umbellatus*)
- Manitoba maple (*Acer negundo*)
- purple loosestrife (*Lythrum salicaria*)
- rusty crayfish (*Orconectes rusticus*)
- Himalayan balsam (*Impatiens glandulifera*)
- Chinese mystery snail (*Cipangopaludina chinensis*)
- *Phragmites* (*Phragmites australis*)
- yellow iris (*Iris pseudacorus*)

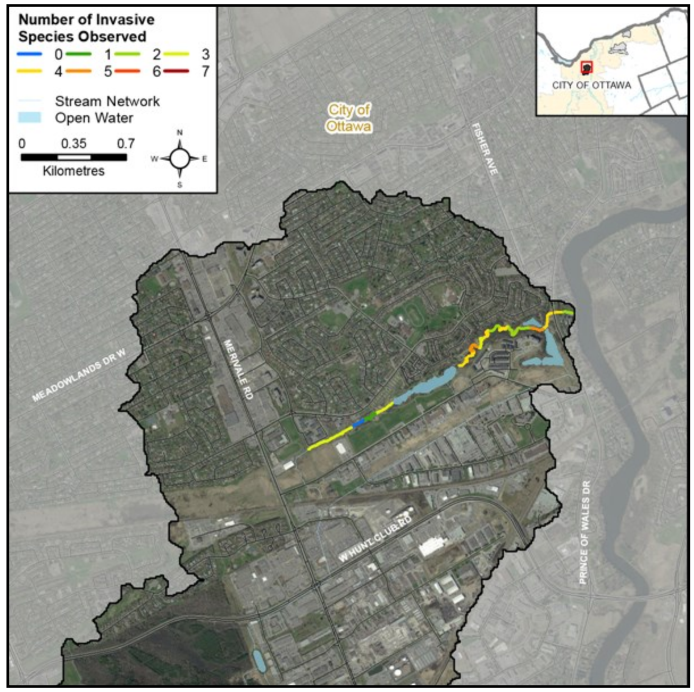

Figure 20 Invasive species abundance along Nepean Creek

Banded mystery snail found in Nepean Creek

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 Nepean Creek. The levels of garbage found in the main portion of the stream were high, with 50 percent of sections surveyed containing floating garbage and 50 percent of sections containing garbage on the stream bottom. Eleven percent of the sections surveyed had no garbage.

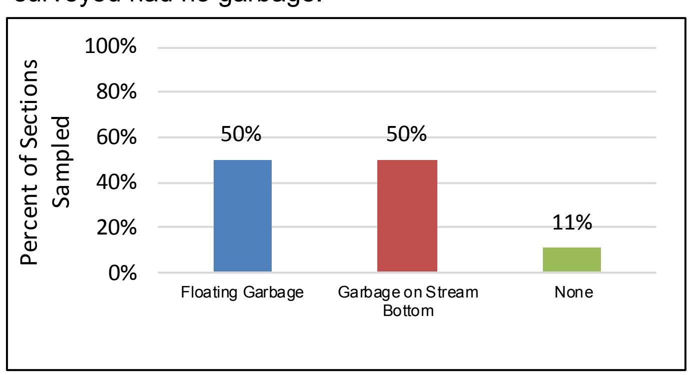

Figure 21 Pollution observed along Nepean Creek

Nepean 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 on Nepean Creek

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 Nepean Creek. The two dashed lines depicted represent the Canadian water quality guidelines. All of the surveyed portions had adequate oxygen levels to support warm and cool water aquatic life. Average levels across the system were 8.6 milligrams per liter.

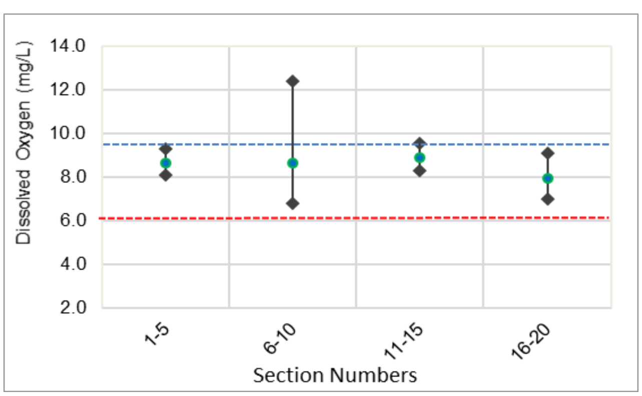

Figure 22 Dissolved oxygen ranges along Nepean Creek

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 Nepean Creek, the average level is depicted by the dashed line (1638 µS/cm). Notable variability was observed at the mouth, (sec. 1-5) likely influenced by the Rideau River; and upstream of the online stormwater pond (sec. 11-15).

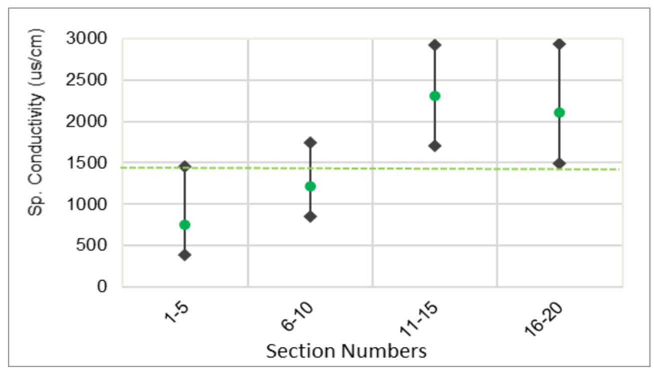

Figure 23 Conductivity ranges along surveyed sections of Nepean Creek

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 Nepean Creek had pH levels that meet the PWQO, depicted by the dashed line. Average levels across the system were pH 7.72.

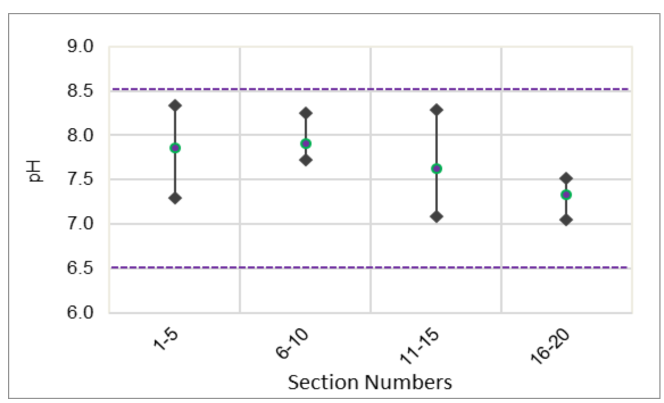

Figure 24 pH ranges along Nepean Creek

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.

Site on Nepean Creek with **sufficient** oxygen conditions for warm water biota

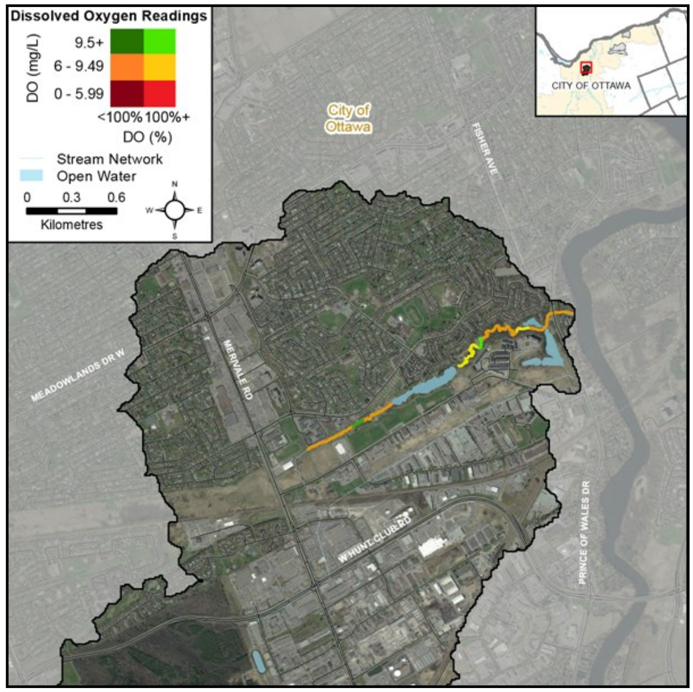

Figure 25 Bivariate assessment of dissolved oxygen concentration (mg/L) and saturation (%) along Nepean Creek

Figure 25 shows the oxygen conditions across the areas that were surveyed in 2018. Overall dissolved oxygen conditions in Nepean Creek are sufficient to sustain warm-water biota although depletion factors are present and maximum saturation is limited. Sections directly downstream of the online stormwater pond have improved levels of saturation and concentration, with some sections suitable for cold water biota. These areas may be benefiting from the stormwater management pond, which takes in water with high anthropogenic nutrient input.

The dark green area upstream of the stormwater ponds is an area with riffle habitat. Riffle habitat is conducive to oxygenation and creates habitat that can support cold water biota.

Site on Nepean Creek that creates **sufficient** oxygen concentration, for both warm and cold water biota, upstream of the stormwater management pond

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 Nepean Creek (1638 μS/cm) exceed the federal guidelines for freshwater (500 μS/cm) used for the Canadian Environmental Performance Index (Environment Canada 2011). These high levels of conductivity are indicative of a high presence of conductive ions in the stream water.

Figure 26 shows relative specific conductivity levels in Nepean Creek. Many sections surveyed showed normal readings of specific conductivity. Moderately elevated conditions were observed near the confluence with the Rideau River and along the offline stormwater pond. Other sections with elevated levels were found upstream of the online stormwater pond where there is strong influence from stormwater outlets.

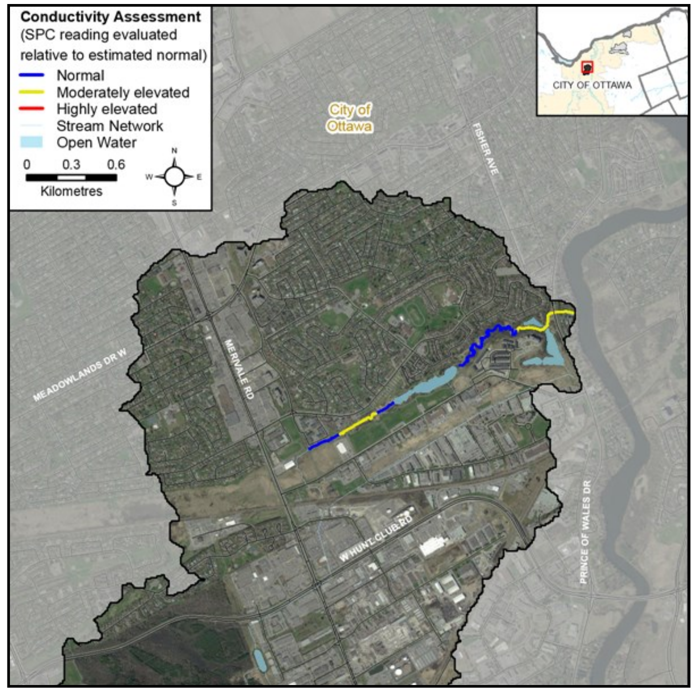

Figure 26 Relative specific conductivity levels along Nepean Creek

Section of Nepean Creek upstream of online stormwater pond with moderately elevated levels of specific conductivity

Section of Nepean Creek adjacent to the offline stormwater management pond with moderately elevated levels of specific conductivity

Nepean 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 Nepean Creek, three temperature loggers were placed in April and retrieved in November.

Figure 27 shows where thermal sampling sites were located. Analysis of data from the loggers depicted in figure 28 (using the Stoneman and Jones, 1996, method adapted by Chu et al., 2009), classifies Nepean Creek as being a **cool-warmwater** system near the mouth. Downstream of the online stormwater management pond, the system is classified as **warmwater**, and upstream of the stormwater pond it is classified as **coolwater**. Within those 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.

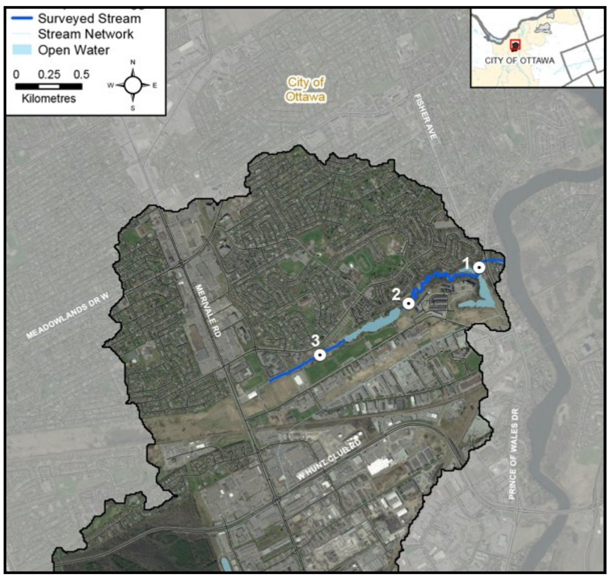

Figure 27 Temperature logger locations on Nepean Creek

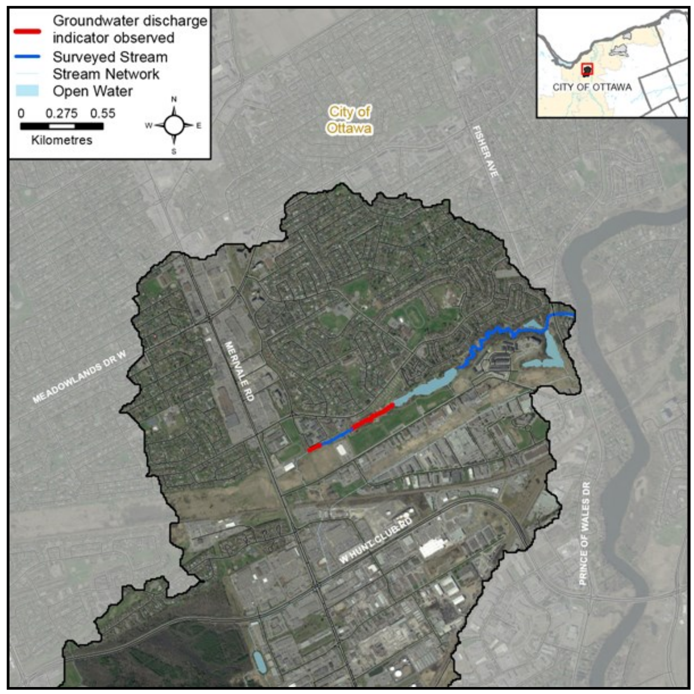

Figure 29 Groundwater indicators observed in Nepean Creek

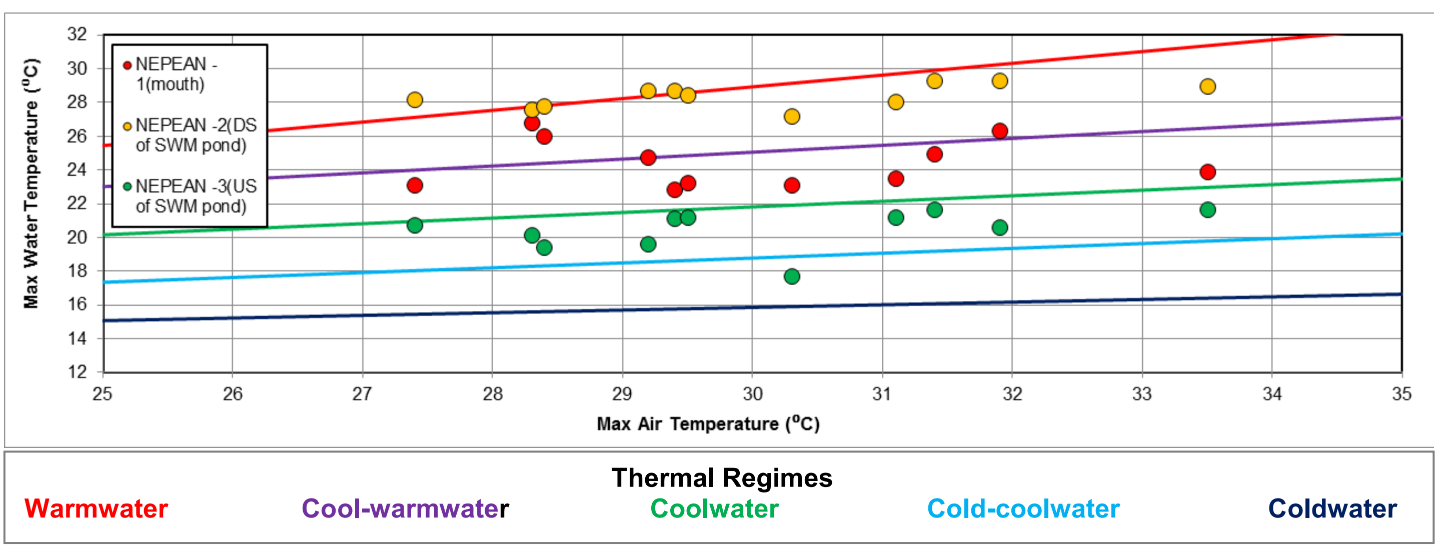

Figure 28 Thermal Classification for Nepean Creek with the five thermal regimes adapted from Stoneman and Jones (1996) by Chu et al. (2009): Site 1, near the mouth of the Creek, is **cool-warmwater**. Site 2, downstream of the stormwater management pond, is **warmwater**. Site 3, upstream of the stormwater management pond, is **coolwater**.

Nepean Creek Fish Community

Fish Community Summary

Three fish sampling sites were evaluated between May and July 2018. The following site locations were sampled by backpack electrofishing: upstream of Prince of Wales Drive, downstream of the stormwater pond and upstream of the stormwater pond.
Seven species were captured in 2018, they are listed in Table 2 along with their thermal classification preferences (Coker et al., 2001) and MNRF species codes. Nepean Creek has 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 MNRF codes provided in Table 2. For comparisons across sampling years and a complete list of RVCA historical fish records from Nepean Creek refer to page 17 of this report.

Table 2 Fish species observed in Nepean Creek

Species	Thermal Class	MNRF Species Code
brook stickleback *Culaea inconstans*	Cool	BrSti
creek chub *Semotilus atromaculatus*	Cool	CrChu
fathead Minnow *Pimephales promelas*	Warm	FhMin
golden shiner *Notemigonus crysoleucas*	Cool	GoShi
northern redbelly dace *Phoxinus eos*	Cool	NRDac
white sucker *Catostomus commersonii*	Cool	WhSuc
brown bullhead *Ameiurus nebulosus*	Warm	BrBul

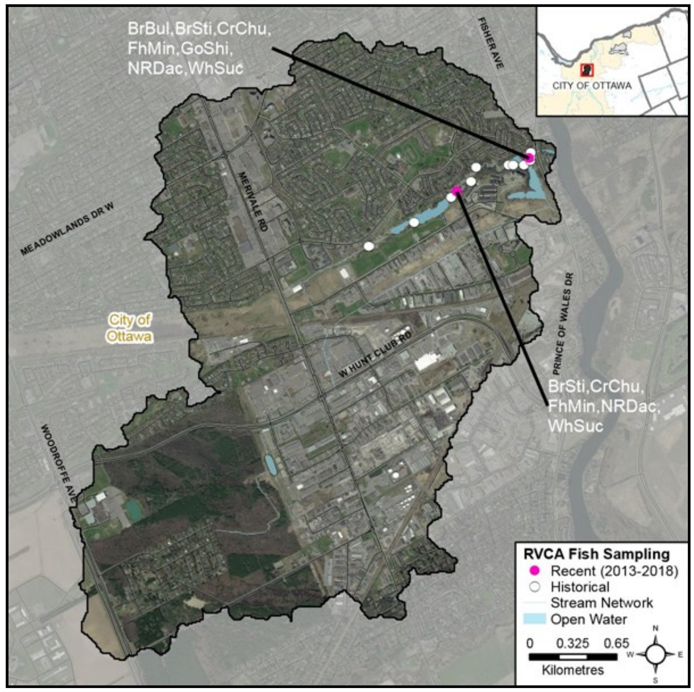

Figure 30 Nepean Creek fish sampling locations and 2018 fish species observations

Fathead minnow captured on Nepean Creek

RVCA staff electrofishing upstream of the stormwater pond

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 2018 the City Stream Watch program assessed 4 HDF sites in the Nepean Creek Catchment (Figure 32).

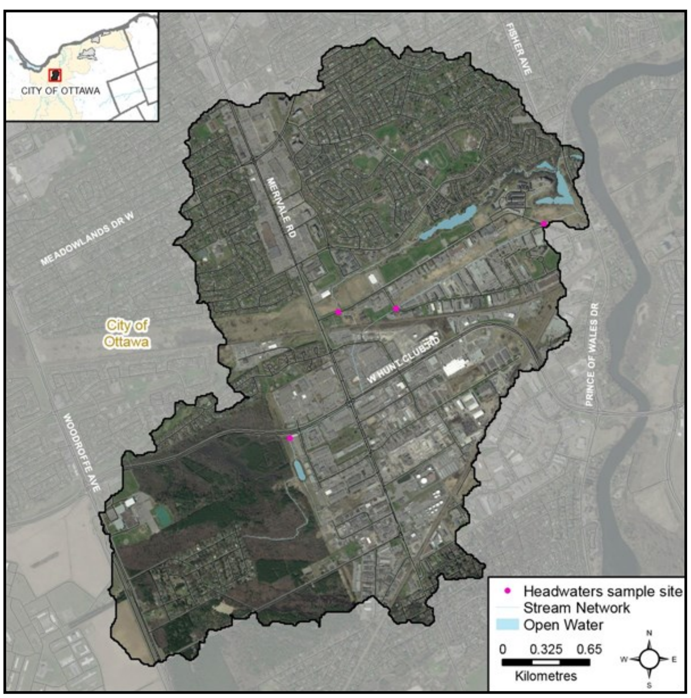

Figure 31 Location of HDF sampling sites in the Nepean Creek catchment

The headwater drainage features of the Nepean Creek catchment have been heavily modified throughout urban development of the area. The majority of the features are no longer present, as they have been transformed into stormwater drainage features. All four of the headwater sampling sites within the Nepean Creek catchment are a part of the stormwater network connected to the creek. These features have been replaced with piping and could not be surveyed using the OSAP protocol.

Both top and bottom images show the conditions of the features sampled in 2018. These features are located along Colonnade Road. Once natural features, they are now a part of the stormwater system for Nepean Creek

Stream Comparison Between 2007, 2012 and 2018

The following tables provide a comparison of observations on Nepean Creek between the 2007, 2012 and 2018 survey years (RVCA 2007, RVCA 2012). Monitoring protocols from 2007 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 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 2012 and 2018. Average summer water temperatures range from cool water in 2018 (19.6°C) to only slightly warmer values in 2012 (19.8°C), with only 0.2 degrees centigrade of variation. 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 0.46°C for every degree of air temperature from 2012 to 2018.

Table 3 Water chemistry comparison (2012/2018)

Water Chemistry (2012 - 2018)				
YEAR	PARAMETER	UNIT	AVERAGE	STND ERROR
2012	pH	-	7.91	± 0.1
2018	pH	-	7.72	± 0.1
2012	Sp. Conductivity	us/cm	-	-
2018	Sp. Conductivity	us/cm	1638	± 203
2012	Dissolved Oxygen	mg/L	10	± 0.5
2018	Dissolved Oxygen	mg/L	8.6	± 0.3
2012	Water Temperature	ºC	19.8	± 0.4
2018	Water Temperature	ºC	19.6	± 0.8
2012	Standardized Stream Temperature[1]	ºC Water / 1ºC Air	1.27	± 0.1
2018	Standardized Stream Temperature[1]	ºC Water / 1ºC Air	0.81	± 0.1

[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 2 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

Average dissolved oxygen levels were found to have decreased by 1.4 milligrams per liter from 2012 to 2018. These changes can also be attributed to weather patterns and warmer temperatures which are less conducive to the stream's ability to hold less oxygen.

Average specific conductivity was not recorded in 2012. In 2018, the average SPC was 1638 us/cm.

Invasive Species

The overall percentage of sections surveyed where invasive species were observed had a reduction of one percent (Table 4). Purple loosestrife had a reduction of observations by 19 percent, this decline may be associated to management efforts (OMNR 2012). Observations for common and glossy buckthorn and Chinese mystery snails also decreased. Notably, no zebra mussels were recorded in 2018. Other invasive species have expanded their range, particularly Manitoba maple, which saw an increase of 63 percent. There are also five invasive species newly reported in 2018. In particular, banded mystery snails and Himalayan balsam were both present in 44 percent of sections surveyed.

Table 4 Invasive species presence observed in 2012 and 2018 (NR are Not Reported species)

Invasive Species	2012	2018	+/-
banded mystery snail	NR	44%	▲
common & glossy buckthorn	20%	6%	▼
Chinese mystery snail	12%	11%	▼
flowering rush	NR	6%	▲
Himalayan balsam	NR	44%	▲
Manitoba maple	15%	78%	▲
Phragmites	NR	6%	▲
purple loosestrife	75%	56%	▼
rusty crayfish	NR	6%	▲
yellow iris	20%	44%	▲
Zebra/quagga mussel	5%	NR	▼
Total	**95%**	**94%**	▼

Pollution

Garbage accumulation on Nepean Creek was found to decrease from 2007 to 2012 and then decreased again by 2018. Table 5 shows that the number of sections surveyed that were free from garbage has increased from zero to 11 percent since 2018.

Table 5 Pollution levels (presence in % of sections)

Pollution/Garbage	2007	2012	2018	+/-
none	0%	10%	11%	▲
floating garbage	83%	70%	50%	▼
garbage on stream bottom	17%	80%	50%	▼
other	100%	85%	0%	▼
Total	**100**	**90**	**89**	▼

Instream Aquatic Vegetation

Table 6 shows instream aquatic vegetation increases from 2012-2018. All plants except free-floating plants showed higher observations in the number of sections surveyed.

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

Instream Vegetation	2012	2018	+/-
narrow-leaved emergent plants	14%	44%	▲
broad-leaved emergent plants	14%	67%	▲
robust emergent plants	13%	28%	▲
free-floating plants	6%	0%	▼
floating plants	10%	17%	▲
submerged plants	13%	67%	▲
algae	20%	72%	▲
none	0%	56%	▲

Fish Community

Fish sampling was carried out by the City Stream Watch program in 2007, 2012 and 2018 to evaluate fish community composition in Nepean Creek (see Table 7). In total 20 species have been observed in Nepean Creek. In 2007, 15 species were captured; 17 species in 2012 and 7 species were observed in 2018. All fishing sites in 2018 were electro-fished. The majority of species observed in 2018 had been captured in previous years, with the exception of the golden shiner as a new record.

Table 7 Comparison of fish species caught between 2007-2018

Species	2007	2012	2018
banded killifish *Fundulus diaphanus*	X	X	
bluegill *Lepomis macrochirus*	X	X	
brassy minnow *Hybognathus hankinsoni*		X	
brook stickleback *Culaea inconstans*	X	X	X
brown bullhead *Ameiurus nebulosus*	X	X	X
central mudminnow *Umbra limi*	X		
common shiner *Luxilus cornutus*		X	
creek chub *Semotilus atromaculatus*	X	X	X
Cyprinid *spp.*	X	X	
Etheostoma spp.		X	
fathead minnow *Pimephales promelas*	X	X	X
golden shiner *Notemigonus crysoleucas*			X
largemouth bass *Micropterus salmoides*	X	X	
Lepomis Spp.	X		
longnose dace *Rhinichthys cataractae*		X	
northern redbelly dace *Chrosomus eos*	X	X	X
pumpkinseed *Lepomis gibbosus*	X	X	
rock bass *Ambloplites rupestris*	X	X	
smallmouth bass *Micropterus dolomieu*	X	X	
white sucker	X	X	X
Total Species 19	**15**	**17**	**7**

A Northern redbelly dace observed in 2018. This species has been captured in Nepean Creek in all three sampling years

Monitoring and Restoration

Monitoring and Restoration Projects on Nepean Creek

Table 8 highlights recent and past monitoring that has been done on Nepean 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 Nepean Creek

Accomplishment	Year	Description
City Stream Watch Stream Monitoring	2007	1.8 km of stream was surveyed
	2012	2.0km of stream was surveyed
	2018	1.8 km of stream was surveyed
City Stream Watch Fish Sampling	2007	Five sites were sampled for fish using a seine net and two sites were sampled for fish using an electrofisher
	2012	Three sites were visited multiple times and sampled using an electrofisher
	2018	Three sites were sampled using an electrofisher
City Stream Watch Thermal Classification	2012	Three temperature loggers were deployed
	2018	Three temperature probes were deployed
City Stream Watch Headwater Drainage Feature Assessment	2018	Four headwater drainage feature sites were assessed in the Nepean Creek catchment
City Stream Watch Riparian Planting	2012	CSW and Shoreline Naturalization Program staff joined 17 volunteers and multiple Scout Groups to plant 1,500 trees and shrubs along Nepean Creek
City Stream Watch Invasive Species Removals	2018	1260 square meters of stream was cleared of invasive Himalayan balsam
City Stream Watch Stream Cleanups	2018	0.63km of stream was cleared of garbage

Temperature probe installation in Nepean Creek downstream of stormwater management ponds

Removing invasive Himalayan balsam along Nepean Creek at a City Stream Watch event

Potential Riparian Restoration Opportunities

Riparian restoration opportunities were assessed in the field and include potential enhancement through riparian planting, habitat enhancement, erosion control and invasive species management. (Figure 32).

Riparian Planting

The first few sections of Nepean Creek riparian area can benefit from riparian planting. These sections are at the mouth of the creek and adjacent to the Rideau River. 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.

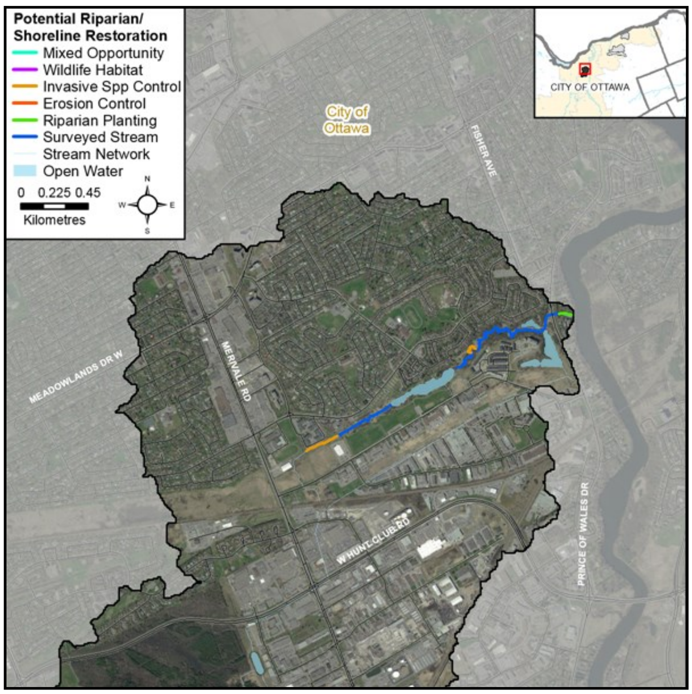

Figure 32 Potential riparian/shoreline restoration opportunities along Nepean Creek

Debris buildup with both natural debris and pollution on Nepean Creek

Potential Instream Restoration Opportunities

Garbage clean up

Nepean Creek would benefit from a garbage clean up in almost any area of the creek (Figure 33). As mentioned in page 9, pollution was observed in almost all sections of the creek due to its residential surroundings and high stormwater input. The system can benefit from more frequent stream and shoreline clean-ups along the highlighted areas in Figure 33.

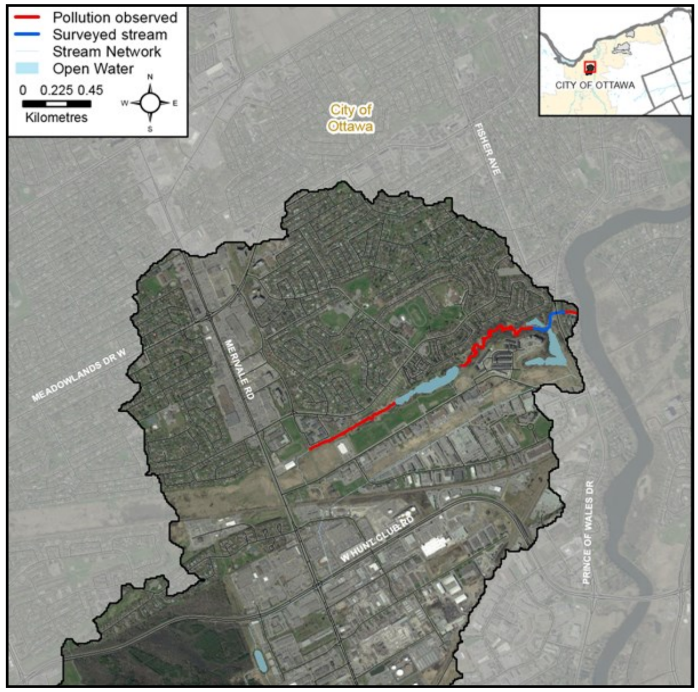

Figure 33 Pollution observed along Nepean Creek

Stormwater outlet partially blocked with garbage and debris; out-letting into Nepean Creek



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For more information on the overall 2018 City Stream Watch Program and the volunteer activities, please refer to the City Stream Watch 2018 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**: South Nation Conservation Authority, Mississippi Valley Conservation Authority, City of Ottawa, Ottawa Flyfishers Society, Ottawa Stewardship Council, Rideau Roundtable, Canadian Forces Fish and Game Club, and the National Capital Commission