CITY STREAM WATCH 2010

City Stream Watch
2010 Annual Report

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Executive Summary

This document summarizes the activities of the City Stream Watch program for the 2010 season. The program is headed by a partnership of six groups from the Ottawa area:

- *The Heron Park Community Association*
- *The Rideau Valley Conservation Authority*
- *The City of Ottawa*
- *The Ottawa Flyfishers Society*
- *The Rideau Roundtable*
- *National Defence Headquarters Fish and Game Club*

Working together, these organizations help outline a program that fulfills many of the community's needs for environmental information and promotion of local streams within the municipality. The goal of the program is to obtain, record and manage valuable information on the physical and biological characteristics of streams in the City of Ottawa, while ensuring that they are respected and valued natural features of the communities through which they flow. To this end, the program relies on and encourages the interest and commitment of volunteers from the community, guided by an experienced coordinator, to learn and conduct macro stream assessments on local waterways over a five-year cycle. Volunteers also participate in sampling fish communities through seining and electrofishing, aquatic invertebrate sampling, assisting in stream clean-ups and habitat rehabilitation projects such as riparian planting. The City Stream Watch program uses a macro stream assessment protocol originally developed by the Ontario Ministry of Natural Resources. To facilitate its use by community volunteers, the Rideau Valley Conservation Authority has since altered the protocol to improve and enhance the information collected.

In 2010, two streams originally sampled in 2005 were re-surveyed: Graham Creek and Green's Creek. Steven's Creek was originally surveyed in 2005 as well, but was postponed for a year and will be surveyed in 2011. In exchange, City Stream Watch sampled Brassil's Creek, which was originally surveyed in 2006 and is a subwatershed adjacent to Steven's Creek. On Graham Creek and Brassil's Creek, anthropogenic alterations appear to have increased; however most of these can be attributed to changes in the survey and not along the creek (see individual creek summaries). Bank stability appeared to have improved on Green's Creek and again, this can be attributed more to changes in the survey than actual improvements on the creek. Visual observation confirms there have been no major improvements. In Brassil's Creek and Graham Creek, more instream vegetation was present than in 2005 and 2006. In all three creeks, there was an increase in the incidence of garbage. The most significant change on all creeks is the expansion of invasive species. On Graham and Green's, there was a minimum of one invasive species noted for 98 percent of the sections surveyed. On Brassil's Creek, all sections surveyed had observations of invasive species. Fish sampling methods and frequency have improved, and therefore, there has been a large increase in the number of fish species recorded. Comparisons can be seen in the results section. In addition to Graham, Green's and Brassil's, McEwan Creek was completed, which had previously not been surveyed.

A total of 216 volunteers from the community participated in the program throughout the spring, summer and fall, contributing a total of 1422 hours working on various projects. Approximately 30.5 kilometres of stream were surveyed in 2010. Volunteers also participated in fish sampling, collecting fish data on 23 sites throughout the city.

In 2011, Beckett's Creek and Pinecrest Creek will be re-surveyed (originally surveyed in 2006), along with Steven's Creek. Creeks are re-surveyed every five years to observe positive/negative trends that may be occurring. The data will complement work conducted by certain municipal and regional programs. In addition, the intrinsic value of community-based environmental monitoring and stewardship through personal involvement will be further developed.

2010 Funding Partners and Program Support

Monterey Inn Resort and Conference Centre

Monterey Inn Resort and Conference Centre has been a long-time supporter of the City Stream Watch program. Monterey staff generously donates lunches, snacks and beverages for various projects to reward volunteers for their efforts. The City Stream Watch program and the volunteers would like to extend an enormous thank you to Jason Kelly (General Manager), Doris Kwok (Director of Marketing) and their talented and wonderful staff at the Monterey Inn Resort for their continued support of the program.

Earth Day Canada, Community Environment Fund

In 2010, City Stream Watch received $8956 in funding from the Earth Day Canada Community Environment Fund. This funding went towards program equipment for staff and volunteer use. The City Stream Watch program would like to extend their sincere thanks for this funding. It is greatly appreciated.

Community Environment Fund

Acknowledgements

A very large and sincere thank you to all the volunteers who spent time with the program this season. The dedication and enthusiasm that you bring to the program is always inspiring and very much appreciated.

Thank you to Jason Kelly (General Manager), Doris Kwok (Director of Marketing) and the incredible staff of the Monterey Inn Resort and Conference Centre for donating sandwiches and drinks for volunteers during our full-day events throughout the summer and fall of 2010. The food is always very much appreciated by everyone!

Thank you to the City Stream Watch collaborative for continuing to support and guide the program. Many initiatives and ideas would not happen without you.

Thank you to **Bruce Clarke** and members of the **Ottawa Flyfishers Society** for running the very popular fly fishing demonstration, sponsoring our summer student and their help with organizing, recruiting and completing the tree plant and invasive species removal on Green's Creek.

Thank you to **Bill Graham** for organizing the "Adopt" volunteers for Green's Creek.

Thank you to **Peter Stewart-Burton** of the **National Defense Headquarters Fish and Game Club** for assisting with organization and completion of both Sawmill Creek cleanups and for piloting "Adopt a Stream" on Sawmill Creek. Thank you to the club members for assisting the cleanups.

Thank you to **Brian Bezaire** for assisting with the July fish demonstration on Green's Creek.

Thank you to **Bruce Froats** from **Hydro One** for finding and accessing bioengineering harvest sites and for taking great photographs!

Thank you to **Julie Mulligan** and **Valérie Rouette** from the **NCC** for coordinating tree planting locations.

Thank you to **Chuck Wheatley** and **Frank Dutrisac**, Area Managers with the **City of Ottawa Parks Department** and their staff for arranging dumpsters to be delivered and removed during the cleanup efforts on Sawmill and Bilberry Creek.

Thank you to **Harold Moore**, **Orleans Propane** and **Terry Fox Elementary School** for allowing City Stream Watch to use their parking lots for the Bilberry Creek garbage cleanup.

Thank you to **Pineview Golf Course** for their co-operation with the City Stream Watch tree plant along Green's Creek and site access for monitoring.

Thank you to **Gemma Kerr** of the **Urban Rideau Conservationists** for all the organizational work for the Mothers Day Cleanup on the Rideau River.

Thank you to **Francois Trudel** of the **4th Orleans Venture Company** for organizing the Green's Creek cleanup and fish demo.

Thank you to **CBC Radio** for taking an interest in the City Stream Watch program and featuring us on their station.

Thank you to **Tom Spears** of the **Ottawa Citizen** for his continuing interest in our City Stream Watch.

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Appendices

1.0 Introduction

1.1 City Stream Watch – An Evolving Program

The health of Ontario's water resources is of paramount importance to its citizens. A dependable supply of clean freshwater is critical to a strong economy and high quality of life, and can only be achieved through proper management of all water supplies. Water resources are threatened by a myriad of stresses, including urbanization and development, pollution, and public apathy. The City Stream Watch program obtains, records and manages valuable information on the physical and biological characteristics of streams in the City of Ottawa. From this data, areas of concern are identified and remediation projects initiated, with the goal of ensuring that city streams remain respected and valued natural features of the communities through which they flow.

1.2 Partners of the City Stream Watch Program

The City Stream Watch program was initiated in 2003 through a partnership of six groups from throughout the City of Ottawa. Without the help and dedication of these organizations the Stream Watch program would not have become the success it is today.

The Heron Park Community Association

The Heron Park Community Association, created in the mid 1980s, functions as a representative body in protecting community interests, supports programs that provide safety and information for community residents, and encourages social and recreational community activities. The Association was the lead organization of the City Stream Watch program and aids in training and recruiting volunteers and organizing conservation efforts on Sawmill Creek.

The Rideau Valley Conservation Authority

Conservation Authorities in Ontario ensure the protection and restoration of Ontario's water, land and natural habitats through responsible management by providing programs that balance human, environmental, and economic needs. In 1966, in response to the above needs as they relate to the Rideau River watershed, the Rideau Valley Conservation Authority (RVCA) was established. The RVCA delivers a wide range of watershed management services to the community, including:

- Floodplain management
- Aquatic environment monitoring and reporting
- Land use and development review
- Regulations administration and enforcement
- Watershed management planning
- Stewardship advice and incentives programs
- Conservation information

The RVCA provides technical management and supervision to the City Stream Watch program to ensure the environmental data is collected, managed and stored to meet appropriate standards.

The City of Ottawa

The City of Ottawa is dedicated to monitoring and improving the natural environment, including water resources, of the municipality. The city's evolving environmental strategy works to ensure that environmental management is an integral part of its practices and policies. The City of Ottawa helps to coordinate, provide technical assistance and recruit volunteers for the City Stream Watch program.

The Ottawa Flyfishers Society

The Ottawa Flyfishers Society is dedicated to promoting flyfishing as well as fish habitat conservation. The Society helps to recruit volunteers for the City Stream Watch program and concentrates its efforts on monitoring, maintaining and improving the natural beauty and health of Greens Creek.

The Rideau Roundtable

The Rideau Roundtable is an incorporated not-for-profit association of individuals, community organizations and government agencies working together to keep the Rideau and Cataraqui Watersheds from Ottawa to Kingston healthy - socially, economically and environmentally.

National Defence Headquarters Fish and Game Club (NDHQ)

The NDHQ Fish and Game Club is dedicated to observe and practice sound conservation of all wildlife and its habitat; to respect the property rights of others; to assist the authorities with implementing conservation measures for the benefit of the community; and to oppose activities such as poaching or pollution that are prejudicial to sound conservation of wildlife and its natural habitat, so as to provide a continuing source of enjoyment for all its present and future members. The NDHQ works closely with the City Stream Watch program to help maintain the health of Sawmill Creek, South of Walkley Road.

1.3 Stream Selection in 2010

In 2010, two of the original three streams from 2005 were re-surveyed. Those creeks were Graham Creek and Green's Creek. Steven's Creek was the third stream that had been surveyed in 2005, but it was switched with Brassil's Creek, originally surveyed in 2006; consequently, Brassil's Creek was surveyed in 2010, and Steven's Creek will be surveyed in 2011. In addition, McEwan Creek was surveyed for the first time in 2010. Figure 1 shows the locations of the 2010 sample streams as well as all streams sampled from 2003 to 2012.

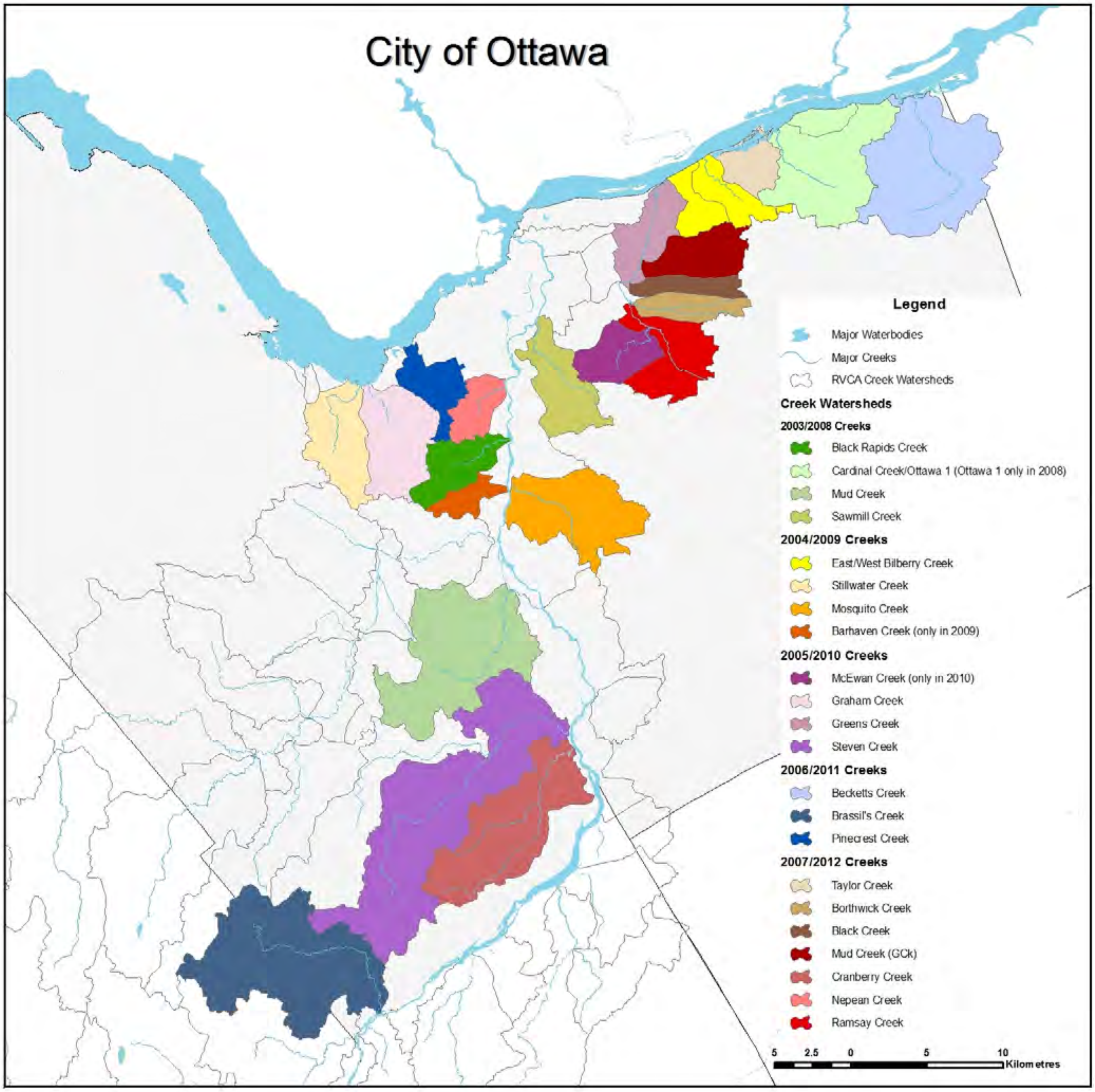


Figure 1. Locations of Streams and Their Watersheds on the 2003-2012 Sampling Schedule

1.4 Stream Study Comparison 2005/2006/2010

The following chart is a comparison summary of activities done on each creek in 2005, 2006 and 2010. Volunteer numbers continue to increase as the program has incorporated more activities and gained greater recognition within the community. In 2005, there were 110 volunteers and over five years, that number has grown to over 200.

ACTIVITIES	McEwan 2010	Brassil's 2006	Brassil's 2010	Graham 2005	Graham 2010	Green's 2005	Green's 2010
Number of sections surveyed	24	68	82	67	64	124	135
Number of volunteers	9	N/A	26	N/A	90	N/A	104
Total volunteer hours	26	105	170.5	N/A	364	N/A	480
Number of fish sampling sites	5	2	6	3	6	2	6
Number of temperature probes	2	2	4	2	4	2	4

Table 1. Stream Study Comparison Between 2005, 2006 and 2010

2.0 Methodology

2.1 The Stream Watchers – The Heart of City Stream Watch

City Stream Watch garbage cleanup on Sawmill Creek

The City Stream Watch program relies on and encourages the interest and commitment of volunteers from the community in order to fulfill its goal. Two formal training sessions for interested volunteers were held in May 2010. Informal training sessions for individuals or small groups were conducted throughout the field season to ensure that everyone had an opportunity to participate in the program. Volunteers were guided through the stream assessment protocol used for monitoring the streams (Appendix A), given a summary and definitions handout for future reference (Appendix B) and shown the equipment used in sampling (Appendix C). RVCA staff then demonstrated the entire process for sampling one section of stream.

2.2 The Macro Stream Assessment Protocol

The City Stream Watch program utilizes a macro stream assessment protocol. The protocol was originally used by the Ontario Ministry of Natural Resources, but has been modified by the RVCA to make it more effective for RVCA monitoring purposes and to create a more user-friendly protocol for community volunteers. In 2008, changes were made to the field sheets to provide more detail in the stream data. Many observations such as bank stability, buffer size, substrate type and instream vegetation, are now recorded in percentages, with some divided even further, into percentages for left bank and right bank. The new field sheets are attached in Appendix A.


Volunteer using the YSI

Streams are sampled in 100-meter sections. At the start of each section, the date, time and section number are recorded. Global Positioning System (GPS) coordinates are taken using a handheld GPS, pre-programmed for the NAD 83 Datum and displaying Universal Transverse Mercator (UTM) coordinates. These parameters were chosen to facilitate analysis and display of City Stream Watch data with other spatial information already digitally recorded in the RVCA's existing spatial database. Overhead cloud cover is estimated and recorded as a percent, air temperature in degrees Celsius is recorded, and a photo upstream is taken. Water temperature is recorded in degrees Celsius. Stream width is measured to the nearest tenth of a meter using a 60-meter tape at right angles to the banks at water level. Stream depth is measured using a meter stick, at the deepest point across the width of the stream.

After all necessary measurements are recorded for the start of the section, one volunteer remains at the start of the section and holds on to one end of the tape while the others begin walking upstream holding the other end. Volunteers walking upstream are asked to remember observations on land use, anthropogenic alterations of the stream, substrate characteristics and instream vegetation, bank characteristics and vegetation on the banks, tributaries, agricultural impacts, presence of wildlife and habitat, pollution and other characteristics as outlined in the macro stream assessment form. When the measuring tape reaches 50 metres, the volunteer left behind joins the others at the 50-metre mark, observing the stream characteristics while walking up.

Water temperature, stream width and stream depth are again recorded at the mid-way point of the section. The procedure used for observing the first 50 metres of the section is repeated for the second 50 metres, thereby completing a 100 metre section. Water temperature, stream width, and stream depth are recorded at the end of the section. The UTM coordinates are recorded for the end of the section and a photo is taken downstream. The volunteers then discuss what they observed, and the macro stream assessment form is filled out for the section. The entire procedure is repeated for each 100 metres section of stream.

2.3 Fish Sampling

This year's City Stream Watch program sampled a total of 23 fish sites on the four creeks. Sampling methods included seine netting, electrofishing and traps (windemere traps, fyke nets). The fish sampling methods are chosen based on habitat characteristics of the site and time of year. The number of sites is based on stream length. On average, City Stream Watch chooses four sites on each creek, and each of those sites is monitored once per month from April to July. Once the fish sampling method is determined, sampling is carried out either with staff or staff and volunteers, depending on date, sampling method and site conditions. After the fish are caught, they are identified, weighed, measured (only certain species) and then released back into the stream. Two fish demonstrations were held in July, and individual volunteers were taken out during other sampling occasions.

Seine Netting

Seine netting is an effective way to sample fish communities in streams, rivers and lakes. Seine nets are dragged through the water column to collect fish in the near shore area. The data is used in conjunction with other methods to determine fish communities and distributions.

Fyke Net

Fyke net set on Green's Creek

A fyke net is a modified hoop net. The net consists of round hoops with funnels leading to the next hoop, followed by a square hoop, joined together with mesh (mesh size, number of hoops and hoop sizes vary). From the square hoop, a lead line is pulled straight out and weighted down. There is a wing on each side of the square hoop which lead out on 45 degree angles, towards the banks. The other end (cottend) of the hoop net is secured with either a weight or an object. The cottend is tied together with a rope to allow for easy processing. The fish find the lead line or a wing and are led into the hoops. Fyke nets can be used in shallow or deeper waters and are good alternatives in places that are difficult to seine or electrofish, for example, at the mouth of a larger stream. The nets can be set up from 24 hours to multiple weeks, but they must be checked every 24 hours to release any fish that have been caught.

Windemere Trap

Windemere trap

A windemere trap resembles a lobster trap, only with a metal frame covered in mesh. Mesh funnels at either end guide the fish into the trap. Windemere traps are used in shallow areas, with either slow or fast moving water. They are used on electrofishing sites in April and May during peak spawning periods.

Electrofishing

Electrofishing is one of the key tools used to effectively sample fish communities. Electricity is passed through the water using a backpack electrofisher which causes a muscle response reaction in fish, temporarily stunning them while the netters scoop them from the stream and place them in a recovery bucket. Electrofishing very seldom kills fish if the correct voltages are used. This makes it the most effective way to sample fish from a variety of habitats in otherwise hard to access areas of stream. Once the data is recorded the fish are returned to the area of stream from where they were collected.

Water Chemistry

Water chemistry data was taken prior to fish sampling using a YSI probe. This instrument measures water temperature, dissolved oxygen (DO), pH, and conductivity. Water temperature of a stream is classified into warm, cool and cold water systems. Temperature has a major influence on the biota found in a stream system. Dissolved oxygen is what stream-dwelling species such as fish and invertebrates use to breathe. Fast flowing, cold water will have higher dissolved oxygen content than slow moving warm water. This is because cold water has the ability to hold more oxygen as it constantly churns, thereby incorporating air from the atmosphere into the water. Conductivity is a measure of the water's ability to pass an electrical current. It is primarily affected by the geology of the area in which the stream flows but is also largely affected by stormwater runoff. Streams with clay soils tend to have a higher conductivity because of ionized materials in the water. The pH of water is a scale used to evaluate the alkalinity or acidity of water and is ranked on a scale of one to 14. Acidity increases as pH gets lower (seven being neutral). The pH determines the solubility and availability of nutrients and heavy metals to stream dwelling organisms.

2.4 Stream Clean-Ups

Garbage collected from Sawmill Creek

In 2010, a total of four stream cleanups were held: one on the Rideau River, two on Sawmill Creek and one on Bilberry Creek. Volunteers were guided in the safe and appropriate removal of garbage from the creek bed and riparian areas. Only human-made (unnatural) materials were removed. Natural debris (i.e. sticks, logs, vegetation) was not removed as it provides valuable habitat for fish and stream dwelling organisms.

2.5 Riparian Planting/Fish and Wildlife Habitat Rehabilitation

In 2010, four riparian planting initiatives were carried out on streams in the City of Ottawa. In partnership with the NCC, approximately 700 trees and shrubs were planted on two sites along Green's Creek. Another two plantings were completed on Pinecrest Creek with 300 trees and shrubs. The goals of the plantings were to try and increase shade and habitat in the riparian area, protecting the shoreline and stabilizing the tablelands above the riparian areas. Additional planting opportunities have been identified for 2011 in conjunction with RVCA's Shoreline Naturalization Program and will commence in the spring.

Volunteers at Pinecrest Creek planting

2.6 Data Management

All data collected, as well as photos taken as part of the City Stream Watch program, have been entered and are maintained in a spatial database by the RVCA. Data on human alterations, instream vegetation, fish habitat, instream pollution or garbage, bank characteristics and invasive species is available for each section of the stream that was surveyed. Data collected is valuable and is used on a variety of levels. Various organizations and community groups throughout the City of Ottawa use City Stream Watch data for:

- Identifying potential rehabilitation projects (riparian and fish habitat)
- Identifying stream cleanup opportunities
- Subwatershed Plans (RVCA/City of Ottawa)
- RVCA Planning and Regulations Review
- NCC rehabilitation projects (e.g. Pinecrest Creek Rehabilitation Project)
- Long-term monitoring of urban streams
- *Fisheries Act* Review
- Private consultants as background data

3.0 Results

3.1 The Community Response

A total of 216 volunteers from the community participated in the 2010 City Stream Watch program, not including school or scout groups. Volunteers consisted of people from a variety of backgrounds and experiences. Each volunteer approached the work in a slightly different way, contributing their own unique qualities to enhance the program as well as the experience of their fellow volunteers. The most significant quality they brought with them was their dedication to the environment in which they live. As a result, 1,422 volunteer hours were given to learning about, sampling and rehabilitating urban and rural streams in the City of Ottawa. Table 2 summarizes volunteer activities for the 2010 season.

	Brassil's	Graham	Green's	McEwan	Sawmill	Bilberry	Pinecrest	Stillwater	Rideau	Jock	Total
Number of sections surveyed	82	64	135	24	N/A	N/A	N/A	N/A	N/A	N/A	**305**
Fishing events	1	1	1	0	N/A	N/A	N/A	N/A	N/A	1	**4**
Fish sites	6	6	6	5	N/A	N/A	N/A	N/A	N/A	N/A	**23***
Number of Fish Sites Sampled from April to July	14	19	19	6	N/A	N/A	N/A	N/A	N/A	N/A	**58**
Number of training sessions	1	1	0	0	1	N/A	N/A	N/A	N/A	N/A	**3**
Number of cleanups	0	0	0	0	2	1	0	0	1	N/A	**4**
Number of kilometres (km) Cleaned	N/A	N/A	N/A	N/A	2.5	2.0	N/A	N/A	1.6	N/A	**6.1**
Number of tree plantings	0	0	2	0	0	0	2	0	N/A	N/A	**4**
Number of invasive species removal	0	1	2	0	0	0	0	1	N/A	N/A	**4**
Number of Volunteers (total for all events)	26	90	104	11	33	13	31	9	1	34	**N/A****
Number of Volunteer Hours	**170.5**	**364**	**480**	**26**	**94**	**52.5**	**77.5**	**10**	**3.5**	**164**	**1442*****

Table 2. City Stream Watch Accomplishments of 2010

*Sites sampled multiple times between April and July for a total of 70 visits overall

**Many volunteers participated in surveys and events on more than one creek; actual total volunteer count for 2010 is 216, not including school and scout groups

***Does not include school or scout groups

3.2 Environmental Monitoring

3.2.1 McEwan Creek

The headwaters of McEwan Creek begin east of Albion Road, close to the Canadian National Railway line and yard; in this area, flow is seasonal and intermittent. The headwaters enter the Eastern Community trunk sewer, west of Conroy Road, and re-emerge between Hawthorne Road and Russell Road. The stream continues to flow east, crossing Russell Road and Highway 417, where it then flows into Ramsay Creek. Ramsay Creek flows into Green's Creek, which then flows into the Ottawa River. The majority of the McEwan Creek watershed is developed, and the open areas that remain are subject to future development. McEwan Creek is one of the tributaries to Green's Creek, and it is the most urbanized of all of the catchments within the Green's Creek watershed (JTB Environmental Systems Inc. & J.F. Sabourin & Associates Inc., 2009). The watercourse has been heavily impacted; the landuse in the McEwan watershed is mainly industrial/commercial, infrastructure (railways, power transmission corridors, roads) with some open space and a residential area (Eastern community of Ottawa). As a result of land use changes in the subwatershed, McEwan Creek is a flashy system. McEwan Creek was re-directed to join the Mather Award Ditch, just upstream of Highway 417. The Mather Award Ditch transports stormwater from the residential area north of Walkley Road and the industrial and commercial lands south of Walkley Road, including a parking lot drainage ditch (CH2M Gore & Storrie Limited, 1999).

The bedrock geology of McEwan Creek consists of interbedded shale, limestone and siltstone. The surficial geology is made up of sand, silt, clay and till. A number of natural areas within the McEwan Creek watershed were evaluated on their environmental importance. Natural areas within the watershed include Jim Durrell Woods, Conroy Woods, Lorry Greenberg Bush and Swansea Woods, Stevenage Woods, and Pine Grove Forest. Out of all areas evaluated, Conroy Swamp and Hawthorne Marsh were determined to be of high significance. Conroy Swamp contains locally significant plant species and is the only deciduous swamp with a clay substrate within the City of Ottawa, although the swamp has been affected by the cutting and dumping of construction waste. Many of the natural areas and corridors that existed have been altered due to development, including the corridor linking the Pine Grove Forest to natural areas along Sawmill Creek (CH2M Gore & Storrie Limited, 1999).

McEwan Creek has been channelized in a few major areas between Blake Road and the mouth, resulting in a wide, shallow channel with few instream features. Fifty-nine percent of the length surveyed was considered channelized which can impair important stream functions. More rehabilitation projects could be carried out to help recreate stream meanders, stabilize eroding banks and enhance fish habitat in the form of pools, root wads and boulders. NCC has carried out a stream stabilization project upstream and downstream of Russell Road in 2004 to help stabilize the shoreline and enhance fish habitat. Another goal of the project was to slow water level fluctuation to help prevent flooding to residents further downstream. One of the habitat features included a small pool downstream of Blake Road that would provide a refuge area for fish in summer and winter months. Unfortunately, it has slowly filled with sediment and is therefore not functioning as it should.

Hunt Club Road is being extended to Highway 417, and it is being constructed adjacent to McEwan Creek. Future monitoring will be important to evaluate any impacts associated with this extension and to identify opportunities for mitigation. A site visit should be carried out after construction is complete to look at potential areas for shrub and tree planting. McEwan Creek is already a flashy system, due to its surrounding land use, and residents along the creek have reported major issues of flooding and dramatic water level fluctuations. Increased stormwater runoff from the Hunt Club extension should be designed so that it does not compound this existing problem. Stormwater also effects water quality, and past studies have shown levels of total phosphorus at the Russell Road crossing to be above the provincial standards, and total suspended solids reflected levels usually found in stormwater. Total phosphorus levels in the Mather Award Ditch also exceeded the provincial standards. Benthic invertebrate sampling indicated poor water quality, which supported the water quality results (CH2M Gore & Storrie Limited, 1999).

Despite surrounding land use and channelization, McEwan Creek does provide habitat to several species of fish, and residents continue to note many different species of birds and wildlife in that area. Fish sampling conducted in 1999 by consultants recorded eight species of fish (CH2M Gore & Storrie Limited, 1999). City Stream Watch conducted fish sampling at five sites and captured eight species of fish overall, which supports the report from 1999. Of the eight species caught, seven of those species were found at a site upstream of the Russell Road crossing and indicates that fish are moving up the system past Russell Road.

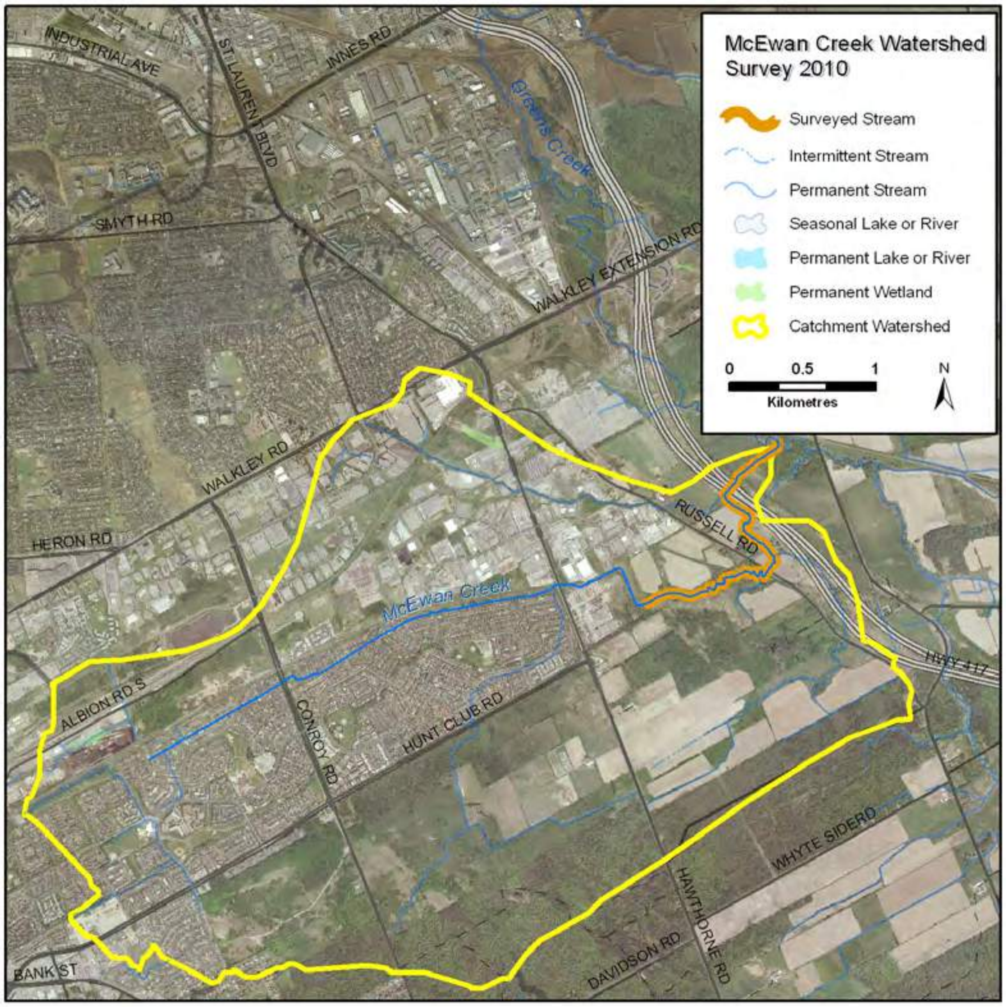


Figure 2. Air photo of McEwan Creek and Surrounding Area

Twenty-four sections or 2.4 kilometres of McEwan Creek were sampled in the 2010 season. The creek was surveyed in its entirety, from the mouth to where the stream emerges from the pipe. The surveyed sections are highlighted in orange in Figure 2, and the remaining blue section is where the stream is entombed (flowing underground in a pipe). The following is a summary of the 24 macro-stream assessment forms completed by technicians and volunteers. Observations concerning anthropogenic alterations, land use, stream morphology, in-stream substrate, in-stream vegetation, bank stability, buffer width, wildlife and pollution are discussed.

1. Observations of Anthropogenic Alterations and Land Use

Figure 3 illustrates the classes of anthropogenic alterations observed along McEwan Creek. Of the 24 sections sampled, only eight percent of the stream remained without any anthropogenic alterations. Sections considered natural, but with some anthropogenic changes made up 13 percent of the sections sampled, and 17 percent accounted for sections that were considered “altered” but still had natural features. Sixty-two percent of the sampled areas were “highly altered” with few natural portions. Areas that were listed as “altered” or “highly altered” were associated with road crossings, culverts, stormwater inputs, channelized sections or areas that had little or no buffer and little aquatic or wildlife habitat.

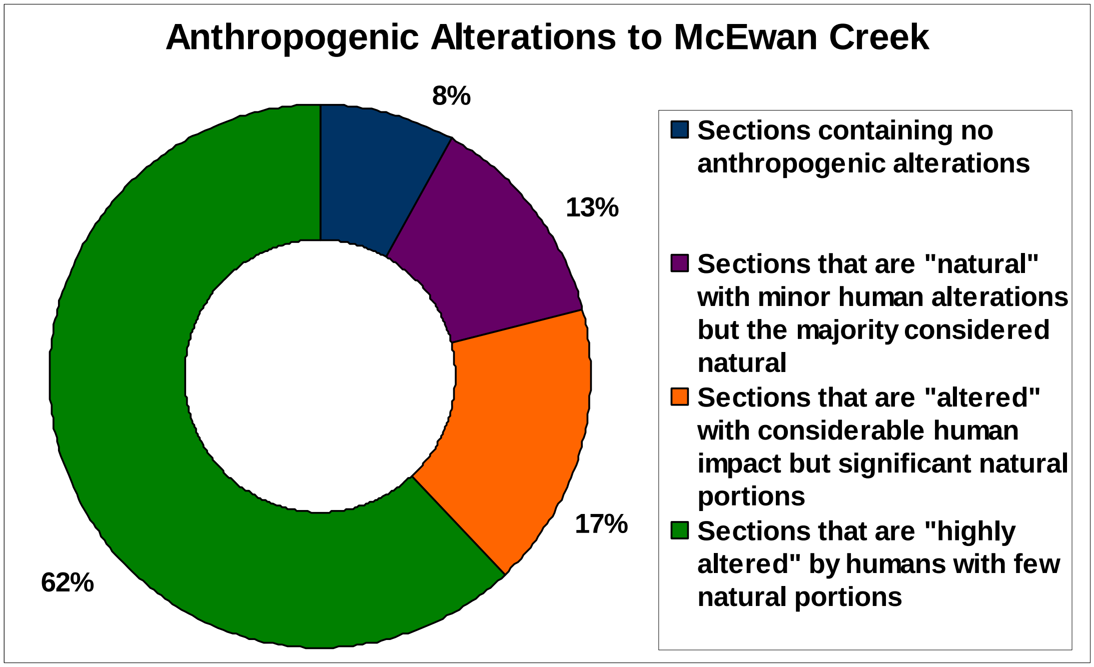


Figure 3. Classes of Anthropogenic Alterations Occurring Along McEwan Creek

McEwan Creek, highly altered

McEwan Creek, no alterations

2. Land Use Adjacent to McEwan Creek

Figure 4 demonstrates eight different land uses identified along the banks adjacent to McEwan Creek. Surrounding land use is considered from the beginning to end of the survey section (100m) and up to 100m on each side of the creek. Land use outside of this area is not considered for they surveys but is nonetheless part of the subwatershed and will influence the creek. Natural areas made up 56 percent of the stream, characterized by forest, scrubland and meadow. The other major land use was infrastructure, mainly Highway 417, the Hunt Club extension and other road crossings. Agricultural land use surrounding McEwan Creek accounted for seven percent and abandoned agriculture for two percent, mainly occurring east of Highway 417. Residential land use occurred around Blake and Russell Road and accounted for four percent.

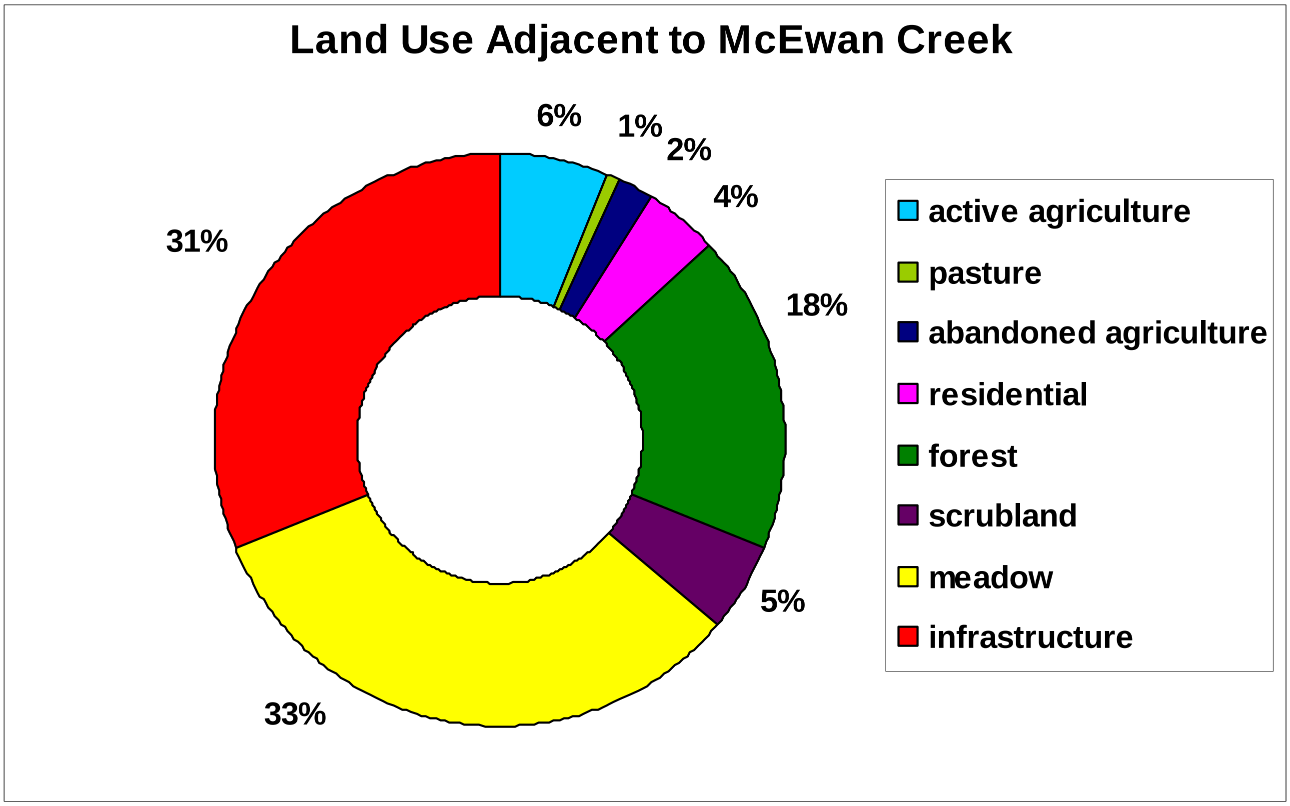


Figure 4. Land Use Identified by Volunteers along McEwan Creek

Land use at the mouth of McEwan Creek: mainly forest with some open meadow

3. Instream Morphology of McEwan Creek

Pools and riffles are important features for fish habitat. Riffles are areas of agitated water, and they contribute higher dissolved oxygen to the stream and act as spawning substrate for some species of fish, such as walleye. Pools provide shelter for fish and can be refuge pools in the summer if water levels drop and water temperature in the creek increases. Runs are usually moderately shallow, with unagitated surfaces of water, and areas where the thalweg (deepest part of the channel) is in the center of the channel. McEwan Creek is very uniform; eighty-two percent consists of runs with eight percent pools and 10 percent riffles, illustrated in Figure 5.

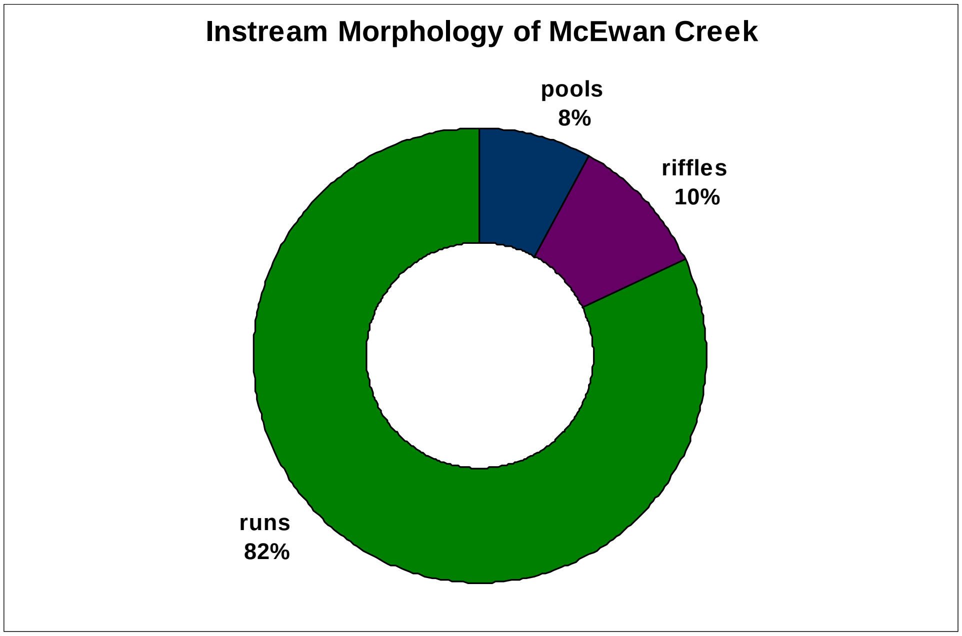


Figure 5. Instream Morphology of McEwan Creek

4. Types of Instream Substrate Along McEwan Creek

Diverse substrate is important for fish and benthic invertebrate habitat because some species will only occupy certain types of substrate and will only reproduce on certain types of substrate. Boulders create instream cover and back eddies for large fish to hide and/or rest out of the current, and cobble provides important over wintering and/or spawning habitat for small or juvenile fish. Other substrates also provide instream habitat for fish and invertebrates. A variety of substrate can be found instream along McEwan Creek, although over 38 percent observed was clay and 20 percent was sand. Other types of substrate that occurred in smaller proportions include gravel, cobble, boulder, muck, silt, detritus and bedrock.

Sandy clay substrate with cobble riffle, McEwan Creek

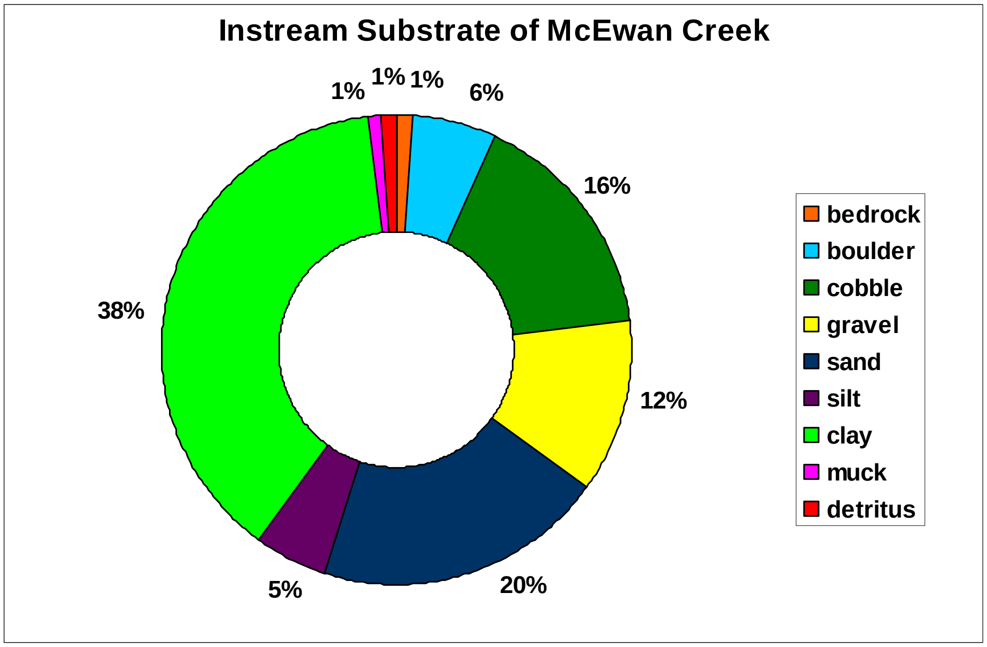


Figure 6. Types of Instream Substrate Along McEwan Creek

5. Observations of Instream Vegetation

Instream vegetation is an important factor for a healthy stream ecosystem. Vegetation helps to remove contaminants from the water, contributes oxygen to the stream, and provides habitat for fish and wildlife. Figure 7 demonstrates the frequency of instream vegetation in McEwan Creek.

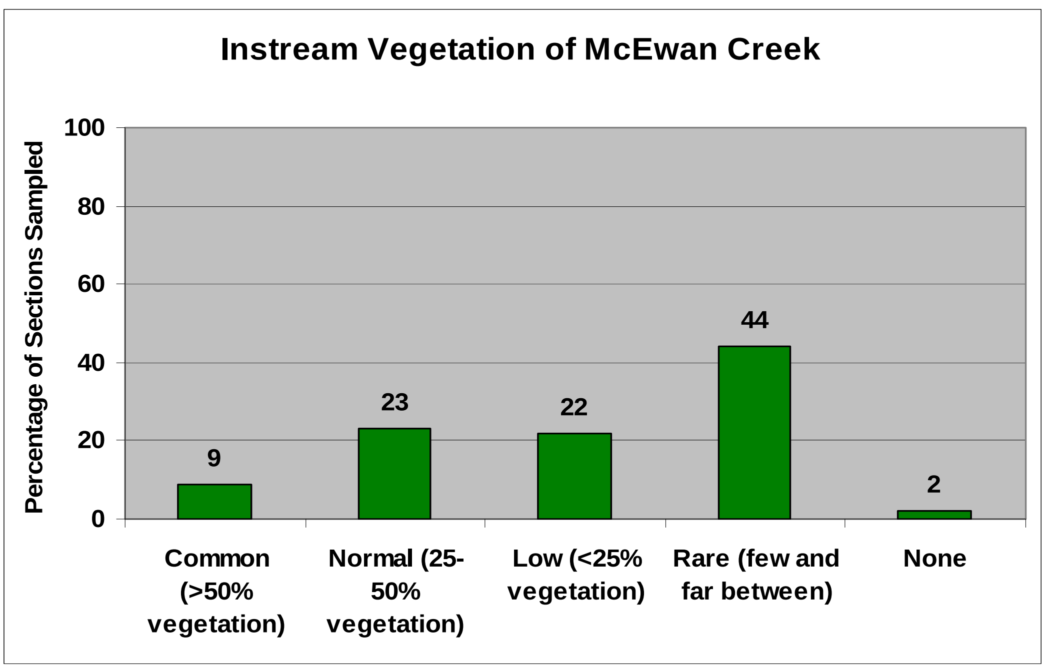


Figure 7. Frequency of Instream Vegetation in McEwan Creek

McEwan Creek did not have a healthy level or variety of instream vegetation. Only 32 percent was considered to have common or normal levels, and in these areas, the only type of vegetation observed was algae. Sixty-six percent of the stream was considered to have low or rare levels and two percent of the surveyed areas had nothing. Close to 40 percent of the instream substrate was clay, in which it would be difficult for instream vegetation to grow. In addition, flashy water level fluctuations could make it challenging for instream vegetation to establish itself.

6. Observations of Bank Stability

Erosion is a normal, important stream process and may not affect actual bank stability; however, excessive erosion and deposition of sediment within a stream can have detrimental effects to important fish and wildlife habitat. Bank stability indicates how much soil has eroded from the bank into the stream. Poor bank stability can greatly contribute to the amount of sediment carried in a waterbody as well as loss of bank vegetation due to bank failure, resulting in trees falling into the stream and the removal of aquatic plants, which provide habitat.

City Stream Watch recorded bank stability separately for left and right banks to obtain greater detail on the areas experiencing erosion. For McEwan Creek, stability was similar for both banks. Figure 8 shows the areas of erosion along McEwan Creek. Sixty-five percent of the left bank and sixty-six percent of right bank was considered stable. Although there were some banks showing exposed soil, direct slope stability did not appear to be compromised. The most severe erosion occurs east of Highway 417.

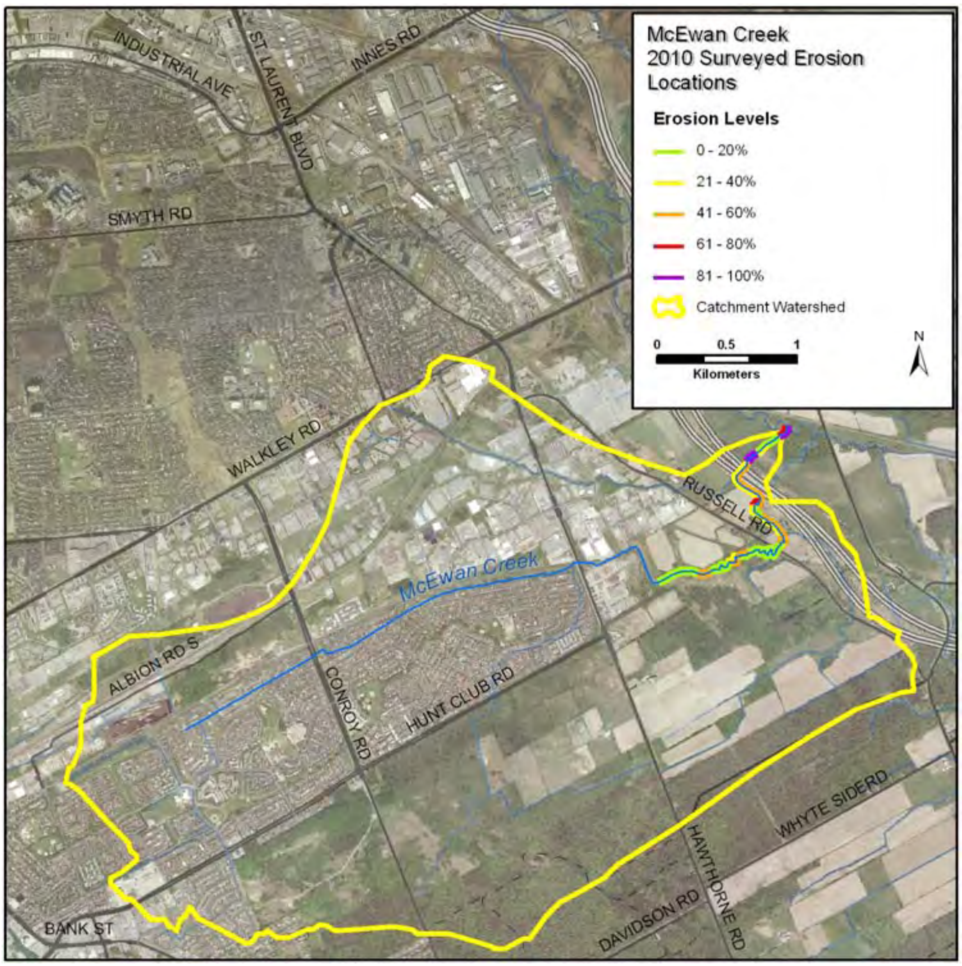


Figure 8. Left and Right Bank Stability of McEwan Creek

7. Buffer Evaluation of McEwan Creek

Natural buffers between watercourses and human alterations are extremely important for filtering excess nutrients running into the creek, infiltrating rainwater, maintaining bank stability and providing wildlife habitat. Natural shorelines also shade the creek, helping maintain baseflow levels and keeping water temperatures cool. According to the document *How Much Habitat Is Enough*, it is recommended that a stream have a minimum of 30 metres of riparian area or more (the more the better). Figure 9 demonstrates the buffer conditions of the left and right banks separately**.** Along McEwan Creek, five to six percent had a buffer of zero to five metres and six to seven percent had a buffer of 15 to 30 metres. There were large differences between left and right banks. Nineteen percent of the left bank had a buffer of five to 15 metres versus 42 percent on the right bank. Sixty-nine percent of the left bank had a buffer greater than 30 metres and the right bank only had forty-six percent. The buffer on the right bank was less mainly due to the Hunt Club Road expansion.

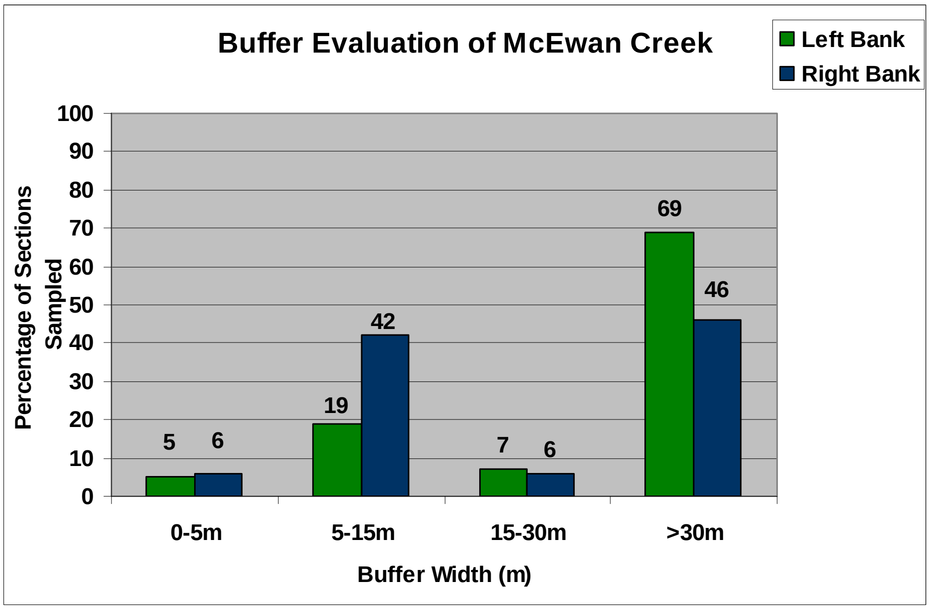


Figure 9. Buffer Evaluation of McEwan Creek

8. Observations of Wildlife

The diversity of fish and wildlife populations can be an indicator of water quality and overall stream health. Table 3 is a summary of all wildlife observed during stream surveys.

Wildlife	Observed While Sampling
Birds	grackle, yellow warbler, red-winged blackbirds, American robins, crow, chickadee, gray catbird, swallows, sandpipers, mallards
Mammals	deer, muskrat, weasel, chipmunk, red squirrel, mink
Reptiles/Amphibians	American toad
Aquatic Insects	leech
Fish (observed when walking)	minnow spp., darter spp.
Other	dragonflies, damselflies, cabbage white, spiders, mosquitoes, bumblebees, grasshoppers, ants, beetles, loosestrife beetle

Table 3. Wildlife Observed on McEwan Creek During Stream Surveys

9. Observations of Pollution/Garbage

Figure 10 demonstrates the incidence of pollution/garbage in McEwan Creek. Pollution and garbage in the stream is assessed visually and noted for each section where it is observed. All 24 sections surveyed had some sort of garbage, although it was not observed in large quantities. No observations of oil and gas trails or unusual colouration of the channel were made. Of the 24 sections, 54 percent of the garbage observed was floating in the water and 83 percent was caught on the stream bottom.

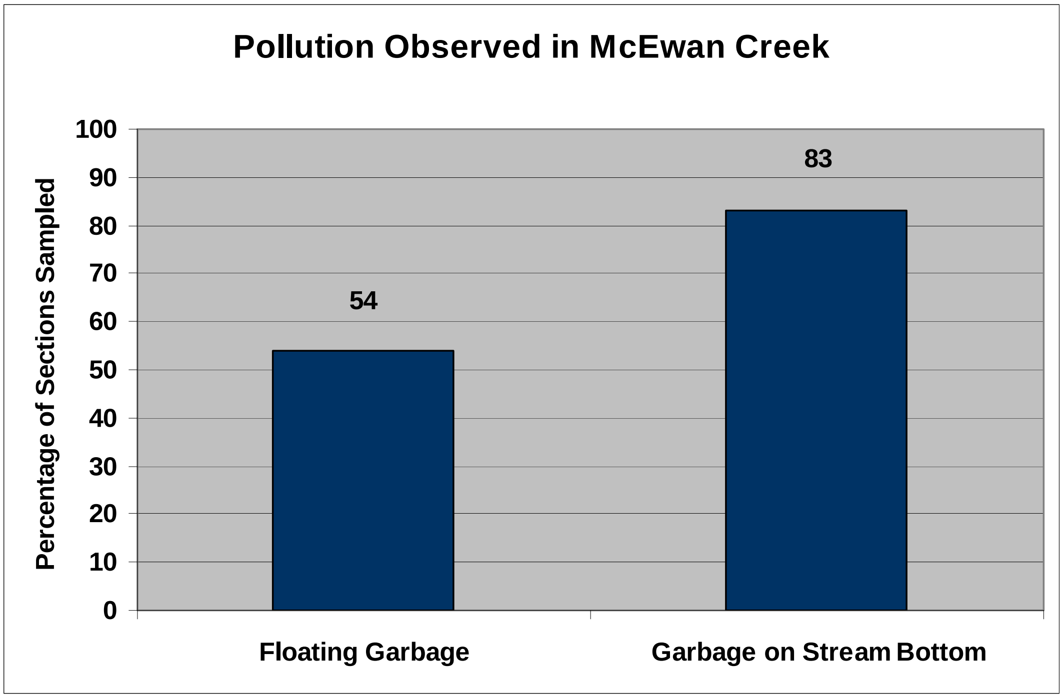


Figure 10. Frequency of Pollution/Garbage Occurring in McEwan Creek

Pollution observed includes garbage in the stream and along its banks. Much of it likely results in trash blowing in or being washed in from storm events, from residential areas, roadways or construction sites. The most common type of garbage observed were plastic items (wrappers, hose, textiles, etc.). Other types of garbage observed included tires, carpet, metal bars, license plate, scissors, broken fishing rod, foil, lawn chair, styrofoam, traffic pylons, tin cans, skipping rope, badminton racket and pop cans.

10. Fish Community Sampling

A total of five sites along McEwan Creek were sampled for fish. One site was established near the mouth of the creek; however it was only sampled once in April due to fluctuating water levels. When water levels were high, it was difficult to access the Highway 417 culvert. Sites two, three and five were sampled once, and site four was sampled twice. Windemere traps were used for the sampling on all sites, and on the fourth site, electrofishing was used in June. The fish sampling sites are shown in Figure 11.

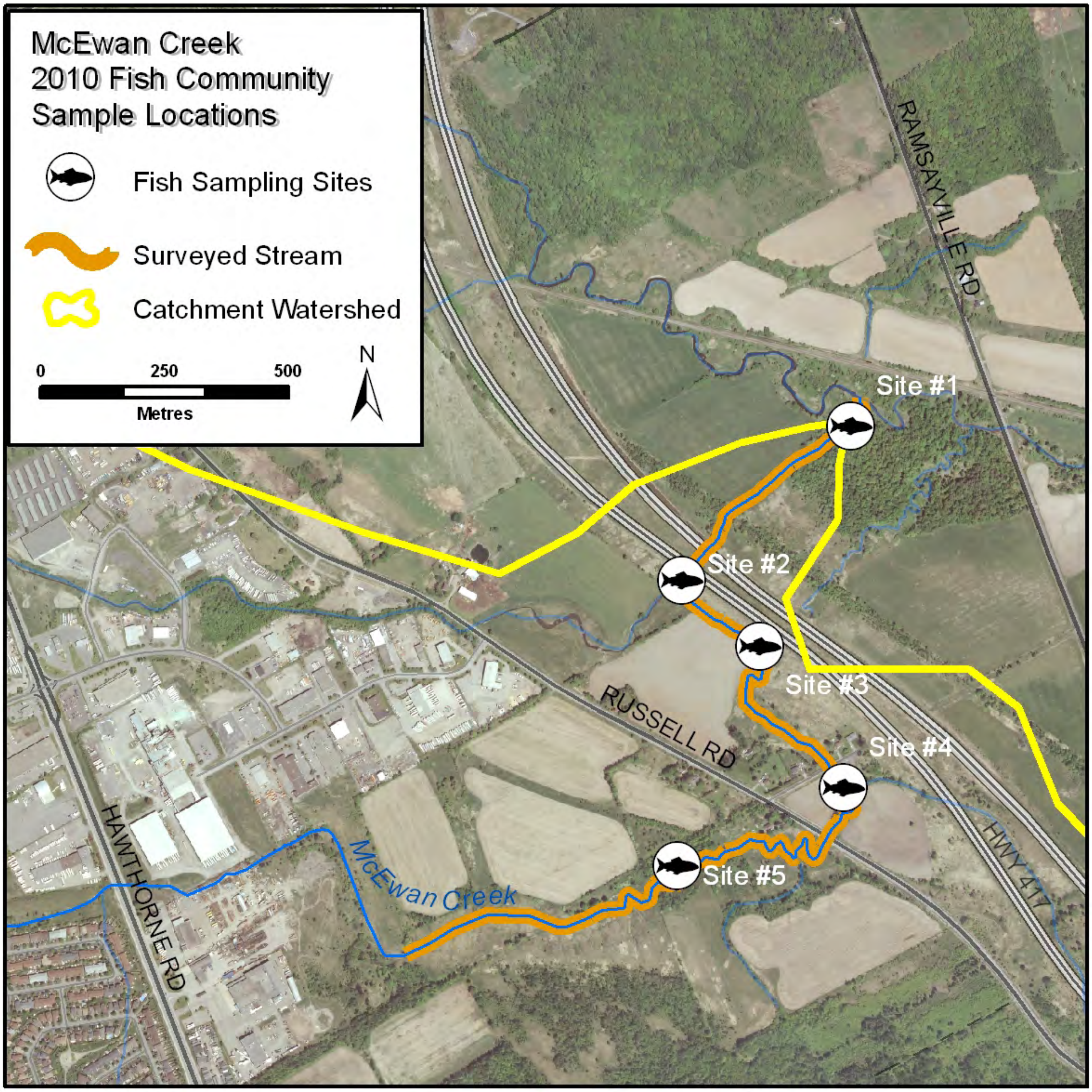


Figure 11. Air Photo of McEwan Creek Showing Sampling Sites

Table 4 summarizes the water chemistry for each fish sampling site and the fish species captured at each sampling event on McEwan Creek. A total of eight different fish species were collected. No top predators were observed within the system, but a variety of baitfish were caught. All fish were live released back to the stream after fish sampling. *Etheostoma spp* indicates that either Johnny darters or tessellated darters were captured. To differentiate between those species, the fish must be removed from the system and brought back to lab; to avoid this, they are only identified to genus level. A sunfish species was also captured, but it was too small to identify between pumpkinseed or bluegill and therefore is labeled as *Lepomis spp*. Three volunteers spent a total of 12 hours fish sampling on McEwan Creek.

Dorsal fins of *Etheostoma spp*.

Site #	Sampling Technique	Data (mm/dd/yy)	Air Temp (°C)	Water Temp (°C)	DO (mg/L)	pH	Conductivity (uS/cm)	Substrate	Instream Vegetation	Species Sampled	Total # of Species Caught
1	windemere trap	4/23/2010	6.65	6.72	17.57	8.14	1061	clay, muck	none	central mudminnow, brook stickleback, *Etheostoma spp.*	3
2	windemere trap	5/20/2010	19.31	11.88	12.14	7.89	1201	hardpan clay, cobble	extensive algae	brook stickleback	1
3	windemere trap	6/20/2010	23.93	17.2	13.7	7.73	2658	hardpan clay, sand, gravel	algae	creek chub, central mudminnow, blacknose dace, *Etheostoma spp*., white sucker	5
4	windemere trap	4/23/2010	19.95	8.63	20.44	8.28	810	hardpan clay, silt, boulder	algae	blacknose dace, creek chub, brook stickleback, central mudminnow, white sucker	5
4	electrofish	6/18/2010	18.49	14.96	10.67	7.69	1295	hardpan clay, silt, boulder	algae	creek chub, longnose dace, brook stickleback, blacknose dace, white sucker, central mudminnow, *Etheostoma spp.*	7

5	windemere trap	7/20/2010	24.5	17.88	13.68	7.67	2797	hardpan clay	algae	creek chub, blacknose dace, longnose dace, brook stickleback, white sucker, *Etheostoma spp.*, *Lepomis spp.*	7

Table 4. Water Chemistry and Fish Community Results for McEwan Creek

Fish Species Status, Trophic and Reproductive Guilds-McEwan Creek

Table 5 was generated by taking the fish community structure of Barrhaven Creek and classifying the recreational, commercial, or bait fishery importance, Species at Risk status, reproductive guild (spawning habitat requirements), thermal classification, and trophic guild (feeding preference). According to the MTO Environmental Guide to Fish and Fish Habitat (2006), all species within McEwan Creek, aside from white sucker, are significant to the baitfish fisheries. The fish community structure consists of cool water species with one cool/warm species. No species at risk fish were captured.

MNR Code	Common Name	Scientific Name	Recreational Fishery	Commercial Fishery	Bait Fishery	Status	Reproductive Guild	Thermal Classification	Trophic Guild
210	blacknose dace	*Rhinichthys atratulus*			X	none	non guarder, open substrate, Lithophils	cool	insectivore/ generalist
281	brook stickleback	*Culaea incontans*			X	none	guarder, nest spawner, Ariadnophils	cool	insectivore
141	central mudminnow	*Umbra limi*			X	none	non guarder, open substrate, Phytophils	cool/warm	insectivore/ omnivore
212	creek chub	*Semotilus atromaculatus*	X		X	none	non guarder, brood hider, Lithophils	cool	insectivore/ generalist
211	longnose dace	*Rhinichthys cataractae*			X	none	non guarder, open substrate, Lithophils	cool	insectivore
163	white sucker	*Catostomus commersoni*				none	non guarder, open substrate, Lithophils	cool	insectivore/ omnivore

Table 5. Fish Species Status, Trophic and Reproductive Guilds for McEwan Creek
(Source: *MTO Environmental Guide to Fish and Fish Habitat*, 2006).

Table 6 summarizes the fish community structure found in McEwan Creek and their sensitivity to sediment and turbidity for reproduction, feeding, and respiration. The composition of the fish community in McEwan Creek ranges from species that are moderately tolerant to those that are intolerant to sediment and turbidity. However, the majority of the species would be classified in the moderately tolerant range for reproduction and feeding. Four of the species (blacknose dace, creek chub, longnose dace, white sucker) have a higher sensitivity to sediment/turbidity for respiration, and a few of the species have a low sensitivity to sediment/turbidity for one of the three functions listed.

Fish Species Sensitivity to Sediment/Turbidity for McEwan Creek

MNR Code	Common Name	Scientific Name	Reproduction	Feeding	Respiration
210	blacknose dace	*Rhinichthys atratulus*	M	M	H
281	brook stickleback	*Culaea incontans*	L	M	unknown
141	central mudminnow	*Umbra limi*	M	M	L
212	creek chub	*Semotilus atromaculatus*	M	M	H
211	longnose dace	*Rhinichthys cataractae*	M	M	H
163	white sucker	*Catostomus commersoni*	M	L	H

Table 6. Fish Species Sensitivity to Sediment/Turbidity (High, Moderate, Low or Unknown) for McEwan Creek (Source: *MTO Environmental Guide to Fish and Fish Habitat*, 2006).

11. Temperature Profiling

Temperature is an important parameter in streams as it influences many aspects of physical, chemical and biological health. The temperature of a stream can vary considerably between the seasons as well as fluctuate between night and day. Many factors can influence fluctuations in stream temperature such as springs, tributaries, precipitation runoff and discharge pipes. The greatest factor of fluctuating temperature is solar radiation and runoff from developed areas. Streams with large amounts of riparian canopy cover will yield lower temperatures while areas with no trees may be warmer. The thermal classifications for cold, cool and warm water are as follows:

Status	Water Temperature
Cold	<19 Degrees Celsius
Cool	19-25 Degrees Celsius
Warm	>25 Degrees Celsius

Table 7. Water Temperature Classifications (Minns et al. 2001)

Two temperature loggers were set in McEwan Creek. One was placed near the mouth, downstream of Highway 417. The second temperature logger was placed upstream of Blake Road on the east side of Russell Road. The temperature loggers were set on April 7 and began recording temperatures every ten minutes at 11:20 until September 30 at 23:50. Figure 12 shows the location of the temperature loggers. Figure 13 shows the temperature logger results.

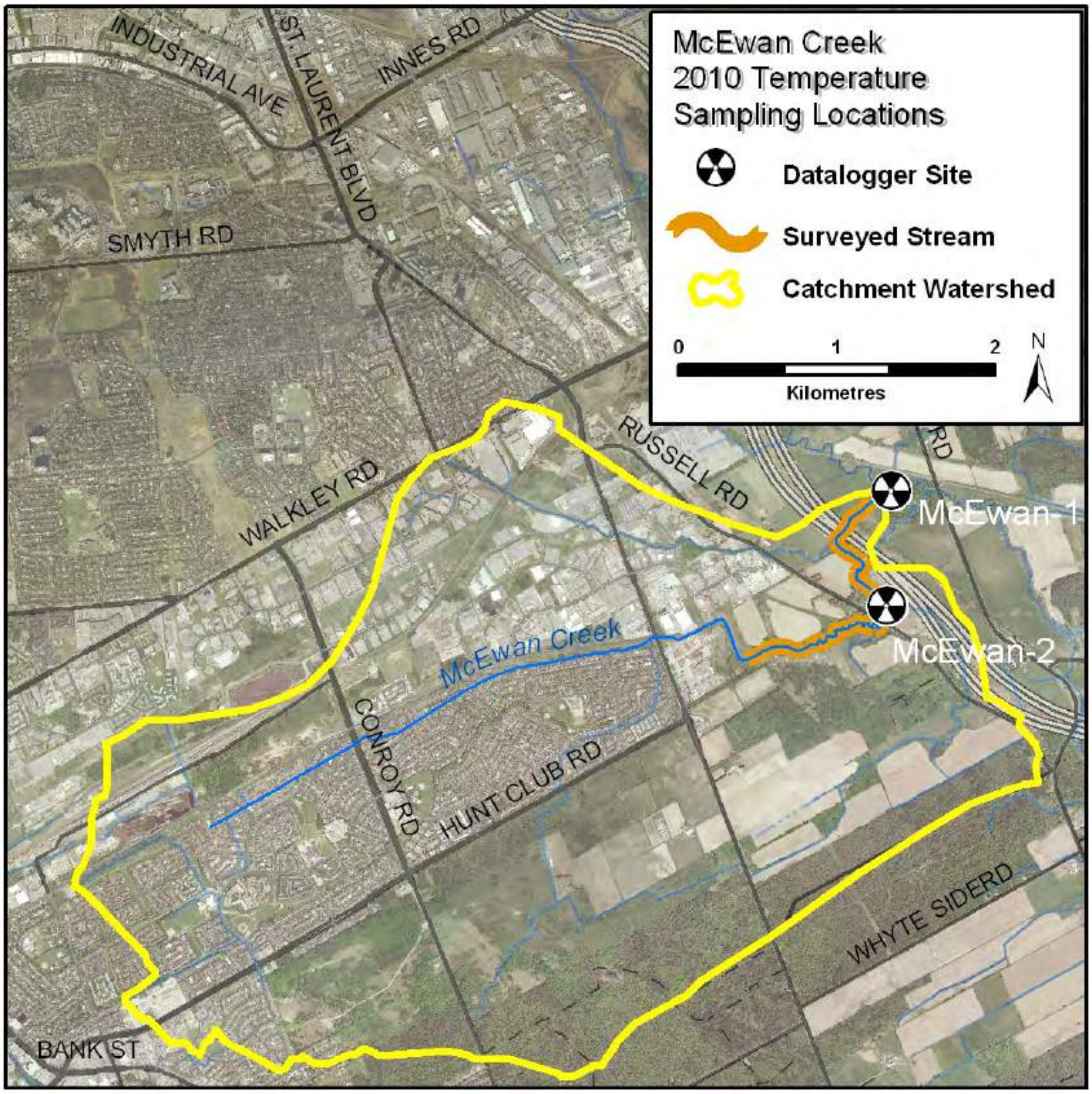


Figure 12. Datalogger Location Along McEwan Creek

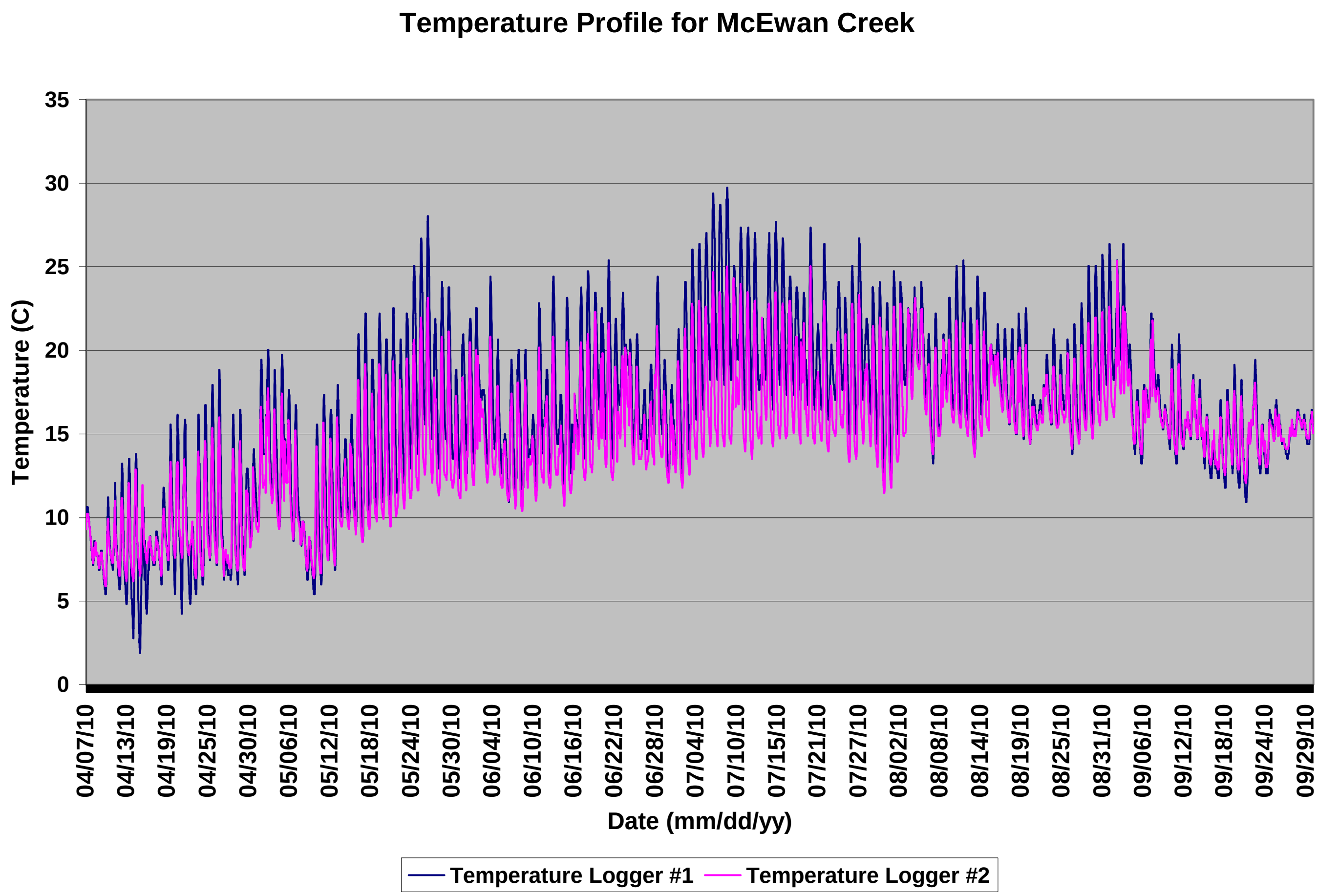


Figure 13. Temperature Profile for McEwan Creek

Figure 13 has a consistent trend of fluctuating temperatures from April to September. Over the testing period, the stream reached a maximum temperature of 29.74°C and a minimum of 1.89°C. Temperature logger 1 had the most extreme fluctuations and exceeded 25°C numerous times. Temperature logger 2 reached a maximum of 25.37°C and a minimum temperature of 5.89°C. The greater fluctuations for the first temperature logger could have been caused by the influence of stormwater, entering the stream from Mather Award Ditch or Highway 417. From Highway 417 to the mouth, McEwan Creek is fairly straight and open, and the channel is wide and shallow. Hot and cold air temperatures may have a greater effect in that area. The temperature logger was placed in a deep area, but if water levels dropped below the logger level for some of the fluctuations, the logger could have recorded air temperature as opposed to water temperature, resulting in higher extremes. For the majority of the season, temperatures ranged between the cool and cold water range.

The method for temperature classification is taken from the Ontario Stream Assessment Protocol, for which the temperature data is taken between 4 and 4:30pm, anywhere between July 1 and September 10, on days where maximum air temperature exceeds 24.5°C and after two previous days without precipitation and air temperatures surpassing 24.5°C. In 2010, there were seven days in July, four days in August and one day in September that met those requirements, for a total of 12 days. Temperature logger 1 rose above 25°C on nine of the 12 days. Temperature logger 2 did not exceed 25°C on any of those days, and the fish community results show a presence of seven cool water species and only one cool/warm species. Based on the stream temperature classification and fish community structure, McEwan Creek appears to be a cool water system with warm water reaches.

12. Invasive Species

Invasive species can have major implications on streams and species diversity. Invasive species are one of the largest threats to ecosystems throughout Ontario and can outcompete native species, having negative effects on local wildlife, fish and plant populations. These species originate from other countries and are introduced through global shipping containers, ship ballast water, pet trades, aquarium and horticultural activities, the live bait industry and more. Species such as European Frog-Bit (*Hydrocharis morsus-ranae*) can be transferred from waterway to waterway through seed dispersal and parts of plants caught on boats, boat trailers, fishing equipment, etc. (OMNR, 2008). Figure 14 shows the locations of invasive species found along McEwan Creek. Invasive species were observed in 98 percent of the surveyed sections, and often more than one species was present in the same area. The species observed were purple loosestrife (*Lythrum salicaria*), Manitoba maple (*Acer negundo*), garlic mustard (*Alliaria petiolata*), wild parsnip (*Pastinaca sativa*) and Himalayan balsam (*Impatiens glandulifera*). Out of the five species, garlic mustard and Himalayan balsam are of greater concern. Garlic mustard actually interferes with the relationship between tree roots and the soil, affecting the growth of the trees, making it quite problematic in natural areas. It spreads aggressively and needs constant pulling for several years in order to control. There are several methods of control being examined by the Nature Conservancy of Canada, on their properties. Himalayan balsam is a newly identified invasive species and where present on McEwan, has formed dense colonies, outcompeting native plants.

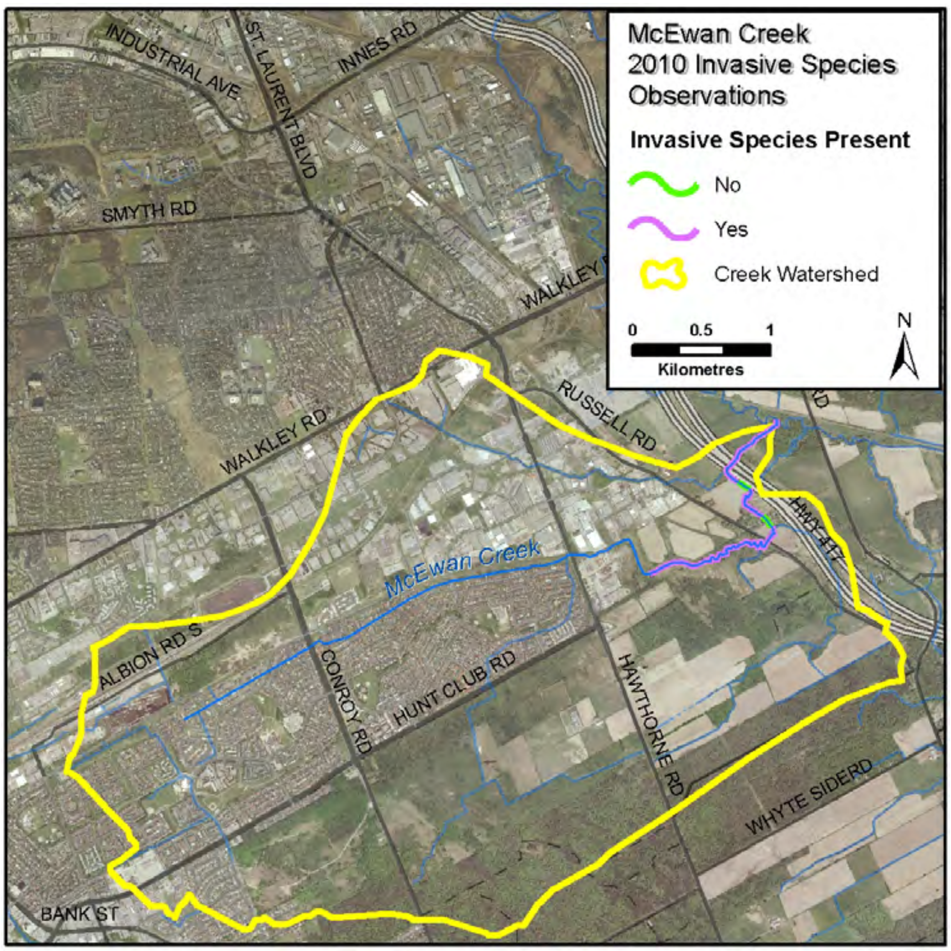


Figure 14. Air Photo Showing Location of Invasive Species Along McEwan Creek

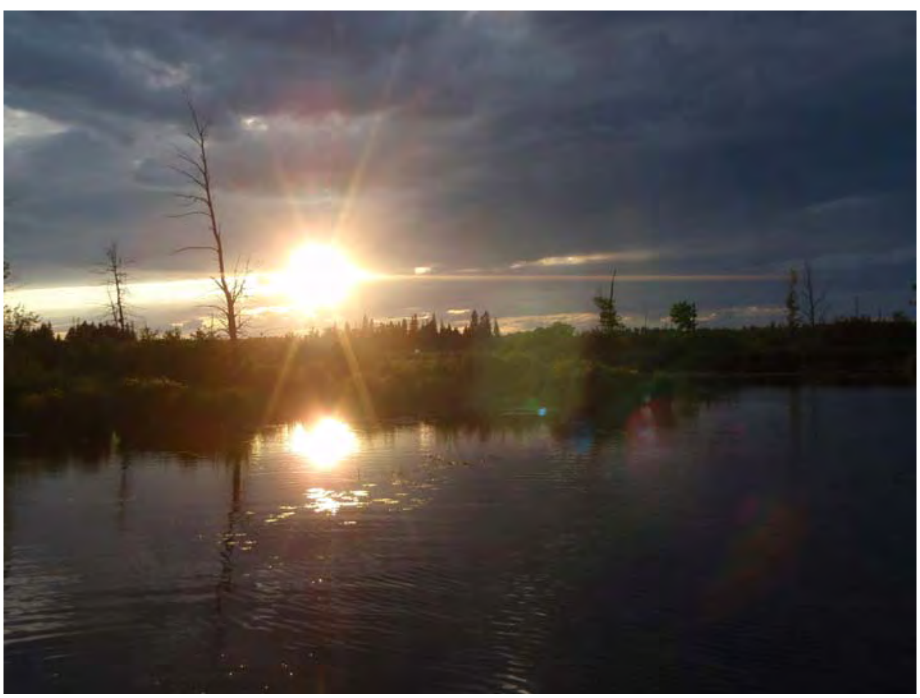
3.2.1.1 Brassil's Creek

The headwaters of Brassil's Creek begin west of Roger Steven's Drive and portions are designated as municipal drains, flowing east towards Dwyer Hill Road. After crossing Dwyer Hill Road, the system is then considered a natural stream. Brassil's Creek flows south, through the Marlborough Forest and crosses Dwyer Hill Road a second time before flowing under Donnelly Drive and into the Rideau River within the community of Burritt's Rapids.

The Brassil's Creek subwatershed mainly consists of forest and wetland with some agriculture in the headwaters and residential development closer to the mouth. A large portion of the creek runs through Marlborough Forest which many people use for hiking, mountain biking, cross-country skiing and hunting. The City of Ottawa owns much of the land within Marlborough Forest, but there are some areas privately owned. Ducks Unlimited Canada carried out a large wetland restoration project in Marlborough Forest. To re-create wetland habitat, they built six dykes throughout the forest to help hold back water and flood the areas around the dykes. Three of those dykes occur on Brassil's Creek, and the other three occur elsewhere in Marlborough Forest. The dykes were recently repaired with funding from Giant Tiger and new signs installed along Dwyer Hill Road (Ducks Unlimited Canada, 2011). The Rideau Trail that runs from Kingston to Ottawa intersects the Marlborough Forest and crosses Brassil's Creek.

According to water quality sampling conducted by the City of Ottawa, Brassil's Creek has one of the lowest average levels for Phosphorus and has low levels of total suspended solids. Levels for E. coli, nitrates and nitrites, chlorides, iron, sulphates and copper are all lower than water quality objectives, except for manganese (City of Ottawa, March 2011).

Residents that live along Brassil's Creek observe many species of wildlife. Along Brassil's Creek there is a small waterfall, which local residents refer to as the "Stepping Stones" and is a favourite spot.



Sunset on Brassil's Creek

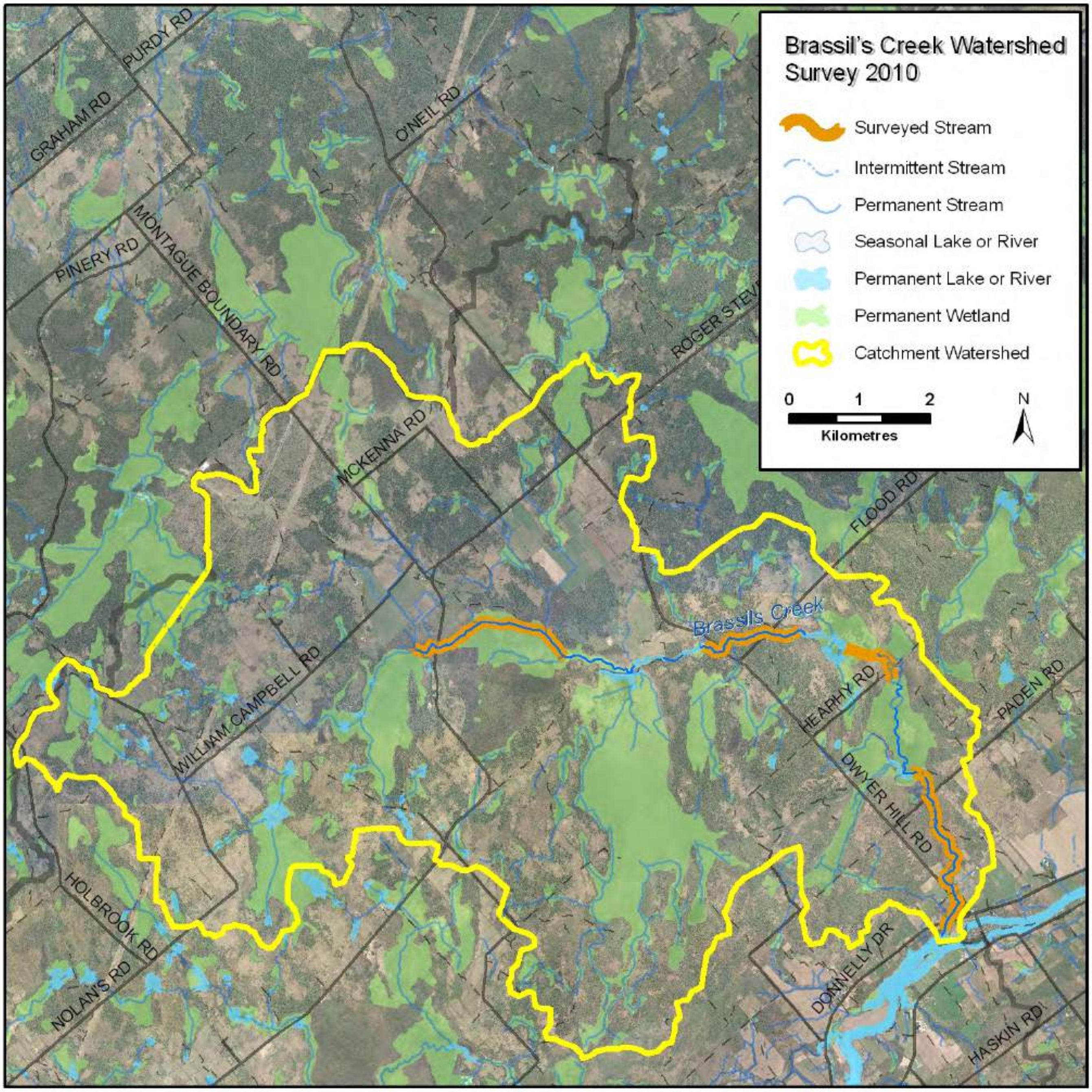


Figure 15. Air photo of Brassil's Creek and surrounding area

Brassil's Creek was surveyed for a total of 8.2 kilometres, until the stream turns into wetland once again. Certain areas between the mouth of the creek and Roger Steven's Drive were not surveyed due to change of habitat (stream to wetland) and where landowner consent was not possible. The following is a summary of the 82 macro stream assessment forms filled out by technicians and volunteers. Observations concerning anthropogenic alterations, land use, instream vegetation, bank stability, wildlife, and pollution/garbage are discussed.

Figure 16 illustrates the classes of anthropogenic alterations volunteers observed along the main branch of Brassil's Creek. Of the 82 sections of stream sampled, volunteers identified that 60 percent had no human alterations. These areas coincided with places that had larger buffers and no road crossings. Twenty-four percent of the sampled sections had some sort of alteration but were still considered natural and ten percent of the sections were altered with considerable human impact. Six percent of the surveyed sections were observed as 'highly altered' with few areas that could be considered natural. The altered and highly altered sections of the stream coincide with bridge structures for roadways, shoreline modification and armouring and loss of buffer. In the 82 sections surveyed, most of the altered or highly altered areas occurred near the mouth and the remainder occurred at road crossings farther upstream.

1. Observations of Anthropogenic Alterations and Land Use

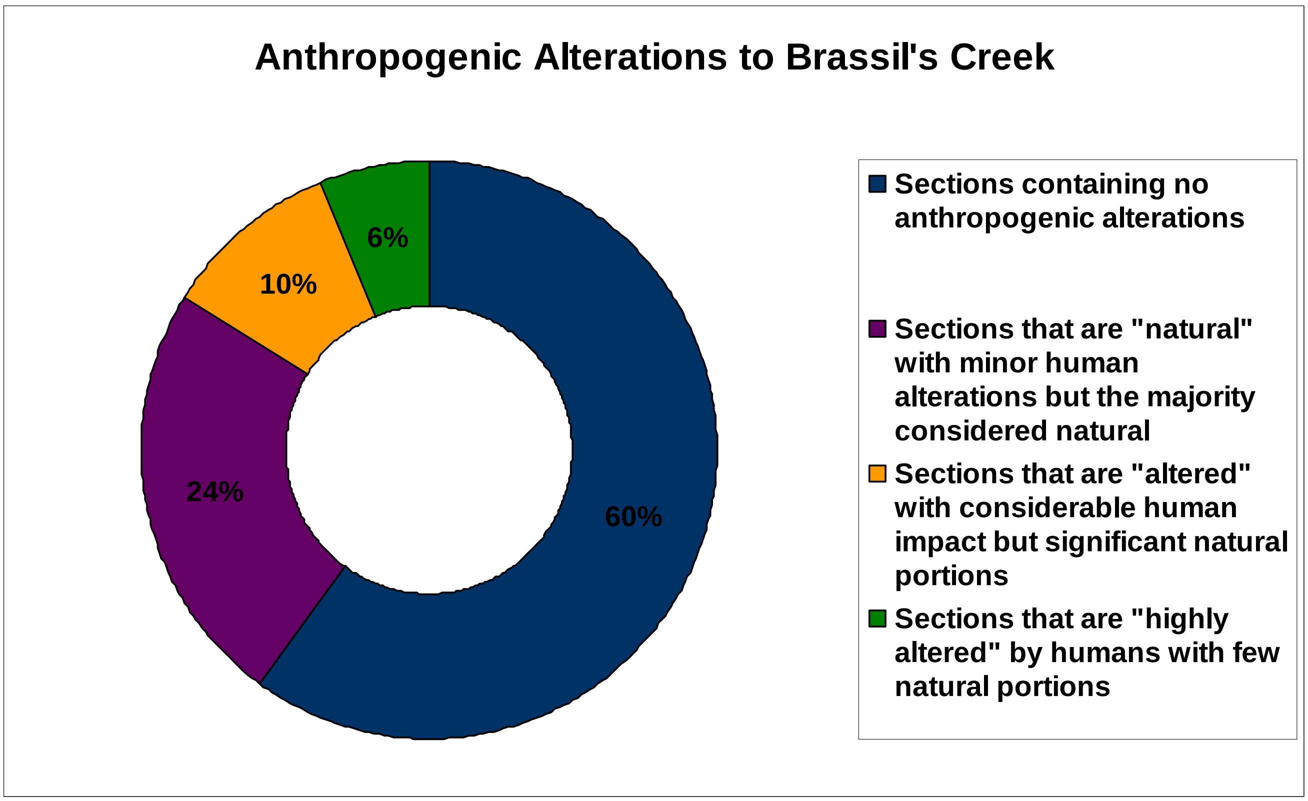
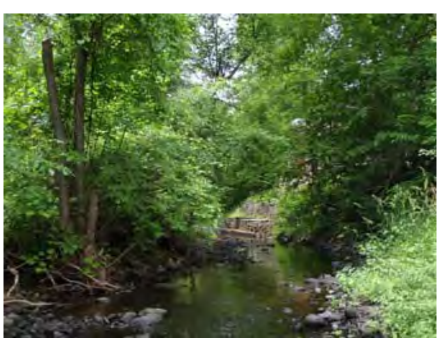
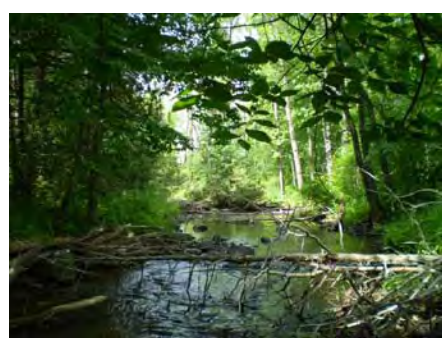


Figure 16. Classes of Anthropogenic Alterations Occurring Along Brassil's Creek



Brassil's Creek, one alteration to shoreline



Brassil's Creek, no alterations

2. Land Use Adjacent to Brassil's Creek

Figure 17 demonstrates the different land uses recognized adjacent to Brassil's Creek. Surrounding land use is considered from the beginning to end of the survey section (100m) and up to 100m on each side of the creek. Land use outside of this area is not considered for they surveys but is nonetheless part of the subwatershed and will influence the creek. Volunteers identified eight land uses along the creek. Of the natural land use adjacent to the creek, 37 percent of the land use was forest, four percent meadow, 16 percent scrubland and 28 percent wetland. Residential areas made up four percent of the land use, and infrastructure accounted for three percent. The remaining land use was five percent pasture, two percent active agriculture and one percent other, which was a cemetery near the mouth.

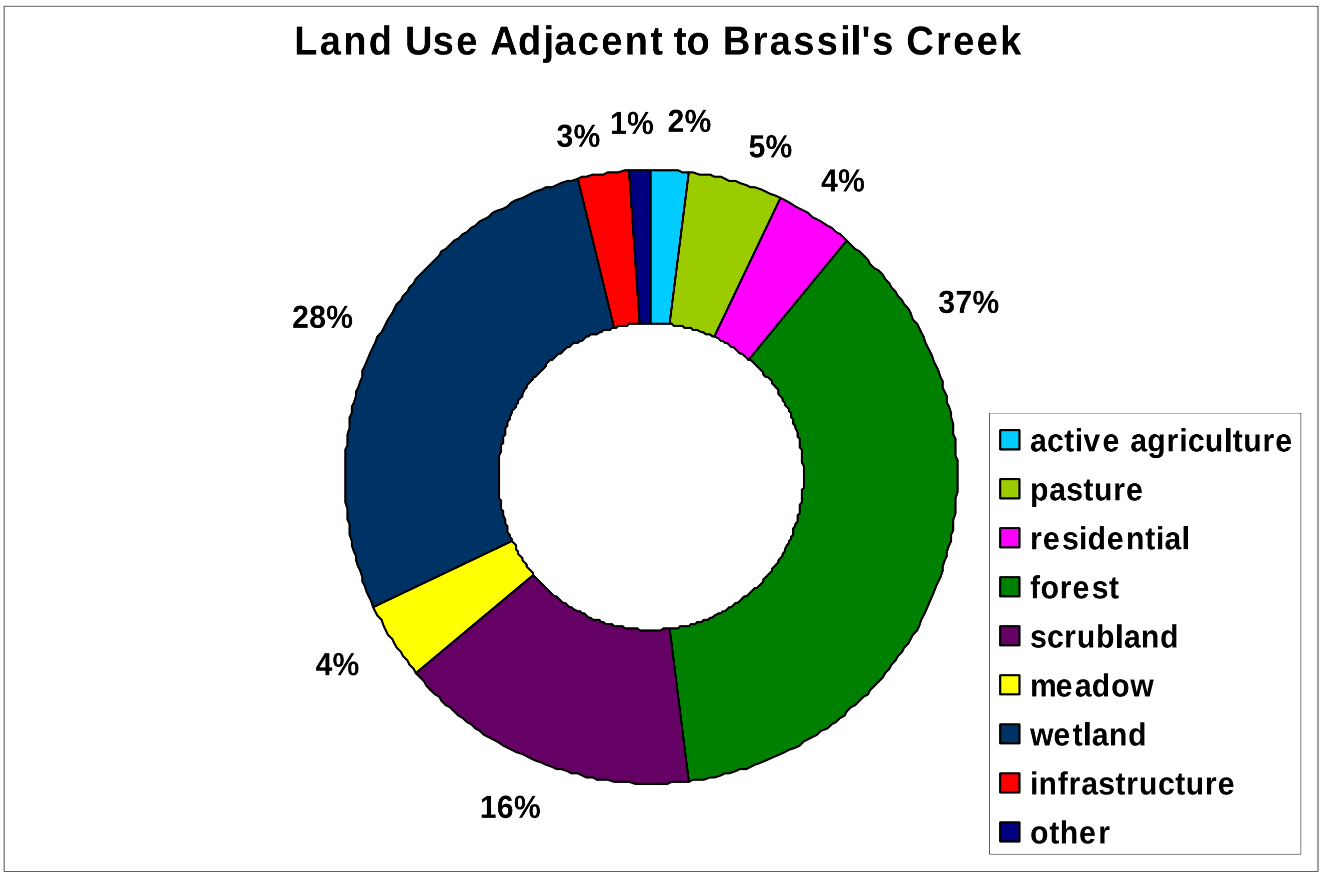


Figure 17. Land Use Identified Along Brassil's Creek

3. Instream Morphology of Brassil's Creek

Instream morphology of Brassil's Creek is fairly homogeneous and mainly consists of large runs (87 percent) with only five percent pools and eight percent riffles. This is illustrated in Figure 18. The morphology of Brassil's Creek may be highly influenced by the wetland creation. The downstream portion of Brassil's Creek consists mainly of bedrock, which lacks pool habitat features. The majority of the riffles found along Brassil's are in the bedrock section between Paden Road and the mouth.

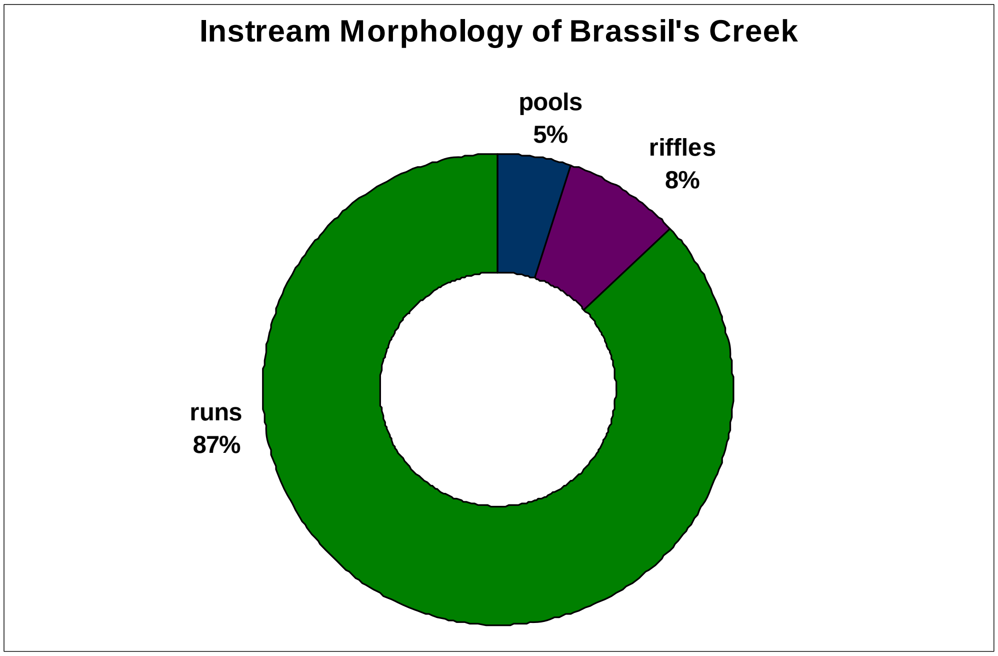


Figure 18. Instream Morphology of Brassil's Creek

An example of a riffle observed along Brassil's Creek

4. Types of Instream Substrate Along Brassil's Creek

A diverse variety of substrate was observed along Brassil's Creek. Diverse substrate is important for fish and benthic invertebrate habitat because some species will only occupy and/or only reproduce on certain types of substrate. Boulders create instream cover and back eddies for large fish to hide and/or rest out of the current, and cobble provides important over wintering and/or spawning habitat for small or juvenile fish. Other substrates also provide instream habitat for fish and invertebrates. Figure 19 demonstrates the instream substrate that was observed.

Thirty-five percent of the surveyed area was bedrock, with some cobble and boulder. The areas close to the wetland creation consisted mainly of muck, silt and detritus with some sand and clay. Gravel was observed in six percent of the areas sampled, and one percent was classified as "other", which refers to culverts without any sediment deposition on the base.

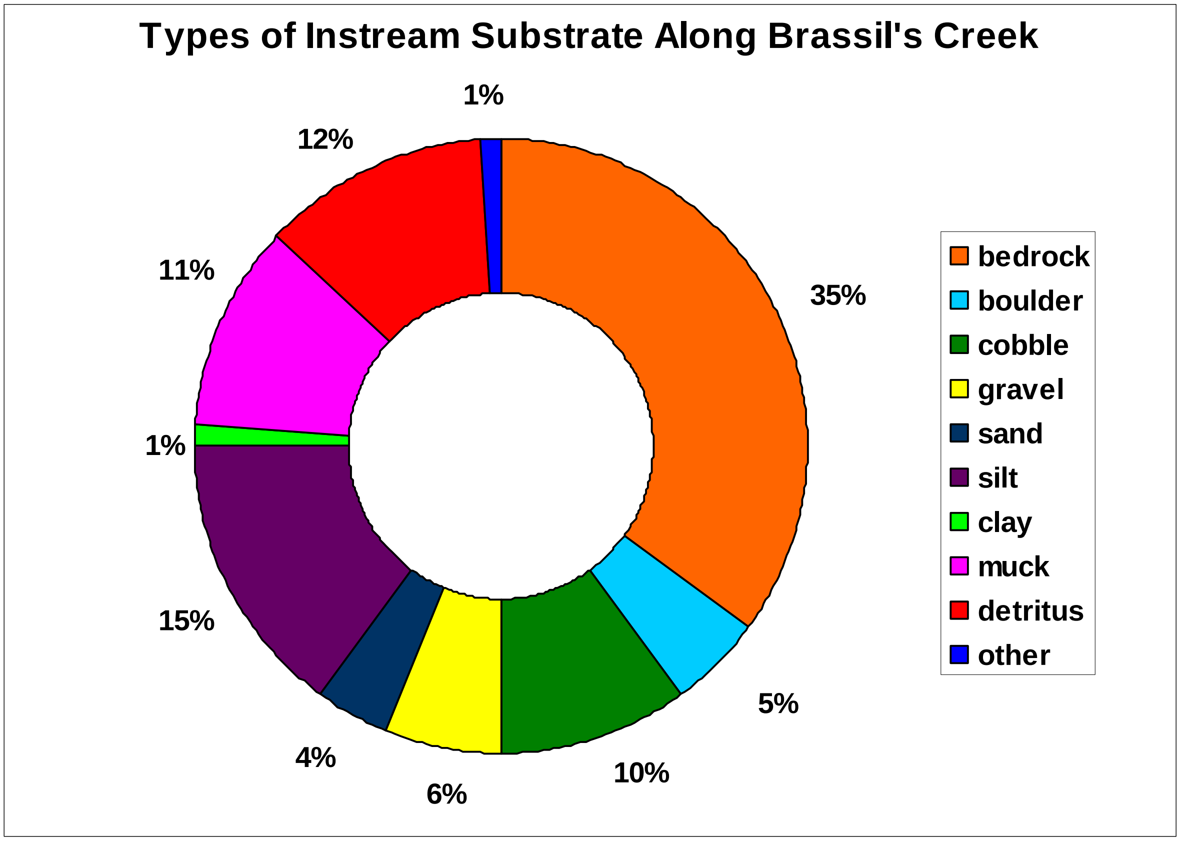


Figure 19. Types of Instream Substrate Along Brassil's Creek

Bedrock substrate creating waterfalls along Brassil's Creek

5. Observations of Instream Vegetation

A healthy amount of instream vegetation was observed along Brassil's Creek, and there were a variety of plants observed, such as reeds, sedges, grasses, submergents, water lilies, algae and cattails. In 57 percent of the sections surveyed, vegetation levels were common and normal. Four percent was considered low, one percent was considered rare and in one percent no vegetation was observed. The areas with low levels occurred mainly in the headwater areas, west of Dwyer Hill Road and Roger Steven's Drive. Thirty-seven percent of Brassil's Creek was observed to be extensive and was recorded when it was difficult to canoe or walk through sections due to heavy plant growth. These areas occurred around the wetland. Extensive vegetation can have negative effects on the stream, such as biological oxygen demand (BOD), which reduces the amount of dissolved oxygen in the system. Choked vegetation also can impact the mobility and migration of aquatic organisms as well as affects the feeding patterns of fish, especially if water levels are low.

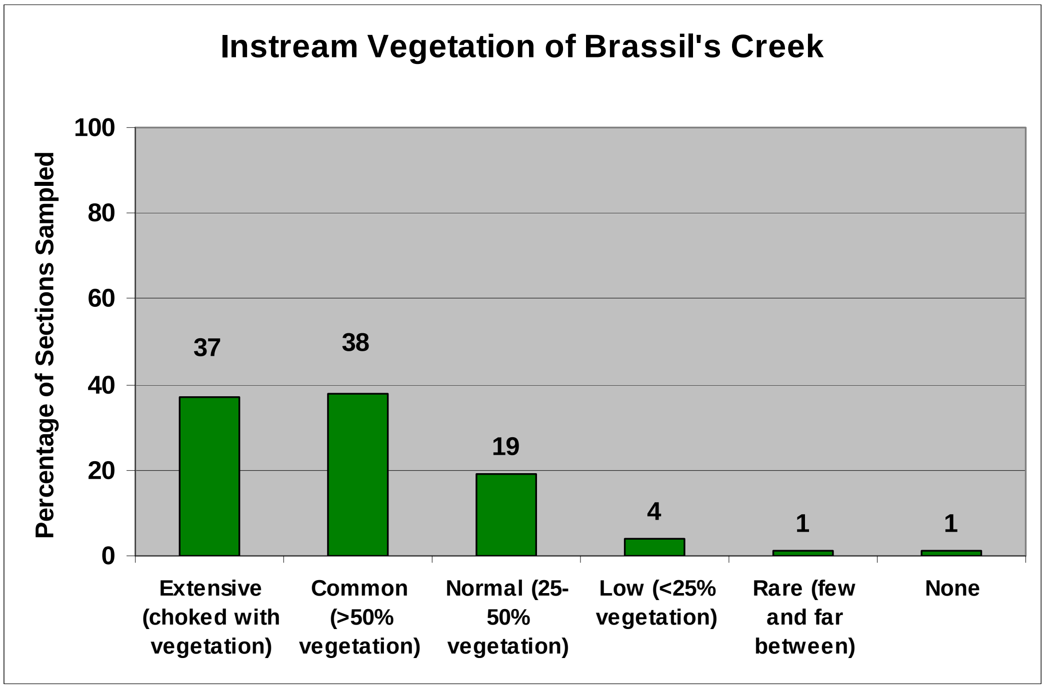


Figure 20. Frequency of Instream Vegetation in Brassil's Creek

Example of extensive aquatic vegetation in Brassil's Creek, close to the wetland. The different types of vegetation observed include submergents, emergents and floating.

6. Observations of Bank Stability

Figure 21 shows the overall bank stability of Brassil's Creek. Bank stability is recorded separately for left and right banks to obtain greater detail on the areas experiencing erosion. Both the left and right banks on Brassil's Creek were 98 percent stable, although the erosion occurred in different areas on the left and right bank. On the right bank, the eroded areas occurred near the mouth of the stream; however when erosion was observed, it was less than 20 percent of the section length, and therefore remains highlighted as green (zero to 20 percent erosion) on the map. On the left bank, there was some erosion near the mouth, but there was also a small area downstream of the Roger Steven's Drive crossing. At that location, erosion accounted for 25 percent of the actual survey length, and therefore is highlighted in yellow on the map. For the most part, Brassil's Creek had very low banks with a high amount of riparian vegetation. The high amount of natural land use cover in the Brassil's Creek subwatershed and the wetlands along the creek also help to slow water level fluctuations after storm events and maintain baseflow. All of these factors result in a very stable shoreline.

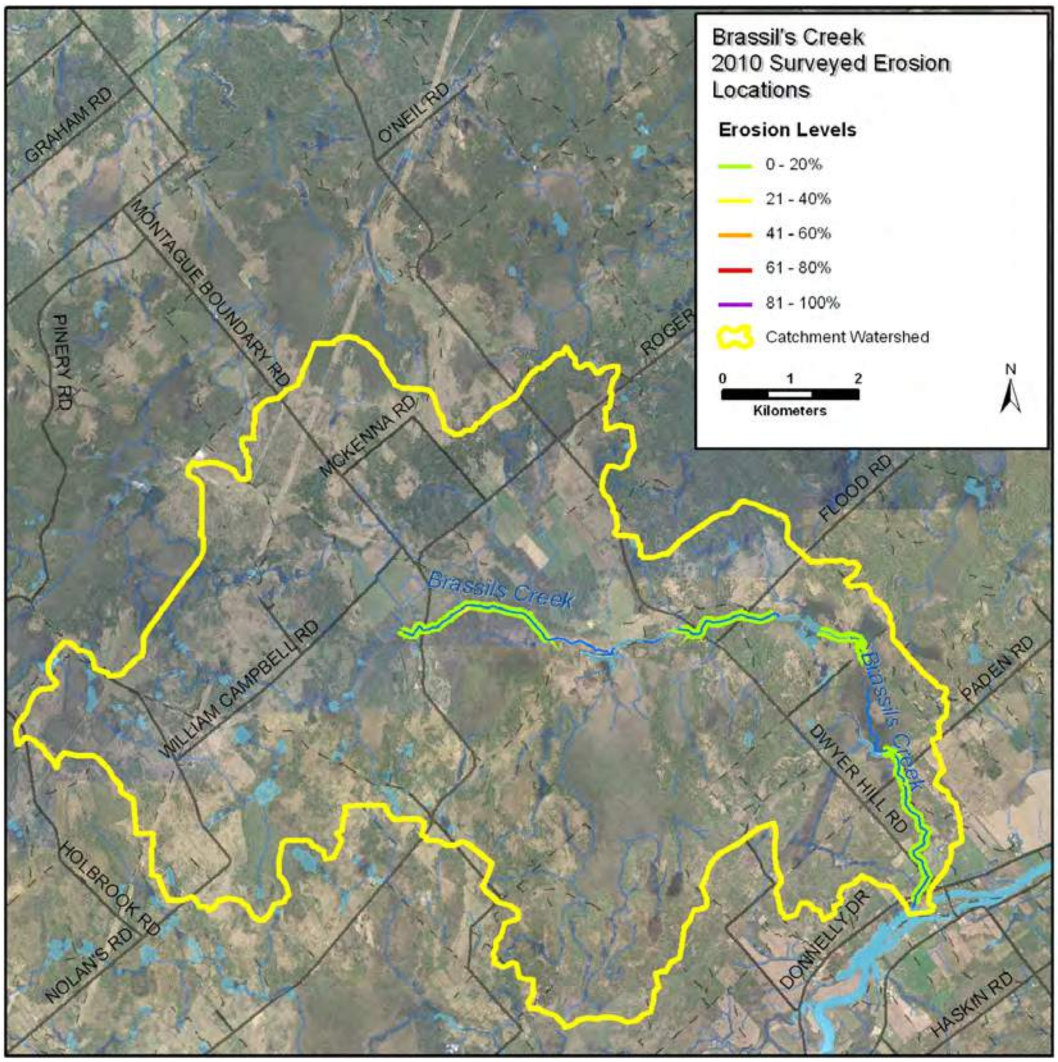


Figure 21. Left and Right Bank Stability of Brassil's Creek

7. Buffer Evaluation of Brassil's Creek

Natural buffers between the creek and human alterations are extremely important for filtering excess nutrients running into the creek, infiltrating rainwater, maintaining bank stability and providing wildlife habitat. Natural shorelines also shade the creek, helping maintain baseflow levels and keeping water temperatures cool. According to the document *How Much Habitat Is Enough*, it is recommended that a stream have a minimum riparian area of 30 metres minimum or more. Of the sections sampled, 91 percent of the left bank and 88 percent of the right bank achieved this. The areas that had reduced buffers mainly occurred near the mouth of the creek in the residential section and at all road crossings.

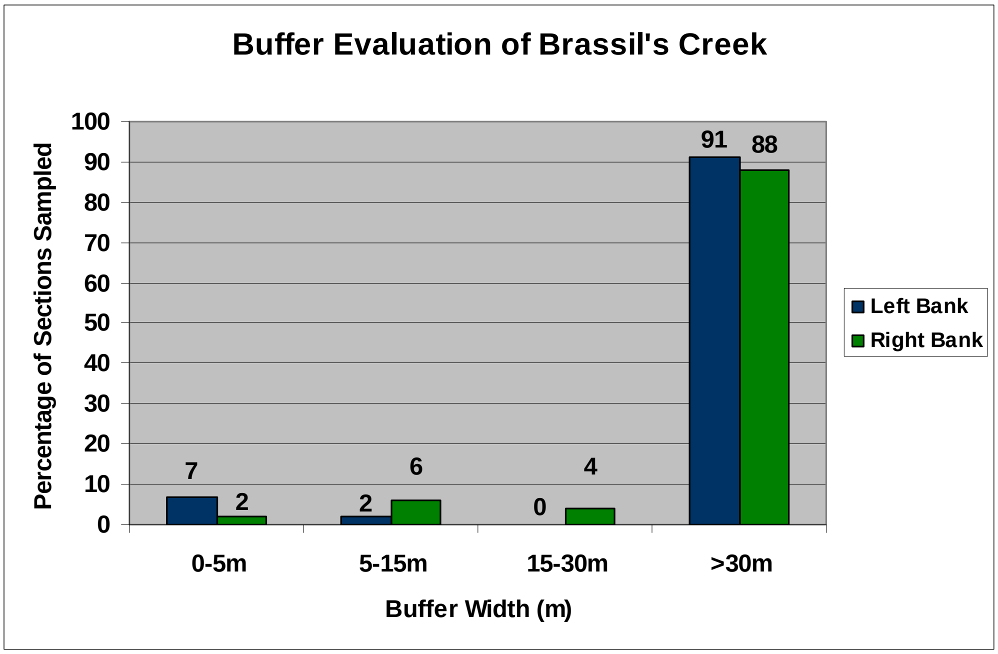


Figure 22. Buffer Evaluation of Brassil's Creek

8. Observations of Wildlife

Volunteers recorded the presence of many types of wildlife in and around Brassil's Creek. Table 8 is a summary of wildlife observed during stream surveys.

Wildlife	Observed While Sampling
Birds	great blue heron, green heron, kingfisher, duck, American bittern, blue jay, oriole, grackle, warbler, red-winged blackbird, red-eyed vireo, robin, cedar waxwing, killdeer, phoebe, woodpecker, crow, Eastern kingbird, chickadees, turkey vulture, Canada geese, mourning dove, ruffed grouse, waterthrush, hawk, ovenbird, gray catbird
Mammals	deer, muskrat, weasel, chipmunk, red squirrel
Reptiles/Amphibians	painted turtle, snapping turtle, water snake, garter snake, tadpole, green frog, bullfrog, leopard frog, mink frog, turtle nest, mudpuppies, smooth green snake
Aquatic Insects	native crayfish, rusty crayfish, whirlygig beetle, megaloptera, sowbug, mayfly larvae, caddisfly larvae, water strider, giant water bug, river boatmen, water scorpion, Eastern toe-biter, mollusc, snail, leech

Fish (observed when walking)	minnow spp., dace spp.
Other	caterpillar, butterfly, dragonfly, damselfly, moth, jewelwing, ebony jewelwing, bluet spp., swallowtail, cabbage white, monarch, woolly bear caterpillar, cricket, spider, cicada, mosquito, deerfly, horsefly, caddisfly, mayfly, bumblebee, wasp, grasshopper

Table 8. Wildlife Observed Along Brassil's Creek

Painted turtle

Mudpuppy

9. Observations of Pollution/Garbage

Sixty-five percent of the sections surveyed on Brassil's Creek were free of garbage. In the remaining thirty-five percent, garbage observed was either floating, on the bottom or both. In most areas, where garbage was found, it was low in abundance and would not require a large cleanup. Some of the items found were tin cans, a window frame, steel bars, coffee cups, broken glass, styrofoam, plastic tarps, plastic pipes, a bucket of transmission fluid, a printer, tires, a boot cleat, an old saw and plastic items such as wrappers, bags, pipes and a tub. The bucket of transmission fluid was found near the residential area. All garbage of human origin can be negatively impact a stream, but items such as transmission oil and printers (any type of electronics), can impact the water quality of a stream and affect the fish and wildlife in that area.

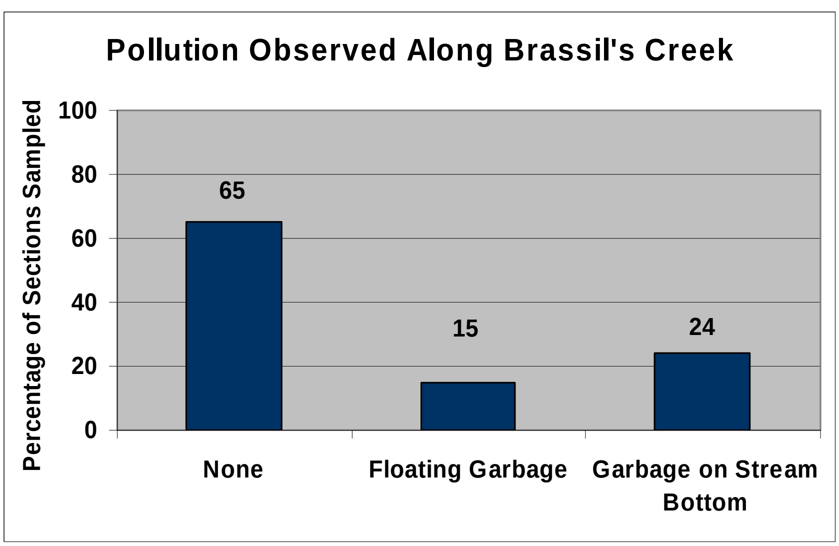


Figure 23. Frequency of Pollution/Garbage Occurring in Brassil's Creek

10. Fish Community Sampling

Stonecat, captured on Brassil's

Fish sampling was carried out at six sites along Brassil's Creek. The creek selection for 2010 changed in May, and Brassil's Creek was surveyed instead of Steven's Creek. As a result, fish sampling was only completed at five sites in June and July. The sixth site was added in September and sampled three times. Capture methods included seine netting, electrofishing, a small fyke net and windemere traps. One small fish sampling demonstration was held on Brassil's Creek for local residents, and individual volunteers accompanied staff on a number of other sampling days. Seven volunteers contributed 26 hours to assist with these. Volunteers were introduced to fish sampling methods, key identification features and how to process the fish captured (weigh/measure). Figure 24 shows the sampling locations for Brassil's Creek. A total of 25 different fish species were collected. Top predators within the stream ecosystem are highlighted in bold and include largemouth bass, smallmouth bass and yellow perch. *Etheostoma spp* indicates that either Johnny darters or tessellated darters were captured. To differentiate between those species, each fish must be removed from the system and brought back to lab; to avoid this, they are only identified to genus level. A sunfish species was also captured, but it was too small to identify between pumpkinseed or bluegill and therefore labeled as *Lepomis spp*. *Phoxinus spp*. refers to dace, a type of minnow species, that frequently hybridize.

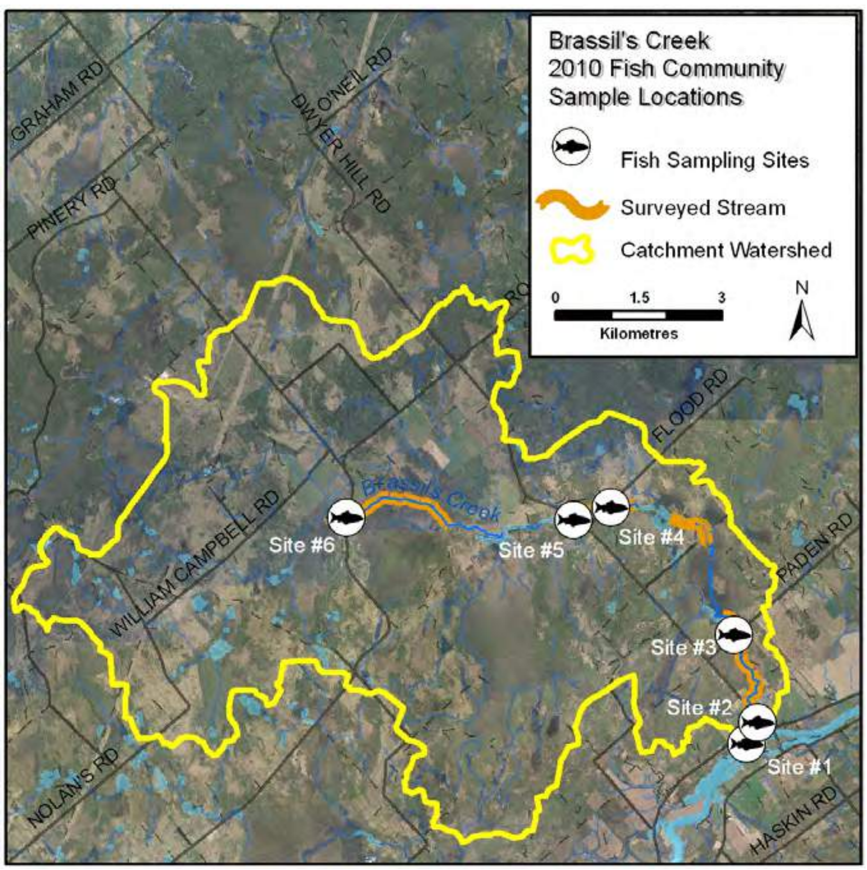


Figure 24. Air photo of Brassil's Creek showing Fish Sampling Sites

Table 9 illustrates the site number with the corresponding water chemistry data, fish community results, capture method and dates sampled. All fish were live released back to the stream after fish sampling, unless lab identification was required.

Site #	Sampling Technique	Data (mm/dd/yy)	Air Temp (°C)	Water Temp (°C)	DO (mg/L)	pH	Conductivity (uS/cm)	Substrate	Instream Vegetation	Species Sampled	Total # of Species Caught
1	electrofish	6/4/2010	21.13	17.96	12.36	8.32	210	bedrock, gravel, silt, cobble	emergents, algae	logperch, rock bass, stonecat, central mudminnow, creek chub, *Cyprind spp.*	6
1	electrofish	7/7/2010	30.80	28.60	7.75	8.38	420	bedrock, gravel, silt, cobble	emergents, algae	**largemouth bass**, **yellow perch**, **smallmouth bass**, blacknose shiner, northern redbelly dace, *Etheostoma spp*., hornyhead chub, creek chub, white sucker, central mudminnow, *Cyprinid spp*., fallfish, common shiner	13
2	electrofish	6/4/2010	25.40	23.57	11.5	8.23	407	bedrock, gravel, cobble, silt	algae	**smallmouth bass**, rock bass, logperch, central mudminnow, rock bass, hornyhead chub, creek chub, *Cyprinid spp*.	8
2	electrofish	7/7/2010	25.25	25.61	7.48	8.23	402	bedrock, gravel, cobble, silt	algae	**largemouth bass**, **yellow perch**, logperch, rock bass, white sucker, common shiner, northern redbelly dace, central mudminnow, creek chub, fathead minnow, hornyhead chub, bluntnose minnow, blacknose shiner, fallfish, brown bullhead	15

3	fyke net	6/2/2010	18.81	20.64	7.02	7.86	376	sandy clay, cobble, boulder	water lilies, wild celery, non-filamentous algae	creek chub, common shiner, white sucker, northern redbelly dace, pumpkinseed, central mudminnow, brook stickleback, pearl dace, blacknose shiner, brassy minnow, golden shiner, fallfish	12
3	fyke net	7/15/2010	26.32	24.22	3.7	7.46	868	sandy clay, cobble, boulder	yellow water lilies, rushes, wild celery, non-filamentous algae	pumpkinseed, creek chub, white sucker, brown bullhead	4
4	windemere trap	6/2/2010	22.10	24.93	7.36	7.65	439	sand, gravel, cobble, boulder, woody material	water lilies, wild celery, European frogbit, bulrushes, sedges, coontail, burreed	northern redbelly dace, common shiner, pearl dace, blacknose shiner	4
4	seine	6/2/2010	22.10	24.93	7.36	7.65	439	bedrock, sand, muck	water lilies, European frogbit, algae, bulrushes, coontail	blacknose shiner, northern redbelly dace, creek chub, common shiner, central mudminnow, white sucker, pumpkinseed, brassy minnow, *Cyprind spp*., *Centrarchid spp*., *Phoxinus spp*.	11
4	windemere trap	7/15/2010	26.53	26.52	6.37	7.24	974	bedrock, sand, muck	sedges, water lilies, algae (filamentous and non-filamentous)	pumpkinseed, white sucker	2
5	windemere trap	6/2/2010	26.06	24.65	7.01	7.83	437	gravel, sand, cobble	water lilies, grasses, European frogbit, purple loosestrife	pumpkinseed, creek chub, common shiner, white sucker	4

5	windemere trap	7/15/2010	27.97	25.81	2.75	7.26	921	gravel, sand, cobble	water lilies, grasses, European frogbit, purple loosestrife, bulrushes, water shield, sedges, wild celery, non-filamentous algae	pumpkinseed, golden shiner	2
6	windemere trap	9/21/2010	15.40	13.02	9.5	7.48	327	bedrock, boulder, silt, cobble	emergents, algae, grasses	creek chub, northern redbelly dace	2
6	windemere trap	9/22/2010	17.09	15.95	9.02	7.47	360	bedrock, boulder, silt, cobble	emergents, algae, grasses	creek chub, common shiner, white sucker	3
6	windemere trap	9/23/2010	12.62	14.23	9.42	7.52	348	bedrock, boulder, silt, cobble	emergents, algae, grasses	creek chub, white sucker	2

Table 9. Water Chemistry and Fish Community Results for Brassil's Creek

Fish Species Status, Trophic, and Reproductive Guilds – Brassil's Creek

Table 10 was generated by taking the fish community structure of Brassil's Creek and classifying the recreational, commercial, or bait fishery importance, Species at Risk status, reproductive guild (spawning habitat requirements), thermal classification, and trophic guild (feeding preference). The majority of the species within Brassil's Creek are significant to the recreational or baitfish fisheries. The fish community structure consists of seven warm water species, 11 cool water species and five cool/warm species.

MNR Code	Common Name	Scientific Name	Recreational Fishery	Commercial Fishery	Bait Fishery	Status	Reproductive Guild	Thermal Classification	Trophic Guild
200	blacknose shiner	*Notropis heterolepis*			X	none	non guarder, open substrate, Psammophils	cool/warm	insectivore
208	bluntnose minnow	*Pimephales notatus*			X	none	guarder, nest spawner, Spelophils	warm	omnivore
189	brassy minnow	*Hybognathus hankinsoni*			X	not at risk	non guarder, open substrate, Phytolithophils	cool	omnivore/ herbivore
281	brook stickleback	*Culaea incontans*			X	none	guarder, nest spawner, Ariadnophils	cool	insectivore
233	brown bullhead	*Ameiurus nebulosus*	X	limited		none	guarder, nest spawner, Spelophils	warm	insectivore
141	central mudminnow	*Umbra limi*			X	none	non guarder, open substrate, Phytophils	cool/warm	insectivore/ omnivore
198	common shiner	*Luxilus comutus*			X	none	guarder, nest spawner, Lithophils	cool	insectivore

212	creek chub	*Semotilus atromaculatus*	X		X	none	non guarder, brood hider, Lithophils	cool	insectivore/ generalist
213	fallfish	*Semotilus corporalis*	X		X	none	non guarder, brood hider, Lithophils	cool	insectivore
209	fathead minnow	*Pimephales promelus*			X	none	guarder, nest spawner, Spelophils	warm	omnivore
194	golden shiner	*Notemigonus crysoleucas*			X	none	non guarder, open substrate, Phytophils	cool/warm	omnivore
192	hornyhead chub	*Nocomis biguttatus*			X	none	non guarder, brood hider, Lithophils	cool	insectivore
317	largemouth bass	*Micropterus salmoides*	X	past		none	guarder, nest spawner, Phytophils	warm	insectivore/ piscivore
342	logperch	*Percina caprodes*			X	none	non guarder, open substrate, Psammophils	cool	insectivore
182	northern redbelly dace	*Phoxinus eos*			X	none	non guarder, open substrate, Phytophils	cool/warm	herbivore
214	pearl dace	*Margariscus margarita*			X	none	non guarder, open substrate, Lithophils	cool	insectivore
313	pumpkinseed	*Lepomis gibbosus*	X			none	guarder, nest spawner, Polyphils	cool/warm	insectivore
311	rock bass	*Ambloplites rupestris*	X			none	guarder, nest spawner, Lithophils	warm	insectivore
316	smallmouth bass	*Micropterus dolomieui*	X	past		none	guarder, nest spawner, Lithophils	cool	insectivore/ piscivore
203	spotfin shiner	*Cyprinella spiloptera*			X	none	non guarder, open substrate, Phytolithophils	warm	insectivore
235	stonecat	*Notorus flavus*	limited			none	guarder, nest spawner, Spelophils	warm	insectivore
163	white sucker	*Catostomus commersoni*				none	non guarder, open substrate, Lithophils	cool	insectivore/ omnivore
331	yellow perch	*Perca flavescens*	X			none	non guarder, open substrate, Phytolithophils	cool	insectivore/ piscivore

Table 10. Fish Species Status, Trophic and Reproductive Guilds for Brassil's Creek (Source: *MTO Environmental Guide to Fish and Fish Habitat*, 2006)

Table 11 summarizes the fish community structure observed in Brassil's Creek and their sensitivity to sediment and turbidity for reproduction, feeding, and respiration. The composition of the fish community in Brassil's Creek ranges from species that are fairly tolerant to those that are intolerant to sediment and turbidity. However, thirteen of the species are classified as having low sensitivity to sediment/turbidity either for reproduction, feeding or respiration.

Young of the year largemouth bass, caught on Brassil's Creek

Fish Species Sensitivity to Sediment/Turbidity for Brassil's Creek

MNR Code	Common Name	Scientific Name	Reproduction	Feeding	Respiration
200	blacknose shiner	*Notropis heterolepis*	M	M	H
208	bluntnose minnow	*Pimephales notatus*	L	M	unknown
189	brassy minnow	*Hybognathus hankinsoni*	M	L	unknown
281	brook stickleback	*Culaea incontans*	L	M	unknown
233	brown bullhead	*Ameiurus nebulosus*	L	L	L
141	central mudminnow	*Umbra limi*	M	M	L
198	common shiner	*Luxilus comutus*	M	M	unknown
212	creek chub	*Semotilus atromaculatus*	M	M	H
213	fallfish	*Semotilus corporalis*	M	H	H
209	fathead minnow	*Pimephales promelus*	L	L	unknown
194	golden shiner	*Notemigonus crysoleucas*	M	M	L
192	hornyhead chub	*Nocomis biguttatus*	M	M	H
317	largemouth bass	*Micropterus salmoides*	L	H	H
342	logperch	*Percina caprodes*	M	M	H
182	northern redbelly dace	*Phoxinus eos*	M	L	L
214	pearl dace	*Margariscus margarita*	M	M	H
313	pumpkinseed	*Lepomis gibbosus*	L	M	unknown
311	rock bass	*Ambloplites rupestris*	L	H	unknown
316	smallmouth bass	*Micropterus dolomieui*	M	H	unknown
203	spotfin shiner	*Cyprinella spiloptera*	M	M	unknown
235	stonecat	*Noturus flavus*	M	L	unknown
163	white sucker	*Catostomus commersoni*	M	L	H
331	yellow perch	*Perca flavescens*	M	H	unknown

Table 11. Fish Species Sensitivity to Sediment/Turbidity (High, Moderate, Low or unknown) for Brassil's Creek (Source: *MTO Environmental Guide to Fish and Fish Habitat*, 2006)

11. Temperature Profiling

Four temperature dataloggers were set in Brassil's Creek to record temperature fluctuations throughout the season. The temperature loggers were deployed on May 18 at 13:20 and recorded temperatures every ten minutes until September 9 at 6:30. Figure 25 shows the locations of dataloggers in Brassil's Creek.

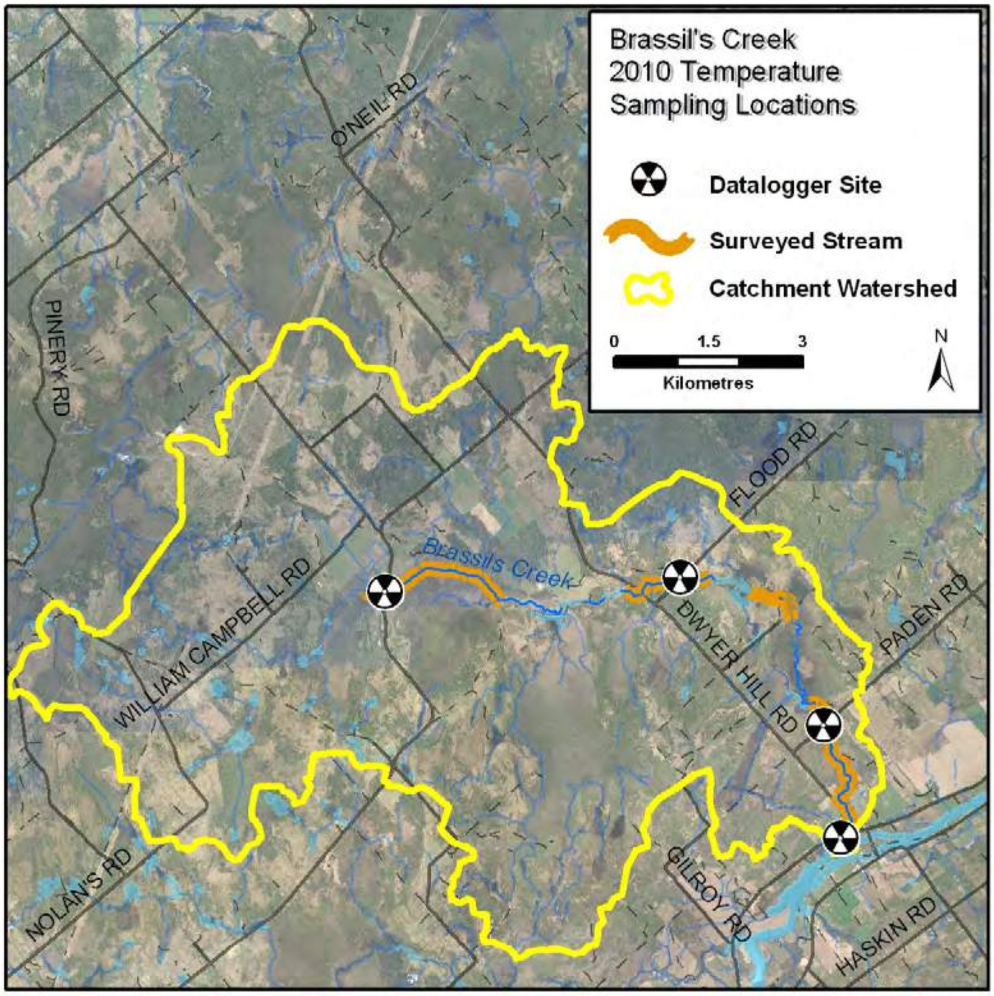


Figure 25. Datalogger Locations Along Brassil's Creek

Data loggers were set in four different locations in the stream to give a representative sample of how temperature fluctuates and differs throughout the course of the stream. Sites begin at the downstream end of the creek and were placed in order upstream. Temperature logger 1 was set just downstream of Donnelly Road. Temperature logger 2 was set downstream of Paden Road. Temperature logger 3 was placed upstream of Flood Road, and temperature logger 4 was place upstream of Roger Steven's Drive. Figure 26 shows results from Dataloggers 1, 2, 3 and 4.

	Water Temperature
Cold	<19 Degrees Celsius
Cool	19-25 Degrees Celsius
Warm	>25 Degrees Celsius

Table 12. Water Temperature Classifications (Minns et al. 2001)

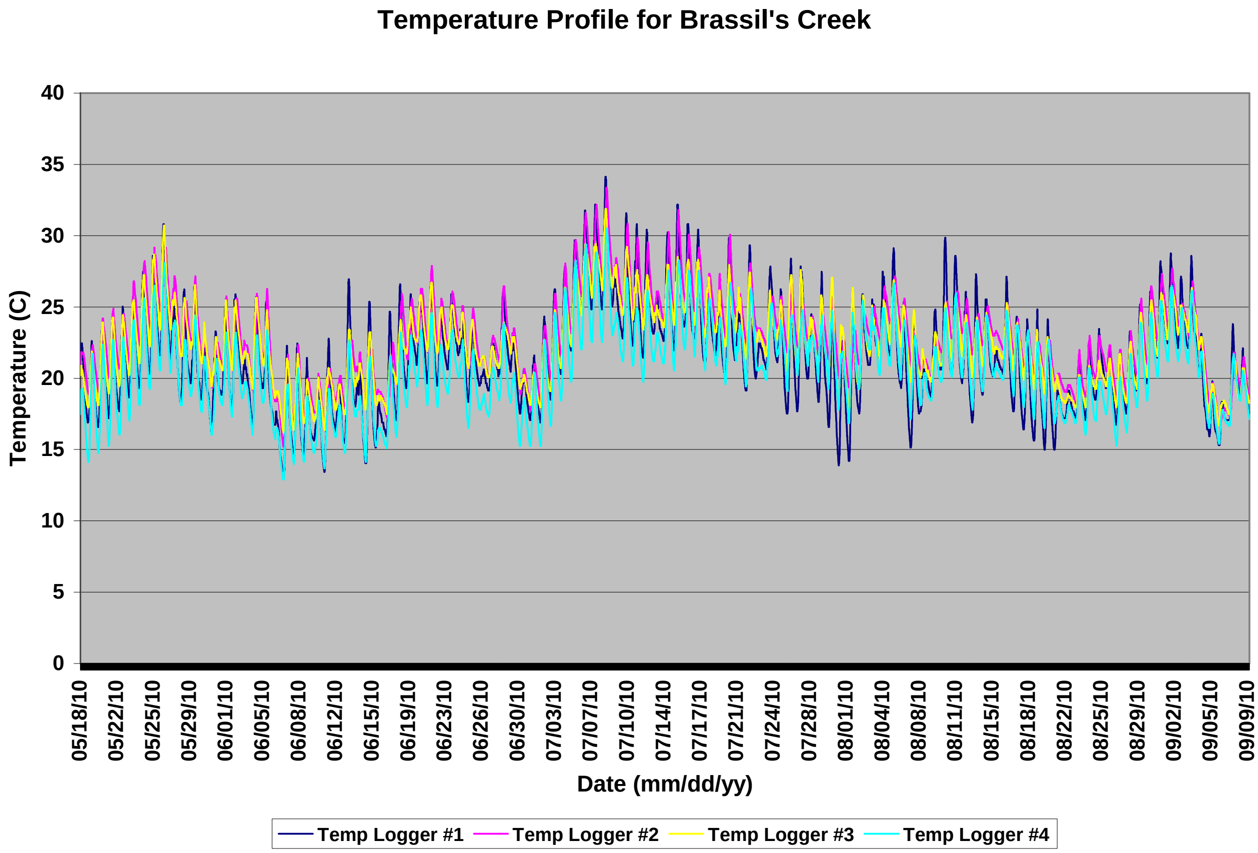


Figure 26. Temperature Profiles for Dataloggers 1, 2, 3 and 4 on Brassil's Creek

Temperature loggers 1, 2, 3 and 4 have consistent trends of fluctuating temperatures throughout the stream, although temperature logger 1 appears to have had greater fluctuations than the others on some occasions.

Temp Logger Number	Minimum Temp (°C)	Date Min Temp was Recorded (mm/dd/yy)	Maximum Temp (°C)	Date Max Temp was Recorded (mm/dd/yy)
Temperature logger 1	13.12	6/7/2010	34.14	7/8/2010
Temperature logger 2	15.2	6/7/2010	33.36	7/8/2010
Temperature logger 3	16.21	6/7/2010	31.88	7/8/2010
Temperature logger 4	12.91	6/7/2010	30.49	7/8/2010

Table 13. Minimum and Maximum Temperatures of Temperature Loggers

The method for temperature classification is taken from the Ontario Stream Assessment Protocol, for which the temperature data is taken between 4 and 4:30pm, anywhere between July 1 and September 10, on days where maximum air temperature exceeds 24.5°C and after two previous days without precipitation and temperatures surpassing 24.5°C. During 2010, six days in July, three days in August and one day in September met these requirements, for a total of ten days. Temperature logger 1 exceeded 25°C on all ten days, and temperature loggers 2, 3 and 4 exceeded 25°C on eight of the ten days. The fish community structure is made up of eleven cool water species, five cool/warm species and seven warm water species. Based on the stream temperature classification and fish community structure, Brassil's Creek can be classified as a warm water system with some cool water reaches.

11. Invasive Species

The most common invasive species observed along Brassil's Creek was purple loosestrife (*Lythrum salicaria*); however, in most sections it did not appear to be outcompeting any native vegetation and was serving as a nectar source for pollinator species. The second-most common invasive species observed was European frog-bit (*Hydrocharis morsus-ranae*). This species is of major concern, as it forms dense floating mats of vegetation. This blocks out sunlight for other aquatic plant species, and they cannot survive. It also affects fish feeding. The other invasive species found along Brassil's Creek were European buckthorn (*Rhamnus catharticus*), glossy buckthorn (*Rhamnus frangula*), Manitoba maple (*Acer negundo*) and rusty crayfish (*Orconectes rusticus*). Invasive buckthorns can outcompete native vegetation, and although they do provide some bird species with berries, insects cannot use them, and the majority of birds rely on insects for food. (Gosling Wildlife Gardens, 2010). The effects of rusty crayfish are not yet well known; however, where RVCA staff have observed them, they appear to be the dominant species of crayfish. Figure 27 shows the locations of invasive species found along Brassil's Creek. Sections where invasive species were observed are highlighted in pink; invasive species were observed along all sections of the stream where surveyed.

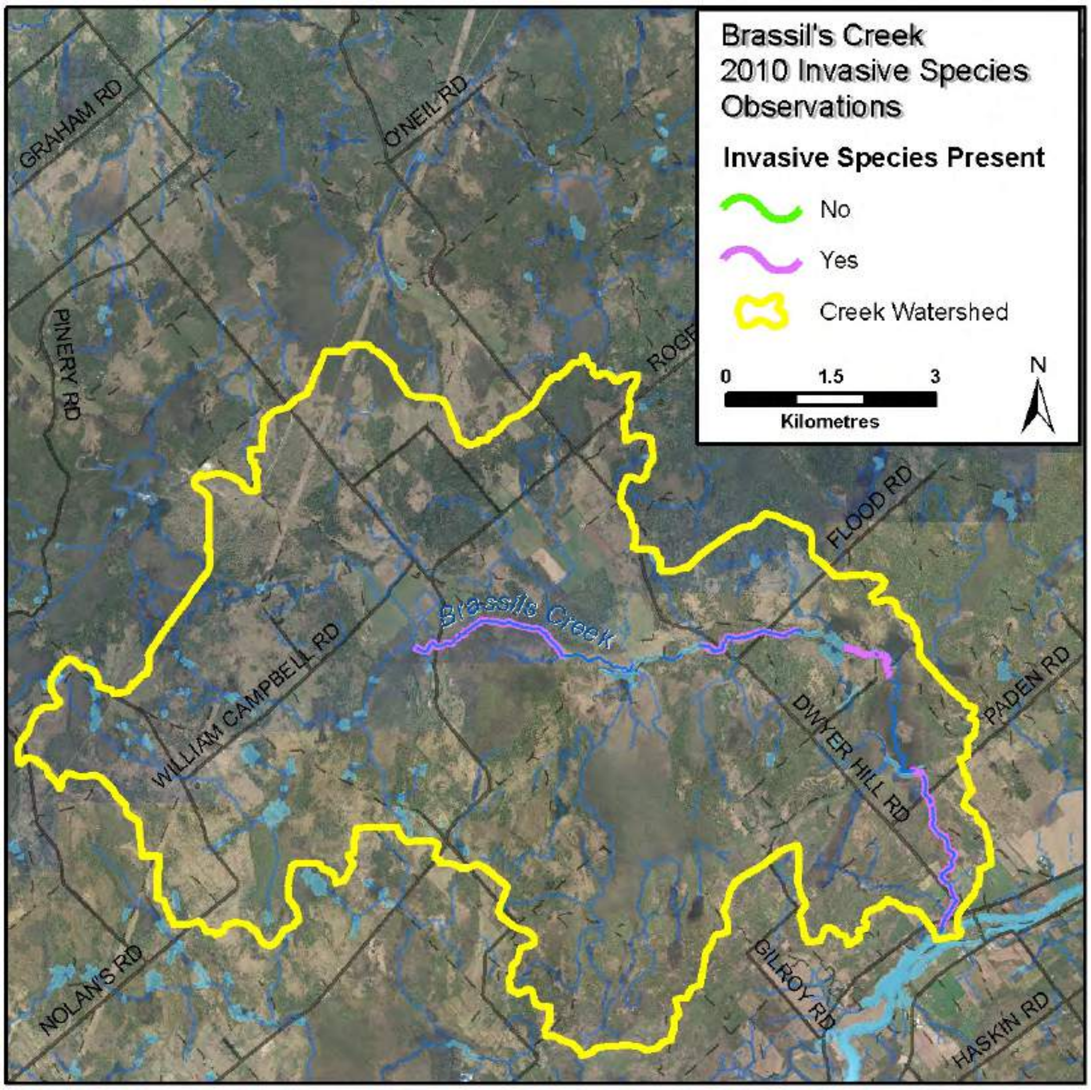


Figure 27. Locations of Invasive Species Observed Along Brassil's Creek

12. 2006/2010 Comparison of Brassil's Creek

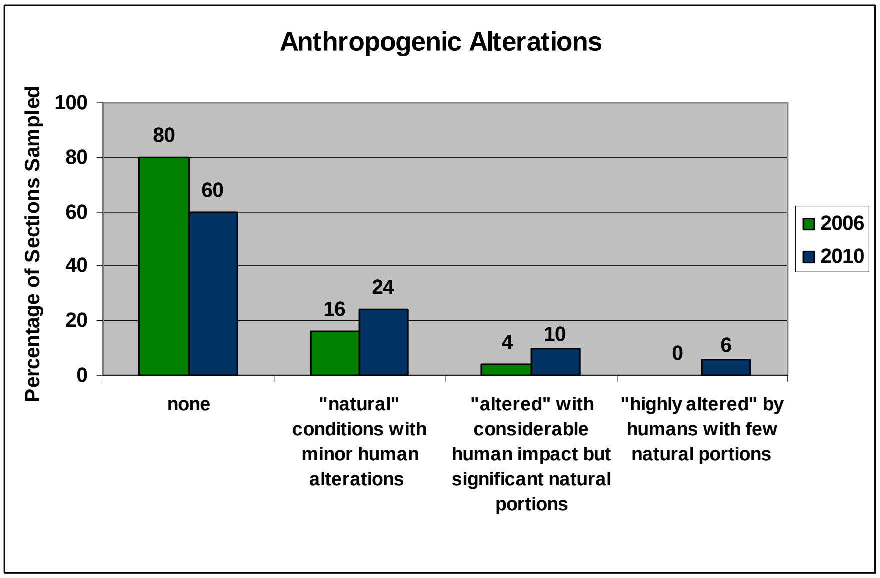


Figure 28. Comparison of Anthropogenic Alterations Between 2006 and 2010

Between 2006 and 2010, anthropogenic alterations have increased along Brassil's Creek. In 2010, anthropogenic alterations were further defined, and this may be the cause of the increase, as there were no sections classified as "highly altered" in 2006. The anthropogenic alterations observed in 2010 along Brassil's Creek included shoreline armouring in residential areas, buffer loss, road crossings and cattle access. Although the road crossings at Paden Road and Flood Road are fairly natural, anytime a stream bank is lined with concrete, it is automatically considered altered or highly altered, depending on the length of the crossing. Ducks Unlimited Canada installed two dykes along Brassil's Creek to create more wetland habitat. While it has created wetland habitat, the dyke is still classified under "highly altered", as it does affect fish passage and stream function.

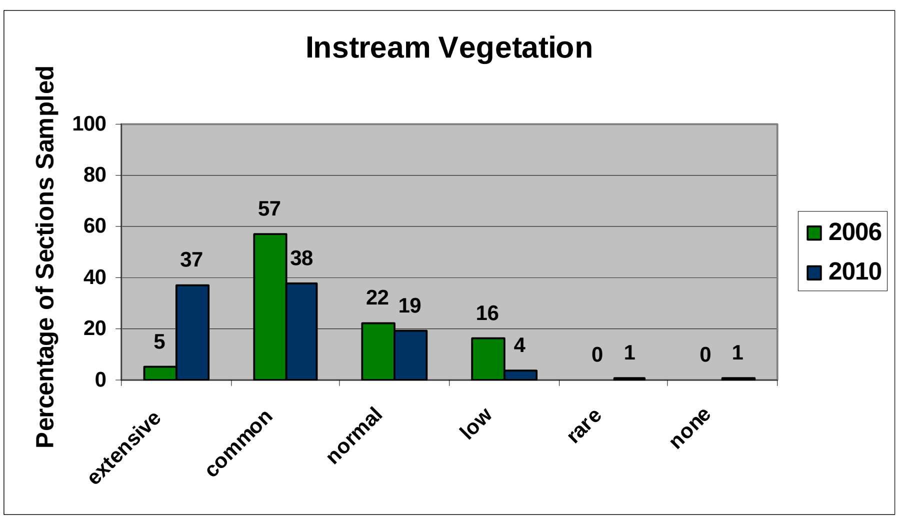


Figure 29. Comparison of Instream Vegetation Between 2006 and 2010

Changes of instream vegetation can be related to weather patterns and also when the creek was surveyed. The category "none" was added after 2006 and would have been listed as "rare" in the 2006 data. More sections were considered "extensive" in 2010 and less were considered "common", "normal" and "low". Many areas where vegetation was considered extensive were located in and adjacent to wetlands, which was the same as 2006, although more area was surveyed in 2010 and could account for some of the increase. Overall weather data shows that there was more precipitation in 2006 than in 2010 which could result in more vegetation growth during the 2010 season.

Bank Stability	2006 (%)	2010 (%)
stable	92	98
unstable	7	2
undercut	1	N/A

Table 14. Comparison of Bank Stability

Bank stability was changed in 2008 to separate left bank from right bank and capture more accurate locations on erosion. The category "undercut" was removed from the survey. Undercuts do not always threaten bank stability and are fish habitat. When undercuts are observed, they are categorized as "stable" or "unstable", depending on how it is affecting bank stability. Separating bank stability into left and right bank can cause major changes in bank stability comparisons. For example, in 2006, if 30% of the left bank and 20% of the left bank were eroding in different areas along the section, it previously would have been listed as 50% erosion. The current survey would show only 30% for left bank and 20% right bank, making it appear that the stream has become much more stable when comparing. For Brassil's Creek, it does appear that bank stability has improved, mainly due to the survey change. In 2006, the main area of concern was a cattle access area. In 2010, the same area was observed, but the banks appeared in good condition, despite cattle access. No areas of the creek had serious erosion issues in either 2006 or 2010.

Low bank profile and well-vegetated shoreline along Brassil's Creek

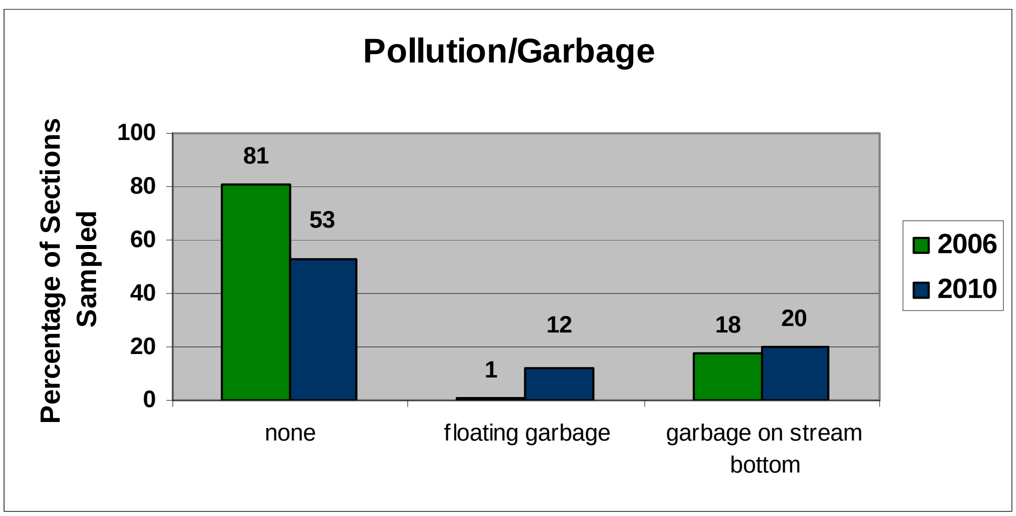


Figure 30. Comparison of Pollution/Garbage Between 2006 and 2010

From 2006 to 2010, garbage along Brassil's Creek has increased. In 2006, 81percent of the sections surveyed did not have garbage; this percentage has fallen to 53 percent in 2010. Amounts of floating garbage and garbage on stream bottom have both increased. Unusual colouration was not an option on the 2006 survey protocol; therefore it is not applicable and was not observed in 2010. There were no oil or gas trails observed in 2006 or in 2010.

Species Caught	2006	2010
blacknose shiner		X
bluntnose minnow		X
brassy minnow		X
brook stickleback	X	X
brown bullhead		X
central mudminnow	X	X
common shiner		X
creek chub		X
Cyprinid spp.	X	X
Etheostoma spp.		X
fallfish		X
fathead minnow		X
golden shiner		X
hornyhead chub		X
largemouth bass	X	X
logperch	X	X
northern redbelly dace	X	X
pearl dace		X
pumpkinseed		X
rock bass		X
smallmouth bass		X
stonecat		X
unknown	X	X
white sucker	X	X
yellow perch		X
total species caught	**8**	**25**

Table 15. Comparison of Fish Species

Smallmouth bass caught along Brassil's Creek, June, 2010

Volunteer sorting fish, July 2010

Fish sampling was conducted along Brassil's Creek in 2006 and 2010. In 2006, two sites were sampled on Brassil's Creek with an electrofisher, once at Dwyer Hill Road and twice at Paden Road. In 2010, six sites were sampled, spread out along the stream and using a combination of methods (electrofishing, seining, traps). The first five sites were sampled once in June and once in July, and the sixth site was sampled three times in September. In 2006, eight species of fish were recorded, and in 2010, 25 species were recorded. The large increase of fish species captured is a result of using a variety of equipment at a variety of sites and repeat sampling.

3.2.1.2 Graham Creek

The headwaters of Graham Creek begin west of Highway 416, south of Hunt Club Road. The stream is directed east through Federal land and then flows north where it empties into the Ottawa River on the east side of Andrew Haydon Park, north of Carling Avenue. The majority of Graham Creek has been modified to some extent by urban development, and there are two areas where the stream is piped underground. An evaluation done on Graham Creek in 1991 from Hunt Club Road to the mouth claimed that only approximately 500m of the stream bottom had not been altered (Niblett Environmental Associates Inc.). Graham Creek was originally longer, but the efforts to control flooding and erosion from urbanization have removed many of the meanders. It was estimated that 34 percent of the stream was altered by rip rap, 20 percent by gabion baskets, 22 percent by culverts, 15 percent by engineered grass slopes and eight percent remained natural. This does not include the portion of the creek that flows south of Hunt Club, where over 500m of the stream has been straightened, although the report identifies the upstream alterations as greatly influencing downstream features (Niblett Environmental Associates Inc., 1991).

Graham Creek has high levels of total suspended solids and exceeds water quality objectives for Phosphorus, E. coli, chlorides, iron, manganese but meets the objectives for nitrates, nitrites and sulphates (City of Ottawa, March 2011). Sampling for benthic invertebrates was conducted in 1991, and recorded a low number of organisms and taxa richness, indicating impairment in water quality. The consultants captured nine species of fish during their evaluation (Niblett Environmental Associates Inc.). In 2009, City Stream Watch sampled for benthic invertebrates upstream of Carling Avenue and samples were identified to family level. Results indicated poor water quality but above average for family richness (RVCA, 2009). In 2005, City Stream Watch captured ten species of fish and in 2010, 25 species of fish were recorded. Although Graham Creek is extremely altered, it still provides important habitat for fish.

A small portion of Stony Swamp is located within the Graham Creek watershed boundary, and it is considered to be an important environmental feature within the City of Ottawa, providing habitat for wildlife. Stony Swamp is almost 2000 hectares in size, and is a mix of woodland, wetland and regenerating fields. Over 700 plant species have been recorded in the conservation area (Del Degan, Massé, 2007). Aside from Stony Swamp, there are not many woodlands left along Graham Creek, aside for the riparian area between the creek and the urbanized areas. The trees found along this buffer include sugar maple, beech, red maple, silver maple, yellow birch, white birch, basswood, white elm, slippery elm, white ash, poplar, white pine, hemlock, red oak willows and red osier dogwood (Niblett Environmental Associates Inc., 1991).

Many residents have drainage pipes leading straight into the creek from driveways, rooftops and lawns. Pipes should be directed into a vegetated area prior to running into the creek so that plants can filter out contaminants, allowing some of the water to infiltrate into the ground and reduce the amount of stormwater running into the creek, helping to reduce water level fluctuations during storm events or freshets.

Graham Creek, highly impacted

Graham Creek, one of the few natural areas

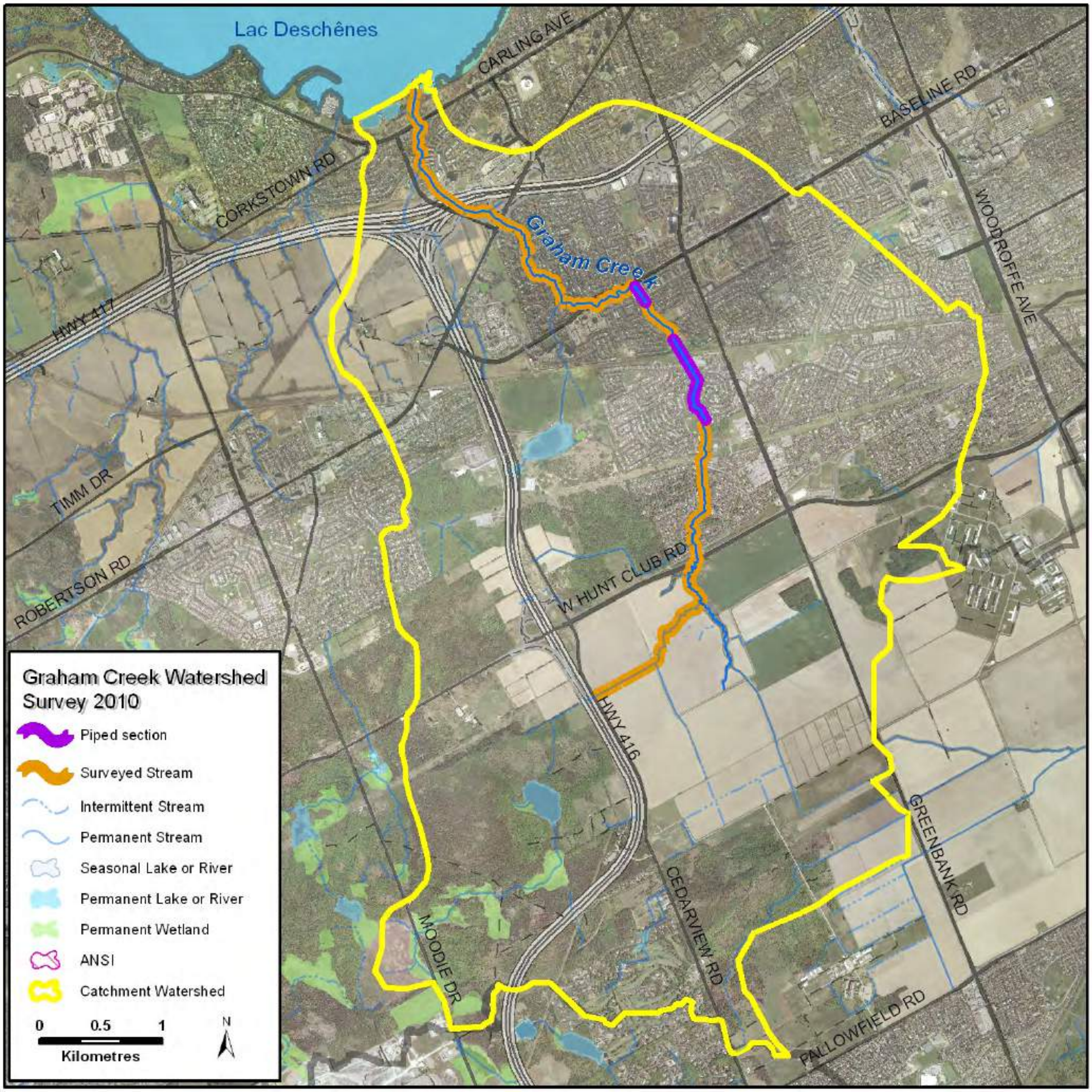


Figure 31. Air Photo of Graham Creek and Surrounding Area

1. Observations of Anthropogenic Alterations and Land Use

Figure 32 illustrates the classes of anthropogenic alterations that volunteers observed along Graham Creek. Graham Creek was surveyed in its entirety, for a total of 6.4 kilometers (64 surveys). Only three percent of the surveys completed on Graham Creek had no anthropogenic alterations. These coincided with areas that had natural meanders, a healthy buffer between the creek and other land uses and where the shoreline had not been armoured. Of the stream area sampled, sixteen percent contained sections that were natural but had some sort of human alteration. These areas coincided with sections that had a smaller buffer between the stream and the residential or agricultural areas. Twenty percent were altered but still had some natural features, and these alterations were mainly stormwater inputs, shoreline armouring and even greater buffer loss. Sixty-one percent of the stream was highly altered, evident through channelization, shoreline armouring, road crossings, stormwater outlets and little to no buffer.

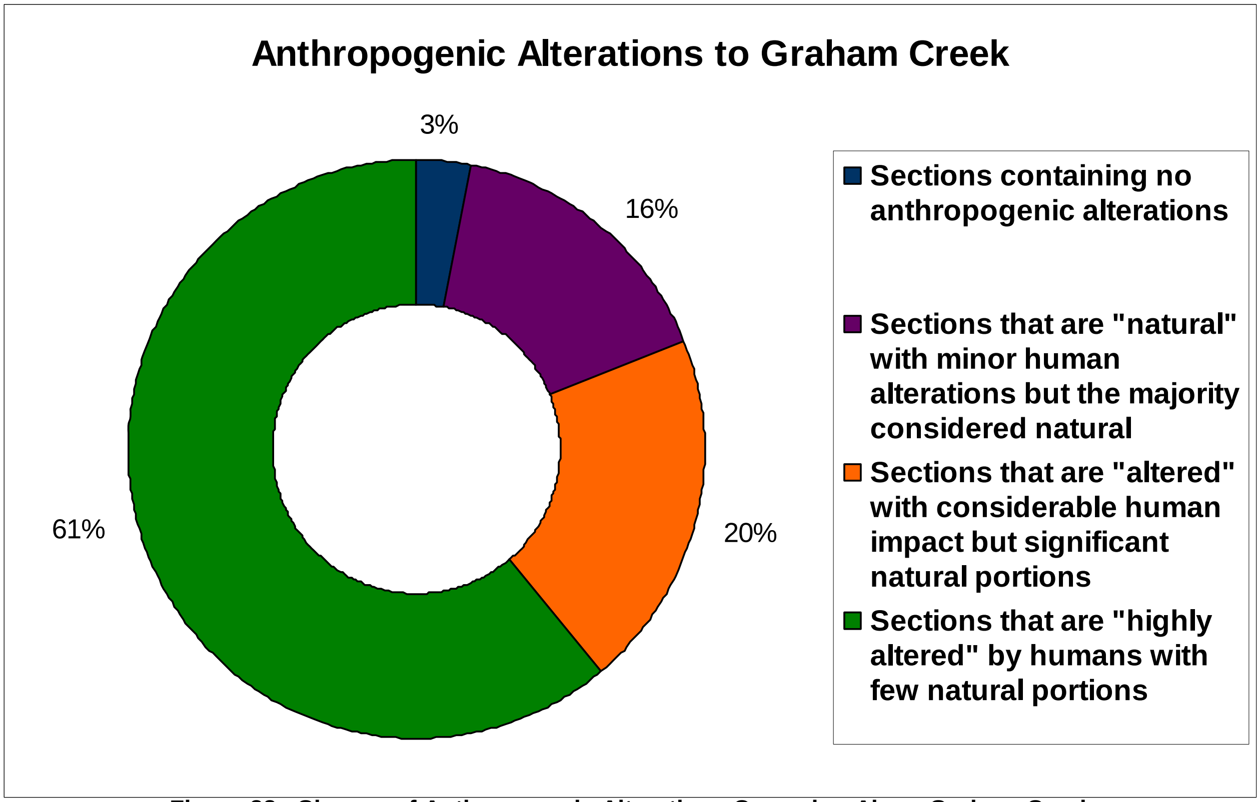


Figure 32. Classes of Anthropogenic Alterations Occurring Along Graham Creek

Channelized section of Graham Creek headwaters

Figure 33 demonstrates the eight different land uses identified by volunteers occurring along the banks adjacent to Graham Creek. Surrounding land use is considered from the beginning to end of the survey section (100m) and up to 100m on each side of the creek. Land use outside of this area is not considered for they surveys but is nonetheless part of the subwatershed and will influence the creek. Only twenty-nine percent of the land use adjacent to Graham Creek is considered natural, consisting of seven percent meadow, 17 percent forest, four percent scrubland and one percent wetland. Agricultural land use accounts for 18 percent, and is located in the headwaters of Graham Creek. Residential land use was observed along thirty-three percent of the creek, and infrastructure accounted for 15 percent. The remaining five percent was recorded as recreational.

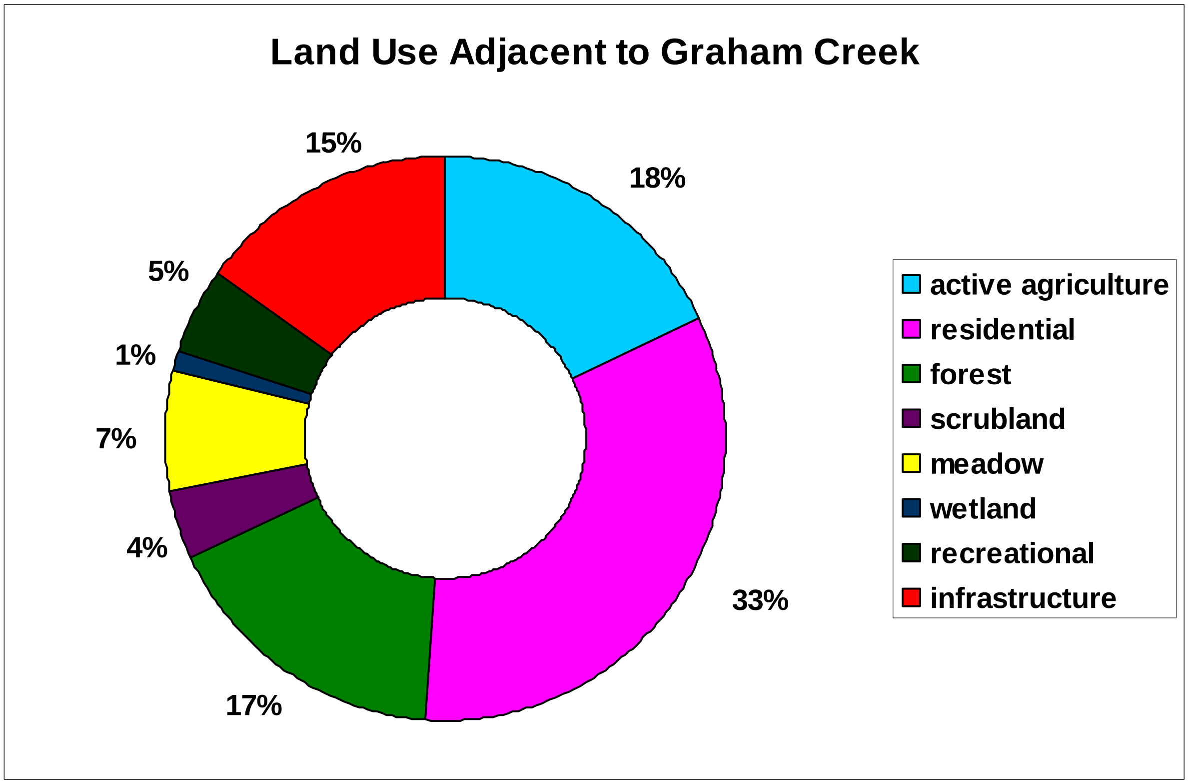


Figure 33. Land Use Identified by Volunteers Along Graham Creek

2. Instream Morphology of Graham Creek

Variety of instream morphology

Pools and riffles are important features for fish habitat. Riffles are areas of agitated water, and they contribute higher dissolved oxygen to the stream and act as spawning substrate for some species of fish, such as walleye. Pools provide shelter for fish and can be refuge pools in the summer if water levels drop and water temperature in the creek increases. Runs are usually moderately shallow, with unagitated surfaces of water, and areas where the thalweg (deepest part of the channel) is in the center of the channel. Graham Creek consists of 80 percent run with 11 percent pool and nine percent riffle, illustrated in Figure 34. More pools and riffles could be created along Graham Creek to enhance fish habitat. Additional habitat features, such as root wads and boulders, could also be installed.

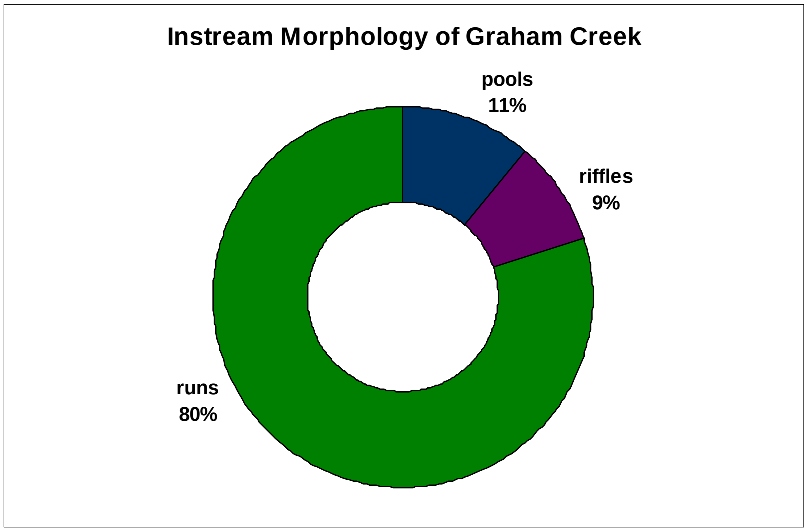


Figure 34. Instream Morphology of Graham Creek

3. Types of Instream Substrate Along Graham Creek

A variety of substrate can be found instream along Graham Creek, although clay and cobble account for forty-nine percent of the substrate observed. Diverse substrate is important for fish and benthic invertebrate habitat because some species will only occupy and/or reproduce on certain types of substrate. Boulders create instream cover and back eddies for large fish to hide and/or rest out of the current, and cobble provides important over wintering and/or spawning habitat for small or juvenile fish. Other substrates also provide instream habitat for fish and invertebrates. Figure 35 demonstrates the types of substrate observed. “Other” refers to areas where the substrate type was a culvert bottom.

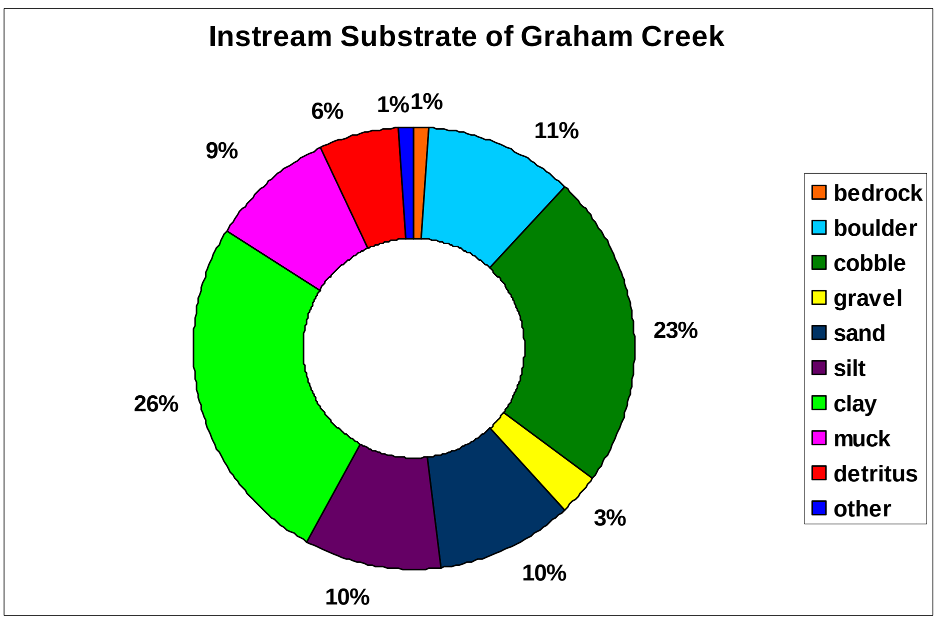


Figure 35. Types of Instream Substrate Along Graham Creek

4. Observations of Instream Vegetation

Volunteers found that twenty-nine percent of Graham Creek contained rare or low amounts of vegetation, illustrated in Figure 36. Although twenty percent of the vegetation was considered normal and 39 percent common, the main type of vegetation observed at those locations was algae. Six percent of the sections surveyed had no vegetation observed, and nine percent were recorded as extensive. Extensive vegetation can have negative affects on the stream, such as biological oxygen demand (BOD), which reduces the amount of dissolved oxygen in the system. Choked vegetation also can impact the mobility and migration of aquatic organisms as well as affects the feeding patterns of fish, especially if water levels are low.

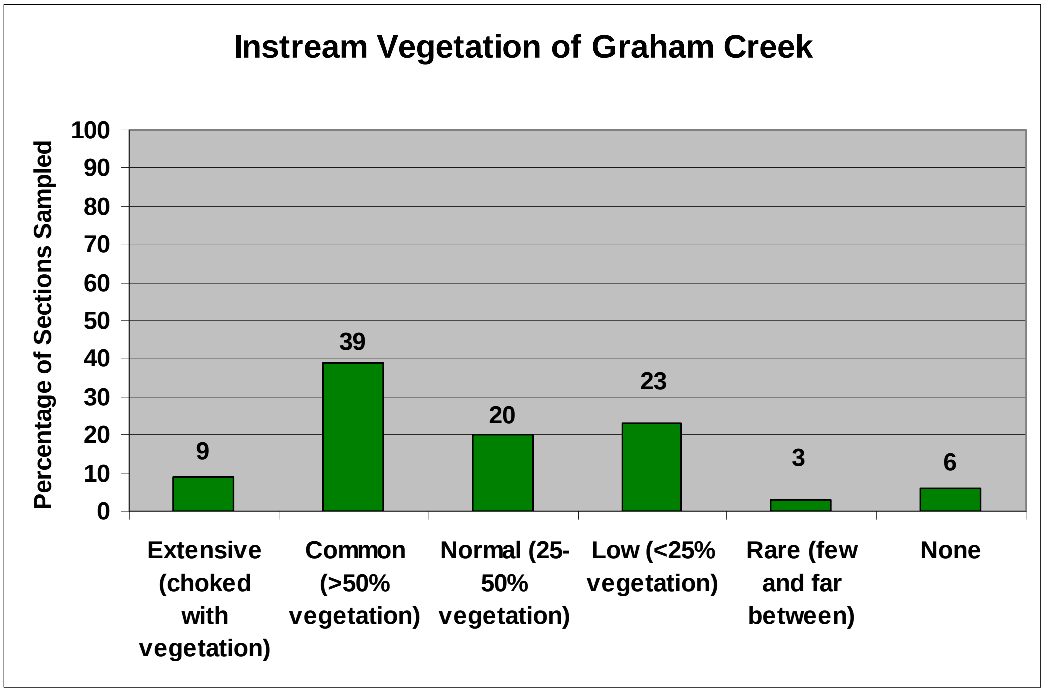


Figure 36. Frequency of Instream Vegetation in Graham Creek

5. Observations of Bank Stability

Figures 37 shows the overall bank stability of Graham Creek. Bank stability is recorded separately for left and right banks to obtain greater detail on the areas experiencing erosion. Both the left and right bank were found to be 73 percent stable and 27 percent unstable. The majority of the creek has been armoured with rip rap or gabion baskets, and erosion was only recorded where that infrastructure was failing, along with areas where no remediation had taken place. The area south of Carling Avenue was experiencing erosion. During the surveys, over 20 percent of the section lengths were experiencing erosion; however, the erosion was not as extreme as observed farther upstream

Bank erosion in headwaters of Graham

or along other urban streams. City Stream Watch carried out one small-scale remediation project in the Carling area along Graham Creek, and the City of Ottawa will be re-armouring a section upstream of the remediation site. On Graham Creek, the area experiencing the worst erosion occurs south of Hunt Club Road where there is little buffer and steep banks are failing.

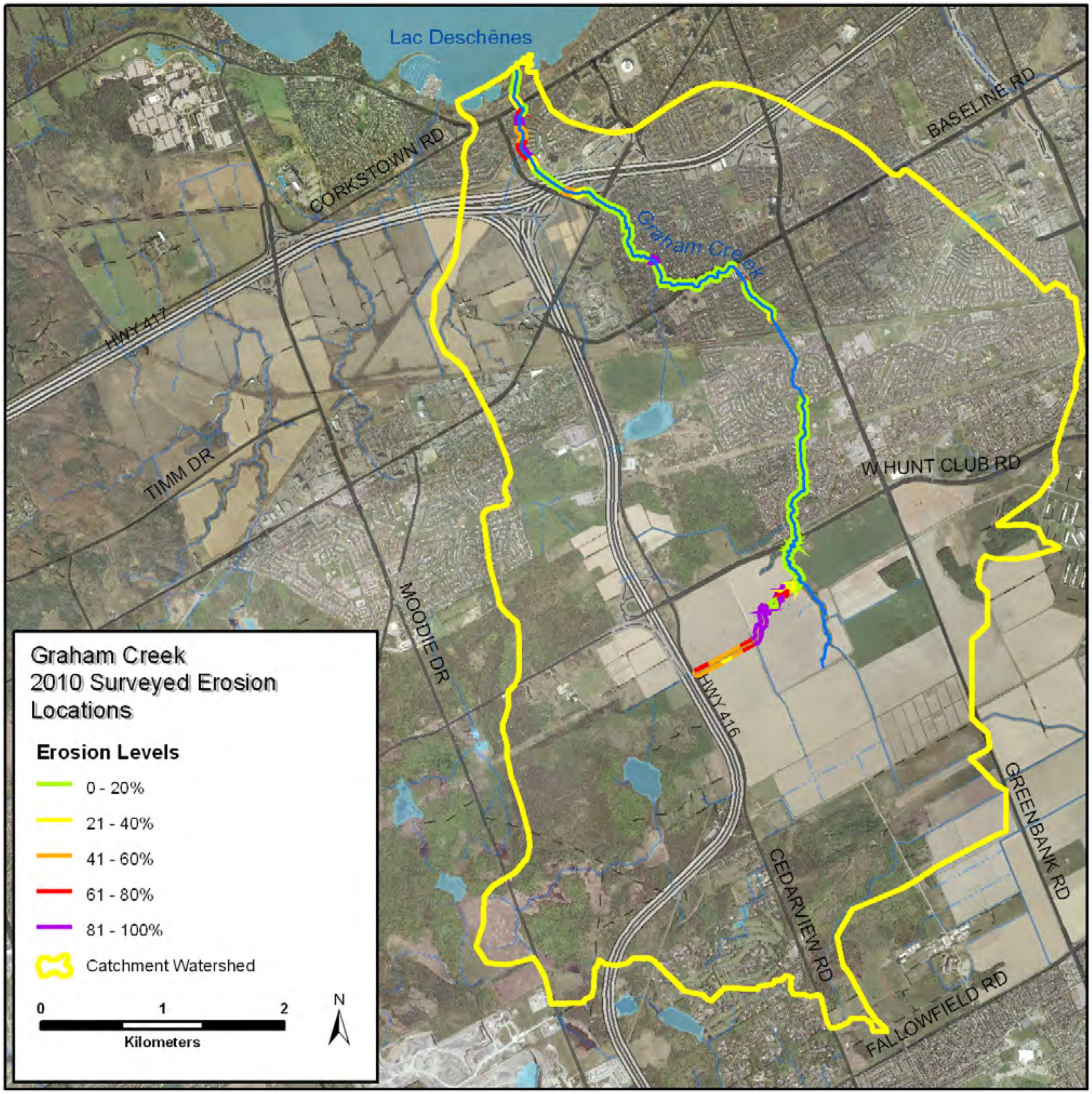


Figure 37. Left and Right Bank Stability of Graham Creek

6. Buffer Evaluation of Graham Creek

Natural buffers between the creek and human alterations are extremely important for filtering excess nutrients running into the creek, infiltrating rainwater, maintaining bank stability and providing wildlife habitat. Natural shorelines shade the creek, helping maintain baseflow levels and keeping water temperatures cool. According to the document *How Much Habitat Is Enough*, it is recommended that a stream have a minimum riparian area of 30 metres or more. Figure 38 compares the buffer width for both left and right banks along Graham Creek. Only thirty-seven percent of Graham Creek achieved the recommendation of 30 metres or greater. Thirty to 31 percent of the sections had a buffer of zero to five metres. These areas included residential areas where the creek has been armoured and road crossing areas. The gabion baskets limit the extent of the riparian buffer in many areas. Sixteen to 19 percent of the sections had a five to 15 metre buffer and 14 to 16 percent had a buffer of 15 to 30 metres.

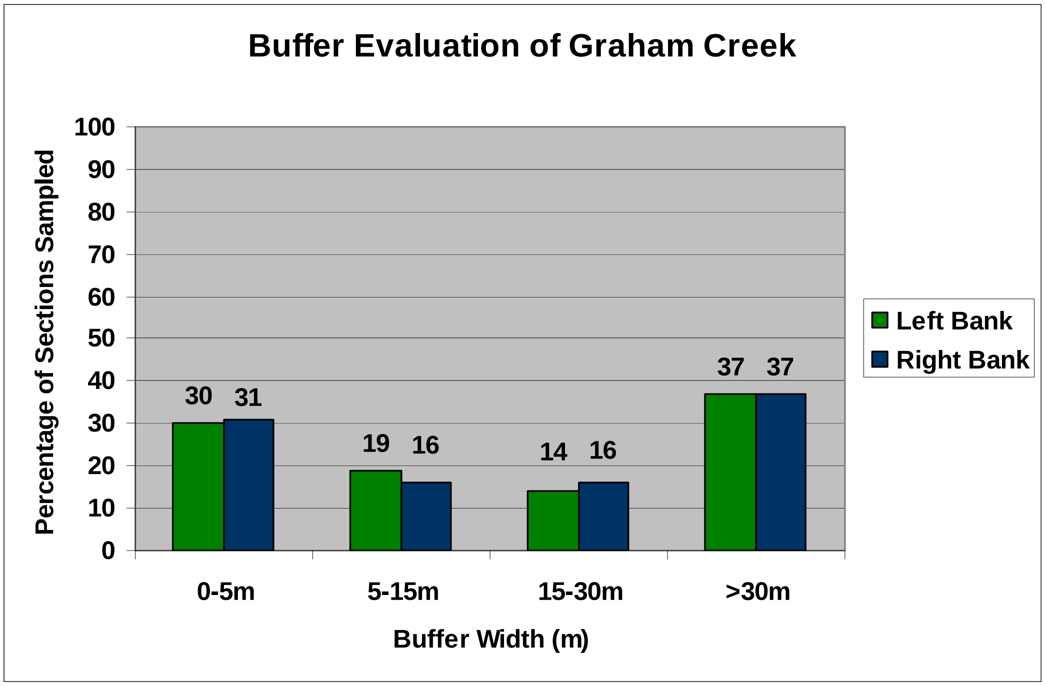


Figure 38. Buffer Evaluation of Graham Creek

7. Observations of Wildlife

The presence of diverse fish and wildlife populations can be an indicator of water quality and overall stream health. Table 16 is a summary of all wildlife observed while surveying on Graham Creek.

Wildlife	Observed While Sampling
Birds	great blue heron, green heron, mallards (adult and young), blue jay, grackle, yellow warbler, red-winged blackbirds, American robins, phoebes, crow, Canada geese, sparrow, kingfisher, cardinal, ring-necked gull, hawk
Mammals	deer, red squirrel, black squirrel, raccoons, groundhog, muskrat, chipmunk
Reptiles/Amphibians	green frog, bullfrog
Aquatic Insects	crayfish, aquatic sowbugs, mayfly larvae, caddisfly larvae, water striders, hemiptera, water boatmen, molluscs, leeches, aquatic worm, dragonfly larvae
Fish (observed when walking)	minnow spp., white sucker, sculpin spp., brook stickleback

Other	jewelwings, ebony jewelwings, common whitetail, bluet spp., dragonflies, damselflies, moth, caterpillar, butterflies, monarch, cabbage white, mosquitoes, bumblebees, wasp, blackflies, cicadas, horseflies, spiders, snails, slugs, ants, worm, luna moth caterpillar, crickets

Table 16. Wildlife Observed Along Graham Creek

8. Observations of Pollution/Garbage

Figure 39 demonstrates the incidence of pollution/garbage in Graham Creek. The area most affected by garbage on Graham Creek was between Carling Avenue and Highway 417. Only 20 percent of the creek was free of garbage. In the sections where garbage was observed, 31 percent was floating and 73 percent was on the stream bed. One percent of the sections had visible oil or gas trails in the water and one percent exhibited unusual colouration of the channel bed.

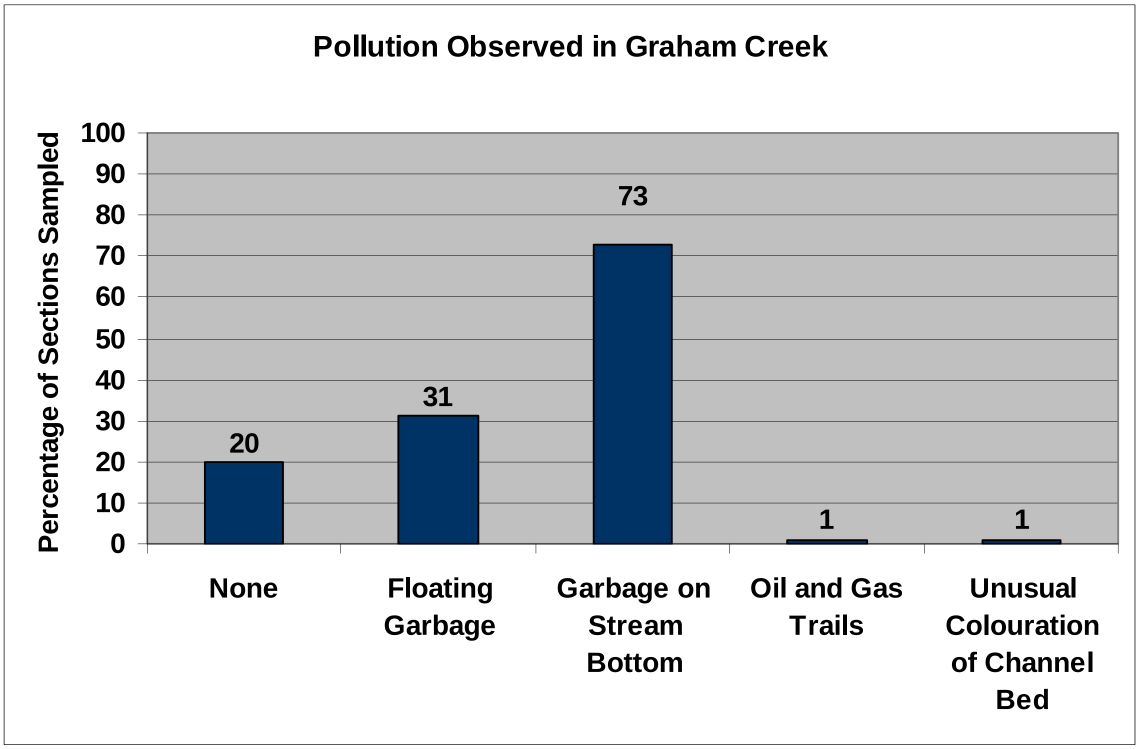


Figure 39. Frequency of Pollution/Garbage Occurring in Graham Creek

There was a large variety of garbage found along Graham Creek. The majority of the garbage found was construction waste and residential items. Items found included plastic items (bottles, bags, wrappers, piping, table covers, planters), car seat, car parts, shoes, fireworks, metal posts, beer bottles, cigarette butts, tires, rubber gloves, disco ball, road signs, pylons, styrofoam, shopping carts, tape, stereo amp, balloon, geotextiles, cement cylinders, scrap metal, comforter, ribbon, lumber, sports equipment, candle, garden hose, tin cans, bicycle, GT snowracers, razor, dog bone, rake, towel, nose spray bottles, aluminum pipes, tree wrappings, motorized toy truck, small oil tank, clothes, skateboard and an iron. Many of these items have a negative effect on wildlife and fish, especially items such as electronics and plastic or metal items that animals can get caught in.

9. Fish Community Sampling

A total of six sites were sampled on Graham Creek. Sites one and six were sampled four times; site two was sampled twice, site three and five were sampled three times and site four was sampled once. A combination of seining, windemere traps, a fyke net and electrofishing were used. One volunteer demonstration was held and individuals assisted RVCA staff with seining and picking up windemere traps for a total of 19 volunteers and 67 volunteer hours. In addition, two fish demonstrations were held at the mouth of Graham Creek for two high schools. All fish were live released after the sampling was finished, unless taken back to the lab to confirm identification. In total, 25 fish species were caught. Sampling locations are shown in Figure 40.

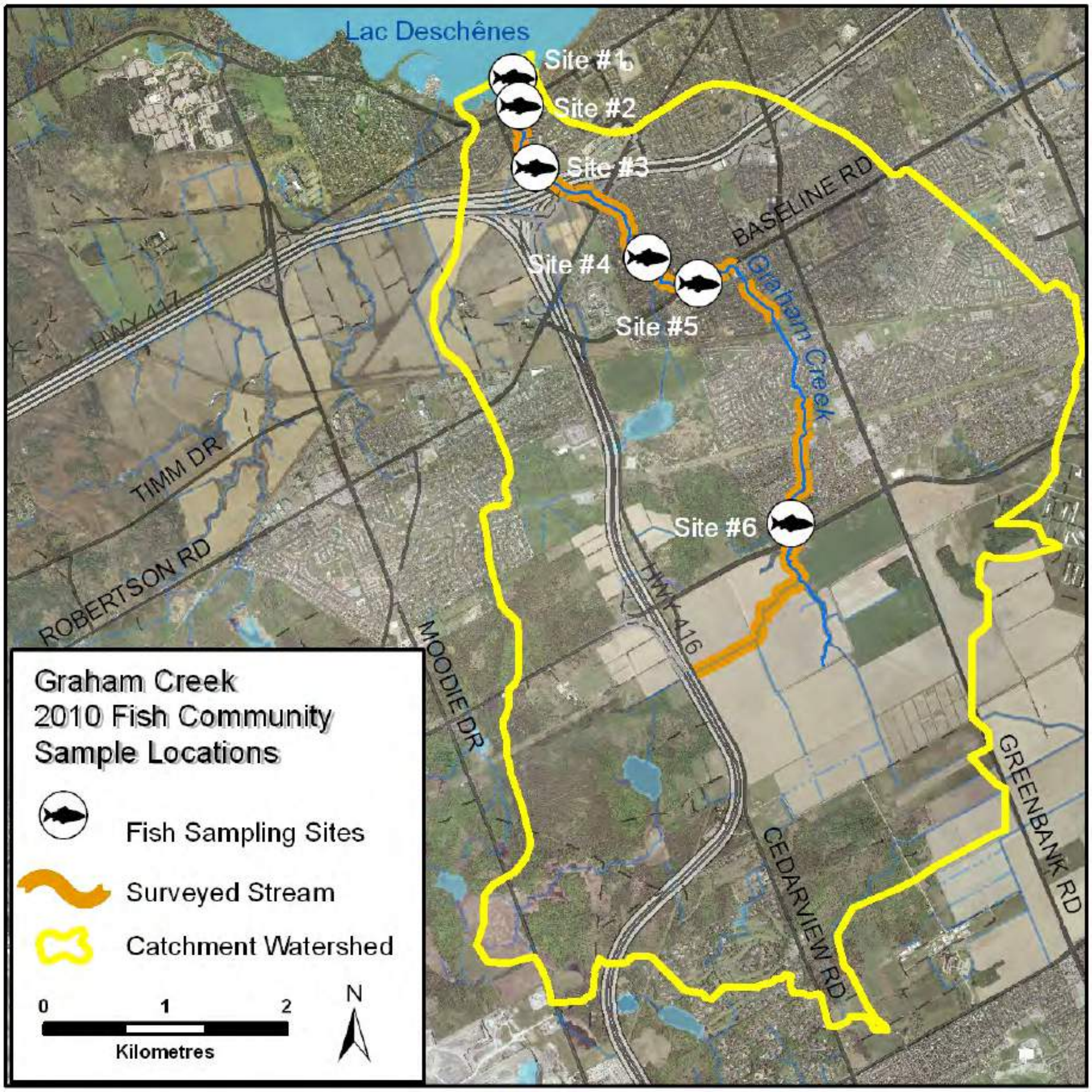


Figure 40. Air Photo of Graham Creek Showing Sampling Sites

Table 17 illustrates the water chemistry values obtained from each site at the time of sampling and the biological data obtained. Minnow species that were too small to be identified are listed as *Cyprinid spp*. Top predators are highlighted in bold. *Etheostoma spp.* indicates that either Johnny darters or tessellated darters were captured. To differentiate between those species, the fish must be removed from the system and brought back to lab; to avoid this, they are only identified to genus level.

Site #	Sampling Technique	Data (mm/dd/yy)	Air Temp (°C)	Water Temp (°C)	DO (mg/L)	pH	Conductivity (uS/cm)	Substrate	Instream Vegetation	Species Sampled	Total # of Species Caught
1	fyke net	4/10/2010	10.91	8.02	17.58	8.22	808	sandy clay, woody material	none	white sucker, spottail shiner, longnose dace, bluntnose minnow, brook stickleback, **yellow perch**, *Etheostoma spp*., *Cyprinid spp*.	8
1	windemere trap	4/10/2010	10.91	8.02	17.58	8.22	808	sandy clay, woody material	none	bluntnose minnow	1
1	seine net	5/26/2010	22.04	18.53	9.92	7.77	1186	sandy clay, woody material	Canada waterweed, curly-leaved pondweed, non-filamentous algae	spottail shiner, brook stickleback, *Etheostoma spp*.	3
1	fyke net	5/26/2010	22.04	18.53	9.92	7.77	1186	sandy clay, woody material	Canada waterweed, curly-leaved pondweed, non-filamentous algae	rock bass, brook stickleback, Iowa darter, banded killifish, *Etheostoma spp.*	5
1	windemere trap	5/26/2010	22.04	18.53	9.92	7.77	1186	sandy clay, woody material	Canada waterweed, curly-leaved pondweed, non-filamentous algae	*Etheostoma spp*.	1
1	seine net	6/22/2010	22.69	17.61	9.34	8.07	1177	sandy clay, muck, woody material	curly-leaved pondweed, Canada waterweed, algae, wild celery	white sucker, **longnose gar**, bluntnose minnow, brook stickleback, banded killifish, mottled sculpin, *Etheostoma spp*., *Cyprinid spp*.	8
1	windemere trap	7/10/2010	35.70	25.47	10.23	7.93	957	sandy clay, muck, woody material	curly-leaved pondweed, algae	mottled sculpin, *Etheostoma spp*.	2
1	fyke net	7/10/2010	35.70	25.47	10.23	7.93	957	sandy clay, muck, woody material	curly-leaved pondweed, algae	white sucker	1
1	seine net	7/10/2010	35.70	25.47	10.23	7.93	957	sandy clay, muck, woody material	curly-leaved pondweed, algae	**yellow perch**, **brown bullhead**, pumpkinseed, white sucker, mottled sculpin, brook stickleback, spottail shiner, emerald shiner, blacknose shiner, *Etheostoma spp*.	10

2	electrofish	6/23/2010	19.45	16.42	8.92	7.91	897	cobble, sandy clay, boulder	non-filamentous algae	**burbot**, logperch, mottled sculpin, blacknose dace, longnose dace, white sucker, *Etheostoma spp*., unknown	8
2	electrofish	7/10/2010	22.07	19.86	8.77	8.21	607	cobble, sandy clay, boulder	non-filamentous algae	longnose dace, mottled sculpin	2
3	windemere trap	4/21/2010	6.96	8.66	13.84	8.13	1195	cobble, boulder	non-filamentous algae	mottled sculpin, pearl dace, creek chub	3
3	windemere trap	5/26/2010	28.52	17.63	10.3	7.66	1213	cobble, boulder	non-filamentous algae	mottled sculpin, white sucker, brook stickleback, blacknose dace	4
3	seine net	5/26/2010	28.52	17.63	10.3	7.66	1213	cobble, boulder	non-filamentous algae	mottled sculpin, white sucker, bluntnose minnow	3
3	electrofish	6/23/2010	22.69	16.79	10.06	7.83	1047	cobble, boulder	non-filamentous algae	white sucker, creek chub, longnose dace, mottled sculpin, unknown	5
4	seine net	4/21/2010	11.7	11.02	16.35	8.09	662	sandy clay, silt, muck, detritus	none	white sucker, mottled sculpin	2
4	windemere trap	5/19/2010	15.82	13.72	10.61	8.03	828	sandy clay, silt, muck, detritus	Canada waterweed, non-filamentous algae	white sucker, brook stickleback	2
4	seine net	6/22/2010	23.85	16.88	10.39	7.9	890	sandy clay, silt, muck, detritus	Canada waterweed, non-filamentous algae	common shiner, brook stickleback, white sucker, northern redbelly dace, northern redbelly dace hybrids, mottled sculpin	5
5	windemere trap	4/22/2010	5.65	8.06	14.47	8.2	825	cobble, boulder, silt, muck	none	central mudminnow, brook stickleback, northern redbelly dace	3
5	windemere trap	5/19/2010	14.3	11.83	11.05	8	928	cobble, boulder, silt, muck	algae	creek chub, brook stickleback, mottled sculpin, *Etheostoma spp*.	4
5	electrofish	6/23/2010	25.61	20.91	12.86	8.4	868	cobble, boulder, silt, muck	algae	white sucker, central mudminnow, longnose dace, brook stickleback, creek chub, mottled sculpin, northern redbelly dace, pearl dace, fathead minnow, unknown	10
5	electrofish	7/8/2010	35.7	25.47	10.23	7.9	957	cobble, boulder, silt, muck	algae	brook stickleback, central mudminnow, longnose dace, mottled sculpin, creek chub, pearl dace	6
6	electrofish	7/8/2010	21.02	18.39	8.92	7.9	917	cobble, silt	non-filamentous algae	mottled sculpin, longnose dace, white sucker, blacknose dace	4

Table 17. Water Chemistry and Fish Community Results for Graham Creek

Fish Species Status, Trophic, and Reproductive Guilds - Graham Creek

The following table was generated by taking the fish community species of Graham Creek and classifying the recreational, commercial or bait fishery importance, the Species at Risk status, reproductive guild (spawning habitat requirements), thermal classification, and trophic guild (feeding preference). The fish community in Graham Creek is made up of two cold, 12 cool, four cool/warm and five warm water species. Two of the warm water species were captured only at the mouth of the stream. The coldwater species found in Graham Creek were burbot and mottled sculpin. Although burbot was only captured at one site, mottled sculpin were captured at all six sites. Most of the fish captured were significant to the baitfish industry, although several were also significant to the recreational industry.

MNR Code	Common Name	Scientific Name	Recreational Fishery	Commercial Fishery	Bait Fishery	Status	Reproductive Guild	Thermal Classification	Trophic Guild
261	banded killifish	*Fundulus diaphanus*	X	X		not at risk	non guarder, open substrate, Phytophils	cool	piscivore/ insectivore
210	blacknose dace	*Rhinichthys atratulus*			X	none	non guarder, open substrate, Lithophils	cool	insectivore/ generalist
200	blacknose shiner	*Notropis heterolepis*			X	none	non guarder, open substrate, Psammophils	cool/warm	insectivore
208	bluntnose minnow	*Pimephales notatus*			X	none	guarder, nest spawner, Spelophils	warm	omnivore
281	brook stickleback	*Culaea incontans*			X	none	guarder, nest spawner, Ariadnophils	cool	insectivore
233	brown bullhead	*Ameiurus nebulosus*	X	limited		none	guarder, nest spawner, Spelophils	warm	insectivore
271	burbot	*Lota lota*	X			none	non guarder, open substrate, Lithopelagophils	coldwater	piscivore
141	central mudminnow	*Umbra limi*			X	none	non guarder, open substrate, Phytophils	cool/warm	insectivore/ omnivore
212	creek chub	*Semotilus atromaculatus*	X		X	none	non guarder, brood hider, Lithophils	cool	insectivore/ generalist
196	emerald shiner	*Notropis atherinoides*			X	none	non guarder, open substrate, Pelagophils	cool	herbivore
209	fathead minnow	*Pimephales promelus*			X	none	guarder, nest spawner, Spelophils	warm	omnivore
338	Iowa darter	*Etheostoma exile*			X	none	non guarder, open substrate, Phytolithophils	cool	insectivore
342	logperch	*Percina caprodes*			X	none	non guarder, open substrate, Psammophils	cool	insectivore
211	longnose dace	*Rhinichthys cataractae*			X	none	non guarder, open substrate, Lithophils	cool	insectivore
41	longnose gar	*Lepisosteus osseus*				none	non guarder, open substrate, Phytophils	warm	piscivore
381	mottled sculpin	*Cottus bairdi*			X	none	guarder, nest spawner, Spelophils	cold	insectivore
182	northern redbelly dace	*Phoxinus eos*			X	none	non guarder, open substrate, Phytophils	cool/warm	herbivore

214	pearl dace	*Margariscus margarita*			X	none	non guarder, open substrate, Lithophils	cool	insectivore
313	pumpkinseed	*Lepomis gibbosus*	X			none	guarder, nest spawner, Polyphils	cool/warm	insectivore
311	rock bass	*Ambloplites rupestris*	X			none	guarder, nest spawner, Lithophils	warm	insectivore
201	spottail shiner	*Notropis hudsonius*			X	none	non guarder, open substrate, Psammophils	cool	insectivore
163	white sucker	*Catostomus commersoni*				none	non guarder, open substrate, Lithophils	cool	insectivore/ omnivore
331	yellow perch	*Perca flavescens*	X			none	non guarder, open substrate, Phytolithophils	cool	insectivore/ piscivore

Table 18. Fish Species Status, Trophic and Reproductive Guilds for Graham Creek (Source: *MTO Environmental Guide to Fish and Fish Habitat*, 2006).

The following table summarizes the fish community structure found in Graham Creek and their sensitivity to sediment and turbidity for reproduction, feeding, and respiration. The composition of the fish community in Graham Creek mainly consists of species that are moderately tolerant to sediment and turbidity, although nine species are sensitive to sediment and turbidity for respiration and five for feeding.

MNR Code	Common Name	Scientific Name	Reproduction	Feeding	Respiration
261	banded killifish	*Fundulus diaphanus*	M	H	unknown
210	blacknose dace	*Rhinichthys atratulus*	M	M	H
200	blacknose shiner	*Notropis heterolepis*	M	M	H
208	bluntnose minnow	*Pimephales notatus*	L	M	unknown
281	brook stickleback	*Culaea incontans*	L	M	unknown
233	brown bullhead	*Ameiurus nebulosus*	L	L	L
271	burbot	*Lota lota*	M	H	unknown
141	central mudminnow	*Umbra limi*	M	M	L
212	creek chub	*Semotilus atromaculatus*	M	M	H
196	emerald shiner	*Notropis atherinoides*	M	L	H
209	fathead minnow	*Pimephales promelus*	L	L	unknown
338	Iowa darter	*Etheostoma exile*	M	M	unknown
342	logperch	*Percina caprodes*	M	M	H
211	longnose dace	*Rhinichthys cataractae*	M	M	H
41	longnose gar	*Lepisosteus osseus*	M	H	L
381	mottled sculpin	*Cottus bairdi*	M	M	unknown
182	northern redbelly dace	*Phoxinus eos*	M	L	L
214	pearl dace	*Margariscus margarita*	M	M	H
313	pumpkinseed	*Lepomis gibbosus*	L	M	unknown
311	rock bass	*Ambloplites rupestris*	L	H	unknown
201	spottail shiner	*Notropis hudsonius*	M	M	H
163	white sucker	*Catostomus commersoni*	M	L	H
331	yellow perch	*Perca flavescens*	M	H	unknown

Table 19. Fish Species Senstivity to Sediment/Turbidity (High, Moderate, Low, unknown) for Graham Creek (Source: *MTO Environmental Guide to Fish and Fish Habitat*, 2006)

10. Temperature Profiles

Four temperature dataloggers were set in Graham Creek. Temperature loggers were set on April 6, 2010 and recorded temperatures every ten minutes until September 30, 2010. Figure 41 shows the locations of the dataloggers. Datalogger 1 was placed at the mouth of the stream, datalogger 2 placed downstream of Highway 417, datalogger 3 placed upstream of Baseline Road and datalogger 4 downstream of Hunt Club Road. We could not retrieve datalogger 3 due to a change in water levels, and it is therefore not shown on the map.

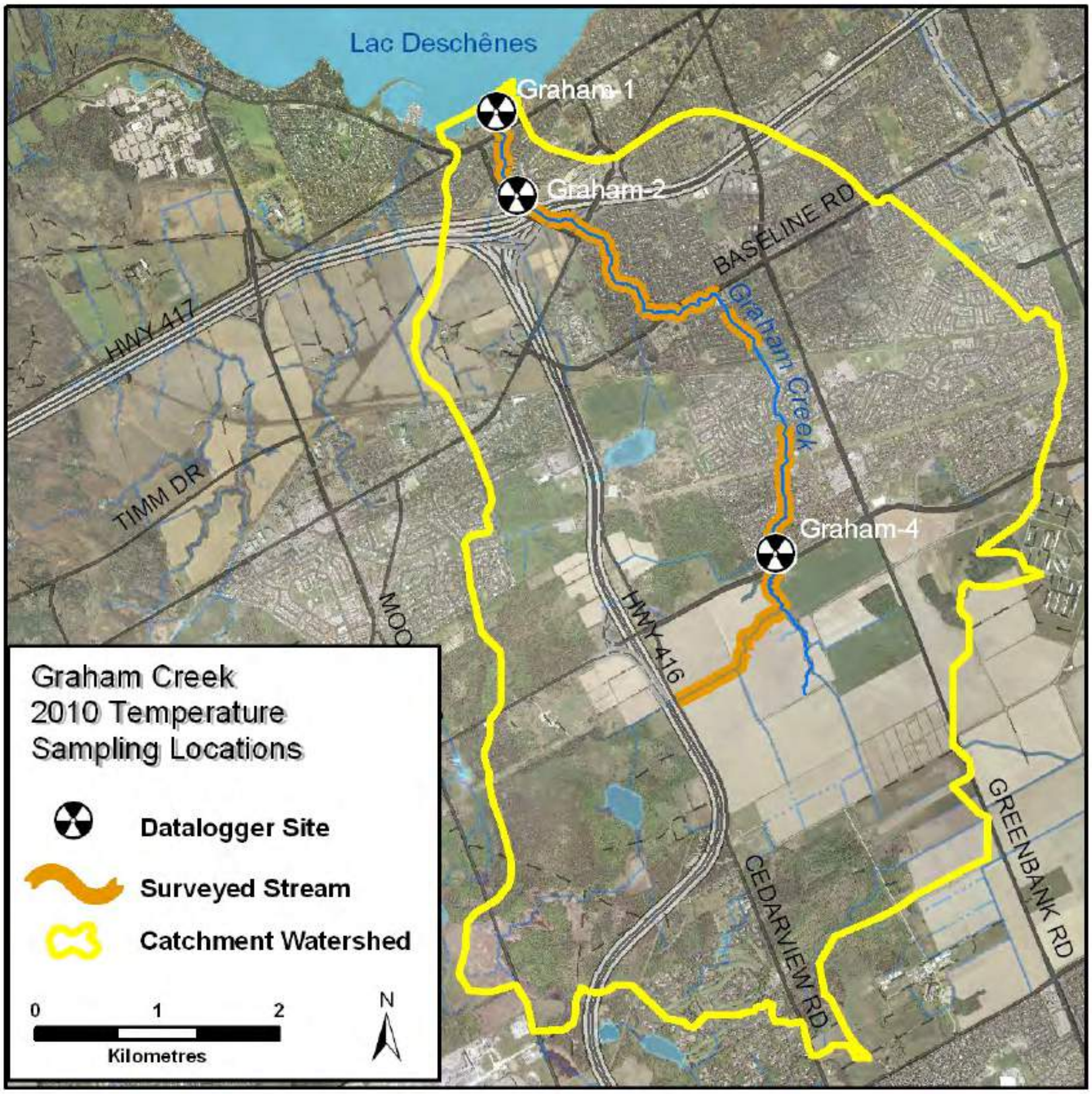


Figure 41. Datalogger Locations Along Graham Creek

Dataloggers were set in four different locations along the stream to give a representative sample of how temperature fluctuates and differs throughout the system. Only the three that were retrieved are illustrated on the map. The thermal classifications for cold, cool and warm water fluvial systems are as follows:

Status	Water Temperature
Cold	<19 Degrees Celsius
Cool	19-25 Degrees Celsius
Warm	>25 Degrees Celsius

Table 20. Water temperature classifications (Minns et al. 2001)

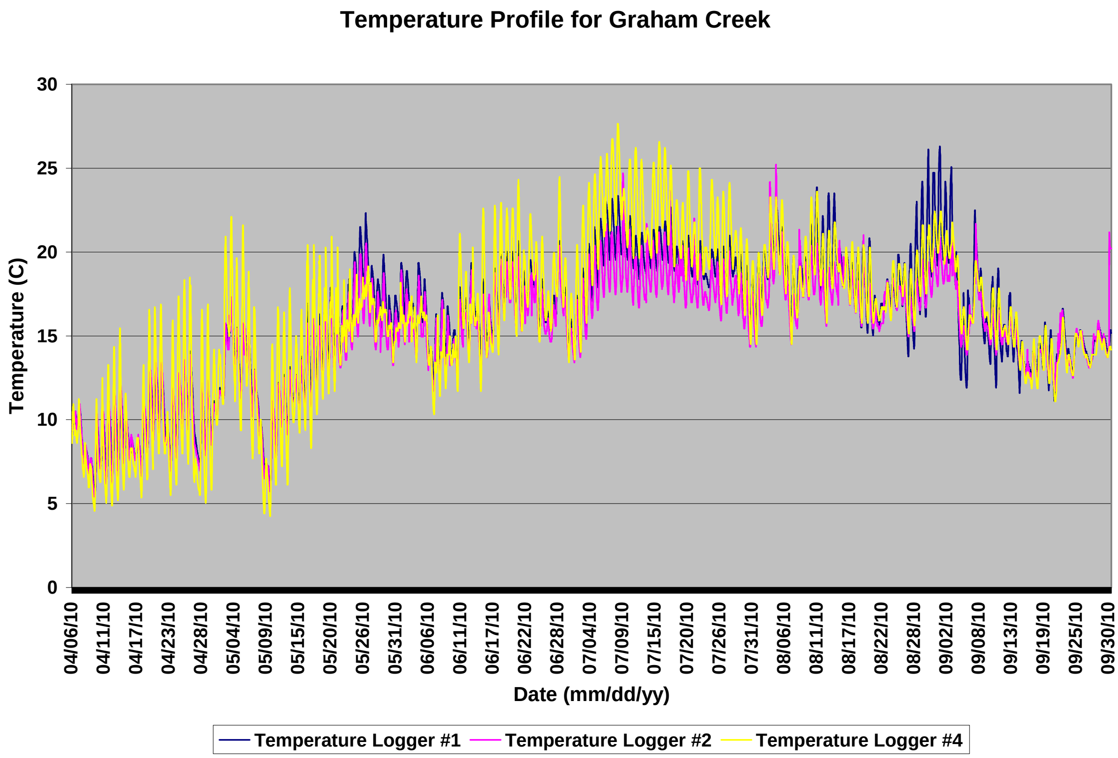


Figure 42. Temperature Profiles for Datalogger 1, 2, 4

Although the dataloggers follow similar trends, datalogger four has much greater fluctuations. It is possible that it could have been out of water for periods of time in April, May, June and July, although each time it was checked, it was submerged. Water levels along Graham Creek were quite low during the summer, and it is possible water levels dropped below the temperature logger. Datalogger 4 was placed downstream of Hunt Club Road, and another reason for larger temperature fluctuations could have been caused by stormwater runoff during rain events. This is reinforced by the timing of the temperature fluctuations, which mainly occurred after precipitation events, not heat waves.

Temp Logger Number	Minimum Temp (°C)	Date Min Temp was Recorded (mm/dd/yy)	Maximum Temp (°C)	Date Max Temp was Recorded (mm/dd/yy)
Temperature logger 1	5.52	4/10/2010	26.3	9/1/2010
Temperature logger 2	5.41	4/10/2010	25.21	8/4/2010
Temperature logger 4	4.25	5/10/2010	27.64	7/8/2010

Table 21. Minimum and Maximum Temperatures of Temperature Loggers

The method for temperature classification is taken from the Ontario Stream Assessment Protocol, for which the temperature data is taken between 4 and 4:30pm, anywhere between July 1 and September 10, on days where maximum air temperature exceeds 24.5°C and after two previous days without precipitation and temperatures surpassing 24.5°C. This occurred during seven days in July, four days in August and one day in September, for a total of 12 days. During that time, temperature loggers 1 and 4 only rose above 25°C for two of the ten days. Temperature logger 2 remained in the cool water range for nine days and the cold water range for one day. The fish community is made up of twelve cool water species, four cool/warm, five warm water species and two cold water species. Based on the temperatures recorded and the fish community, Graham Creek can be classified as a cool water stream. Mottled sculpin were found at all six fish sampling locations, indicating temperatures are cold enough to provide habitat throughout the stream.

11. Invasive Species

Figure 43 shows the locations of invasive species found along Graham Creek, highlighted in pink.

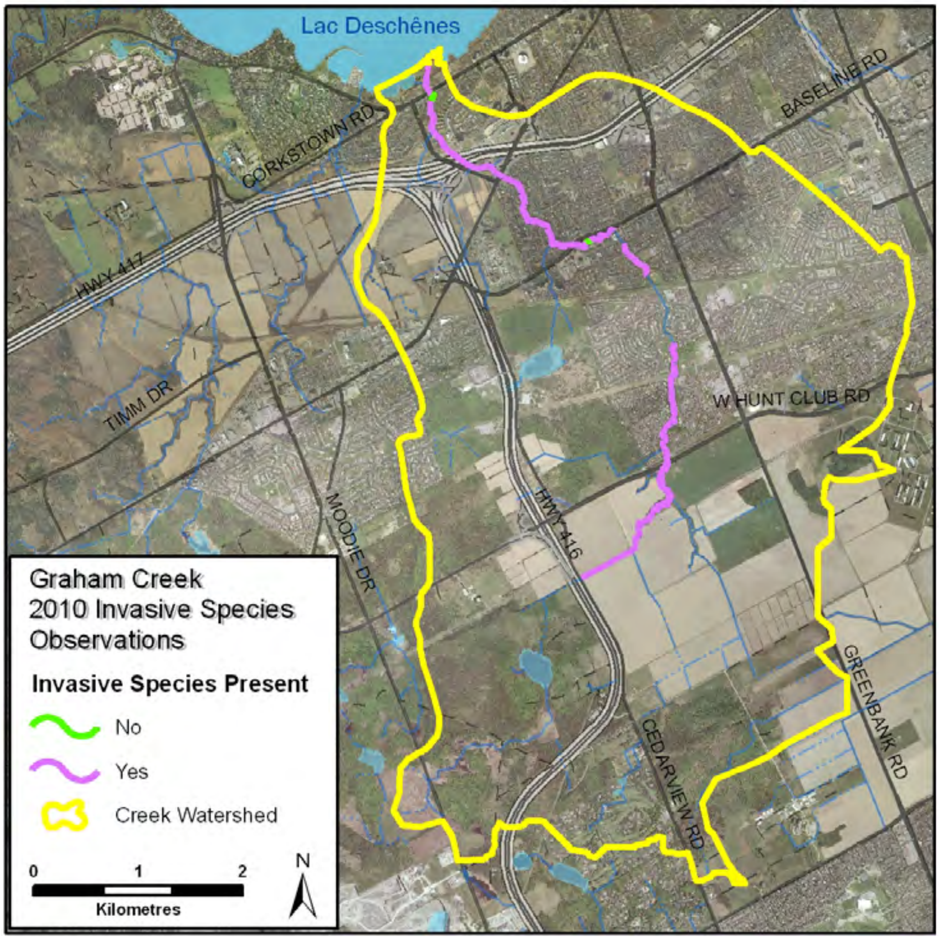


Figure 43. Air Photo of Graham Creek Showing Locations of Invasive Species

Ninety-eight percent of the sections surveyed along Graham Creek had invasive species. The types of invasive species occurred were yellow iris (*Iris pseudacorus*), garlic mustard (*Alliaria petiolata*), purple loosestrife (*Lythrum salicaria*), European buckthorn (*Rhamnus cathartica*), Manitoba maple (*Acer negundo*), dog-strangling vine (*Cynanchum rossicum & C. nigrum*), curly-leaved pondweed (*Potamogeton crispus*), Himalayan balsam (*Impatiens glandulifera*), Norway maple (*Acer platanoides*), Japanese knotweed (*Polygonum cuspidatum*), periwinkle (*Vinca minor*) and wild parsnip (*Pastinaca sativa*). The purple loosestrife was not a problem where it was observed. The greatest species of concern were the garlic mustard, dog-strangling vine, yellow iris, Himalayan balsam, Japanese knotweed and curly-leaved pondweed due to their aggressive growth characteristics and the difficulty of removal. Garlic mustard interferes with the relationship between tree roots and the soil, affecting the growth of the trees, making it quite problematic in natural areas. It spreads aggressively and needs constant pulling for several years in order to control. There are several methods of control being examined by the Nature Conservancy of Canada, on their properties. City Stream Watch completed an invasive species removal for yellow iris at the mouth of Graham Creek and will monitor the site next year to determine success.

12. 2005/2010 Comparison of Graham Creek

Between 2005 and 2010, the field sheets have been modified to include more variables in the assessment. Several of the questions have been modified and improved to provide more detail; therefore, making direct comparisons difficult. The following tables are a comparison between 2005 and 2010.

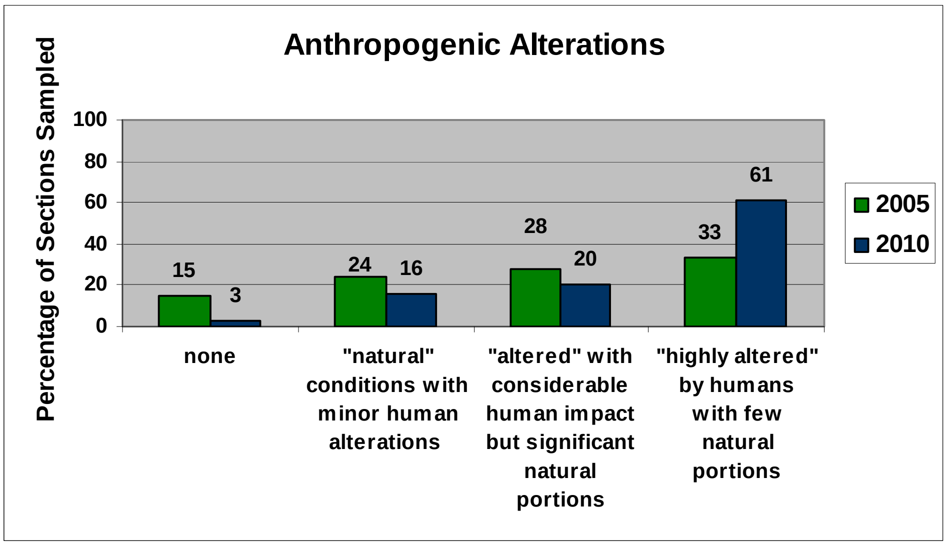


Figure 44. Comparison of Anthropogenic Alterations Between 2005 and 2010

Anthropogenic alterations appear to have greatly increased along Graham Creek in five years; however, many of those changes can be attributed to the survey changes, not physical changes in the creek. Graham Creek is a highly altered system, and it has been altered for many years, leaving little room for further modifications.

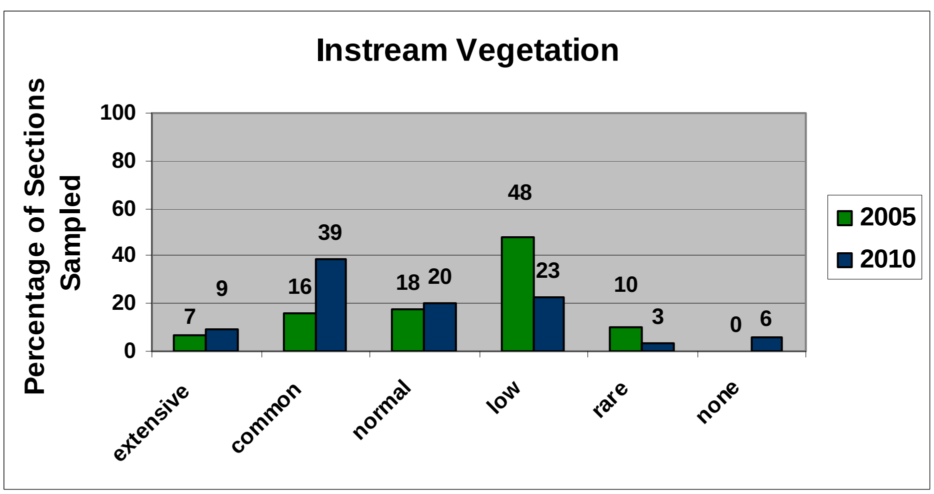


Figure 45. Instream Vegetation Comparison Between 2005 and 2010

Changes of instream vegetation can be related to when the stream was surveyed and weather patterns. The category for "none" was also added after 2005 and would be reflected as "rare" in the 2005 data. Instream vegetation data does differ, with increased levels of extensive, common and normal vegetation in 2010. In 2010, precipitation levels were below average, and in 2005, they were above average, which could affect the amount of growth. Although 2010 appears to have a healthier amount of vegetation, the majority observed was algae, with few other types.

Bank Stability	2005 (%)	2010 (%)
stable	71	73
unstable	28	27
undercut	1	N/A

Table 22. Comparison of Bank Stability

Bank stability was changed in 2008 to separate left bank from right bank and capture more accurate locations on erosion. The category "undercut" was removed from the survey. Undercuts do not always threaten bank stability and are fish habitat and when these are observed, they are categorized as either "stable" or "unstable", depending on its affect on bank stability. It can still be concluded that erosion has not changed significantly in the last five years, mainly due to the shoreline armouring that has taken place along the creek. In many areas, the creek does not have room to move or meander.

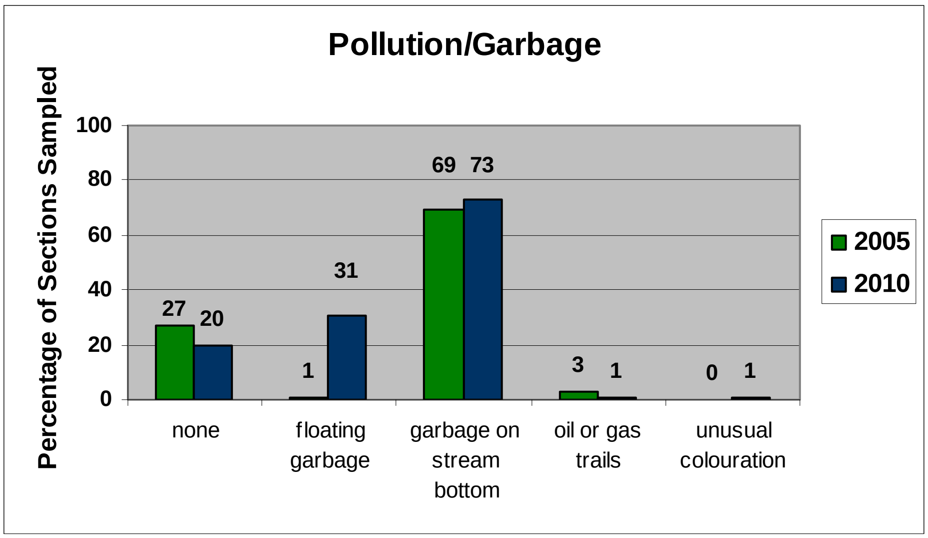


Figure 46. Comparison of Pollution/Garbage Between 2005 and 2010

Pollution has gotten slightly worse in the last five years. Sections without pollution/ garbage have decreased from 27 percent to 20 percent. Graham Creek is a highly impacted system, and garbage was common in most sections. The amount of floating garbage did increase significantly, from one percent to 31 percent, and garbage on the stream bottom increased by four percent. Fewer oil or gas trails were observed in 2010. Unusual colouration of the streambed was added after 2005 and therefore, was not noted during that year. It was observed in 2010.

Shopping cart with plastic caught in the basket on Graham Creek

Species Caught	2005	2010
banded killifish		X
blacknose dace		X
blacknose shiner		X
bluntnose minnow	X	X
brook stickleback	X	X
brown bullhead		X
burbot		X
central mudminnow		X
common shiner	X	
creek chub		X
Cyprinid spp.	X	X
emerald shiner		X
Etheostoma spp.		X
fathead minnow	X	X
Iowa darter		X
johnny darter	X	
logperch	X	X
longnose dace	X	X
longnose gar		X
mottled sculpin	X	X
northern redbelly dace	X	X
pearl dace		X
pumpkinseed		X
rock bass		X
spottail shiner	X	X
white sucker	X	X
yellow perch	X	X
total species caught	**13**	**25**

Table 23. Comparison of Fish Species

Iowa darter caught near mouth of Graham Creek, May 2011

Burbot caught along Graham Creek, June 2011

Fish sampling was done on Graham Creek in 2005 and in 2010. In 2005, 13 species were captured, and in 2010, that number grew to 25. One species caught in 2004 that was not found in 2009, was common shiner. This does not mean the species have disappeared but could be influenced by location and time of sampling. Johnny darter was caught in 2005 and could have been caught in 2010, but it is classified as *Etheostoma spp*. due to its similarities to tessellated darter. Fish sampling methods for 2010 on Graham Creek included seining, a fyke net, windemere traps and electrofishing, whereas only seining was used in 2005. These methods target different types of habitat. Using a variety of methods may increase the chances of capturing more fish species. Although 16 seines were carried out in 2005, most of the seining occurred at the mouth of the creek, with one site at Hunt Club and one site at Baseline. Sampling in 2010 occurred at six locations with repetition on all but one.

3.2.1.3 Green's Creek

Green's Creek is located in the east end of the City of Ottawa. Borthwick Creek, Mud Creek, Black Creek and Ramsay Creek all flow from Mer Bleue Bog and enter into Green's Creek to form its headwaters. McEwan Creek flows into Ramsay and receives water from another tributary and drain and is also part of the Green's Creek subwatershed.

Green's Creek provides an important link between the Mer Bleue Bog and the Ottawa River. Much of the valley along Green's Creek, from Innes Road to the mouth, is considered a Life Science Area of Scientific Interest (ANSI). The Green's Creek valley provides important bird habitat, and there have been over 500 plant species recorded which has led to the ANSI classification, 425 hectares in size (Niblett Environmental Associates Inc., 2009). More uncommon species, such as blue beech and black maple, grow within that valley (Del Degan, Massé, 2007). Along the Green's Creek valley, a variety of vegetation types can be observed, including mixed woodland, deciduous woodland, deciduous thicket swamps, wet meadows and mature deciduous swamp (Niblett Environmental Associates Inc., 2009). Within the Green's Creek subwatershed, there is also Green's Creek Earth Science ANSI (255 hectares), Borthwick Creek Life Science ANSI (52.8 hectares) and Baseline Road Woods Life Science ANSI (JTB Environmental Systems Inc. & J.F. Sabourin & Associates Inc., 2009).

Despite the natural areas found in the Green's Creek area, the creek itself has erosion problems, especially between Innes Road and St. Joseph Boulevard. Two types of Leda clay are found within the subwatershed (JTB Environmental Systems Inc. & J.F. Sabourin & Associates Inc., 2009), and this can create stability and land slide issues along the creek valley. Currently, many stormwater outlets flow into Green's Creek which can exacerbate fluctuating water levels and create increased flow along the creek, contributing to further erosion and poor water quality. Some tributaries to Green's Creek are under development pressure (JTB Environmental Systems Inc. & J.F. Sabourin & Associates Inc., 2009), which can increase the amount of stormwater runoff and sediment entering the system.

A water quality study carried out in 1987 identified a number of water quality issues along Green's Creek, including seepage from a waste site via Borthwick Creek, high spring chloride levels, high levels of iron, manganese, aluminum and phosphorus, high amounts of suspended solids (sediment entering the system from Mud Creek and eroding shoreline of Green's Creek between Innes and Montreal Road) and contributions of human sewage (between Montreal Road and Highway 417, Innes Road at Mud Creek and Borthwick Creek (A.J. Robinson & Associates Inc., 1987). Although this study was completed in 1987, it is unknown which areas may have been remediated to help mitigate some of the water quality concerns identified in the report. From current water quality monitoring data, Green's Creek exceeds water quality objectives for E. coli, phosphorus, chlorides, copper, manganese and iron. The creek also has high levels of total suspended solids (City of Ottawa, March 2011).

The NCC commissioned a fluvial geomorphological study on Green's Creek to seek recommendations on a number of issues they had identified. While the nine issues identified vary in location, all nine were related to land use, stormwater and its impact on the system. JTB Environmental Systems Inc. carried out the study, and came up with 15 recommendations. The overlying recommendation was for the NCC to create a plan for Green's Creek which would include goals and objectives for stormwater management, stream processes and aquatic habitat and to then work with other agencies on carrying out those objectives (JTB Environmental Systems Inc. & J.F. Sabourin & Associates Inc., 2009).

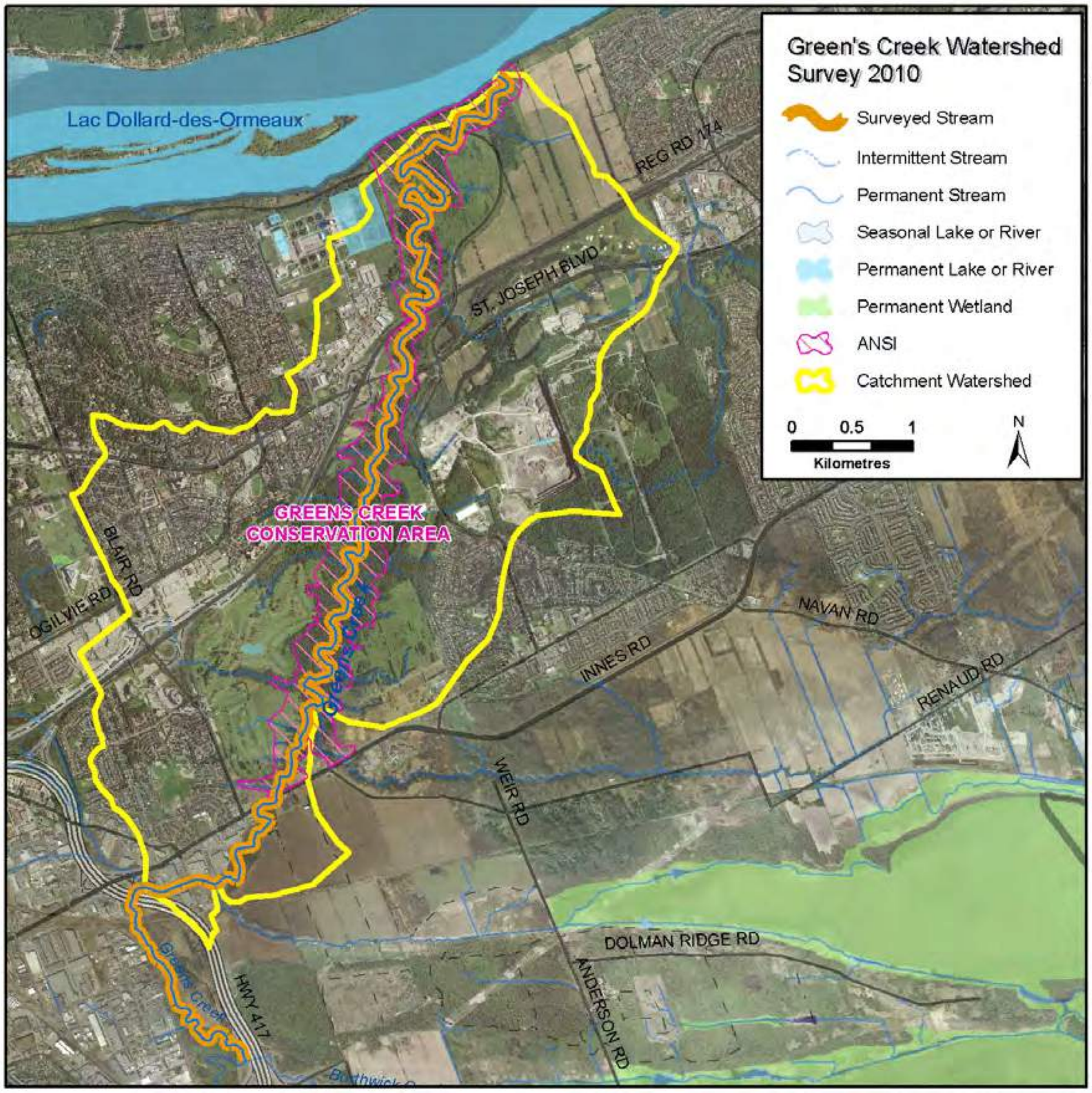


Figure 47. Air Photo of Green's Creek and Surrounding Area

1. Observations of Anthropogenic Alterations and Land Use

Green's Creek was surveyed in its entirety, from the mouth of the creek to the confluence of Ramsay and Borthwick Creek. The surveyed area is highlighted in orange in Figure 47, for a total of 13.5 kilometres (135 surveys). Figure 48 illustrates the classes of anthropogenic alterations observed by volunteers along Green's Creek.

Of the 135 sections of stream surveyed, volunteers identified that 65 percent displayed no human alterations or disturbances, mainly due to the large buffer area along Green's Creek and natural shoreline found from the mouth to Innes Road, aside from road crossings. Of the remaining sections, five percent were considered natural with some human alteration. Ten percent of the creek was considered altered but with some natural portions. The remaining 20 percent was considered highly altered with few natural portions. The altered and highly altered areas were sections of Green's Creek that had been straightened, armoured or had little or no buffer, the majority occurring at road crossings. For example, at Innes Road, the right bank has been armoured with a concrete wall for over 400 metres, which is classified as highly altered.

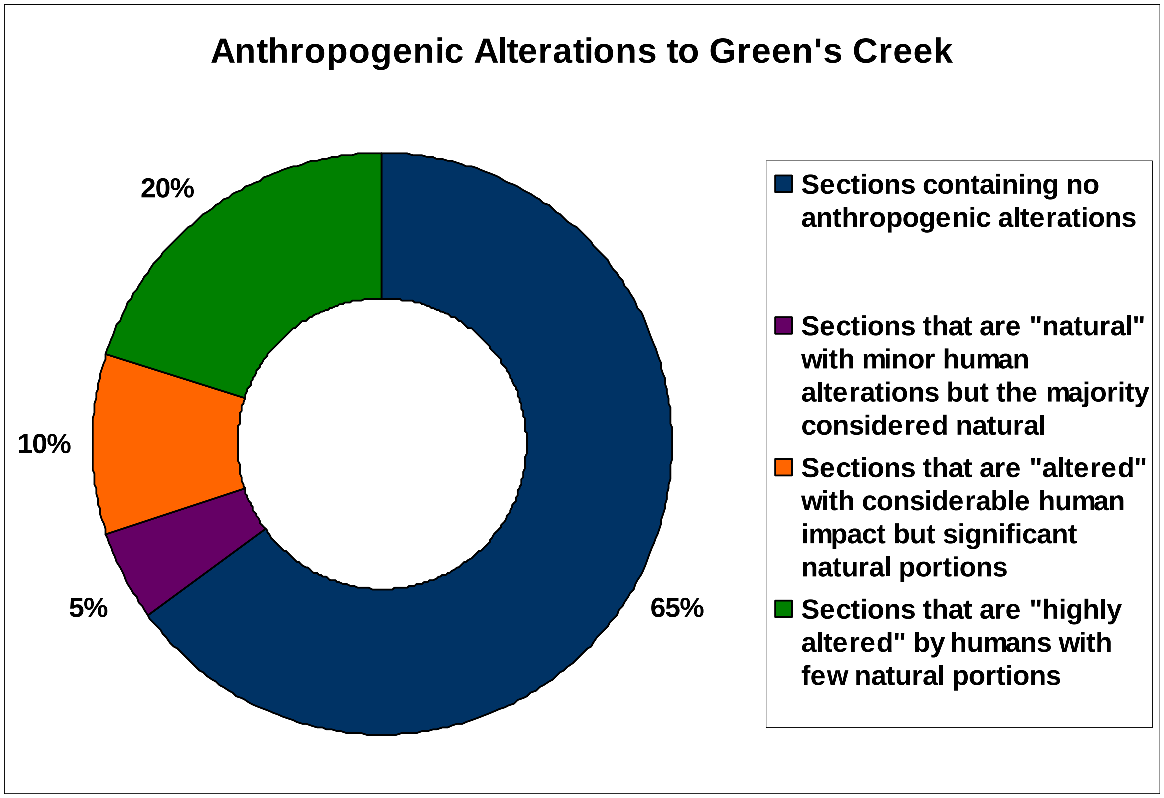


Figure 48. Classes of Anthropogenic Alterations Occurring Along Green's Creek

Triple box culvert at St. Joseph causing log jams

Figure 49 demonstrates the eight different land uses adjacent to Green's Creek observed by volunteers. Surrounding land use is considered from the beginning to end of the survey section (100m) and up to 100m on each side of the creek. Land use outside of this area is not considered for they surveys but is nonetheless part of the subwatershed and will influence the creek. For example, there is residential land within the Green's Creek subwatershed that would have an effect on the creek, but it occurs beyond the 100m boundary.

Eighty-five percent of the area surveyed still consists of natural areas, which are classified as sixty percent forest, one percent wetland, 15 percent meadow and nine percent scrubland. Five percent of the creek is considered industrial/commercial (south of Innes Road), two percent recreational, one percent active agriculture and seven percent infrastructure. Green's Creek has several road crossings; the crossing under Highway 417 splits the creek into four separate culverts which would affect stream function and aquatic habitat. One of the culverts is full of sediment. The newly-reconstructed St. Joseph crossing is already causing flow issues. A box culvert was installed, splitting the stream into three sections. Woody material floating downstream gets caught across the culverts and had created a major log jam that was observed by City Stream Watch during surveys.

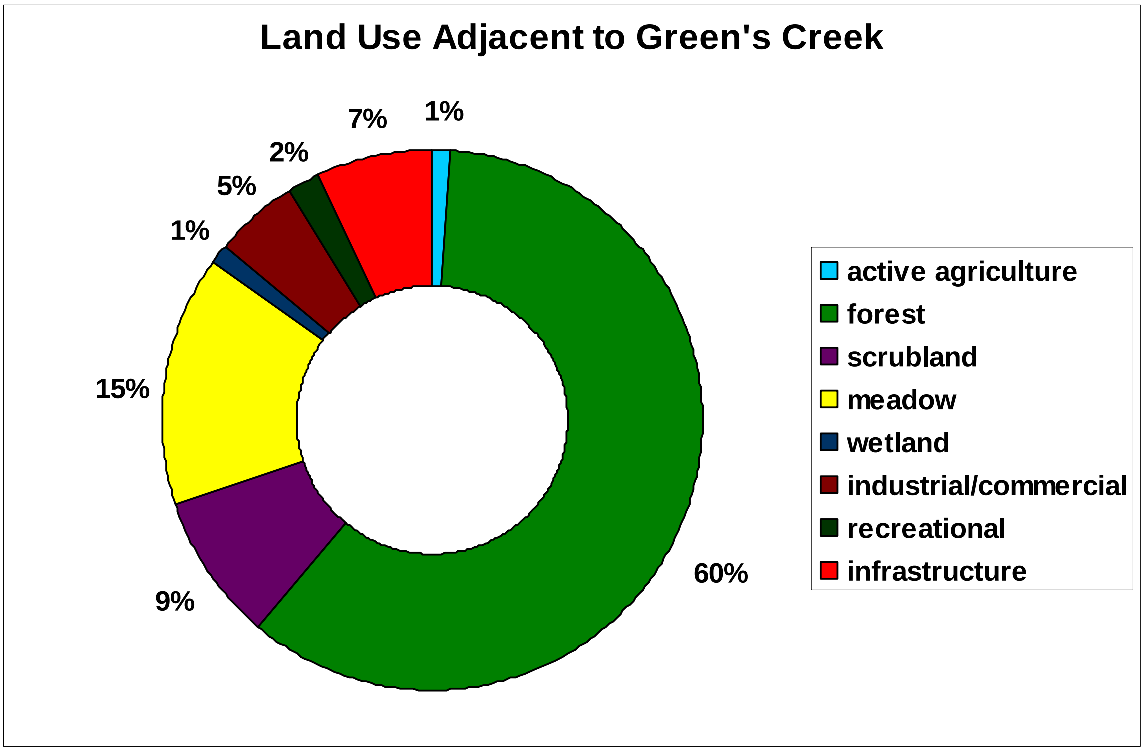


Figure 49. Land Use Identified by Volunteers Along Green's Creek

Forested land use near the mouth of Green's Creek, with a bit of open meadow

2. Instream Morphology of Green's Creek

Pools and riffles are important features for fish habitat. Riffles are areas of agitated water, and they contribute higher dissolved oxygen to the stream and act as spawning substrate for some species of fish, such as walleye. Pools provide shelter for fish and can be refuge pools in the summer if water levels drop and water temperature in the creek increases. Runs are usually moderately shallow, with unagitated surfaces of water, and areas where the thalweg (deepest part of the channel) is in the center of the channel. Green's Creek consists mainly of runs, with few pool and riffle features.

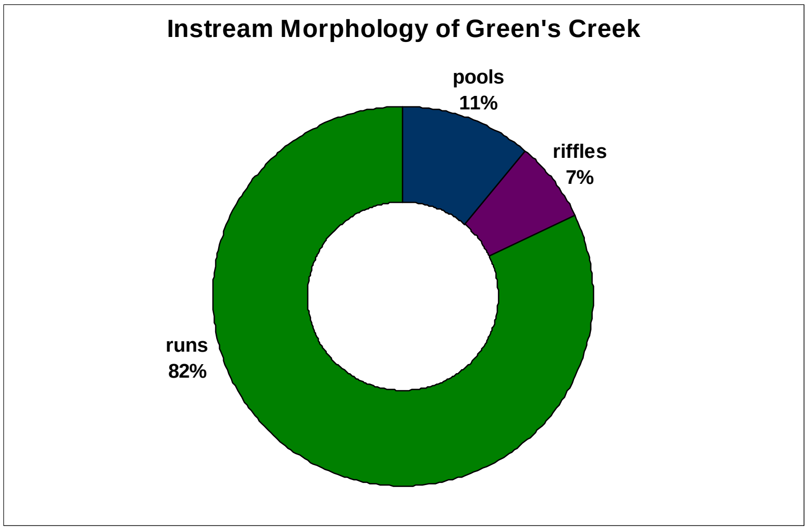


Figure 50. Instream Morphology of Green's Creek

3. Types of Instream Substrate Along Green's Creek

A variety of substrate can be found instream along Green's Creek and is demonstrated in Figure 51. Diverse substrate is important for fish and benthic invertebrate habitat because some species will only occur and/ or reproduce on certain types of substrate. Boulders create instream cover and back eddies for large fish to hide and/or rest out of the current, and cobble provides important over wintering and/or spawning habitat for small or juvenile fish. Other substrates also provide instream habitat for fish and invertebrates. Clay accounted for the largest percentage of instream substrate (30 percent). Fourteen percent of the substrate observed was sand, 13 percent was muck, 12 percent was gravel and ten percent was silt. Other substrate types observed were cobble, boulder, bedrock, detritus and "other". The "other" substrate noted was culvert, on which there was no other substrate deposited. Many of the sites that had coarser substrates, such as cobble and gravel, had been covered by layers of finer material (clay, silt, sand).

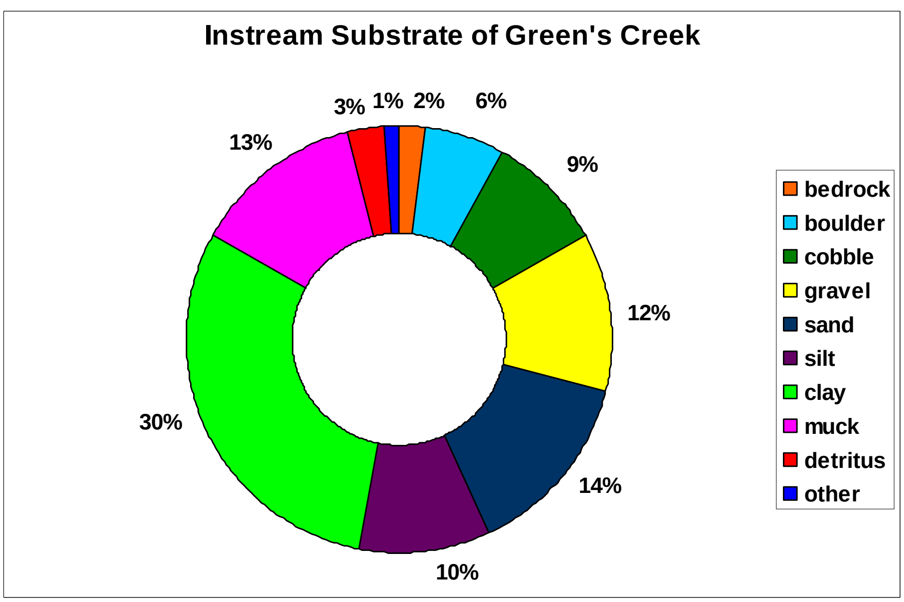


Figure 51. Types of Instream Substrate Along Green's Creek

4. Observations of Instream Vegetation

Figure 52 demonstrates the incidence of instream vegetation in Green's Creek. For the majority of its length, a healthy amount or variety of instream vegetation was not present. This could be due to a dominant clay substrate, fluctuating water levels and murky water, making it difficult for sunlight to penetrate to the bottom of the stream. Instream vegetation was categorized as being common for 13 percent of the stream and 14 percent normal. Low vegetation made up 19 percent of the creek. For 32 percent of the sections surveyed, vegetation was rare, and in 20 percent there was none. Only two percent of the creek was considered to have extensive vegetation, most of which occurred south of Innes Road where flowering rush, an invasive species, is choking the stream bed.

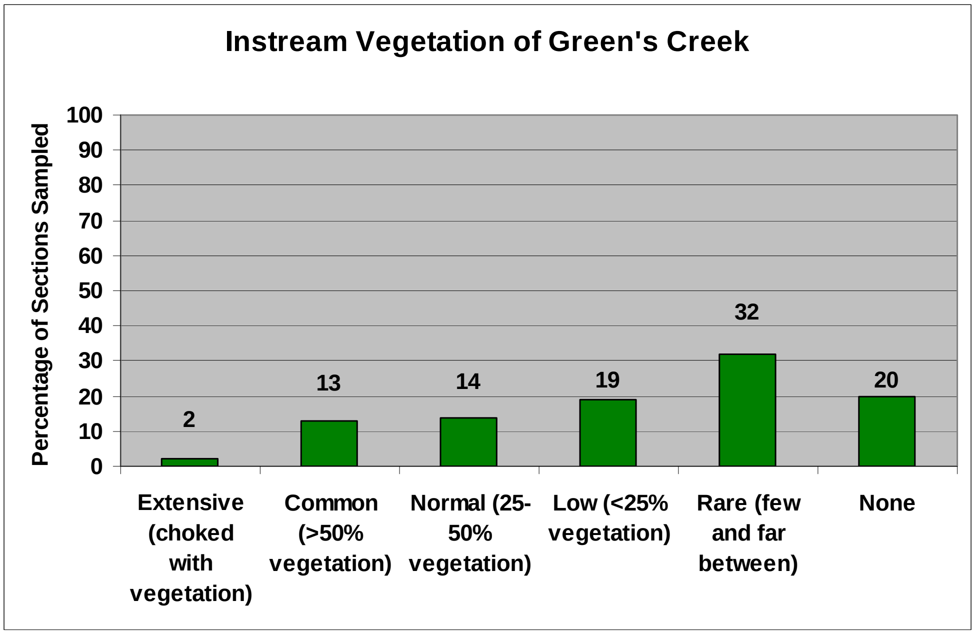


Figure 52. Frequency of Instream Vegetation in Green's Creek

A lack of instream vegetation can greatly increase bank erosion and sediment pollution, which was an issue, observed in many areas along the stream. Instream vegetation also provides habitat for fish and wildlife, aids in removing contaminants from the water, and contributes oxygen to the stream. Areas with little or no vegetation can negatively impact aquatic organisms by resulting in reduced refuge and cover areas. Extensive vegetation can also negatively impact the stream by reducing the amount of dissolved oxygen in the system and can impact the mobility and migration of aquatic organisms as well as the feeding patterns of fish. High levels of nutrients can lead to extensive vegetation growth. Stormwater outlets can carry water with high levels of nutrients and contaminants during rain events, elevating the levels in the stream.

5. Observations of Bank Stability

Bank stability is recorded separately for left and right banks to obtain greater detail on the areas experiencing erosion.

Photo of an unstable bank between Innes Road and St. Joseph Boulevard

Along Green's Creek, the right bank was considered 66 percent stable and 34 percent unstable. The left bank was considered 64 percent stable and 36 percent unstable. The area of greatest instability was recorded between St. Joseph Boulevard and Innes Road, where landslides have occurred and large unstable bluffs line the creek. In some areas, only RVCA staff carried out the surveys because of unstable creek conditions; volunteers resumed participation when more appropriate areas were reached.

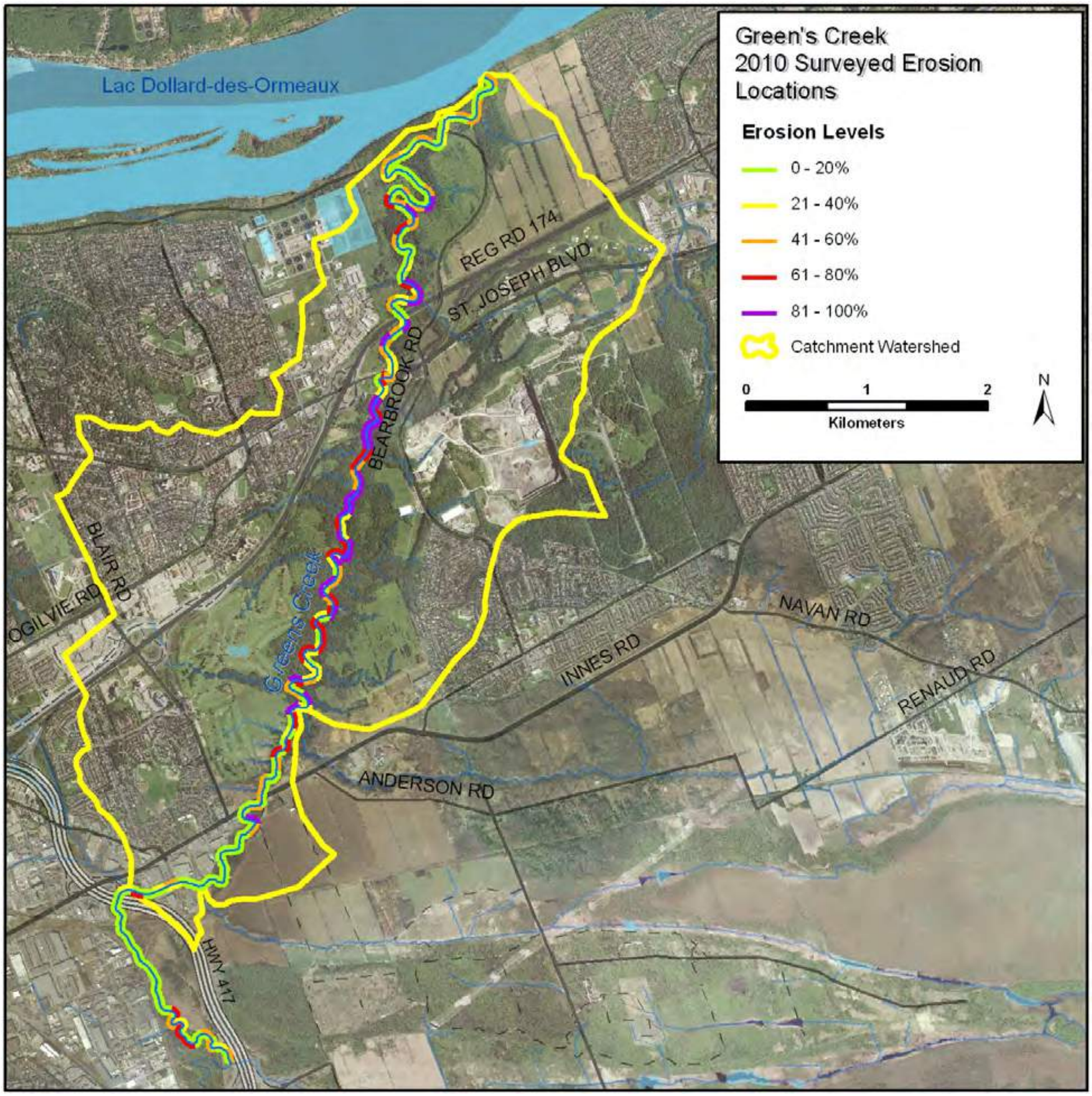


Figure 53. Left and Right Bank Stability of Green's Creek

6. Buffer Evaluation of Green's Creek

Buffer widths for both the left and right banks of Green's Creek are illustrated in Figure 54. Aside from road crossings and some industrial/commercial areas, Green's Creek had an extensive buffer. Natural buffers between the creek and human alterations are extremely important for filtering excess nutrients running into the creek, infiltrating rainwater, maintaining bank stability and providing wildlife habitat. Natural shorelines also shade the creek, helping maintain baseflow levels and keeping water temperatures cool. According to the document *How Much Habitat Is Enough*, it is recommended that riparian areas of a stream be a minimum of 30 metres or more. Green's Creek meets this requirement for 94 percent the left bank and 88 percent of the right bank. Only three to four percent had a buffer of zero to five metres. Two to three percent had a buffer of five to 15 metres and one to five percent had 15 - 30 metres.

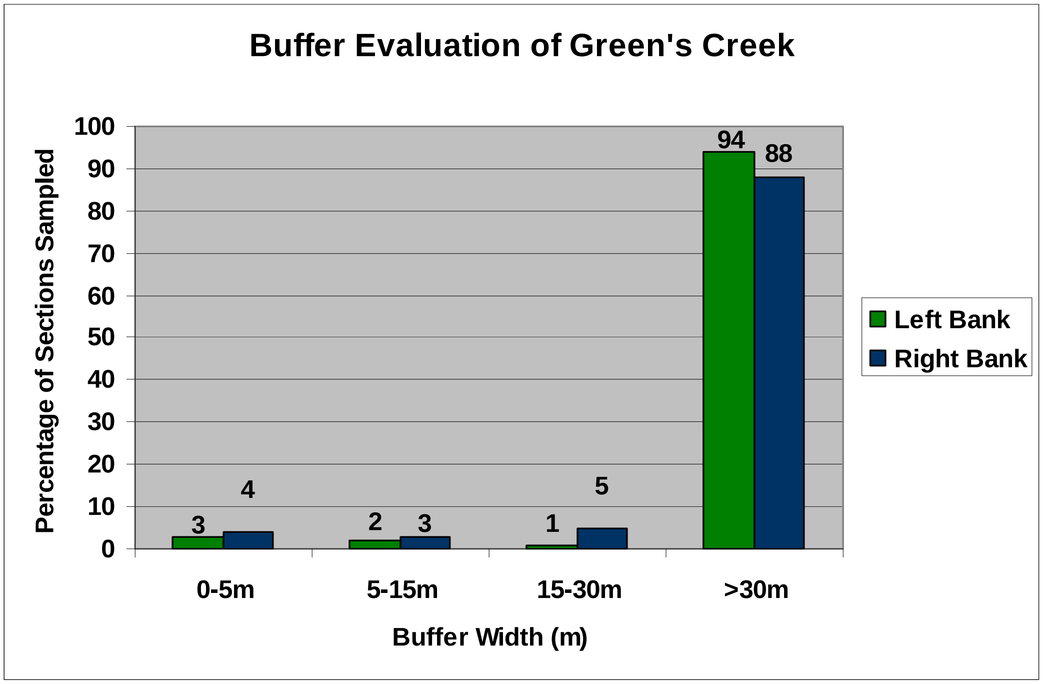


Figure 54. Buffer Evaluation of Green's Creek

7. Observations of Wildlife

Volunteers recorded the presence of types of wildlife in and around Green's Creek. Table 24 is a summary of the wildlife observed.

Wildlife	Observed While Sampling
Birds	ring-necked gull, Canada geese, great blue herons, duck prints, mallards, kingfishers, sandpiper, red-winged blackbirds, phoebes, woodpeckers, crows, chickadees, blue jays, turkey vultures, downy woodpecker, American robin, cardinals, nuthatch, partridge, white-throated sparrow, Eastern kingbird, goldfinches, owl, gray catbird, passerines, bobolinks (species at risk-threatened)
Reptiles/Amphibians	Northern map turtles (species at risk-special concern), snapping turtle (species at risk-special concern), painted turtles, snake, gray treefrog, green frogs, bullfrogs, American toad, leopard frog
Mammals	deer, beaver, muskrat, red squirrels, black squirrels, chipmunk, groundhogs, mole, skunk
Aquatic Insects	water striders, water boatmen, whirlygig beetles, diving beetles, water scorpions, toe-biter, giant water bug, mayfly larvae, caddisfly larvae, crayfish, unionids, aquatic sow bugs, amphipods, snails, rusty crayfish, leeches

Fish (observed when walking)	minnow spp., darter spp., creek chub, white sucker
Other	moths, butterflies, damselflies, dragonflies, monarch, ebony jewelwings, cabbage white, woolly bear caterpillars, horseflies, deerflies, mosquitoes, blackflies, spiders, terrestrial snails, slugs, crickets, grasshoppers, bumblebees, hornets, wasps, cicadas, gnats

Table 24. Wildlife Observed Along Green's Creek

8. Observations of Pollution/Garbage

Figure 55 demonstrates the incidence of pollution/garbage along Green's Creek. Pollution and garbage were observed in many sections. Only 11 percent of the sections surveyed did not have any occurrence of garbage. Oil and gas trails were recorded for one percent of the sections surveyed, and unusual colouration of the channel bed were recorded in one percent of the sections.

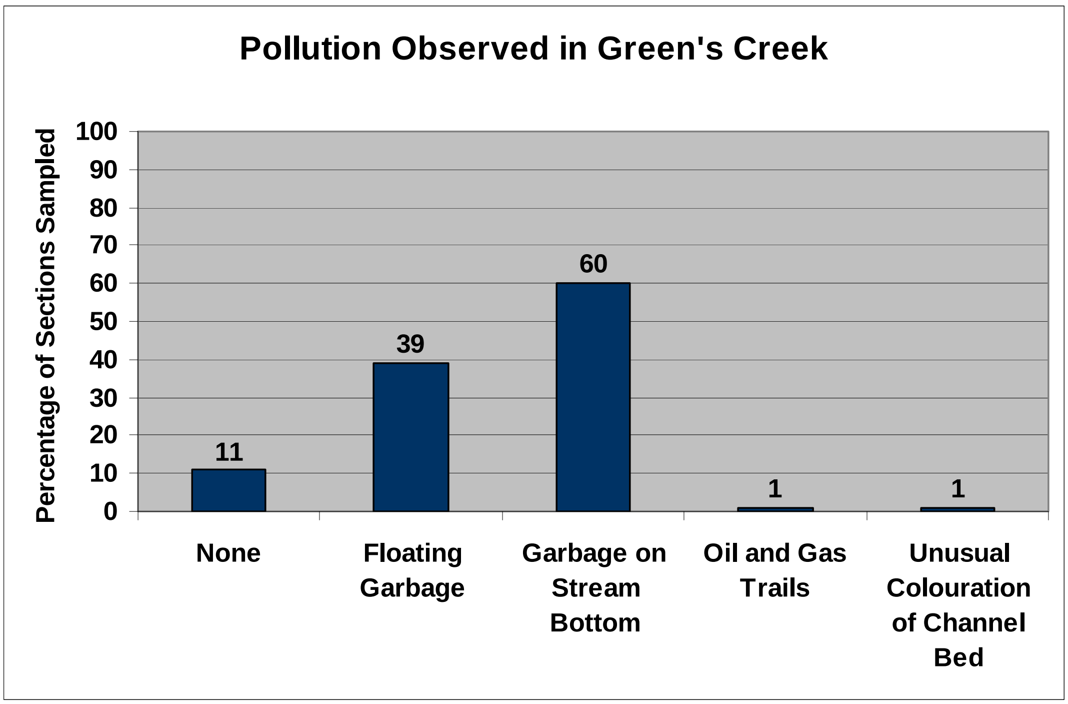


Figure 55. Frequency of Pollution/Garbage Occurring in Green's Creek

On many surveys, both floating garbage and garbage on the stream bottom were observed. A wide variety of garbage was recorded along Green's Creek, although the most abundant was plastic (wrappers, bags, cups, bottles, piping, etc.). Aerosol paint cans were found in high quantities, entering the stream from Innes Road at a graffiti site and should be cleaned up regularly. Some of the items included tires, scrap metal, road signs, pylon, broken glass, pop cans, styrofoam, bicycles, toboggan, fencing, lighters, cigarette butts, rubber, buckets, tinfoil, paper, belt buckle, metal frames, caution tape, old metal culverts, insulation, tires, steak knife, computer monitor, bricks, snow tube, plastic raven decoy, shopping carts, recycling bin, lumber, gold running shoes, cookie cutter, office chair, rebar, concrete, weights, car battery, lawnmower, seat cushion, gypsum board, golf balls, metal gate and wood pallets. The amount of garbage along parts of Green's is a concern and can negatively impact fish and wildlife, especially the aerosol paint cans. A cleanup was done with the 4th Orleans Venture Company Scouts at Innes Road along the streambank, where garbage had been dumped down the slope from the roadway.

9. Fish Community Sampling

Fish sampling was completed at six sites along Green's Creek. Sites three and six were sampled in April, May, June and July. Site four was sampled twice, and site five was sampled three times. Sites two to six were sampled using a variety of equipment, including a seine net, a small fyke net, windemere traps and an electrofisher. At the mouth (sites one and two), large fyke nets were set for one week. Due to intensity of fish sampling methods, sites one and two were sampled in May and June only. Figure 56 shows the locations of the sampling sites. A total of 29 species were collected from the sites. All fish were live released back to the stream after fish sampling, unless taken back to the lab to confirm identification. One large volunteer demonstration was held, and some volunteers were involved in individual sampling for a total of 22 volunteers and 75.5 volunteer hours.

quillback, caught at the mouth

Table 25 illustrates the water chemistry values and summarizes the biological data obtained from each site at the time of sampling. Minnow species that were too small to be identified are listed as *Cyprinid spp*. *Etheostoma spp* indicates that either Johnny darters or tessellated darters were captured. To differentiate between those species, the fish must be removed from the system and brought back to lab; to avoid this, they are only identified to genus level. Top predators are highlighted in bold, and invasive fish species are highlighted in red.

Site #	Sampling Technique	Data (mm/dd/yy)	Air Temp (°C)	Water Temp (°C)	DO (mg/L)	pH	Conductivity (uS/cm)	Substrate	Instream Vegetation	Species Sampled	Total # of Species Caught
1	fyke net	5/11/2010	12.58	11.59	10.58	8.58	933	clay, muck, woody material	none	**silver redhorse**, **quillback**	2
1	fyke net	5/12/2010	19.10	13.95	10.72	8.6	158	clay, muck, woody material	none	**silver redhorse**, **quillback**	2
1	fyke net	5/13/2010	16.66	11.38	10.2	8.66	202	clay, muck, woody material	none	**quillback**, **walleye**	2
1	fyke net	5/14/2010	15.40	12.90	10.38	8.38	171	clay, muck, woody material	none	**silver redhorse**, **quillback**	2
1	fyke net	6/15/2010	20.52	19.23	8.37	8.34	97	clay, muck, woody material	grasses	**yellow bullhead**	1
1	fyke net	6/16/2010	18.60	19.51	10.66	8.31	198	clay, muck, woody material	grasses	**longnose gar**, **freshwater drum**, **silver redhorse**, **shorthead redhorse**, golden shiner, **yellow bullhead**	6

1	fyke net	6/17/2010	19.80	17.47	8.9	7.8	427	clay, muck, woody material	grasses	**silver redhorse**, white sucker, **black crappie**, rock bass	4
1	fyke net	6/18/2010	33.00	24.20	8.45	7.81	704	clay, muck, woody material	grasses	**walleye**, **silver redhorse**, **shorthead redhorse**, **brown bullhead**, white sucker, **channel catfish**, **smallmouth bass**	7
2	fyke net	5/11/2010	10.24	9.80	10.16	8.41	911	clay, muck	none	**black crappie**	1
2	fyke net	5/13/2010	13.38	12.33	8.61	8.63	1049	clay, muck	none	**black crappie**, pumpkinseed	2
2	fyke net	5/14/2010	13.10	14.16	9.32	8.5	1138	clay, muck	none	**black crappie**	1
2	fyke net	6/15/2010	21.27	21.20	8.06	7.71	1232	silty clay, woody material	instream sedges, curly-leaved pondweed	white sucker, rock bass, **brown bullhead**, **shorthead redhorse**, **silver redhorse**	5
2	fyke net	6/17/2010	24.90	18.50	9.05	7.69	533	silty clay, woody material	instream sedges, curly-leaved pondweed	**black crappie**	1
2	fyke net	6/18/2010	29.03	23.20	7.6	7.74	877	silty clay, woody material	instream sedges, curly-leaved pondweed	**smallmouth bass**, white sucker, **brown bullhead**, white sucker, **channel catfish**, **shorthead redhorse**	6
3	fyke net	4/21/2010	6.90	9.92	13.43	8.07	1149	clay, muck, cobble, silt, woody material	none	rock bass, white sucker, **brown bullhead**, fathead minnow	4
3	fyke net	5/13/2010	18.41	13.00	10.8	8.17	1113	clay, muck, cobble, silt, woody material	filamentous algae	white sucker, trout-perch, blacknose dace	3
3	windemere trap	5/20/2010	14.36	12.15	12.55	8.04	1182	clay, muck, cobble, silt, woody material	none	brook stickleback, creek chub, longnose dace, white sucker	4

3	seine net	6/24/2010	24.70	18.21	9.86	7.8	526	clay, muck, cobble, silt, woody material	none	**walleye**, white sucker, *Etheostoma spp., Cyprinid spp.*	4
3	seine net	7/6/2010	29.50	30.80	11.65	8.25	2105	clay, muck, cobble, silt, woody material	emergent	**goldfish**, *Etheostoma spp.*	2
4	windemere trap	5/13/2010	18.90	16.98	9.56	8.88	1174	sand, clay, cobble, gravel	filamentous algae	central mudminnow, white sucker, creek chub	3
4	windemere trap	6/15/2010	24.20	23.60	13.35	8.32	1653	sand, clay, cobble, gravel	algae (filamentous and non-filamentous), curly-leaved pondweed	**burbot**, longnose dace, creek chub, common shiner	4
5	seine net	5/17/2010	20.57	21.68	8.48	8.19	1591	clay, cobble, boulder	algae, grasses	common shiner, trout-perch, blacknose dace, longnose dace, creek chub, white sucker, northern redbelly dace, *Etheostoma spp., Cyprinid spp.*	9
5	electrofish	6/16/2010	16.31	16.70	11.19	8.01	1564	clay, cobble, boulder	algae, grasses	white sucker, creek chub, longnose dace, blacknose dace, central mudminnow, trout-perch, brook stickleback, *Etheostoma spp.*, unknown	9
5	electrofish	7/11/2010	34.30	22.23	10.39	7.88	1280	clay, cobble, boulder	algae, grasses	**largemouth bass**, longnose dace, blacknose dace, creek chub, white sucker, central mudminnnow, dace spp.	7
6	windemere trap	4/21/2010	6.26	8.96	11.64	7.87	897	clay,muck, gravel	none	*Etheostoma spp.*	1
6	windemere trap	5/14/2010	15.47	13.31	9.72	7.95	1134	clay, muck, gravel	water lilies, filamentous algae	brook stickleback, blacknose shiner, fathead minnow, *Etheostoma*	4

										spp.	
6	windemere trap	6/15/2010	24.31	20.52	10.1	7.86	1542		yellow water lily, arrowhead, flowering rush, algae	rock bass, white sucker, brook stickleback, *Etheostoma spp.*	4
6	windemere trap	7/20/2010	29.47	22.92	6.71	7.42	2442		yellow water lily, arrowhead, flowering rush, algae, water shield	*Etheostoma spp.*	1

Table 25. Water Chemistry and Fish Community Results for Sampling Sites Along Green's Creek

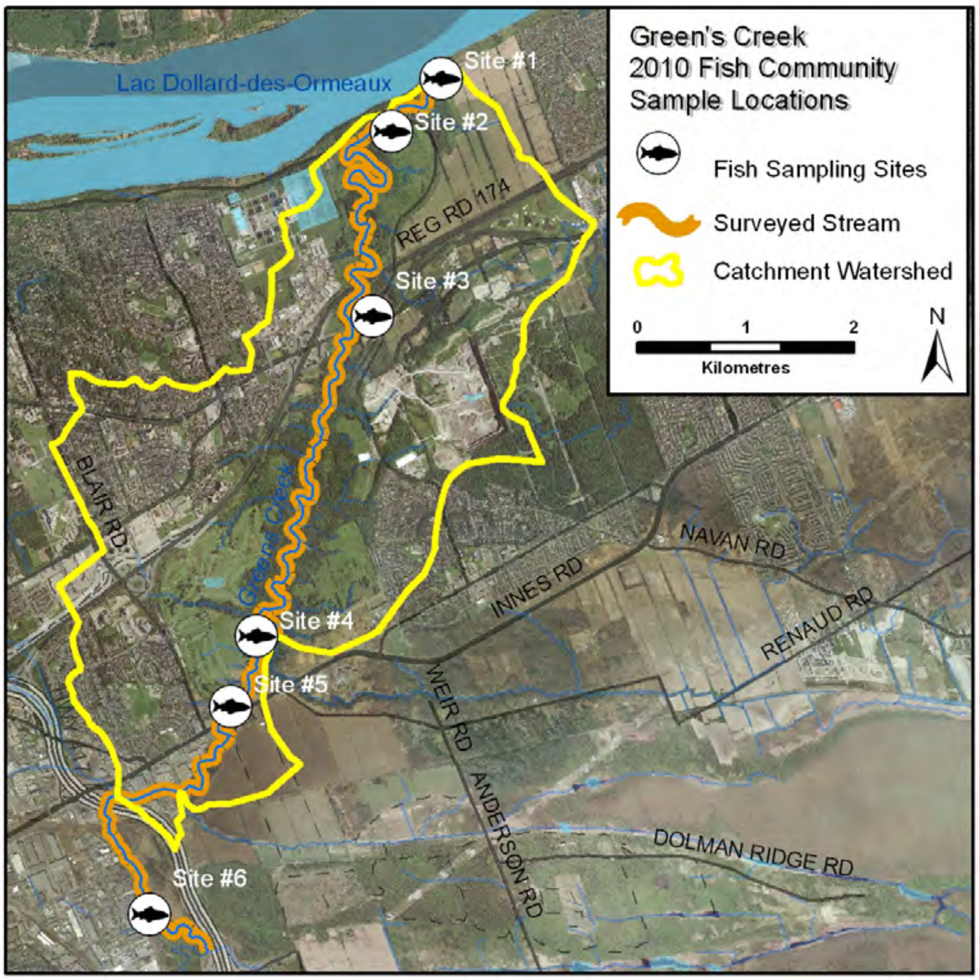


Figure 56. Air photo of Green's Creek Showing Sampling Sites

Fish Species Status, Trophic, and Reproductive Guilds – Green's Creek

The following table was generated by taking the fish community structure of Green's Creek and classifying the recreational, commercial or bait fishery importance, the Species at Risk status, reproductive guild (spawning habitat requirements), thermal classification, and trophic guild (feeding preference). The fish community in Green's Creek is mainly a mixture of cool and warm water species. Eleven species caught are classified as cool water, nine species as warm water, four species as cool/warm and two as cold water. Burbot was caught at site three and trout-perch were caught at site five, both of which are coldwater species, indicating there are some cold water reaches. Spawning habitat requirements within Green's Creek are fairly diverse and can been seen in the table below. Most fish captured are part of the recreational and bait fishery. Most of the species in the recreational category were caught closer to the mouth of the creek. Brown bullhead, channel catfish and walleye were captured, and they are of significance to the commercial fishery in addition to the recreational fishery.

MNR Code	Common Name	Scientific Name	Recreational Fishery	Commercial Fishery	Bait Fishery	Status	Reproductive Guild	Thermal Classification	Trophic Guild
319	black crappie	*Pomoxis nigromaculatus*	X			none	guarder, nest spawner, Phytophils	cool	insectivore/ piscivore
210	blacknose dace	*Rhinichthys atratulus*			X	none	non guarder, open substrate, Lithophils	cool	insectivore/ generalist
281	brook stickleback	*Culaea incontans*			X	none	guarder, nest spawner, Ariadnophils	cool	insectivore
233	brown bullhead	*Ameiurus nebulosus*	X	limited		none	guarder, nest spawner, Spelophils	warm	insectivore
271	burbot	*Lota lota*	X			none	non guarder, open substrate, Lithopelagophils	coldwater	piscivore
141	central mudminnow	*Umbra limi*			X	none	non guarder, open substrate, Phytophils	cool/warm	insectivore/ omnivore
234	channel catfish	*Ictalurus punctatus*	X	limited		none	guarder, nest spawner, Spelophils	warm	insectivore/ piscivore
198	common shiner	*Luxilus comutus*			X	none	guarder, nest spawner, Lithophils	cool	insectivore
212	creek chub	*Semotilus atromaculatus*	X		X	none	non guarder, brood hider, Lithophils	cool	insectivore/ generalist
209	fathead minnow	*Pimephales promelus*			X	none	guarder, nest spawner, Spelophils	warm	omnivore
371	freshwater drum	*Aplodinotus grunniens*	X			none	non guarder, open substrate, Pelagophils	warm	insectivore
194	golden shiner	*Notemigonus crysoleucas*			X	none	non guarder, open substrate, Phytophils	cool/warm	omnivore
181	goldfish	*Carassius auratus*				none			
317	largemouth bass	*Micropterus salmoides*	X	past		none	guarder, nest spawner, Phytophils	warm	insectivore/ piscivore
211	longnose dace	*Rhinichthys cataractae*			X	none	non guarder, open substrate, Lithophils	cool	insectivore

41	longnose gar	*Lepisosteus osseus*				none	non guarder, open substrate, Phytophils	warm	piscivore
182	northern redbelly dace	*Phoxinus eos*			X	none	non guarder, open substrate, Phytophils	cool/warm	herbivore
313	pumpkinseed	*Lepomis gibbosus*	X			none	guarder, nest spawner, Polyphils	cool/warm	insectivore
161	quillback	*Carpiodes cyprinus*				none	non guarder, open substrate, Psammophils	cool	omnivore
311	rock bass	*Ambloplites rupestris*	X			none	guarder, nest spawner, Lithophils	warm	insectivore
168	shorthead redhorse	*Moxostoma macrolepidotum*				none	non guarder, open substrate, Lithophils	cool	insectivore
171	silver redhorse	*Moxostoma anisurum*				none	non guarder, open substrate, Lithophils	warm	insectivore
316	smallmouth bass	*Micropterus dolomieui*	X	past		none	guarder, nest spawner, Lithophils	cool	insectivore/ piscivore
291	trout-perch	*Percopsis omiscomaycus*			X	none	non guarder, open substrate, Lithophils	coldwater	insectivore
334	walleye	*Stizostedion vitreum*	X	X		none	non guarder, open substrate, Lithophils	cool	piscivore
163	white sucker	*Catostomus commersoni*				none	non guarder, open substrate, Lithophils	cool	insectivore/ omnivore
232	yellow bullhead	*Ameiurus natalis*	X			none	guarder, nest spawner, Spelophils	warm	insectivore

Table 26. Fish Species Status, Trophic and Reproductive Guilds for Green's Creek (Source: *MTO Environment Guide to Fish and Fish Habitat*, 2006)

Table 27 summarizes the fish community structure found in Green's Creek and their sensitivity to sediment and turbidity for reproduction, feeding, and respiration. The composition of the fish community in Green's Creek ranges from species that are fairly tolerant to sediment and turbidity to species that are intolerant. The majority of the species are classified in the moderately tolerant range to sediment/turbidity for reproduction and feeding, but some of those species have a higher sensitivity to sediment/turbidity for respiration.

MNR Code	Common Name	Scientific Name	Reproduction	Feeding	Respiration
319	black crappie	*Pomoxis nigromaculatus*	L	H	unknown
210	blacknose dace	*Rhinichthys atratulus*	M	M	H
281	brook stickleback	*Culaea incontans*	L	M	unknown
233	brown bullhead	*Ameiurus nebulosus*	L	L	L
271	burbot	*Lota lota*	M	H	unknown
141	central mudminnow	*Umbra limi*	M	M	L
234	channel catfish	*Ictalurus punctatus*	L	M	L

198	common shiner	*Luxilus comutus*	M	M	unknown
212	creek chub	*Semotilus atromaculatus*	M	M	H
209	fathead minnow	*Pimephales promelus*	L	L	unknown
371	freshwater drum	*Aplodinotus grunniens*	M	M	H
194	golden shiner	*Notemigonus crysoleucas*	M	M	L
181	goldfish	*Carassius auratus*	M	L	unknown
317	largemouth bass	*Micropterus salmoides*	L	H	H
211	longnose dace	*Rhinichthys cataractae*	M	M	H
41	longnose gar	*Lepisosteus osseus*	M	H	L
182	northern redbelly dace	*Phoxinus eos*	M	L	L
313	pumpkinseed	*Lepomis gibbosus*	L	M	unknown
161	quillback	*Carpiodes cyprinus*	M	L	H
311	rock bass	*Ambloplites rupestris*	L	H	unknown
171	shorthead redhorse	*Moxostoma macrolepidotum*	M	L	H
168	silver redhorse	*Moxostoma anisurum*	M	L	H
316	smallmouth bass	*Micropterus dolomieui*	M	H	unknown
291	trout-perch	*Percopsis omiscomaycus*	M	M	H
334	walleye	*Stizostedion vitreum*	M	H	H
163	white sucker	*Catostomus commersoni*	M	L	H
232	yellow bullhead	*Ameiurus natalis*	L	L	unknown

Table 27. Fish Species Sensitivity to Sediment/Turbidity (High, Moderate, Low, unknown) for Green's Creek (Source: *MTO Environment Guide to Fish and Fish Habitat*, 2006)

longnose gar,

Green's Creek

10. Temperature Profiles

Five temperature dataloggers were set in Green's Creek. Dataloggers were set on April 6, 2010 and recorded temperatures every ten minutes until September 30, 2010. Figure 57 shows the locations of dataloggers.

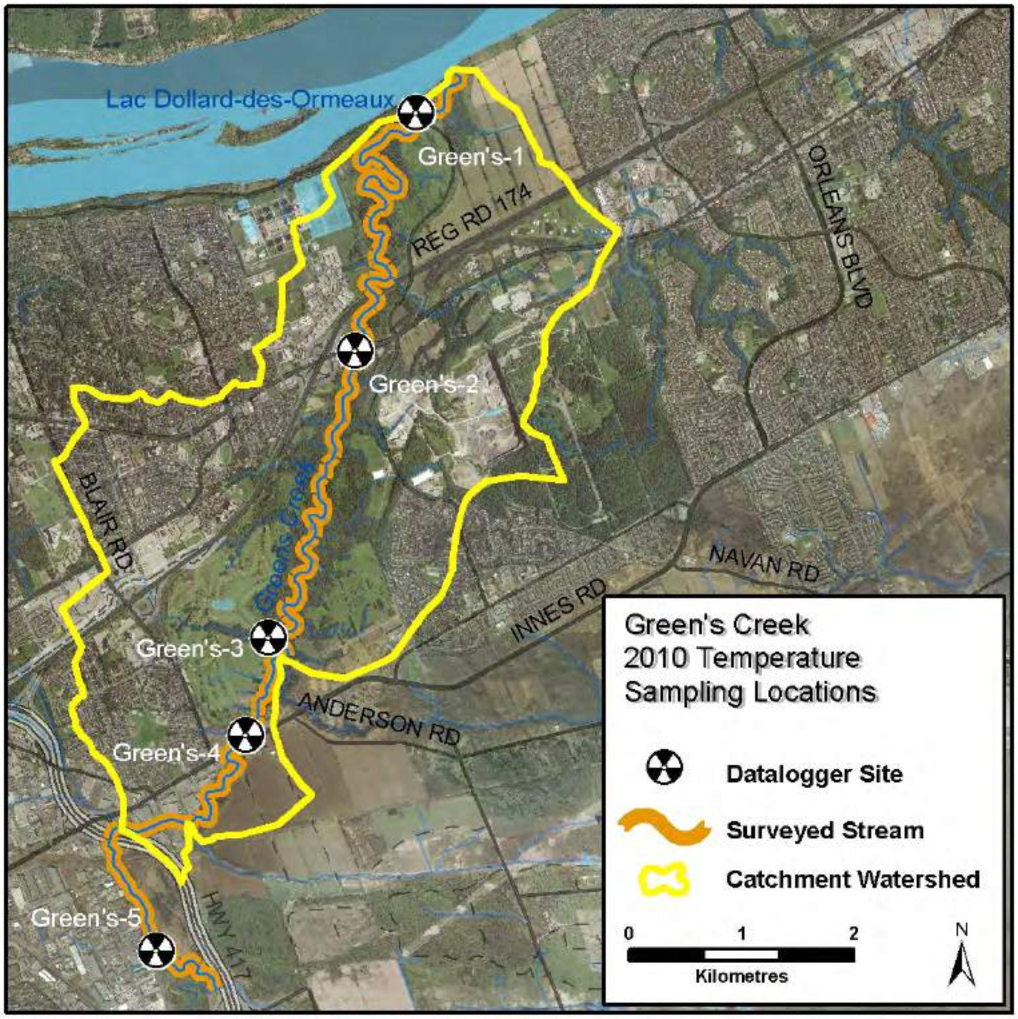


Figure 57. Datalogger Locations Along Green's Creek

Temperature loggers were set in five different locations along the stream to give a representative sample of how temperature fluctuates and differs throughout the course of the stream. Sites begin at the furthest downstream site and were placed in order upstream. Temperature logger 1 was set downstream of the Rockcliffe Parkway. Temperature logger 2 was set upstream of St. Joseph Boulevard, and temperature logger 3 was set adjacent to the Pine View Golf Course. Temperature logger 4 was placed downstream of Innes Road, and temperature logger 5 was placed adjacent to the railway lines, close to Leeds Road. Temperature logger 1 was retrieved but the information could not be downloaded. Figure 58 shows the results from temperature loggers two to five.

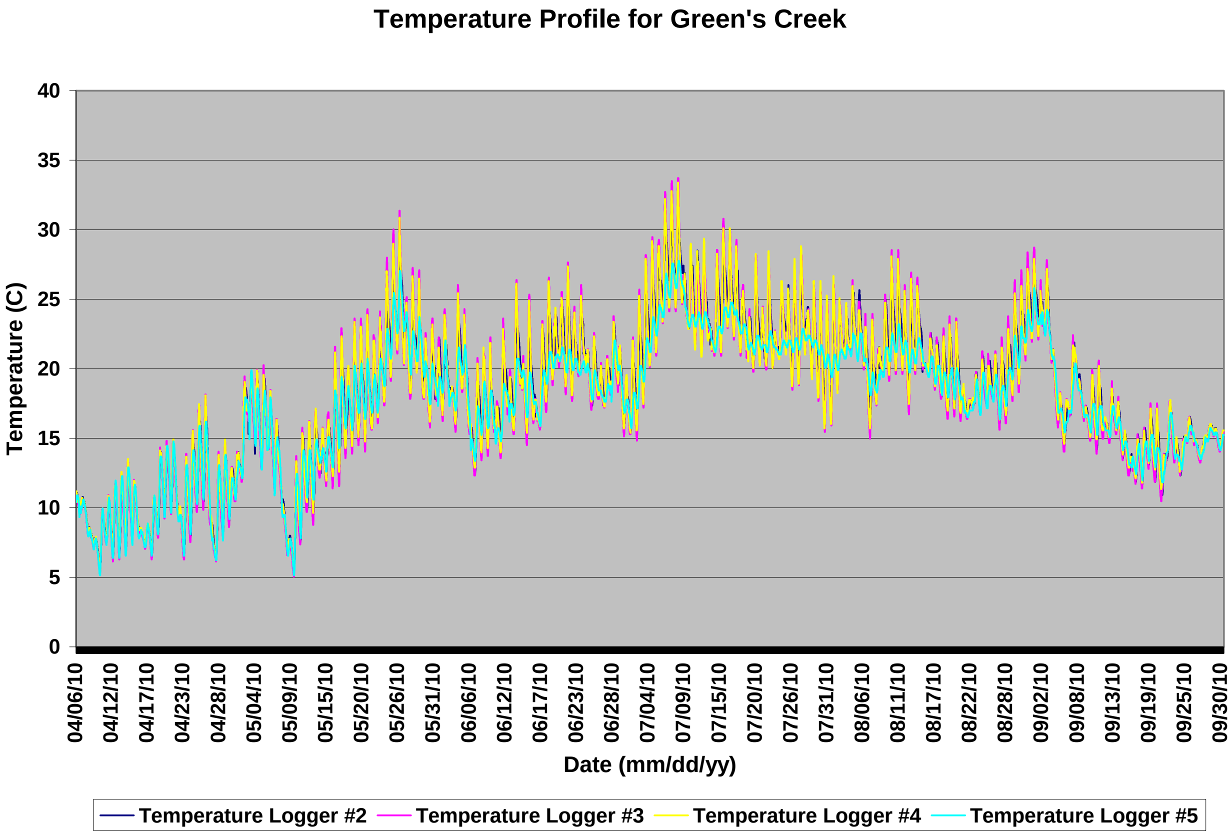


Figure 58. Temperature Profiles of Dataloggers 2, 3, 4, 5

Dataloggers 2, 3, 4 and 5 show consistent trends, and minimum and maximum temperatures are shown in the table below.

Temp Logger Number	Minimum Temp (°C)	Date Min Temp was Recorded (mm/dd/yy)	Maximum Temp (°C)	Date Max Temp was Recorded (mm/dd/yy)
Temperature logger 2	5.65	4/10/2010	31.69	7/8/2010
Temperature logger 3	5.04	5/10/2010	33.71	7/8/2010
Temperature logger 4	5.44	4/10/2010	33.38	7/8/2010
Temperature logger 5	5.14	4/10/2010	27.75	7/8/2010

Table 28. Minimum and Maximum Temperatures of Temperature Loggers

The method for temperature classification is taken from the Ontario Stream Assessment Protocol, for which the temperature data is taken between 4 and 4:30pm, anywhere between July 1 and September 10, on days where maximum air temperature exceeds 24.5°C and after two previous days without precipitation and temperatures surpassing 24.5°C. This occurred on seven days in July, four days in August and one day in September, for a total of 12 days. Temperature logger 2 exceeded 25°C on 9 of the 12 days. Temperature loggers 3 and 4 exceeded 25°C on 11 of the 12 days. Temperature logger 5 exceeded 25°C on three of the 12 days. Based on stream temperature classification and fish community structure, it appears that Green's Creek is a warm water stream with cool water reaches. The presence of burbot and trout-perch indicate there may be cold water reaches.

11. Invasive Species

Figure 59 shows the locations of invasive species found along Green's Creek, highlighted in pink.

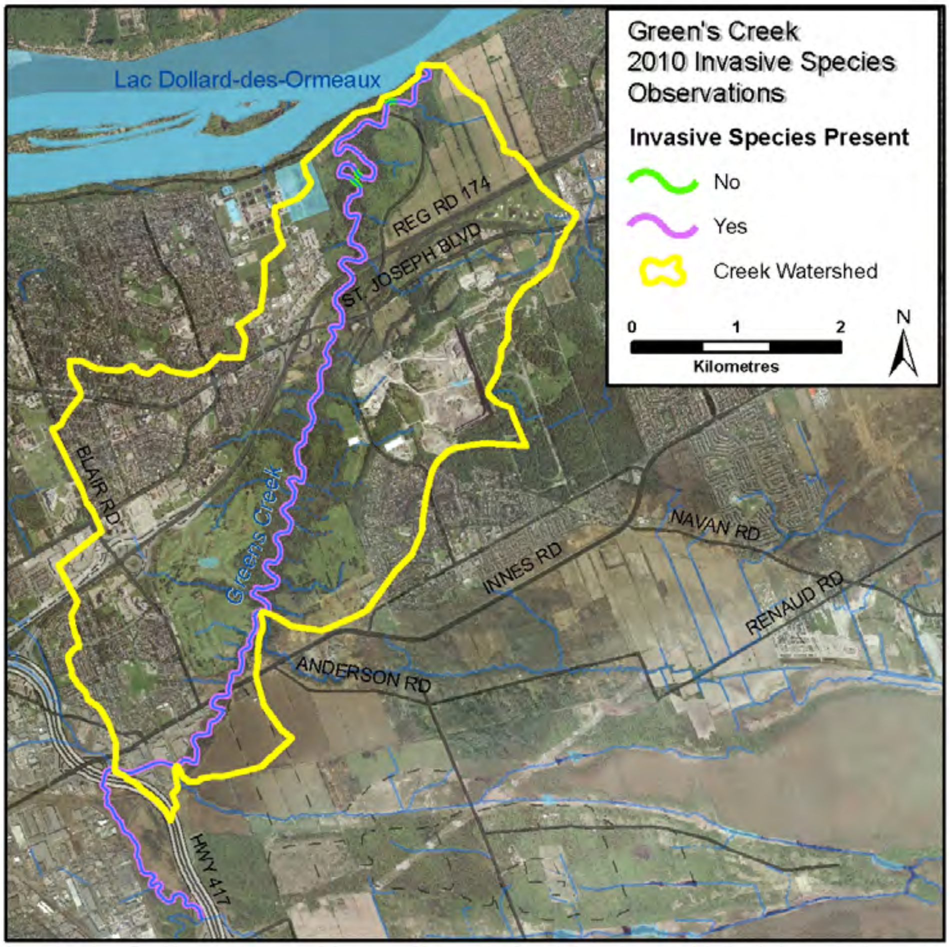


Figure 59. Air Photo of Green's Creek Showing Locations of Invasive Species

Invasive species were observed in 98 percent of the sections surveyed on Green's Creek. On many occasions, four to six invasive species were present, although the types varied in severity. The most common invasive species found was purple loosestrife (*Lythrum salicaria*), which did not seem to be having a negative effect on the surrounding vegetation. Near the mouth and in a few other areas, yellow iris (*Iris pseudacorus*) was observed. Both European buckthorn (*Rhamnus cathartica*) and glossy buckthorn (*Rhamnus frangula*) were observed; their presence is an issue because it forms large, dense canopies and crowds out native species and do not support the insect life that birds require for food (Gosling Wildlife Gardens, 2010). Other invasive species observed were garlic mustard (*Alliaria petiolata*), dog-strangling vine (*Cynanchum rossicum* and *C. nigrum*), Manitoba maple (*Acer negundo*), Himalayan balsam (*Impatiens glandulifera*) curly-leaved pondweed (*Polygonatum crispus*), flowering rush (*Butomus umbellatus*) and rusty crayfish (*Orconectes rusticus*). The greatest species of concern are the garlic mustard, dog-strangling vine, yellow iris, Himalayan balsam, flowering rush, and curly-leaved pondweed due to their aggressive growth characteristics and the difficulty of removal. Garlic mustard interferes with the relationship between tree roots and the soil, affecting the growth of the trees, making it quite problematic in natural areas. It spreads aggressively and needs constant pulling for several years in order to control. There are several methods of control being examined by the Nature Conservancy of Canada, on their properties. There is a site on Green's Creek, upstream of Innes road, where flowering rush is grown extensively into the stream and is filling in the channel. This has been reported to the NCC. During fish sampling, two young of the year goldfish (*Carassius auratus*) were captured downstream of St. Joseph Boulevard and kept for verification.

Flowering rush, outcompeting native instream vegetation and choking the stream

12. 2005/2010 Comparison of Green's Creek

Since 2005, the field sheets have been modified to include more variables. Several of the questions have been modified and improved to provide more detail, therefore making direct comparisons difficult. The following tables are a comparison between 2005 and 2010.

Overall, areas without anthropogenic alterations have not increased significantly over the last five years. However, areas that were natural and altered decreased and areas that were highly altered increased. Some of these changes can be attributed to shoreline armouring and road crossing changes, but much of it is due to changes in the field sheet. In 2010, anthropogenic alterations were further defined to help make the degree of alterations less subjective.

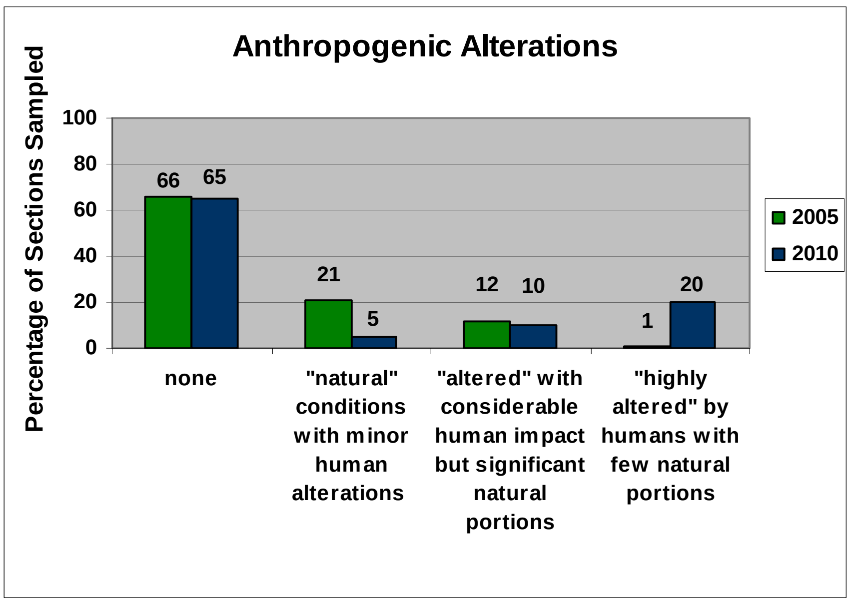


Figure 60. Comparison of Anthropogenic Alterations Between 2005 and 2010

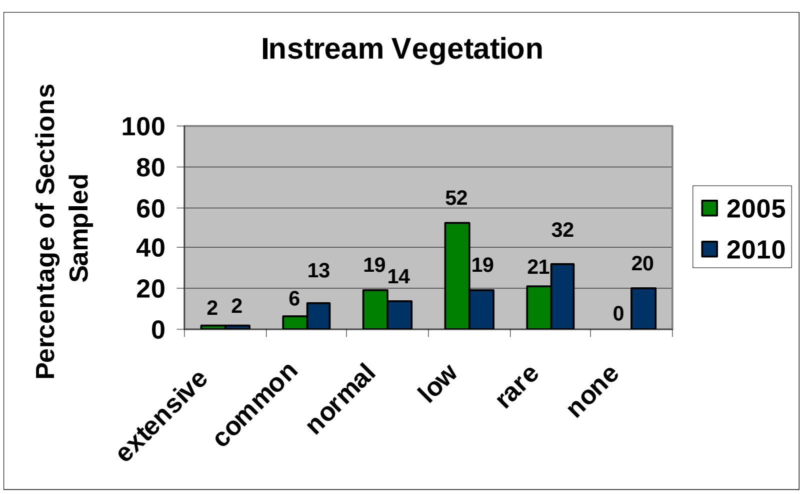


Figure 61. Comparison of Instream Vegetation Between 2005 and 2010

Changes of instream vegetation can be affected by when the stream was surveyed and different weather patterns. The category for "none" was also added after 2005 and would be reflected in the 2005 data as "rare". Common levels of instream vegetation increased and normal levels decreased slightly. The areas classified as low and rare in 2005 totalled 73 percent, and in 2010, low, rare and none totalled

71 percent. Between 2005 and 2010, the ratio between healthy levels of vegetation (common and normal) and unhealthy levels (extensive, low, rare and none) have not seen any significant changes, despite the different weather patterns between 2005 (above average precipitation) and 2010 (below average precipitation).

Bank Stability	2005 (%)	2010 (%)
stable	49	64LB, 66RB
unstable	43	36LB, 34RB
undercut	8	N/A

Table 29. Comparison of Bank Stability

Over the last five years, bank stability appears to have improved significantly, moving from 49 percent stable to 64 and 66 percent stable. However, bank stability changed in 2008 to separate left bank from right bank and capture more accurate locations on erosion. The category "undercut" was removed from the survey. Undercuts do not always threaten bank stability and are important fish habitat and when these are observed, they are categorized as "stable" or "unstable", depending on their influence on bank stability. Separating bank stability into left and right bank can cause major changes in bank stability comparisons. For example, in 2005, if 30% of the left bank and 20% of the right bank were eroding in different areas along the section, it previously would have been listed as 50% erosion. The current survey would show only 30% for left bank and 20% right bank, making it appear that the stream has become much more stable when comparing. This is likely the case on Green's. When comparing survey photos between 2005 and 2010, bank stability does not appear to have improved.

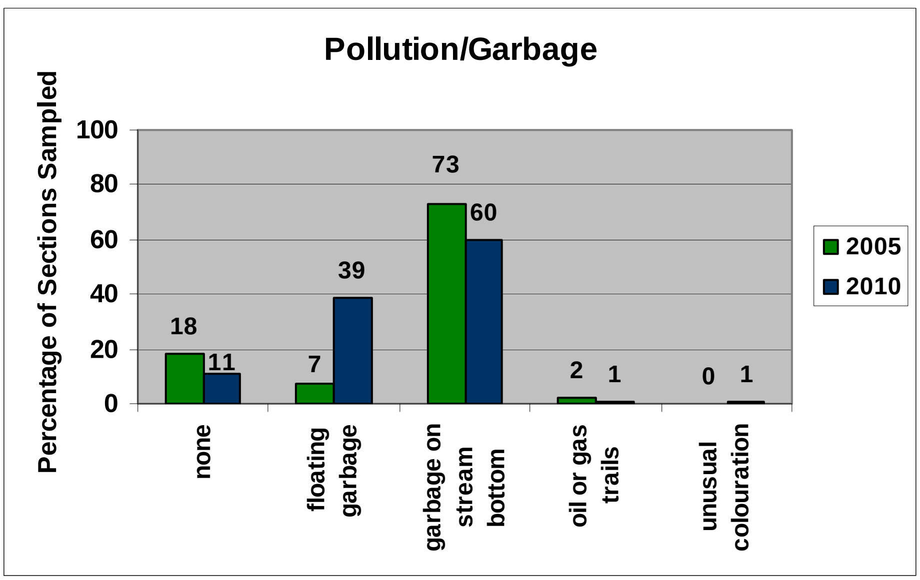
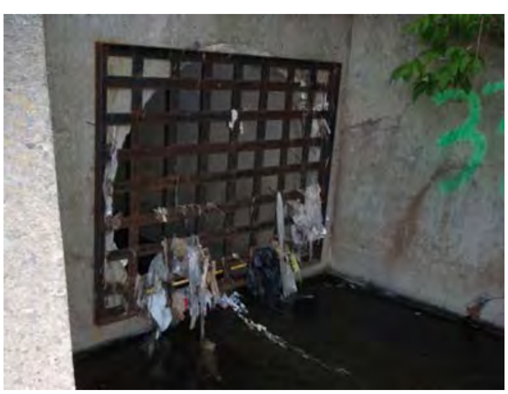


Figure 62. Comparison of Pollution/Garbage Between 2005 and 2010

Sections with pollution/ garbage increased. Floating garbage increased by 32 percent, and garbage on the stream bottom decreased by 13 percent. Oil and gas trails decreased by one percent. Unusual colouration of the streambed was added after 2005 and was observed in 2010.



Stormwater outlet on Green's Creek

Species Caught	2005	2006	2010
black crappie			X
blacknose dace	X		X
brook stickleback			X
brown bullhead			X
burbot			X
central mudminnow			X
channel catfish			X
common shiner		X	X
creek chub		X	X
Cyprinid spp.			X
emerald shiner		X	
Etheostoma spp.			X
fathead minnow			X
freshwater drum			X
golden shiner			X
goldfish			X
johnny darter	X	X	
largemouth bass	X		X
logperch		X	
longnose dace		X	X
longnose gar			X
northern pike	X		
northern redbelly dace			X
pumpkinseed			X
quillback			X
rock bass			X
shorthead redhorse			X
silver redhorse			X
smallmouth bass			X
spottail shiner	X	X	
trout-perch		X	X
walleye			X
white sucker	X	X	X
yellow bullhead			X
total species caught	**6***	**9***	**29***

Table 30. Comparison of Fish Species

***sampling intensity and methods varied between these three years**

Channel catfish caught in Green's Creek, June 2011

Silver redhorse caught in Green's Creek, May 2011

Fish sampling was done on Green's Creek in 2005, 2006 and 2010. In 2005, six species were caught, and in 2006 nine species were caught. In 2010, due to increased sampling sites, a variety of equipment and repetitive sampling, 29 species of fish were caught. In 2005, two sampling sites were seined over three days. In 2006, three seines were pulled at one site. In 2010, six sites were targeted and sampled a minimum of two times. City Stream Watch was able to purchase two large fyke nets which enabled the program to sample areas that could not have been sampled previously. The mouth of Green's Creek was deep, and the program was able to set the fyke nets with a boat to properly assess fish community in those areas. Species such as channel catfish, quillback, freshwater drum and the redhorses were only caught at the first two fish sampling sites, near the mouth of Green's Creek in the fyke nets. Four species caught in 2005 and 2006 were not found in 2010, which were emerald shiner, logperch, northern pike and spottail shiner. This does not mean the species have disappeared but could be influenced by location, weather or time of sampling. Johnny darter was caught in 2005 and 2006, and could have been caught in 2010 but is classified as *Etheostoma spp*., due to its similarities to tessellated darter.

3.3 Special Events

Over the summer, City Stream Watch ran 13 special events outside of regular sampling. These events included three tree plants, three invasive species removals, three garbage cleanups, two fish sampling demos (using seining, electrofishing, a fyke net and windemere traps) and a benthic invertebrate sampling/flyfishing demonstration with the Ottawa Flyfishers Society.

Riparian Planting

Riparian zones are the vegetated transition areas between aquatic and terrestrial habitat. They make up one of the most important aspects of stream health because they protect surface water from polluted runoff, siltation and most importantly, erosion. Riparian zones also offer very important habitat for many fish and wildlife species. Healthy riparian zones are densely populated with vegetation, and thus have an intricate root system that helps to stabilize the bank and prevent erosion. In a stream surrounded by a healthy riparian zone, increased sediment from banks is minimized. Water bodies that have lost this essential vegetation require rehabilitation projects such as these to help restore stream health. It is crucial for landowners who live around water to leave a natural buffer of vegetation between their property and the water edge. Removing this vegetation eliminates root systems, which are required to stabilize banks, and increases runoff, which allows pollutants and silt to degrade habitat for aquatic life. For more information on how to naturalize your property and eliminate erosion of your property, visit "Living By the Water Project" on the web at: http://www.livingbywater.ca/main.html.

A variety of species were planted in 2010 to help provide diverse habitat: highbush cranberry, nannyberry, red osier dogwood, sweet gale, sandbar willow, black willow, white cedar, silver maple, sugar maple, red oak, white pine, white spruce and staghorn sumac. Lowland species were planted near the water's edge (nannyberry, red osier dogwood, etc.) and upland species (white pine, sugar maple, etc.) were planted at the top of slope. All planting was done on NCC land.

dog-strangling vine along Green's Creek

Invasive Species Removal: Dog-Strangling Vine

Dog-strangling vine (DSV) was observed by City Stream Watch in 2008 on Green's Creek in an area where the program had previously planted shrubs and trees. DSV is a non-native, aggressive species which spreads by seed pods and roots. It outcompetes other native species, including shrubs and trees (smothering effect). Recent studies have also shown that monarch butterflies will lay their eggs on the plant, because its seed pods are similar to that of our native common milkweed. The only host plant that the monarch butterfly can survive on is the common milkweed; therefore when the eggs are laid on DSV, all of the eggs die. Common milkweed still remains on the noxious weed list of Ontario, regardless of concerns over monarch populations. After consulting with members of the Fletcher Wildlife Garden, who have a long history of dog-strangling vine control, the best method for removal and disposal were chosen and a removal on was held on Green's Creek and Sawmill Creek in 2009. The vine was cut at the base, as opposed to being dug out. It was then bagged and composted at the Trail Rd. facility, where temperatures were hot enough to kill the seeds. The removals were held after the seed pods had formed to prevent further spread of the plant. Another removal was held in 2010 on the same site along Green's Creek. There is an ongoing study between native goldenrod and DSV, and it appears that goldenrod is establishing itself in areas where DSV grows. A future initiative may be to plant goldenrod at the Green's Creek site to see if it will withstand the DSV.

Invasive Species Removal: Yellow Iris

Yellow iris was observed at the beginning of the 2010 field season in clumps between the Rockcliffe Parkway and the mouth along Green's Creek. It was also observed at the mouth of Graham Creek and Stillwater Creek. Removals were planned for August, and the best methods for removal were taken from the OFAH website. The yellow iris was dug by hand and put into compostable bags to be composted as part of the City of Ottawa's green bin program. The temperatures at the new composting facility are hot enough to kill the seeds.

For more information on dog-strangling vine, yellow iris, invasive species and other research initiatives, check out the Ontario Federation of Anglers and Hunters (OFAH) website: http://www.invadingspecies.com/

3.3.1 Pinecrest Creek- Riparian Planting

Volunteers planting at Pinecrest

A rehabilitation project on Pinecrest Creek was completed by the NCC in 2009, but there were no allocated funds to complete the riparian planting where the creek had been restored. In collaboration with the NCC, City Stream Watch volunteers planted a total of 300 shrubs and trees on two sites along Pinecrest Creek. On May 2, 18 volunteers came out to plant for a total of 42.5 hours. The second planting event was with a group of volunteers from Adobe. Fourteen Adobe staff attended the planting event and spent a total of 35 hours planting the remainder of the shrubs and trees allocated to Pinecrest Creek. Figure 63 shows the planting locations.

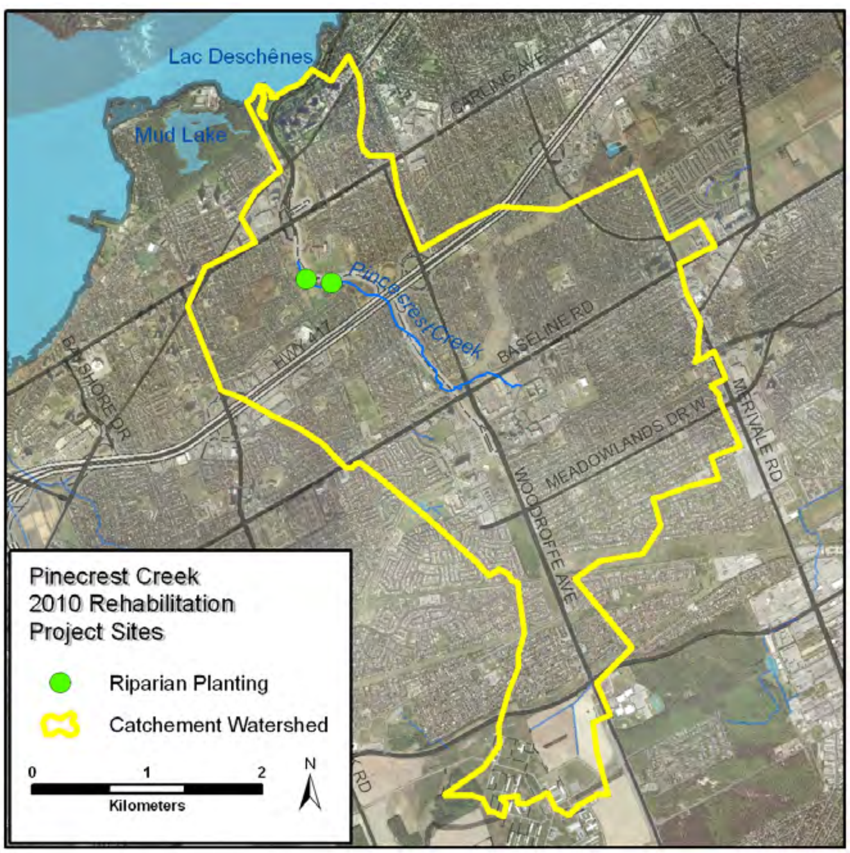


Figure 63. Air Photo of Pinecrest Creek Showing Tree Planting Sites

3.3.2 Green's Creek-Riparian Planting, Invasive Species Removal and Stream Garbage Cleanup

Volunteers planting at Green's Creek

The Green's Creek planting site was chosen in collaboration with the NCC. This site was an open meadow above the treed ravine to Green's Creek. This site is in an unstable area, and planting shrubs and trees on the tableland above the ravine can help intercept runoff from the Pine View Golf Course and help improve the biodiversity and habitat in the meadow. On May 1, 28 volunteers came out to plant for a total of 87 hours. This event was held in collaboration with the Ottawa Flyfishers Society, and many of their members assisted with the planting. With the hard work from all the volunteers, six hundred trees and shrubs were planted at the site. There were 100 species that City Stream Watch had ordered that did not fit at the Pinecrest site and were not suitable to the upland habitat of the first Green's Creek plant. RVCA staff planted the remaining 100 shrubs and trees at a site farther downstream on Green's Creek that volunteers had previously planted in 2009.

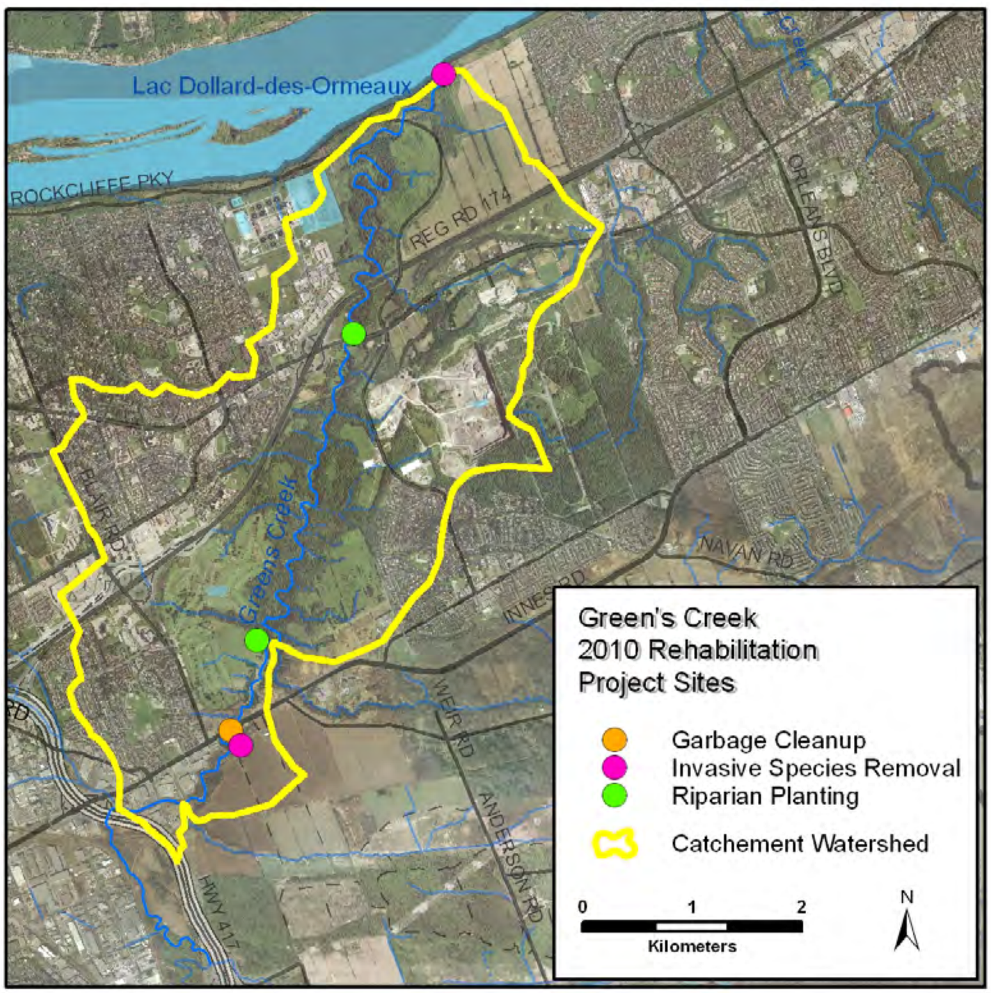


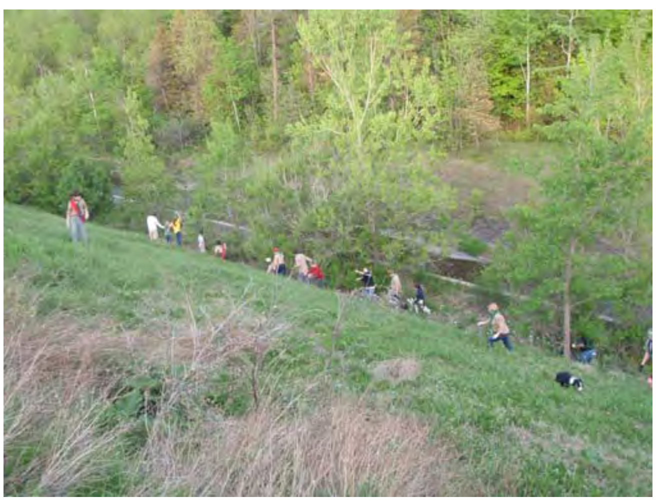
Figure 63. Air Photo of Green's Creek Showing Tree Planting Sites, Invasive Species Removal Sites and Garbage Cleanup Site

Volunteers removing DSV

The dog-strangling vine removal site chosen on Green's Creek is located just upstream of the Innes Road bridge. Dog-strangling vine is taking over the open shoreline area and beginning to wind its way into the scrubland further back from the water's edge. This section of Green's Creek is quite modified and does not have a healthy amount of vegetation along the shoreline, due to a cement retaining wall and rip rap. Although there was a lot of DSV at the Green's Creek site, it was manageable, and it was hoped that we could control its spread and success. However, after surveying Green's Creek in 2010, an extensive area of DSV was discovered and will likely grow into the removal site along an NCC trail. Future success in this area is uncertain, and City Stream Watch will re-visit the site in 2011 to determine whether a third removal should be held or not. The Ottawa Flyfishers Society assisted with this removal, along with other City Stream Watch volunteers. A total of 23 volunteers spent 96 hours clearing the site, including the portion along the NCC trail.

Volunteers removing yellow iris

A yellow iris removal event was held on August 31, and four volunteers spent 14 hours digging out yellow iris between the mouth of the creek and the Rockcliffe Parkway. That section of the creek is quite wide and deep, and canoes were needed to transport volunteers to and from the site and haul the yellow iris out of the creek. It was an extremely warm day, and volunteers worked very hard on the removal.



4th Venture Orleans Scouts Removing Garbage from Green's Creek Shoreline

The 4th Venture Orleans Company Scouts spent an evening with City Stream Watch on May 17 on Green's Creek at the Innes Road crossing. Scouts took part in cleaning up the shoreline leading down to the creek, on which many people dump their garbage from the road. This site was one of the fish sampling sites for 2010, so a small fish sampling demonstration was held with the scouts so they could see what species of fish were present in that area. The data was used as part of the fish sampling information, and it can be found under site five in Table 29.

3.3.3 Graham Creek and Stillwater Creek-Invasive Species Removal

During macrostream surveys on Graham Creek in June 2010, patches of yellow iris were observed at the mouth of the creek. RVCA staff also observed yellow iris at the mouth of Stillwater Creek, next to Graham. On August 20, nine volunteers spent 30 hours digging out yellow iris in those locations. City Stream Watch will re-visit the removal sites in 2011 to determine the success of the removal and plan another removal if required. Figure 64 shows the two creeks and the removal sites.

Volunteers removing yellow iris

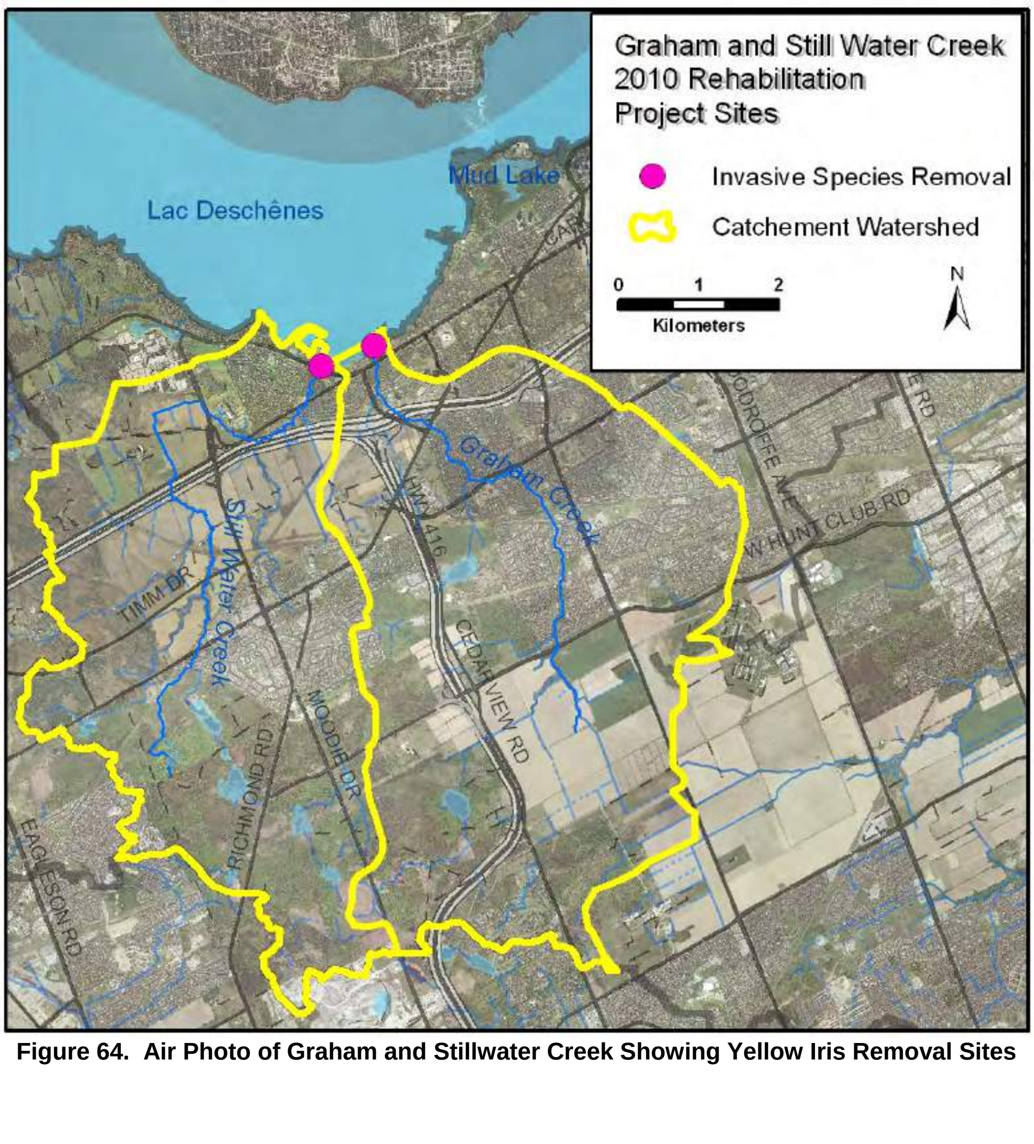


Figure 64. Air Photo of Graham and Stillwater Creek Showing Yellow Iris Removal Sites

3.3.4 Sawmill Creek- Stream Garbage Cleanup

Due to the amount of garbage found along Sawmill Creek every year, City Stream Watch organized a garbage cleanup on Sawmill to celebrate Canadian Rivers Day on June 14. In conjunction with the National Defence Headquarters Fish and Game Club (NDHQ), 20 volunteers were recruited and spent 56 hours picking garbage out of Sawmill Creek. Two volunteers started at the mouth of Sawmill Creek and worked their way up to the Bank Street crossing. Two groups of volunteers began at Heron Park; one group worked upstream and one group worked downstream. A small group of volunteers worked around the Bank Street crossing at Home Depot, where an extensive amount of garbage collects annually, and a fifth group cleaned up the area between Johnston Road and the rail yards. The Monterey Inn Resort and Conference Center supplied delicious sandwiches for volunteers at the end. The following weekend, a small cleanup with the NDHQ fish and game club was held farther south, near the South Keys and the Blossom Park area. Figure 65 shows the areas of Sawmill Creek that were cleaned for a total of approximately two and a half kilometers.

Volunteers removing garbage from Sawmill Creek

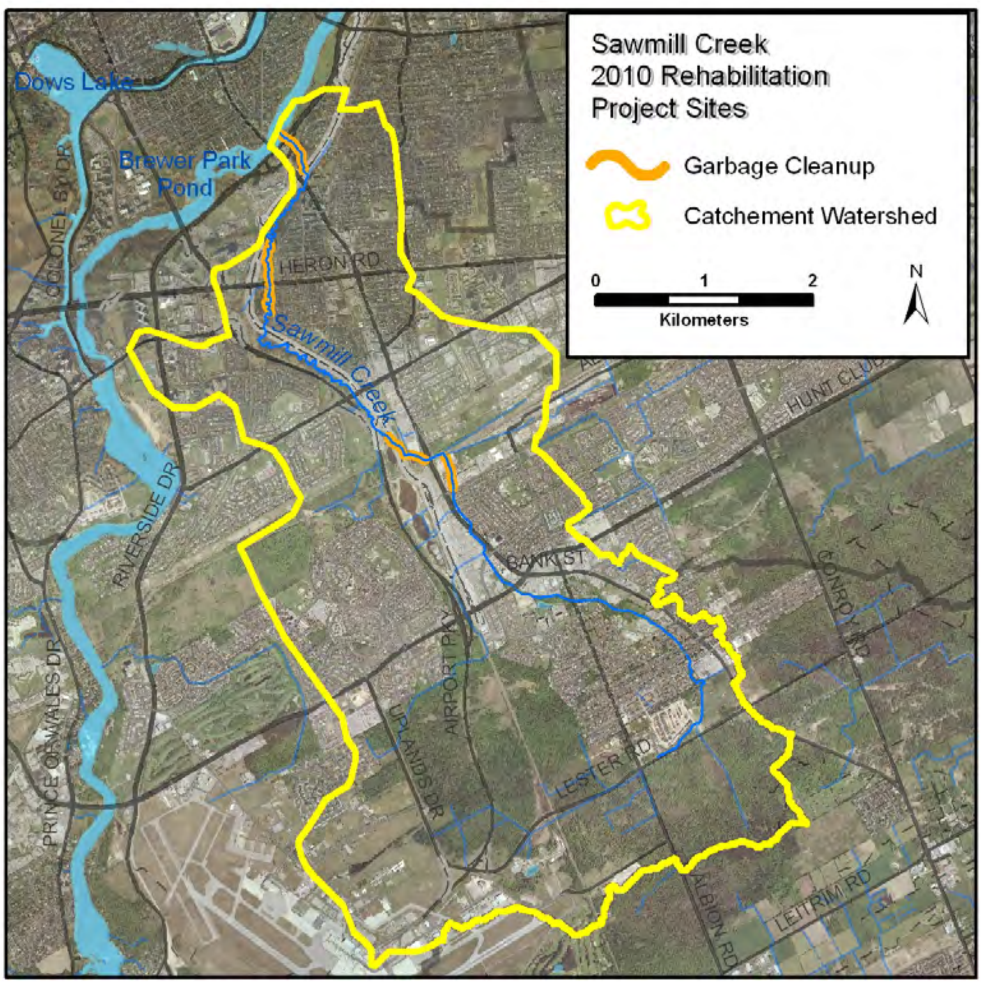


Figure 65. Map of Sawmill Creek Garbage Cleanup Sites

3.3.5 Bilberry Creek-Stream Garbage Cleanup

The TD Great Canadian Shoreline Cleanup happens each year across Canada in September. It started 17 years ago as a conservation initiative of the Vancouver Aquarium and has now grown into the second largest cleanup in the world. 2010 was another successful year for cleanup initiatives. Community members collectively removed 98,071 kg of litter from 2235 kilometres of shoreline in one week across Canada. City Stream Watch takes part in this event every year, and this year the cleanup was held on Bilberry Creek. During the stream surveys in 2009, a large amount of garbage was recorded along the creek between Jeanne d'Arc and St. Joseph Boulevard, including the west branch. This is the area that was focused on for the cleanup, and thirteen volunteers spent a total of 52.5 hours cleaning up garbage along three sections of Bilberry Creek for a total of approximately two kilometers. Those areas are highlighted in Figure 66. For the TD cleanup, volunteers are asked to mark down each piece of garbage they collected so the organizers could rate the five most common pieces of garbage. Again, in 2010, cigarette butts were the most common piece of garbage, followed by food wrappers, plastic bags, caps/lids and disposable cutlery. During all 2010 City Stream Watch cleanups, plastic items were the most common pieces of garbage.

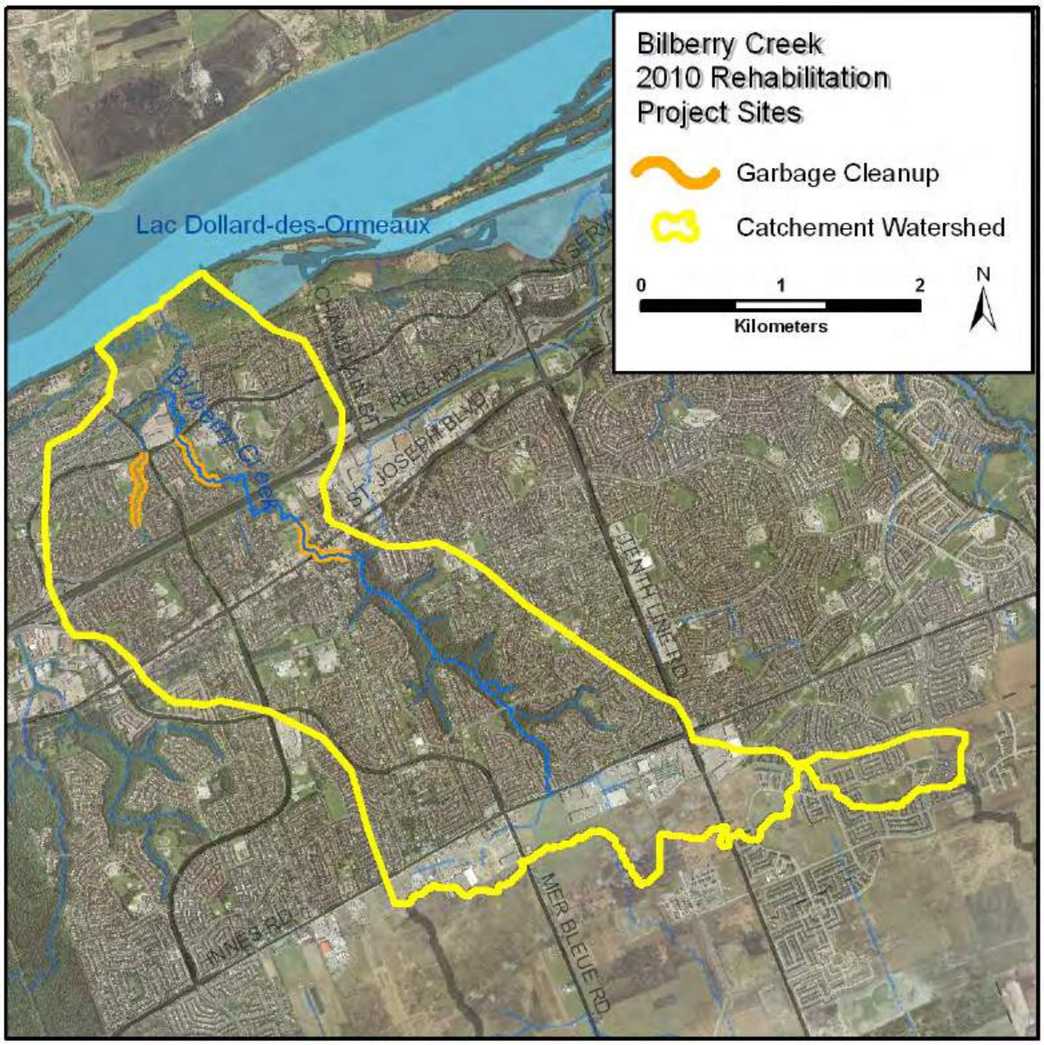


Figure 66. Map Showing the Bilberry Creek Garbage Cleanup Location

3.3.6 The Ultimate Aquatic Workshop

Bruce Clarke from OFS, giving a presentation on flyfishing

On September 18, 2010, City Stream Watch teamed up with a member of the City Stream Watch collaborative, the Ottawa Flyfishers Society (OFS), to put on a very exciting day of benthic i.d. and fly fishing lessons. The event was held at the Jock River Landing, and staff from the RVCA taught the basics of the OBBN protocol (Ontario Benthos Biomonitoring Network), how to survey, process and identify the benthos to order level. Volunteers had a chance to put on the waders and try out the OBBN protocol and identify the organisms. After a great lunch provided by the Monterey Inn and Resort Conference Center, volunteers got down to the serious business of fly fishing. OFS members explained the relationship between stream functions, habitat, benthos and their importance to fly fishing. The OFS gave an introduction to fly fishing and provided samples of fly ties. Participants were paired up with a member of the OFS to try casting and get assistance with their techniques. Thirty-four volunteers, including the OFS members, dedicated 164 hours to the Ultimate Aquatic Workshop. The Ottawa Flyfishers Society was formed in 1983 to unite local area fly fishers. The Society is dedicated to fostering and furthering the practice of activities associated with the art of flyfishing, conservation and resource renewal.

3.3.7 Fish Sampling and Identification Sessions

Volunteers at Green's Creek fish demo

Two large fish sampling demonstrations were held during the 2010 season, one at the mouth of Graham Creek and the second on Green's Creek at Innes Road. For the Graham Creek sessions, two windemere traps and a small fyke net was set for 24 hours before the demonstration. Unfortunately, a large storm occurred overnight, and water levels and flow changed to the extent that it dismantled the nets that had been set. Large, fast increases in water flow and volume can flush fish and benthos out of a system, and this occurred during that storm. Staff attempted to electrofish prior to the event, and there were few fish found. An electrofishing demonstration was given for eighteen volunteers, and they participated in collecting identifying, weighing and measuring the fish. A seine net was pulled downstream, close to a log jam, and many fish were collected from that sample. It is likely that fish were seeking refuge in the pool created above the log jam. A total of 64 volunteer hours were spent on Graham Creek for the demonstration. For the Green's Creek demonstration, one windemere trap was set downstream of the site, and electrofishing was the main method used to collect fish. After the electrofishing was completed, volunteers helped with indentifying, weighing and measuring the fish, in addition to collecting the windemere trap. A total of 18 volunteers took part in the session, for a total of 60.5 hours. In addition to the two larger demonstrations, individual volunteers were brought out to assist RVCA staff with seining and setting and retrieving nets. The informal fish demonstrations took place on all four creeks, and involved 15 volunteers for a total of 55 hours. One of the informal demonstrations took place on Brassil's Creek for members of the Burritt's Rapids community.

3.4 Rideau River Cleanup


Volunteers at Mother's Day Cleanup

The City Stream Watch Program joined forces with the Urban Rideau Conservationists (URC) to help clean the Rideau River as part of their annual "Mother's Day Cleanup" held in May. The URC received a grant from the City of Ottawa to carry out this cleanup and recruited a number of partners from around the City of Ottawa. City Stream Watch takes part in this initiative every year. This year, weather was extremely poor and seemed to influence volunteer participation. One volunteer participated in the event, joined by two City Stream Watch staff in canoes to clean up litter along and in the Rideau River.

3.5 School Demonstrations


Students retrieving fish sampling nets


Students sampling for benthic invertebrates

City Stream Watch had several requests from schools to provide hands-on education for students. With a full field season, City Stream Watch and RVCA staff were not able to meet all requests but did run four events for four different schools. The spring demonstrations were held at sites that City Stream Watch needed to sample for field data collection. The first school session was held in late April for St. Lawrence College in the United States. A small group of students learned about fyke nets and windemere traps, and helped to retrieve the ones set at the mouth of Graham Creek the day before. After retrieving the nets, students learned some key identification features of the species caught and assisted in weighing and recording the fish captured. The second demonstration was held in May. In the morning, a group of students from Holy Trinity High School met at the mouth of Graham Creek to retrieve nets set the day before, learn key identification features of the species caught and assisted in weighing and recording the fish captured. In the afternoon, a group of students from All Saints High School took part in the same activities that were held in the morning, but the demonstration was held at site three on Graham Creek.

The fourth school demonstration was done in October on Bilberry Creek for Cairine Wilson Secondary School. Because Bilberry Creek was not a stream scheduled to be surveyed in 2010, the request went through RVCA's Baxter Conservation program. Peter Goddard, the coordinator of the program and City Stream Watch staff held an outdoor education session for two groups of students. During this session, students learned about stream life, benthic invertebrates and were able to do some hands-on sampling and identification.

3.6 Bioengineering

In the fall of 2010, 28 volunteers spent 121 hours on a bioengineering project on Graham Creek.

Before

After

Bioengineering is an erosion control method that combines engineering with ecological function, designed to mimic what nature already does. It is an old science that has been around since 28 B.C. (Riparian Workshop, 2010) and uses plant species with specific growth habits (willows, dogwoods) to create structures that form large root masses which stabilize soil and provide riparian habitat. The exposed area of vegetation (branches, leaves) creates a rough surface, helping to slow water flows and reduce the velocity of the water. When this occurs, the energy the water carries is dispersed through the vegetation and not the soil. The root systems hold the soil together and the structures are created in a way that provides a much larger and denser root mass, as opposed to individual trees, which is key in stabilizing the shoreline. The benefits of improving the riparian area are numerous and include improved aesthetics, better habitat for both instream and riparian areas (nesting, shelter, food), and improved water quality (filtration and uptake of contaminants, nutrients). In terms of structural benefits, bioengineering can be used on steep slopes and sensitive areas with limited access or in areas where machinery cannot be brought in. Another structural benefit is that plants are flexible, can bend and are able to repair themselves, whereas harder structures can break, require maintenance and the costs are much higher.

For the Graham Creek project, the site was fairly shaded which provided challenges to bioengineering. Because of this challenge, a more complicated design and project were created. This type of project had been installed farther upstream of the proposed project site on Graham Creek and has established very well. Machinery was used to create a terraced bank of soil layers, like a staircase. Each layer of soil was wrapped with two types of fabric, coir material to provide structure and coconut matting to hold the finer sediments in. Between each layer, live cuttings were placed. In the spring, the live cuttings will begin to grow root structures and help hold in the soil layer. Over the next few years, as the site becomes more established, the live cuttings will have formed a dense root structure that will stabilize the bank and the foliage will emerge. In most bioengineering projects, a mix of willows and dogwoods are used. Because there was partial shade at the project site, more dogwoods were used than willow. Red osier dogwood and willow cuttings were used at the base where the water level will frequently inundate. Grey dogwood was used on the top layer and is more shade tolerant. This will also to help provide a diversity of species at the site. Live cuttings of Bebb's willow were brought in, which is a native, shade tolerant willow. At the top of the bank, native shrubs such as nannyberry, highbush cranberry and serviceberry were planted. At the water level, a fascine was installed to help create roughness and stabilize the first layer of wrapped soil. A fascine is a type of bioengineering structure. It is a long, tubular structure, built from overlaying live cuttings of willows and dogwoods. Fascines can be installed horizontally along the shoreline or vertically to help mitigate gully erosion

This project was a collaboration between the City of Ottawa, private landowners and the RVCA. The project began years ago when landowners became concerned about bank stabilization and brought it forward to the City and Conservation Authority. The City of Ottawa managed the project, and City Stream Watch designed and implemented the project. Hydro One provided access to a harvest site, and on Friday, October 22, six volunteers spent 20 hours harvesting live cuttings of red osier dogwood and some willow. The material was loaded into trucks and transported to the bioengineering site. On Saturday, machinery was used to excavate and build the soil layers, while fourteen volunteers spent a total of 59 hours wrapping the soil layers, securing the fabric, cutting the fabric, creating the layers of harvested material and other jobs such as unloading and loading trucks. The main structure was finished by the end of the day. On Sunday, ten volunteers met at the project site to create and install the fascine. Once the fascine was installed, shrubs were planted at the top of slope and other shrubs and trees were planted in other areas to enhance the shoreline.

Photos of the bioengineering project are available on the City Stream Watch website: http://www.rvca.ca/programs/streamwatch/index.html

4.0 A Look Ahead to 2011

The City Stream Watch program is currently planning projects for the 2011 season. Stream surveys run on a 5-year cycle. This allows managers to update data and determine if a creek has undergone major changes. In 2011, the program will be returning to the streams sampled in 2006, but will be surveying Steven's Creek instead of Brassil's Creek. The streams to be re-surveyed in 2011 include Pinecrest Creek, Beckett's Creek and Steven's Creek. Figure 59, below, illustrates the stream watersheds in relation to the City of Ottawa. Maps of 2011 streams in relation to other years can be found at the beginning of the report on page 10.

The program is always looking to extend its efforts to new initiatives and make improvements. For the 2011 program, various projects have been identified and plan to be implemented beginning in the spring. Some projects include:

- Stream surveys on Beckett's, Pinecrest and Steven's Creek
- Fish community sampling through seine netting, fyke netting and electrofishing
- Aquatic invertebrate sampling/identification
- Flyfishing demonstration by OFS members, along with invertebrate ID session
- Temperature profiling of 2011 streams
- Cleanups on city streams as part of Canadian Rivers Day and the TD Great Canadian Shoreline Cleanup (streams TBD)
- Riparian plantings on three city streams (Black Rapids Creek, Stillwater Creek, Mud Creek) in coordination with RVCA's Shoreline Naturalization Program;
- One small-scale bioengineering project if feasible
- Monitor success of yellow iris removal at the mouth of Graham Creek, Stillwater Creek and Green's Creek

Some of these projects are explained further in the special projects section or are shown in Appendix F, where maps of Potential Projects are listed. For more information, refer to the RVCA website (www.rvca.ca) in the spring for updates and contact information for how to sign up.

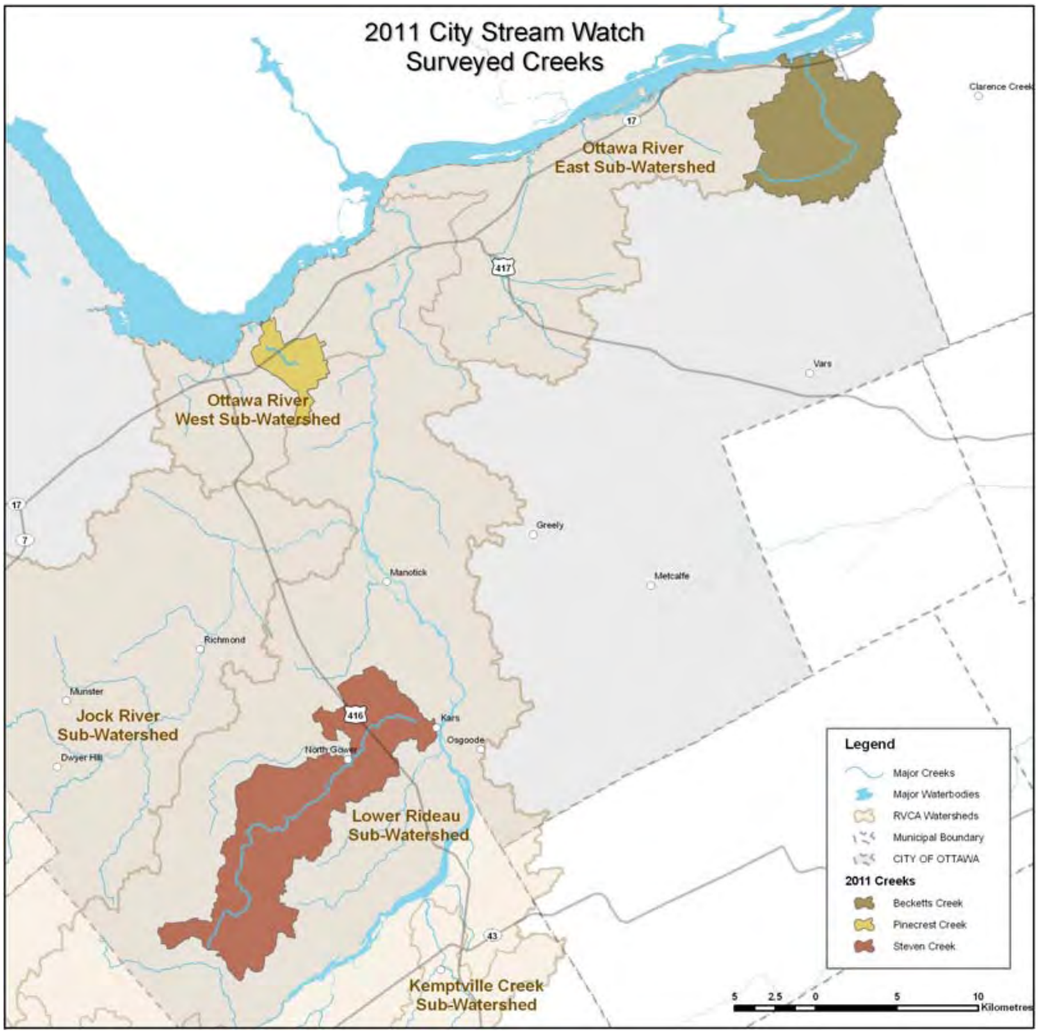


Figure 59. Locations of Streams and Their Watersheds to be surveyed in 2010

4.1 Recommendations

It is important that City Stream Watch be sustained in order to inform, involve and educate community residents on the state of urban creeks and streams, as well as to encourage restoration projects and sound stewardship practices. To this end, the City Stream Watch program should build on the successes achieved during the past eight years. Through its ongoing activities, temporal and spatial environmental trends of streams in the Ottawa area may be observed and recorded. The data will complement work conducted by a few municipal and watershed-based programs and will incorporate the intrinsic value of community-based environmental monitoring and stewardship through personal involvement.

4.2 Program Direction

The following are recommendations to help guide the program.

- Continue to develop creative means in order to contact, as well as ensure, the involvement and ongoing interest of all concerned members of the community.
- Continue to build upon the strong relationship with collaborative groups
- Employ one short-term technician and one summer student to assist with fieldwork and allow more flexibility to match volunteer schedules

- Continue contacting the community early in the year to maximize both the involvement and the diversity of the local participants.
- Foster relationships with environmentally oriented groups (i.e. Scouts Canada) to facilitate student involvement and to assist with spring riparian plantings
- Continue to run stream cleanups on city streams to enhance fish and wildlife habitat and maintain the natural beauty of our city's streams
- Develop new, creative projects to keep volunteer interest high
- Maintain the master list of potential projects in order to be ready if opportunities arise
- Incorporate more improvement projects (funding dependent) to act on previous years' recommendations with interested community groups and/or agencies
- Continue to ensure that the needs of the participating community are satisfied as they relate to their continued involvement in the program
- Attract funding opportunities from outside funders for the program and rehabilitation projects
- Sustain relationships with universities to encourage students to participate and gain experience
- Every year, many seasonal migratory obstructions are observed; when feasible, City Stream Watch could remove migratory obstructions on a priority basis where appropriate
- Involve more businesses adjacent to the creeks — contact businesses to do their own cleanups, improve the buffer, etc., with guidance from the City Stream Watch program
- Engage more neighborhoods surrounding creeks with information on the importance of riparian vegetation, ways to lessen the impact on streams from residential buildings. This can be done with the help of the collaborative members and educational material already available through the RVCA
- Continue with the pilot project of Adopt-A-Stream on Green's Creek and Sawmill Creek to encourage stream stewardship on creeks between survey years
- Target three schools per year that are located close to the current year's streams to run cleanups and provide hands-on educational opportunities
- Install signs on Sawmill Creek and potentially other creeks to encourage local stewardship, discourage people from throwing garbage into the creek and to increase awareness of the program

4.3 Special Projects

The following are projects that have been developed from information obtained through monitoring, and could be implemented through City Stream Watch or other community-based environmental initiatives. Every year, more projects are identified than can be completed. For a more extensive list, please contact the coordinator. Table 37 identifies several possible rehabilitation projects that were developed through monitoring.

Table 37. City Stream Watch– Project Potentials

Location	Issue	Picture	Remediation Strategy	Expected Results
Green's Creek, Graham Creek and other various creeks	The accumulation of garbage along various stretches of city streams is an ongoing problem. Not only does man-made pollution take away from the aesthetic quality of the stream but it limits and degrades the quality of fish and wildlife habitat.		• Determine land ownership • Utilize existing volunteer base of the City Stream Watch to continue garbage cleanups each year in order to rid the stream and riparian areas of unnatural debris.	• Community involvement • Enhancement of fish and wildlife habitat • Enhancement of the creek's aesthetic qualities

Location	Issue	Picture	Remediation Strategy	Expected Results
Graham Creek	Andrew Haydon Park is located at the mouth of Graham Creek. The creek has lost some of its buffer downstream of Carling Avenue crossing. Grass is mowed to the edge of the stream. The streambanks have eroded due to fluctuating water levels.		• Meet with land owners and discuss possible partnership and remediation options • Use bioengineering techniques • Riparian planting where possible • Identification of areas that require more intensive methods of erosion protection (i.e. bioengineering, etc.) • Utilize existing volunteer base of the City Stream Watch program and recruit volunteers from neighbouring communities	• Community involvement • Effective stream bank protection • Reduce siltation of fish spawning habitat • The enhancement of conditions for natural colonization of existing plant community and enhancement of biodiversity • Produce streamside wildlife habitat • Provide public demonstration site of a healthy shoreline

Location	Issue	Picture	Remediation Strategy	Expected Results
Stillwater Creek, at the mouth	Andrew Haydon Park is located at the mouth of Stillwater Creek. The creek has lost its buffer between the mouth and the Carling Avenue crossing. Grass is mowed to the edge of the stream. The streambanks have eroded due to fluctuating water levels.		• Determine land ownership and discuss possible partnership and remediation options • Riparian planting where possible • Identification of areas that require more intensive methods of erosion protection (i.e. bioengineering, etc.) • Utilize existing volunteer base of the City Stream Watch program and recruit volunteers from neighbouring communities to participate in this rehabilitation effort	• Community involvement • Effective stream bank protection • Reduce siltation of fish spawning habitat • The enhancement of conditions for natural colonization of existing plant community • Produce streamside wildlife habitat • Provide public demonstration site of a healthy shoreline
Location	**Issue**	**Picture**	**Remediation Strategy**	**Expected Results**
Sawmill Creek, at the mouth	The mouth of Sawmill Creek flows into the Rideau River near Billing's Bridge. There is a well-used park and walking path in its vicinity. There is little riparian vegetation along the banks at the mouth, and the shoreline needs stabilization as previous stabilization efforts have failed and washed into the creek. Banks could be re-graded and bioengineering techniques could be used to enhance to restore the bank, provide more riparian habitat and create a visual buffer demonstration for the public to experience.		• Determine possible project partnership and design with landowner • Use bioengineering methods • Plant a variety of native species at top of slope, after bioengineering is complete • Utilize existing volunteer base of the City Stream Watch program and recruit volunteers from interested neighbourhood community associations	• Community involvement • Effective stream bank protection • Reduce siltation of fish spawning habitat • Produce streamside wildlife habitat and enhance biodiversity • Create attractive buffer demonstration site for public to showcase a healthy shoreline

Location	Issue	Picture	Remediation Strategy	Expected Results
Sawmill Creek, at Artistic Landscape	Sawmill Creek has been channelized in this area and has lost much of its buffer. The banks are eroding and need natural stabilization techniques.		• Determine landowner interest and/or permission • If landowner is interested, develop project partnership and design with a number of stakeholders • Use bioengineering methods • Plant a variety of native species at top of slope, after bioengineering is complete • Utilize existing volunteer base of the City Stream Watch program and recruit volunteers from interested neighbourhood community associations	• Community involvement • Effective stream bank protection • Reduce siltation of fish spawning habitat • Produce streamside wildlife habitat and enhance biodiversity • Create attractive buffer demonstration site for public
Location	**Issue**	**Picture**	**Remediation Strategy**	**Expected Results**
Bilberry Creek, various locations	Along Bilberry Creek, there are small areas that have little riparian vegetation. The banks along Bilberry are quite unstable, and a lack of riparian vegetation exacerbates the issue.		• Determine land ownership • Utilize existing volunteer base of the City Stream Watch to participate in several planting efforts along the shorelines	• Community involvement • Enhancement of fish and wildlife habitat • Enhance conditions for natural colonization of existing plant community • Improve water quality and water quantity entering the stream in those areas • Enhancement of the creek's aesthetic qualities

Location	Issue	Picture	Remediation Strategy	Expected Results
Bilberry Creek, upstream of Highway 174	The left bank of Bilberry Creek has slumped in this spot, creating bank instability and increasing sediment loading into the watercourse.		• Determine landowners • Examine possibility of completing a bioengineering project to stabilize bank and enhance riparian vegetation • Utilize existing volunteer base of the City Stream Watch program to assist with installation of the plant material	• Community involvement • Enhancement of fish and wildlife habitat • Enhance conditions for natural colonization of existing plant community • Improve water quality and water quantity entering the stream in those areas • Enhancement of the creek's aesthetic qualities

Location	Issue	Picture	Remediation Strategy	Expected Results
Green's Creek, Graham Creek and Stillwater Creek	Yellow iris (an invasive species) is growing along the shoreline near the mouth of the creek. The first removals were completed in 2010. City Stream Watch staff will re-visit the site to determine success. If the yellow iris returns, another removal will be held with volunteers.		• Conduct site visits in June • Organize a removal day, if needed, with existing and new volunteers • Partner with other groups working on invasive species removal	• Promote community involvement in rehabilitation projects • Protect native plants and help maintain biodiversity • Increase awareness of invasive species, their impacts and the importance of biodiversity • Enhance the creek's aesthetic qualities.

Location	Issue	Picture	Remediation Strategy	Expected Results
Mosquito Creek, near the mouth	A patch of Common Reed (*Phragmites australis*) has taken root along the left bank of Mosquito Creek. Phragmites is an aggressive invasive species and can be very problematic to remove once established. This area provides important pike and muskellunge spawning habitat.	No photo available	• Determine landowners and obtain permission • Access site by canoe and remove Phragmites with a small group of volunteers • Dispose of the plant properly to prevent its spread to other areas (take to Trail Road composting facility) • Continue to monitor site to ensure successful removal	• Community involvement • Protection of fish and wildlife habitat • Increase awareness of invasive species, their impacts and importance of biodiversity

Location	Issue	Picture	Remediation Strategy	Expected Results
Mosquito Creek, various locations	There are a number of areas along Mosquito Creek that have a limited buffer. These areas are not providing the habitat they should be for fish or wildlife.		• Determine land ownership • Address planting proposals with private landowners through existing tree planting programs at the RVCA and the Shoreline Naturalization Program	• Community involvement • Improve water quality and quantity entering stream • Enhance fish and wildlife habitat • Provide shade to help moderate water temperatures • Enhance conditions for natural colonization of existing plant community

Location	Issue	Picture	Remediation Strategy	Expected Results
Green's Creek	Between the Pineview Golf Course and Green's Creek is open field and there are erosion issues along that shoreline, despite an existing buffer. One planting of the tableland was carried out in 2010, but due to the large area, it requires several more years of planting.		• Carry out riparian planting in future years when feasible in collaboration with Pine View Golf Course and the NCC • Continue to monitor the site and evaluate shrub and tree survival	• Community involvement • Protection of lower slope by planting the tableland above • Enhance biodiversity and provide greater wildlife food and habitat
Location	**Issue**	**Picture**	**Remediation Strategy**	**Expected Results**
Green's Creek, south of Innes Road	There is a section along Green's Creek where flowering rush (an invasive species) is becoming problematic and choking the creek. This can affect fish passage and stream health. Native aquatic plants, such as pickerelweed, are being outcompeted.		• Identify landowners • If landowner is in agreement, discuss possible removal strategies • Implement the removal strategy	• Community involvement • Improve water quality and flow • Protection of fish habitat and biodiversity • Increase awareness of invasive species, their impacts and importance of biodiversity

Location	Issue	Picture	Remediation Strategy	Expected Results
McEwan Creek	McEwan Creek has been channelized between the 417 and the mouth. The creek has widened out and is flat and shallow. There is an area where a bank is eroding into the creek.		• Determine possible project partnership and design with landowner • Use bioengineering methods for shoreline area needing stabilization • Plant a variety of native species at top of slope • Enhance fish habitat with boulder placement, old Christmas trees and root wads • Utilize existing volunteer base of the City Stream Watch program and recruit volunteers from interested neighbourhood community associations	• Community involvement • Effective stream bank protection • Reduce siltation of fish spawning habitat • Enhance fish habitat by providing refuge areas and instream structure • Produce streamside wildlife habitat • Improve water quality and water level fluctuations through increased riparian vegetation and roughness
Location	**Issue**	**Picture**	**Remediation Strategy**	**Expected Results**
McEwan Creek	The new Hunt Club extension runs adjacent to McEwan Creek in two major areas, the headwaters and adjacent to Hwy 417. The proximity of the extension and the increased stormwater runoff may have detrimental impacts to the creek.		• Conduct site visits post-construction to determine any problem areas • If problem areas are identified, contact appropriate landowner and discuss remediation solution (riparian planting or bioengineering)	• Determine whether future riparian plantings and buffer enhancements are needed

5.0 References

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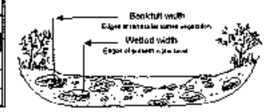
Appendix A

Name of Stream/River/Drain:			
Date:	Time:	Section:	Photo: Up - Down -

	Start	Middle	End
UTM Easting			
UTM Northing			
Water temperature (°C)			
pH			
Dissolved oxygen (mg/L)			
Conductivity (µs/cm)			
Air temperature (°C)			
Max wetted width (m)			
Max bankfull width (m)			
Max wetted depth (m)			

Cloud Cover:

%	75 - 100%
%	25 - 74%
%	0 - 24%



1. Has this section been altered? Yes / No (circle one) If yes, select one of:

	Natural, minor human alterations but the majority considered natural.
	Altered, considerable human impact but significant natural portions.
	Highly altered by humans with few natural portions.

2. What is the general land-use along this 100m section?

%	Active agriculture
%	Pasture
%	Abandoned agricultural fields
%	Residential
%	Forests
	Scrubland
%	Meadows
%	Wetlands
%	Industrial/Commercial
%	Recreational
%	Infrastructure (e.g., roads, bridges, culverts)
%	Other (specify) ____________________
100%	Total

3. Instream Substrate?

%	Bedrock - exposed rock
%	Boulders - > 25cm
%	Cobble - 8 - 25cm
%	Gravel - 0.2 - 8cm
%	Sand - 0.05 - 0.10cm, gritty
%	Silt - < 0.05cm, powdery
%	Clay - 0.01cm, greasy feel
%	Muck - combo sand, silt, clay
%	Detrius - organic material
%	Other
100%	Total

4. Substrate type is fairly: Homogeneous / Heterogeneous (circle one)

5. Instream Morphology

(A) Type:

%	Natural
%	Channelized
100%	Total

(B) Flow:

%	Permanent
	Intermittent
	Ephemeral

(C) Features:

%	Pools
%	Riffles
%	Runs
100%	Total

6. Instream Habitat

	Left	Right	
(A) Undercut banks	%	%	
(B) Boulder	%	%	
Cobble	%	%	
None	%	%	
Total	100%	100%	
(C) Large trees & branches	%	%	Instream
	%	%	Overhanging
	%	%	None
Total	100%	100%	
(D) Vascular plants:	%	%	Instream
	%	%	Overhanging
	%	%	None
Total	100%	100%	

7. Shore cover (% stream shaded): %

8. Beaver Activity

Are there any beaver dams in this 100m section: Yes / No (circle one)

(A) If yes, please specify the number:

#	Active beaver dams
#	Abandoned beaver dams
#	Beaver lodges

(B) Tree cropping:

%	Extensive
%	Common
%	Low
%	None
100%	Total

	Location (UTM)		Photo Numbers			Head
Dam #	Easting	Northing	US	CS	DS	(cm)
			#	#	#	
			#	#	#	

9. Migratory Obstructions — Are there any migratory obstructions present? Yes / No (circle one)

(A) If yes, specify if they are: Seasonal [ ] Permanent [ ]

#	Location (UTM) Easting	Northing	Photo #	Short description

10. Instream Vegetation

%	Extensive (choked with vegetation)
%	Common (>50% vegetation)
%	Normal (25-50% vegetation)
%	Low (<25% vegetation)
%	Rare (vegetation few and far between)
%	None
100%	Total

11. Are there dominant types of instream vegetation?

%	Narrow-leaved Emergents (e.g., grasses, sedges)
%	Broad-leaved Emergents (e.g., arrowhead)
%	Robust Emergents (e.g., cattails, rushes, burreed)
%	Free-floating Plants (e.g., duckweed)
%	Floating Plants (e.g., water lilies)
%	Submerged Plants (e.g., coontail, pondweed)
%	Algae (e.g., filamentous, non-filamentous)
100%	Total

Tributaries: 12. Are there any major tributaries in this section? Yes / No (circle one)

#	Location (UTM) Easting	Northing	Photo #	Short description

13. Do any of these tributaries obviously alter the stream? Yes / No (circle one)

(A) If yes, in what way (e.g., pollution)

(B) What are the types of tributaries?

- [ ] Small, intermittent natural streams
- [ ] Large, permanent natural streams
- [ ] Other (e.g., ditch or ravine) ______________

14. Any tribs worthy of further study? Yes / No If so, which ones? ______________

15. Is this tributary flowing at present? Yes / No (circle one)

16. Are there any storm water outlets in this section? Yes / No (circle one)

#	Location (UTM) Easting	Northing	Photo #	Short description

17. Bank Erosion: How would you characterize bank erosion:

Left	Right	
%	%	Stable (little or no erosion)
%	%	Unstable (eroding, little or no vegetation)
100%	100%	Total

18. Bank Steepness:

Left	Right	
%	%	Steep >25%
%	%	Moderate 11-24%
%	%	Low 0-10%
100%	100%	Total

19. Composition of banks?

Left	Right	
%	%	Bedrock - exposed rock
%	%	Boulders - rock over 25cm
%	%	Cobble - 8 - 25cm
%	%	Gravel - 0.2 - 8cm
%	%	Sand - >0.05 - 0.10cm, gritty
%	%	Silt - >0.05 - 0.10cm, powdery
%	%	Clay - 0.01, greasy feel
100%	100%	Total

20. Shoreline structures on banks:

Left	Right	
%	%	Natural
%	%	Bioengineering
%	%	Wooden retaining wall
%	%	Rip rap stone
%	%	Armour stone
%	%	Gabion cage
%	%	Concrete (e.g., bridge)
%	%	Other (please specify)
100%	100%	Total

21. Dominant vegetation types along banks?

Left	Right	
%	%	Coniferous Trees (Softwoods)
%	%	Deciduous Trees (Hardwoods)
%	%	Dead Trees
%	%	Tall Shrubs
%	%	Low Shrubs
%	%	Dead Shrubs
%	%	Tall Grass
%	%	Short Grass
%	%	Wetland Plants (cattails, sedges, other)
%	%	Ground Cover
%	%	Mosses
100%	100%	Total

22. Shoreline Classification:

Left	Right	
%	%	Natural
%	%	Regenerative
%	%	Ornamental
%	%	Degraded
%	%	Total

23. Vegetated Buffer:

Left	Right	
%	%	0-5m
%	%	5-15m
%	%	15-30m
%	%	30m +
100%	100%	Total

24. Are there any agricultural impacts in the section? Yes / No If yes, what kinds:

(A) Cattle access Yes / No

Left	Right	
		Extreme (>20m)
		Moderate (10-20m)
		Low (<10m)

#	Location (UTM) Easting	Northing	Photo #

(B) Field erosion Yes / No

Left	Right	
		Observed
		Potential

#	Location (UTM) Easting	Northing	Photo #

(C) Agricultural drain Yes / No

#	Location (UTM) Easting	Northing	Photo #

(D) Tile drain Yes / No

Left	Right
y	y

If yes, how many? ________

#	Location (UTM) Easting	Northing	Photo #

25. Did you notice any wildlife? Yes / No

	Water Birds (ducks, herons, etc.) ________		Dragonflies & Damselflies ________
	Land Birds ________		Butterflies and Moths ________
	Reptiles (snakes, turtles) ________		Aquatic Insects ________
	Amphibians (frogs, salamanders) ________		Fish ________
	Large Mammals ________		Flying Insects ________
	Small Mammals ________		Other ________

Observed:

26. Did you notice any critical fish habitat? Yes / No

If yes, what kind?

Spawning	
Evidence of groundwater springs	
Other	

27. Springs in this 100m? Yes / No (circle one)

If yes, how many? #

28. Pollution in or entering stream in this 100m? Yes / No (circle one) If yes, which kinds?

	Oil or Gas trails in the water
	Floating garbage
	Garbage on the stream bottom
	Unusual colouration on channel bed (e.g., red iron staining)

Observed: ________

29. Invasive Species in the stream? Y / N (circle one) Observed: ________

30. Potential angling opportunities in this 100m section? Y / N (circle one) If yes, identify: ________

31. Are there any potential enhancement opportunities in this 100m section? Yes / No (circle one)

	Riparian planting		Invasive species control
	Stream garbage clean-up		Cattle access restriction
	Fish habitat enhancement		
	Erosion control (bioengineering)		
	Channel enhancement or modification		

Comments:

Name of Surveyors:

1. ________
2. ________
3. ________

Date entered: ________

Entered by:

Appendix B

RVCA MACRO STREAM SURVEY – SUMMARY AND DEFINITIONS

Descriptive Information
Name of watercourse: Record the name of the watercourse that is being surveyed

Date: Record the date that the sampling occurred on.

Start time: Record the time the sampling started.

Section number is the section number of the current 100m of stream being sampled. Please note that sampling always occurs in the upstream direction (i.e., the first section sampled will be the furthest one downstream and they are numbered chronologically as you progress upstream).

Starting and ending UTM coordinates: UTM coordinates are needed for both the starting and ending points of the 100m sections. These are taken using the GPS receivers. The GPS supplies both an easting and northing. The UTM grid number is 18 for all of Eastern Ontario.

Upstream and downstream photos: Record the photo number from the digital camera so that it will be easy to correctly label the photos when they are uploaded and organized later at the office. An upstream photo should be taken while looking upstream at the start of the stream section while the downstream photo should be taken while looking downstream at the end of the stream section.

Water temperature in °C at the starting point, middle, and end of the 100m section.

pH is measured using the YSI at the starting point and end of the 100m section.

Dissolved oxygen in mg/L and is measured using the YSI at the starting point and end of the 100m section.

Conductivity in µs/cm measured using the YSI at the starting point and end of the 100m section.

Air temperature is measured in °C at the starting point of the 100m section.

Max wetted width (m): The maximum distance from the edge of the present water level on one stream bank to the edge of the present water level on the opposite stream bank. The transect is taken perpendicular to the stream flow.

Max bankfull width (m): The maximum distance from high water mark (i.e., the edge of terrestrial rooted vegetation) on one stream bank to the opposite stream bank. The transect is taken perpendicular to the stream flow.

Max wetted depth (m): The maximum depth of water at the present level within this section

Overhead cloud cover: Record the overhead cloud cover in percent

1. Please determine if the 100m section of the stream being surveyed has been altered; once determined please circle either "Yes" or "No" on the field sheet.
   An **unaltered natural section of stream** is one characterized as:
   - Stream section has not been diverted or straightened;
   - Riparian buffer (transitional zone between aquatic and terrestrial habitats that contains moist soils and lush plant growth) is greater than 30m;
   - No human-made structures (docks, bridges, etc.) or alterations (lawn, ornamental garden, beach, etc.)

Natural with minor human alterations:

- Stream section has not been diverted or straightened;
- Riparian buffer is 15 to 30m; less than 25% of section altered by lawn, ornamental garden or beaches
- Less than 25% of the shoreline is armored with rip rap or human-made wood structures
- May have small wood bank structures (i.e. a dock) but no concrete structures
- No section of the shoreline has been armoured with gabion baskets, concrete or armourstone
- No metal culvert crossings

Altered with considerable human alterations:

- Channel is straightened or diverted for less than 50% of the section length
- Riparian buffer is 5-15m; over 25% of section is altered by lawn, ornamental garden or beaches
- More than 50% of section has been armoured with rip rap or human-made wood structures
- Under 30% of section has been armoured with gabion baskets, concrete or armourstone
- One or two stormwater outlets are present in the section
- No metal culvert crossings

Highly altered by humans, with few natural portions

- Channel is straightened or diverted for greater than 50% of the section length
- Riparian buffer is only 0-5m
- Greater than 30% of the section has been armoured with gabion baskets, concrete or armourstone
- More than two stormwater outlets are present in section
- Any part of the section runs through a metal culvert

2. **Land use:** Please note and record the land use patterns along this section of the stream. *Must total to 100%*
Active agricultural: Refers to land that is currently being farmed.
Pasture: Refers to land being used by grazing livestock.
Abandoned agricultural fields: Refers to land previously, but not currently, farmed.
Residential: Refers to land occupied by homes.
Forests: Areas of high tree density.
Scrub land: Areas of high woody shrub density.
Meadows: Rolling or flat terrain where grasses dominate.
Wetlands: Land where saturation with water is the dominant factor determining the soil development and has specialized plants and animals adapted to live in such conditions.
Industrial/Commercial: Refers to land occupied by industry/businesses.
Recreational: Used for recreational activities such as soccer fields, walking trails etc.
Infrastructure: Public facilities and services required for development including roads, bridges, culverts etc.

Instream Substrate

3. **Instream substrate** is the material that constitutes the stream bed. Please record the percentage of each instream substrate present in the section of the stream.

4. The instream substrate can be **homogenous** (all of one type), or **heterogenous** (diverse types). *Check one*

Morphology

5. **Stream morphology** refers to the physical structure and shape of the stream.
   A) Type: Record the type of stream present in the section in percent. *Must total to 100%*
   Natural: Contains a series of meanders, pools, and riffles with unaltered stream banks
   Channelized: Constructed or altered/straightened channel, drain, ditch or canal that is straight and uniform in structure

   B) Flow: Record the flow regime of the stream section being surveyed. *Check one*
   Permanent: A stream that flows all year
   Intermittent: A stream that typically flows for at least 6 months a year and has a defined channel
   Ephemeral: A stream that flows for a short period of time in the spring or in response high precipitation events but does not have a defined channel

   C) Features: Record the natural features of the stream in percent. *Must total to 100%*
   Pools: Any area of the stream that has a deep pocket of water typically found between riffles
   Riffles: Shallow, moderate to rapid current velocity, agitated water surface, substrate typically composed of gravel, pebble, cobble and boulder-sized particles
   Runs: Characterized by moderately shallow water (10-30cm deep), an unagitated surface with substrate typically composed of gravel and/or cobble, and areas where the thalweg (deepest part of the channel) is in the center of the channel

<u>**Instream Habitat**</u>

6. **How would you characterize the type of major structures in this 100m stretch?**
   A) Record the percentage of each bank that is **undercut**.
   A bank that has been eroded away and overhangs the water.

   B) Record the percent of the right and left sides of the stream section containing boulders and cobble. *Must total to 100% for each bank*
   Boulder: Instream rocks greater than 25 cm in diameter. Boulders create instream cover and back eddies for large fish to hide and/or rest out of the current
   Cobble: Instream rocks 8-25 cm in diameter. Cobble provides important over wintering and/or spawning habitat for small or juvenile fish
   None: Areas of the stream that are not comprised of boulders or cobble buts till possess areas that can provide some instream habitat for fish and macroinvertebrates (e.g., bedrock, fine organic islands etc.)

   C) Large woody debris: Record the percent of the stream and riparian area containing large woody debris for both the left and right sides. *Must total to 100% for each bank*
   Fallen trees, stumps and/or logs that are within the stream **(instream)** or < 1m above water surface **(overhanging)**

   D) Vascular plants: Record the percent of each bank that has vascular plants. *Must total to 100% for each bank.*
   Vegetation provides shelter, protection and habitat for food items (e.g., macroinvertebrates) and can be found **instream** or **overhanging** (<1 m above water surface)

7. **Shore cover (% stream shaded):** The percent of the stream that is shaded by overhanging trees and tree canopy that is >1m above stream surface

<u>**Beaver Activity**</u>

8. Record if there are any beaver dams in the stream section being surveyed by circling "Yes" or "No"
   If yes:
   A) Record the number of active and/or abandoned beaver dams in the stream section.

Active beaver dam: Characterized as a maintained beaver dam that is holding back water and acting as a barrier to movement. Active beaver dams are generally reinforced with mud and have new beaver chews present on twigs
Abandoned beaver dam: Characterized as an old beaver dam that is not holding back any water and is not reinforced
Head (cm): The distance (in cm) between the water surface upstream of the dam and the water surface downstream of the dam

B) Record if there is any tree cropping within the stream section.
Tree cropping: Tree cropping is characterized as the presence of chews on the bottom of tree trunks and generally are found on the trees within the riparian zone of the waterbody. Tree cropping can be characterized as being **extensive, common, low** or **none**

Migratory Obstructions

9. Indicate if there are there any migratory obstructions in the surveyed stream section by circling "Yes" or "No"
If yes,
Migratory obstruction: A natural (e.g., log jam) or constructed (e.g., perched culvert) obstruction that blocks fish movement

Seasonal: Obstruction only present when water levels are very low (e.g., not enough water for fish movement) or too high (e.g., extreme velocities)
Permanent: Obstruction is present at all times of the year during all flow conditions

Instream Vegetation

10. **Aquatic vegetation** refers to vegetation occurring within the stream. *Check one*

Extensive: Vegetation within entire stream
Common: >50%
Normal: 25-50%
Low: <25%
Rare: Vegetation very sparse

11. **Dominant types of instream vegetation** are dominant plant types that occur in the stream. Record the percentage of each vegetation type. *Must total 100%*

Narrow-leaved emergents: Plants with submerged roots and stems emerging from the water (e.g., grasses, sedges)
Broad-leaved emergents: Plants with submerged roots, stems emerging from the water with leaves attached to main stem (e.g., arrowhead)
Robust emergents: Plants with submerged roots with hard or woody steams emerging from the water (e.g., cattails, rushes, burreed)
Free-floating plants: Plants that are not rooted to the substrate and are freely moving on the water surface (e.g., duckweed)
Floating plants: Characterized by having a leaf floating on the surface attached to a main stem (e.g., frogbit, duckweed)
Submerged plants: Completely submerged vegetation including coontail, pondweed etc.
Algae: Simple photosynthetic organisms, often covering substrate; feels slimy. Can be filamentous or non-filamentous

Tributaries

12. Indicate if there are any **tributaries** in the surveyed stream section by circling "Yes" or "No"
Tributaries are waterways that flow into/enter the stream.

If yes, number the tributaries upstream chronologically. Also, record the location using UTM coordinates and take a photo looking upstream towards the tributary from the stream section.

13. **A)** Tributaries drain water into the stream, as well as anything suspended or dissolved in the water. Tributaries can alter the character of the stream in a number of ways, including **sediment deposition**, **nutrient loading**, **and other pollutants**.

    B) Intermittent natural streams are natural streams that flow periodically throughout the year, usually in the spring and in times of high amounts of precipitation.

    Permanent natural streams are natural streams that flow year round.

14. Is the tributary significant enough to justify further surveying?

15. Is water entering the stream from the tributary?

16. Are there any stormwater outlets in this section?
If yes, number the stormwater outlets upstream chronologically. Also, record the location using UTM coordinates and take a photo looking towards the stormwater outlet from the stream section. Give a short description of the outlet.

<u>Bank Characteristics</u>

17. **Bank stability:** *Each bank must total 100%*
    Stable: May be some exposed soil, but banks are generally well vegetated or covered with boulders or cobble. Small undercuts may be present but the bank is fully stable. Trees on the shoreline are not leaning into or have fallen into the stream as a result of stream flow.

    Unstable: Large areas of shoreline with exposed soil or tree roots and generally <50% of banks are vegetated or covered with boulders/cobble. Bank could be slumping or sloughing and sever unstable undercutting is present. There may be signs of failed erosion control (rip rap washed into stream, exposed geotextile material on bank, failed gabion baskets, etc.). Trees may be collapsing into the stream.

18. **Steepness** of the shoreline is represented by the general slope, calculated by: $\frac{\text{Rise}}{\text{Run}} \times 100\%$
    Each bank must total 100%

19. **Soil composition:** *Each bank must total 100%*
    Bedrock – Exposed rock.
    Boulders – Rock over 25 cm (10 in) in diameter.
    Cobble – Rock between 8 cm and 25 cm (3 – 10 in) in diameter.
    Gravel – Rock between 0.2 cm and 8 cm (1/8 – 2 in) in diameter.
    Sand – Rock between 0.05cm and 0.2cm in diameter (feels gritty between fingers)
    Silt – Approximately 0.05 cm in diameter (feels powdery/velvety between fingers)
    Clay – Approximately 0.01cm in diameter (feels greasy between fingers)

20. **Shoreline structures:** Natural or human-made structures generally in place to reduce erosion and increase bank stability. *Each bank must total 100%*

    Natural – Consists of vegetation, trees and/or rock material
    Bioengineering – Shoreline stabilization structures that are comprised of vegetation (e.g., live crib walls, brush bundles)
    Wooden retaining wall – A vertical wall made of wood used to stabilize a shoreline
    Rip Rap stone – Chunks of broken concrete/brick used to armor a shoreline

Armor stone – Large (e.g., ≥1m in length) chunks of stone placed on shorelines to stabilize banks and prevent further erosion
Gabion cage – A square or rectangular cage filled with rocks used to armor a shoreline.
Concrete wall – A concrete wall (including bridge structures) used to armor a shoreline
Other – please specify

21. **Dominant vegetation**: The type of vegetation that is dominant along the stream banks in and beyond the riparian zone. *Each bank must total 100%*

Coniferous trees: Softwoods, evergreens
Deciduous trees: Hardwoods
Dead trees:
Tall shrubs: Shrubs >1m in height with stems that are brown, hard and woody (not green and herbaceous).
Low shrubs: Shrubs <1m in height with stems that are brown, hard and woody (not green and herbaceous).
Dead shrubs:
Tall grasses: >1m
Short grasses: <1m
Wetland plants: cattails, sedges, etc.
Ground cover
Mosses

22. Shoreline Classification

Natural- No significant human disruption; shoreline is in its natural state and there is a thick buffer of indigenous, healthy native vegetation. Development is generally not visible or screened from view by stable, well established native vegetation
Regenerative- Significant alteration of the shoreline has been avoided and an effort has been made to preserve or regenerate the natural character of the shoreline. Also included in this category are those properties which have been allowed to regenerate from an ornamental shoreline to a naturalized shoreline with indigenous species. There is evidence that active planting has been undertaken. There is a notable absence of manicured waterfront and no structures at/near the water. Disturbance within the slope to water is minimal – less than 20 - 25% of the shoreline is disturbed.
Ornamental- Indicates an area where maintenance is being undertaken; natural vegetation has been removed and replaced with turf grass lawn and other non-native vegetation; there may be artificial structures such as gazebos, docks or non-natural shoreline stabilization structures present and occupying a notable percentage (20-25%).
Degraded-May impact stream health; natural vegetation has been lost. The result is evident in active soil erosion, undercutting of the shore and/or run-off. There are often artificial structures such as failing retaining walls, slumping or slope failure or bare earth present which contribute to the negative ecological impact. Degradation may also be a natural occurance (slope failure, wave action, damage from storm events, etc).

23. **Vegetated Buffer**: The amount of riparian area on the left and right bank
0-5m: record the percentage of each bank that has a 0-5m buffer
5-10m: record the percentage of each bank that has a 5-15m buffer
15-30m: record the percentage of each bank that has a 15-30m buffer
30+m: record the percentage of each bank that has a buffer greater than 30m

24. **Agricultural impacts:** If agricultural impacts are present within the 100m section of stream that is being surveyed, please indicate (with a check mark) whether they were observed on the left or right bank (or both) then take a photo and record the location (UTM).

Cattle access: Evidence of cattle using the stream, such as tracks or manure. Cattle access can be **extreme** (>20m of the stream bank in the 100m section), **moderate** (10-20m) or **low** (<10m).

Field erosion: Evidence of excavation/deposition of material from fields in or around the stream. Erosion can be **observed** (present at time of sampling) or **potential**

Agricultural drain: A drainage ditch from agricultural fields entering the stream.

Tile Drain: A tile is a perforated pipe buried under ground that drains an area. It usually drains water into the stream by a protruding pipe from the bank.

What is extent of the vegetated buffer (if present)? A vegetated buffer is the area directly adjacent to the stream, consisting of natural vegetation (grasses, shrubs, trees, etc.). Record this in meters.

25. **Water birds:** Ducks, geese, etc.
Land birds: Osprey, king fisher, etc.
Reptiles: Snakes, turtles, etc.
Amphibians: Frogs, toads, etc.
Large mammals: Deer, beavers
Small mammals: muskrat, weasel, mink
Dragonflies and damselflies
Butterflies and moths
Aquatic insects: Water striders, whirligig beetles, dragonflies/nymphs, etc.
Fish: Minnows, bass, pike, perch, sunfish spp., etc.
Flying Insects: mosquitoes, etc.

26. **Critical fish habitat:** areas that are directly responsible for the level of recruitment of individuals into a population.
Spawning habitat are areas fish utilize for reproduction. For example, pike spawning habitat includes submerged vegetation (i.e., grasses/sedges). Areas that are known spawning habitats within the surveyed stream section should be examined thoroughly.
Refuge areas/habitat: areas that provide cover, food or refuge (large pools, riffles or fallen wooden material)
Groundwater springs provide thermal refuge for fish and their offspring as groundwater is typically cooler in temperature than the waterbody it is entering. As water temperatures increase through the summer months, fish will seek out cool water areas.

27. Springs are areas where groundwater flows out of the ground.
Watercress is an indicator of the presence of springs. Watercress has alternate, compound leaves with 3-11 oval leaflets, shiny, dark green, rounded at the tip, smooth, without teeth or with wavy-toothed margins. Flowers are white with 4 petals about 1/6-1/4 inch across
The water from the spring is generally **cooler** than the waterbody that it is entering. If a sudden decrease in temperature is observed in a localized area, a spring is likely present.

28. Is there any **pollution** in the stream, entering the stream, or near the stream? The pollution can be in the form of **oil/gas** on the stream surface, **floating garbage**, **garbage on the stream bottom** and/or **unusual colouration on the channel bed.**

29. **Invasive species** are non-native plant and animal species.
Examples of invasive species in and around the Rideau River are:

-Purple loosestrife	- Flowing rush
-Eurasian water milfoil	- Curly pondweed
-Zebra mussels	- European fingernail clam
-European frogbit	- Rusty crayfish

-Common carp - Red-eared slider (turtle)
-Garlic mustard -European and common buckthorn

27. **Potential angling opportunities** includes presence of anglers, used/old fishing line, bait containers, lures, areas with good fish habitat, etc.

28. Potential enhancement opportunities improve existing habitat conditions.

Riparian planting: Planting vegetation along the stream banks help to stabilize the banks, decrease erosion and increase wildlife habitat

Stream garbage pick-up: Removing garbage from the stream increases its overall health

Fish habitat enhancement: Adding instream structure, removing barriers to migration, and increasing the heterogeneity of the stream can all enhance fish habitat quality

Erosion control: Bank stabilization using bioengineering methods (natural shoreline stabilization techniques-fascines, brush mattresses, soil wrapping, etc.)

Channel enhancement or modification: realignment of the channel into a more natural state-recreate meanders, stream function, etc.

Invasive species control: Removing invasive species from an area decreases the competition with native species and increases the overall health and abundance of native species

Cattle access: Fencing cattle out of creeks, installation of alternate watering devices, bed-level crossings, and/or riparian plantings will decrease erosion, increase riparian vegetation and improve water quality and fish habitat by lowering the amount of sediment entering the watercourse and creating buffered areas.

Appendix C

Equipment List / Stream Watch Crew (2 person minimum)

1 handheld GPS unit
1 60 metre Tape / 50 meter length of rope
1 meter stick
1 thermometer
1 clipboard with several stream assessment forms
Pencils
Sunscreen
1 waders/person
1 camera
2 extra batteries for GPS unit
Bottled water
1 garbage bag

Appendix D

Landowner Permission Letter

Dear Landowner,

City Stream Watch is a collaborative partnership between the Heron Park Community Association, National Defence HQ – Fish and Game Club, Ottawa Flyfishers Society, Rideau Roundtable, City of Ottawa and Rideau Valley Conservation Authority.

Each year, City Stream Watch conducts surveys on various streams throughout the Ottawa area. We record information such as bank stability, bank vegetation, instream vegetation, stream width, stream depth, temperature, fish community, etc. This year's focus will be on Graham Creek, Green's Creek, McEwan Creek and Brassil's Creek.

The program is designed to increase public participation and awareness concerning the state of streams around the city and to ensure that our streams remain a point of pride in our communities.

While we are completing the surveys, we may need to access the creek via your property, or we may be canoeing or walking up the middle of the creek, as it flows by your property. We seek your permission to carry out these surveys on the creeks adjacent to your land. The work will involve a crew of 2-5 people working for approximately 1-3 hours on the site, depending on the activity. We will respect all private property and leave the site clean.

If you would like more information on the project, get involved or have any concerns regarding stream access, please contact me. To learn more about the program and view 2003 – 2009 reports, visit us on the web at:

http://www.rvca.ca/programs/streamwatch/index.html

Thank you for your cooperation.
Best regards,

Julia

Julia Sutton
City Stream Watch Coordinator
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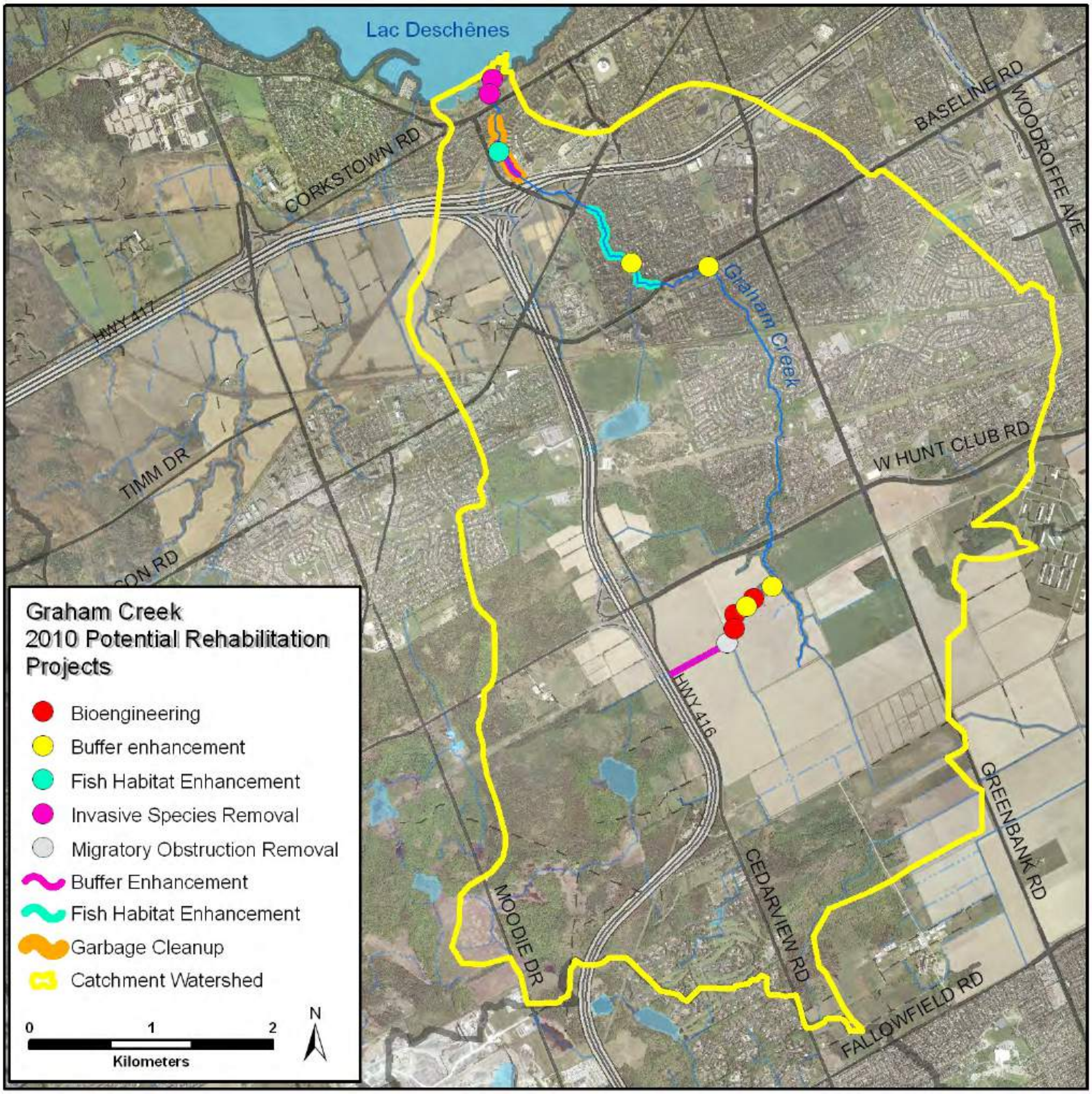
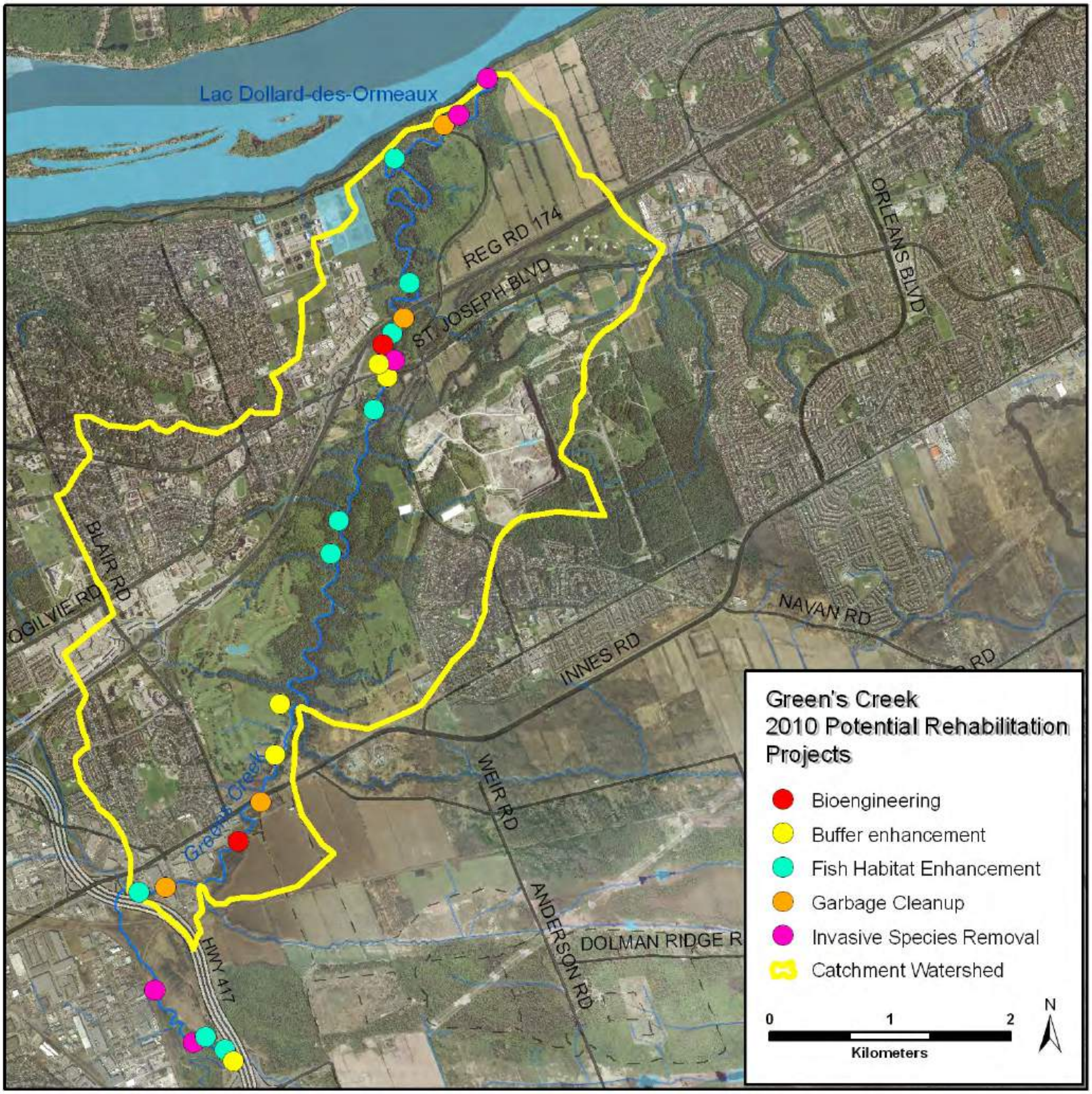
Appendix E

Maps of Potential Project Areas

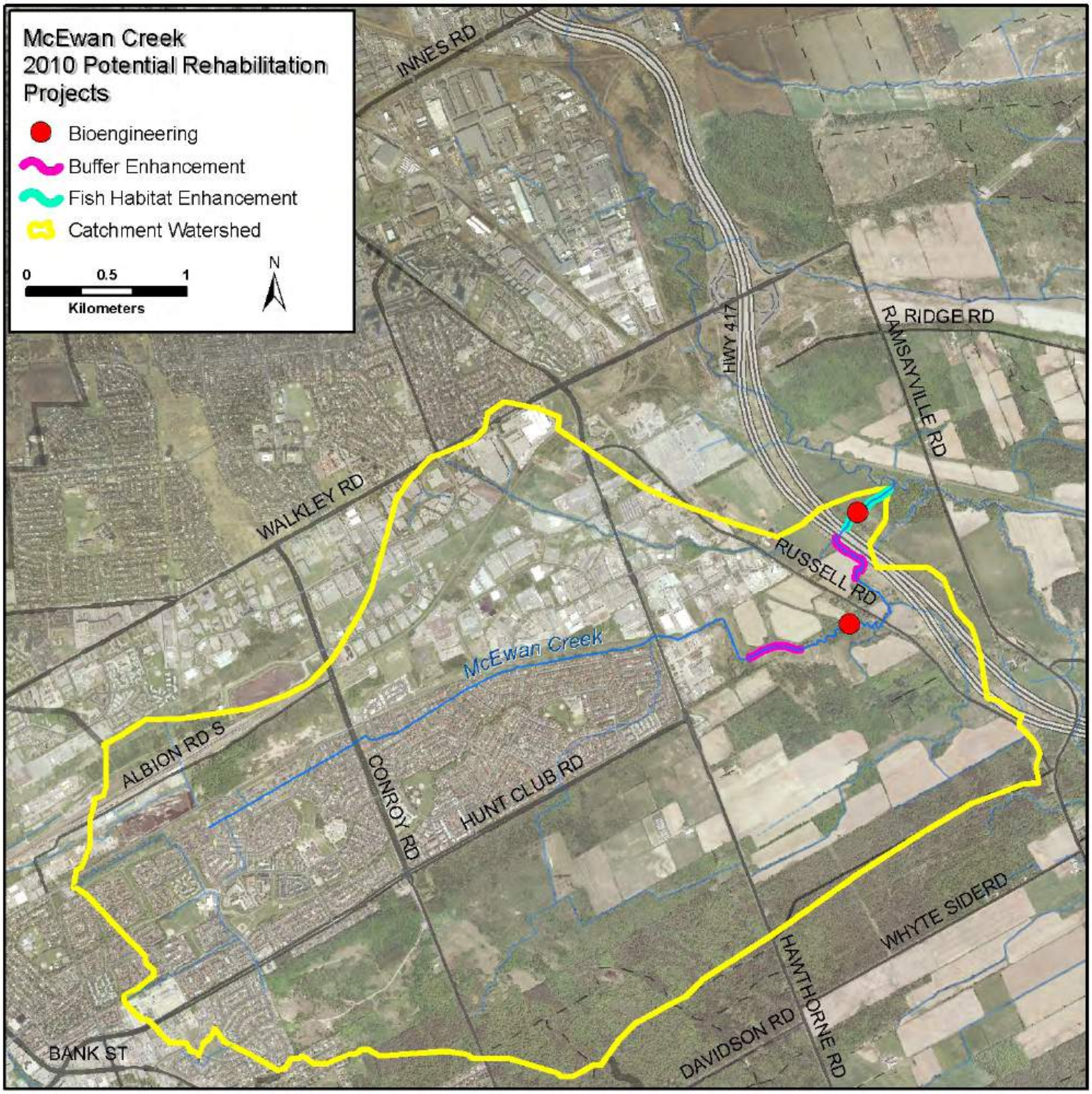
i) Graham Creek Projects



ii) Green's Creek Projects



iii) McEwan Creek Projects


McEwan Creek
2010 Potential Rehabilitation Projects
Bioengineering
Buffer Enhancement
Fish Habitat Enhancement
Catchment Watershed
0
0.5
1
Kilometers
N
INNES RD
RIDGE RD
RAMSAYVILLE RD
HWY 417
WALKLEY RD
RUSSELL RD
McEwan Creek
ALBION RD S
CONROY RD
HUNT CLUB RD
WHYTE SIDERD
HAWTHORNE RD
DAVIDSON RD
BANK ST

Appendix F

Ontario Fish Species		
Reproductive Guild	**Common Names**	**Scientific Name**
A. NON-GUARDER		
A.1 Open Substrate Spawners		
A.1.1 Pelagophils		
• non-adhesive eggs scattered in open water in areas where current direction is favourable to egg distribution and survival	American eel	*Anguilla rostrata*
	American shad	*Alosa sapidissima*
	longjaw cisco	*Coregonus alpenae*
	blackfin cisco	*C. nigripinnis*
	shortnose cisco	*C. reighardi*
	shortjaw cisco	*C. zenithicus*
	emerald shiner	*Notropis atherinoides*
	freshwater drum	*Aplodinotus grunniens*
A.1.2 Litho-pelagophils		
• fishes which undergo full range of transition from lithophils to pelagophils • eggs initially deposited on rocks/gravel but eggs or embryos become buoyant and are carried away from spawning substrates	lake sturgeon	*Acipenser fulvescens*
	gizzard shad	*Dorosoma cepedianum*
	cisco (lake herring)	*Coregonus artedi*
	bloater	*C. hoyi*
	deepwater cisco (chub)	*C. johannae*
	kiyi	*C. kiyi*
	goldeneye	*Hiodon alosoides*
	mooneye	*H. tergisus*
	burbot	*Lota lota*

Ontario Fish Species		
Reproductive Guild	**Common Names**	**Scientific Name**
A.1.3 Lithophils		
• deposit eggs on a rock, rubble or gravel bottom (streams or lakes) • usually well oxygenated waters; embryos hatch early and are highly photophobic	lake whitefish	*Coregonus clupeaformis*
	pygmy whitefish	*Prosopium coulteri*
	round whitefish	*P. cylindraceum*
	Arctic grayling	*Thymallus articus*
	rainbow smelt	*Osmerus mordax*
	redside dace	*Clinostomus elongatus*
	lake chub	*Couesius plumbeus*
	pugnose shiner	*Notropis anogenus*
	blacknose dace	*Rhinichthys atratulus*
	longnose dace	*R. cataractae*
	pearl dace	*Margariscus margarita*
	longnose sucker	*Catostomus catostomus*
	white sucker	*C. commersoni*
	northern hog sucker	*Hypentelium nigricans*
	spotted sucker	*Minytrema melanops*
	silver redhorse	*Moxostoma anisurum*
	river redhorse	*M. carinatum*
	black redhorse	*M. duquesnei*
	golden redhorse	*M. erythrurum*
	shorthead redhorse	*M. macrolepidotum*
	greater redhorse	*M. valenciennesi*
	trout-perch	*Percopsisomiscomaycus*
	sauger	*Stizostedion canadense*
	blue pike (blue pickerel) walleye (yellow pickerel)	*S. vitreum*
A.1.4 Phyto-lithophils		
• deposit eggs usually in clear water habitats on submerged plants, if available or on other submerged debris such as logs, gravel and rocks • late hatching, presence of cement glands	alewife	*Alosa pseudoharengus*
	finescale dace	*Phoxinus neogaeus*
	brassy minnow	*Hybognathus hankinsoni*
	silvery minnow	*H. nuchalis*
	gravel chub	*Erimystax x-punctata*
	spotfin shiner	*Cyprinella spiloptera*
	silver chub	*Macrhybopsis storeriana*
	redfin shiner	*Lythrurus umbratilis*
	mimic shiner	*Notropis volucellus*
	brook silverside	*Labidesthes sicculus*
	white perch	*Morone americana*
	white bass	*M. chrysops*
	yellow perch	*Perca flavescens*
	Iowa darter	*Etheostoma exile*

Ontario Fish Species		
Reproductive Guild	**Common Names**	**Scientific Name**
A.1.5 Phytophils		
• scatter or deposit eggs with an adhesive membrane that sticks to submerged, live or dead, aquatic plants, or to recently flooded terrestrial plants • sometimes deposited on logs and branches but never on the bottom • adapted to low oxygen concentrations • cement glands present	spotted gar	*Lepisosteus oculatus*
	longnose gar	*L. osseus*
	central mudminnow	*Umbra limi*
	grass pickerel	*Esox americanus vermiculatus*
	northern pike	*E. lucius*
	muskellunge	*E. masquinongy*
	chain pickerel	*E. niger*
	northern redbelly dace	*Phoxinus eos*
	golden shiner	*Notemigonus crysoleucas*
	bridle shiner	*Notropis bifrenatus*
	pugnose minnow	*Opsopoeodus emiliae*
	blackchin shiner	*Notropis heterodon*
	lake chubsucker	*Erimyzon sucetta*
	bigmouth buffalo	*Ictiobus cyprinellus*
	banded killifish	*Fundulus diaphanus*
	greenside darter	*Etheostoma blennioides*
	least darter	*E. microperca*
A.1.6 Psammophils		
• eggs scattered directly on sand or near fine roots of plants that hang over the sandy bottom • usually adapted to running water • eggs adhesive • usually in highly oxygenated waters	quillback	*Carpiodes cyprinus*
	blacknose shiner	*Notropis heterolepis*
	spottail shiner	*N. hudsonius*
	sand shiner	*N. stramineus*
	eastern sand darter	*Ammocrypta pellucida*
	logperch	*Percina caprodes*

Ontario Fish Species		
Reproductive Guild	**Common Names**	**Scientific Name**
A.2 BROOD HIDERS		
A.2.1 Lithophils		
• hide eggs in natural or specially constructed places • none guard deposited eggs through to emergence • in most cases the hiding places are excavated in gravel • generally eggs are buried under gravel • clean gravel or rocks and cold, clean fast flowing water or springs are almost essential to assume some exchange of water around eggs to provide sufficient oxygen	chum salmon	*Oncorhynchus keta*
	pink salmon	*O. gorbuscha*
	coho salmon	*O. kisutch*
	sockeye salmon	*O. nerka*
	chinook salmon	*O. tshawytscha*
	rainbow trout	*O. mykiss*
	Atlantic salmon	*Salmo salar*
	Arctic char	*Salvelinus alpinus*
	brook trout	*S. fontinalis*
	lake trout	*S. namaycush*
	hornyhead chub	*Nocomis biguttatus*
	river chub	*N. micropogon*
	creek chub	*Semotilus atromaculatus*
	fallfish	*S. corporalis*
	rainbow darter	*Etheostoma caeruleum*
	channel darter	*Percina copelandi*
	blackside darter	*P. maculata*
	river darter	*P. shumardi*
B. GUARDERS		
B.1. SUBSTRATUM CHOOSERS: spawning site is guarder and kept clean by parent		
B.1.1 Phytophils		
• eggs are scattered or attached onto submerged plants • male guards and fans eggs	white crappie	*Pomoxis annularis*
B.2 NEST SPAWNERS: variable structures built for egg deposition and guarding		
B.2.1 Lithophils		
• eggs deposited in single layer or multi layer clutches on cleaned rocks or in pits dug in gravel	common shiner	*Luxilus cornutus*
	cutlips minnow	*Exoglossum maxillingua*
	black bullhead	*Ameiurus melas*
	rock bass	*Ambloplites rupestris*
	green sunfish	*Lepomis cyanellus*
	bluegill	*L. macrochirus*
	longear sunfish	*L. megalotis*
	smallmouth bass	*Micropterus dolomieu*
	fourhorn sculpin	*Myoxocephalus quadricornis*

Ontario Fish Species		
Reproductive Guild	**Common Names**	**Scientific Name**
B.2.2 Phytophils		
• nests built on a soft, muddy bottom usually amid algae, plants, plant roots, leaves	bowfin	*Amia calva*
	largemouth bass	*Micropterus salmoides*
	black crappie	*Pomoxis nigromaculatus*
B.2.3 Speleophils		
• guard spawn in natural holes and cavities or in specially constructed burrows • frequently eggs are deposited on a cleaned area of the undersurface of flat stones	bluntnose minnow	*Pimephales notatus*
	fathead minnow	*P. promelas*
	yellow bullhead	*Ameiurus natalis*
	brown bullhead	*A. nebulosus*
	channel catfish	*Ictalurus punctatus*
	stonecat	*Noturus flavus*
	tadpole madtom	*N. gyrinus*
	brindled madtom	*N. miurus*
	fantail darter	*Etheostoma flabellare*
	johnny darter	*E. nigrum*
	mottled sculpin	*Cottus bairdi*
	slimy sculpin	*C. cognatus*
	spoonhead sculpin	*C. ricei*
B.2.4 Polyphils		
• fishes that are not particular in the selection of nest building material and substrate • usually circular nests with sticks and roots left in place • often among or next to plants growing in muddy or sandy shallows of slow rivers or lagoons	pumpkinseed	*Lepomis gibbosus*
B.2.5 Ariadnophils		
• skill nest building and parental care remarkably well developed • nest materials are bound together by a viscid thread secreted by male	brook stickleback	*Culaea inconstans*
	threespine stickleback	*Gasterosteus aculeatus*
	ninespine stickleback	*Pungitius pungitius*

References: Balon (1975) and Robins *et al.* (1991)

Appendix G

City Stream Watch 2010 Organizational Chart