CITY STREAM WATCH 2009

City Stream Watch
2009 Annual Report

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Executive Summary

This document summarizes the activities of the City Stream Watch program for the 2009 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 2009, the original three streams sampled in 2004 were re-surveyed: Bilberry Creek, Mosquito Creek and Stillwater Creek. On all three watercourses, changes in stream characteristics were observed. Anthropogenic alterations increased along Bilberry and Stillwater Creeks, probably due to shoreline modifications and loss of buffer. On Mosquito Creek, the incidence of garbage increased greatly. There was a 54 percent increase in floating garbage and a nine percent increase in garbage found on the stream bottom. On Stillwater Creek, the amount of floating garbage increased by 15 percent. Comparisons can be seen in the results section.

In addition to Bilberry, Mosquito and Stillwater, two streams were surveyed that had not previously been: Barrhaven Creek and the West branch of Bilberry Creek A total of 227 volunteers from the community participated in the program throughout the spring, summer and fall, contributing a total of 1,499 hours working on various projects. Approximately 26 kilometres of stream were surveyed in 2009. Volunteers also participated in intensive fish sampling, collecting fish data on 15 sites throughout the city. All information is housed in the Rideau Valley Conservation Authority's Watershed Information System and is available interactively on the Authority's website at *www.rvca.ca*.

In 2010, the original three streams sampled in 2005 will be re-surveyed. Creeks are re-surveyed every five years to observe positive/negative trends that may be occurring. McEwan Creek will also be added to the 2010 list of streams, which has not yet been assessed through CSW. The data will complement work conducted by certain municipal and regional programs, most of which do not survey the smaller urban streams which are the focus of City Stream Watch. In addition, the intrinsic value of community-based environmental monitoring and stewardship through personal involvement will be further developed.

2009 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 kindly 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 a huge thank you to Jason Kelly (General Manager), Doris Kwok (Director of Marketing) and their talented and generous staff at the Monterey Inn Resort for their continued support of the program.

Fisheries and Oceans Canada

TD Canada Trust Friends of the Environment

RBC Blue Water Project

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 fantastic 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 2009. The food was always welcome, especially on those rainy days!

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 **Fisheries and Oceans Canada** for their financial contribution to the program for program costs and survey and event supplies.

Thank you to **RBC Blue Water Project** for their financial contribution to the program for survey and event supplies.

Thank you to the **TD Friends of the Environment** for their financial contribution to purchase a YSI probe for the program.

Thank you to Chuck Wheatley and Joe Imbesi, 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 Stillwater Creek.

Thank you to Peter Stewart-Burton of the **National Defense Headquarters Fish and Game Club** for assisting in organizing the Sawmill Creek cleanup.

Thank you to Donna Silver of the **Heron Park Community Association** for assisting in organizing the Sawmill Creek Cleanup and for her work in co-presenting at the 6th Canadian Heritage Rivers Conference.

Thank you to Frances Pick of the **Rideau Roundtable** for her assistance with the City Stream Watch presentation at the 6th Canadian Heritage Rivers Conference.

Thank you to Bruce Clarke and the **Ottawa Flyfishers Society** for running the very popular fly fishing demonstration and to the volunteers who piloted the Adopt a Stream project.

Thank you to **Bruce Clarke** for all of his hard work to initiate and develop the Adopt a Stream program.

Thank you to **Bill Graham** for organizing volunteers and setting up the Adopt a Stream sampling.

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 Brad Eckert of the **1st Manotick Scouts** for organizing the Rideau River cleanup.

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 writing the City Stream Watch article in spring of 2009. The article generated an incredible amount of volunteer interest.

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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 2009

In 2009 the original three streams from 2004 were re-surveyed. Those creeks were Bilberry Creek, Mosquito Creek and Stillwater Creek. In addition, West Bilberry Creek and Barrhaven Creek were surveyed for the first time. Figure 1 shows the locations of the 2009 sample streams as well as all streams sampled from 2003 to 2012.

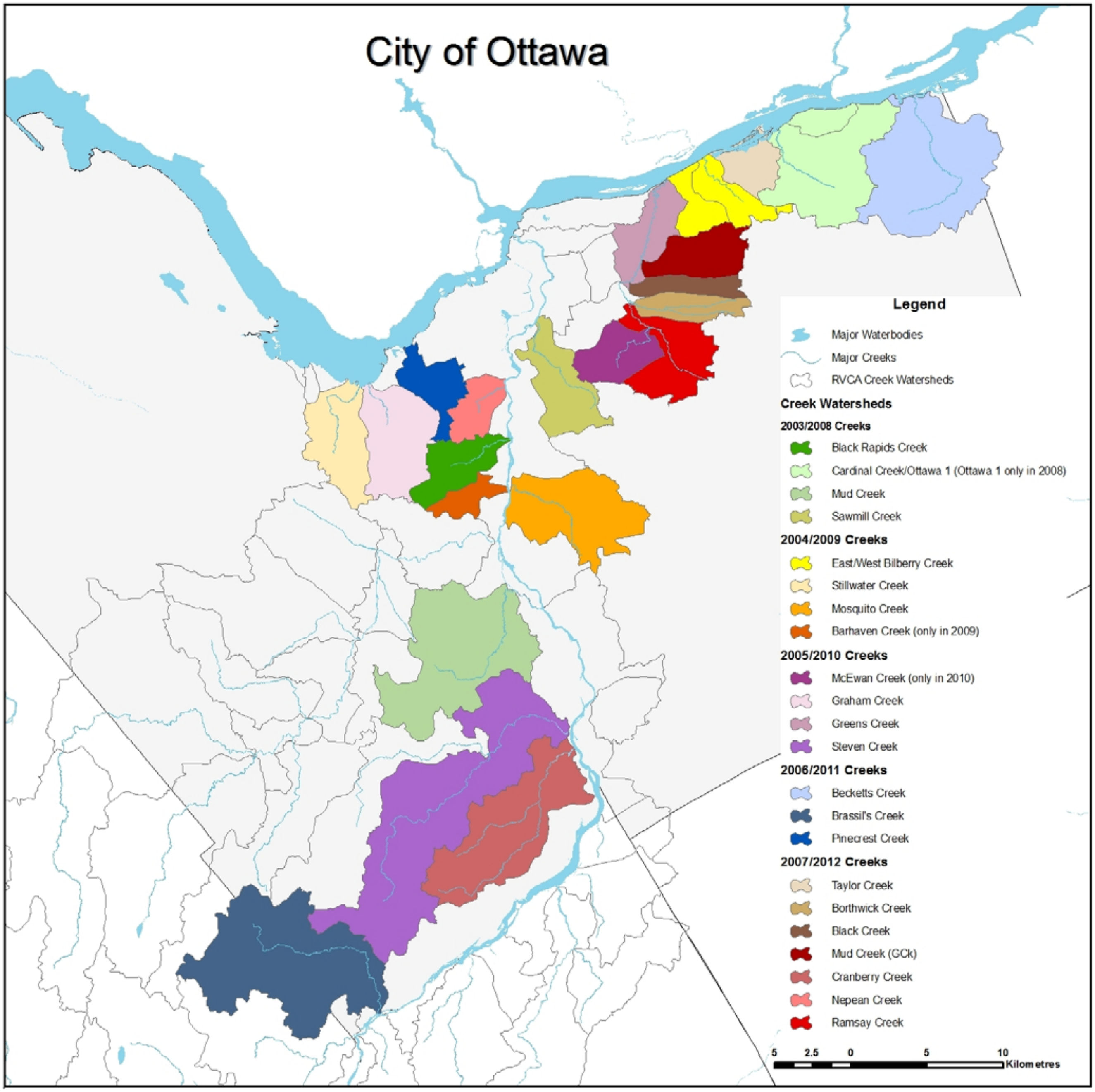

Figure 1. Locations of Streams and Their Watersheds on the 2003-2012 Sampling Schedule

1.4 Stream Study Comparison 2004/2009

The following chart is a comparison summary of activities done on each creek in both 2004 and 2009. Volunteer numbers continue to increase as the program has incorporated more activities and gained greater recognition within the community. In 2004, there were 65 volunteers and over five years, that number has grown to 227.

ACTIVITIES	Barrhaven 2009	Bilberry 2004	Bilberry 2009	Mosquito 2004	Mosquito 2009	Stillwater 2004	Stillwater 2009
Number of sections surveyed	20	45	75	28	85	65	79
Number of volunteers	31	N/A	63	N/A	44	N/A	74
Total volunteer hours	113	65	267.5	38	210.5	72	318.5
Number of fish sampling sites	3	6	5	1	6	5	4
Number of temperature probes	1	2	4	2	4	2	4

Table 1. Stream Study Comparison Between 2004 and 2009

2.0 Methodology

2.1 The Stream Watchers – The Heart of City Stream Watch

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 2009. 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). Representatives from the RVCA 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.

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 tape hits 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.

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.

2.3 Fish Sampling

This year's City Stream Watch program sampled a total of 18 fish sites on the four creeks. Sampling methods included seine netting, electrofishing and traps (windemere traps and a fyke net). Appropriate seining sites were chosen and volunteers assisted in pulling the net through the water column, processing, and identifying the catch. The different species of fish were sorted and counted. Minnow species were counted and a bulk weight (weight of all the individuals of a particular species) was measured. Game species were counted, a round weight was taken, and individual fish were measured for total length (from tip of the nose to the end of the caudal fin).

The fyke net was used at the mouths of the streams, where the water levels were high. The net was set for a 24-hour period. Windemere traps were used in shallower areas and set for a 24-hour period. Nets were picked up by RVCA staff and volunteers. Fish data was recorded in the same way as the seine net sampling. Volunteers gained valuable insight into fish sampling methodology as well as experience in identifying different fish species. Electrofishing was done by RVCA certified technicians only. There were two electrofishing demonstrations held on Barrhaven Creek and Bilberry Creek where volunteers stayed on the shore during the electrofishing but were able to fully participate after, processing and recording the fish species caught.

2.4 Stream Clean-Ups

In 2009, a total of four stream cleanups were held, two on the Rideau River, one on Sawmill Creek and one on Stillwater 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 2009, two riparian planting initiatives were carried out on streams in the City of Ottawa. In partnership with the NCC, 700 trees were planted on a site at Green's Creek. Another planting was completed on Bilberry Creek, in partnership with the City. The goals of the plantings were to try and increase shade and habitat in the riparian area, along with protecting the bank. Additional planting opportunities have been identified for 2010 and will commence in the spring.

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. Information on each stream is made available to the public through the Watershed Information System on the RVCA website *www.rvca.ca*.

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 227 volunteers from the community participated in the 2009 City Stream Watch program, consisting 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, 1,520 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 2009 season.

	Barrhaven	Bilberry	Mosquito	Stillwater	Sawmill	Green's	Rideau	Jock	Total
Number of sections surveyed	20	75	85	79	N/A	N/A	N/A	N/A	**259**
Fishing demos	2	3	3	2	N/A	N/A	N/A	1*	**11**
Fish sites	3	5	6	4	N/A	N/A	N/A	N/A	**18**
Number of cleanups	0	0***	0	1	1	0	2**	N/A	**4**
# of kilometres (km) Cleaned	N/A	N/A	N/A	1.5	2.5	N/A	5	N/A	**9**
Number of tree plantings	0	1	0	0	0	1	N/A	N/A	**2**
Number of invasive species removal	0	0	0	0	1	1	N/A	N/A	**2**
# of Volunteers (total for all events)	31	63	44	74	103	35	17	31	**N/A******
# of Volunteer Hours	**113**	**269.5**	**210.5**	**318.5**	**301**	**105**	**54**	**148.5**	**1520**

Table 2. City Stream Watch Accomplishments of 2009

*This event was the benthic sampling/identification and flyfishing demo with the Ottawa Flyfishers Society; no fish were sampled

**Two cleanups were organized on the Rideau River, one by the 1st Manotick Scouts and one by the Urban Rideau Conservationists, which City Stream Watch took part in

***A cleanup was completed on Bilberry by Cairine Wilson Secondary Students, discussed in Special Events

****Many volunteers participated in surveys and events on more than one creek; actual total volunteer count for 2009 is **237**, not including school groups

3.2 Environmental Monitoring

3.2.1 Barrhaven Creek

The headwaters of Barrhaven Creek begin at Woodroffe Avenue and flow east through a large two-celled stormwater management pond, before crossing Prince of Wales Drive and flowing into the Rideau River. Its headwaters used to begin near Greenbank but were lost to development. In late 1974, an experimental online-stormwater facility was first constructed at the location of the current stormwater facility on Leikin Drive to treat stormwater by impoundment. This pilot facility was replaced by the East Barrhaven Stormwater Facility in 1980/81 and subsequently upgraded in 1991/92, increasing storage volume and providing ultraviolet disinfection to the stormwater before discharge (Rooke, City of Ottawa, 2009). The surficial geology of the Barrhaven Creek subwatershed consists of silty clay, clay and silt. Most of the vegetation was cleared years ago for agricultural purposes, aside from the banks of the creek itself. The shoreline of the creek is mainly wooded, consisting of sugar maple, basswood, ash and elm. In a watershed planning study conducted in 1989, it was recommended that due to the amount of deforestation that had already occurred in that drainage area, there should be no further loss of forested buffer and that it would be beneficial to enhance the buffer with further plantings to improve the integrity of the stream. The Ontario Ministry of Natural Resources (OMNR) did not find any game fish production in the creek; however, from fish sampling done in 2009, smallmouth bass and walleye were found between the mouth of the creek and Prince of Wales Drive. The benthic study done in 1989 suggested some organic pollution present (UMA Engineering Ltd., 1989).

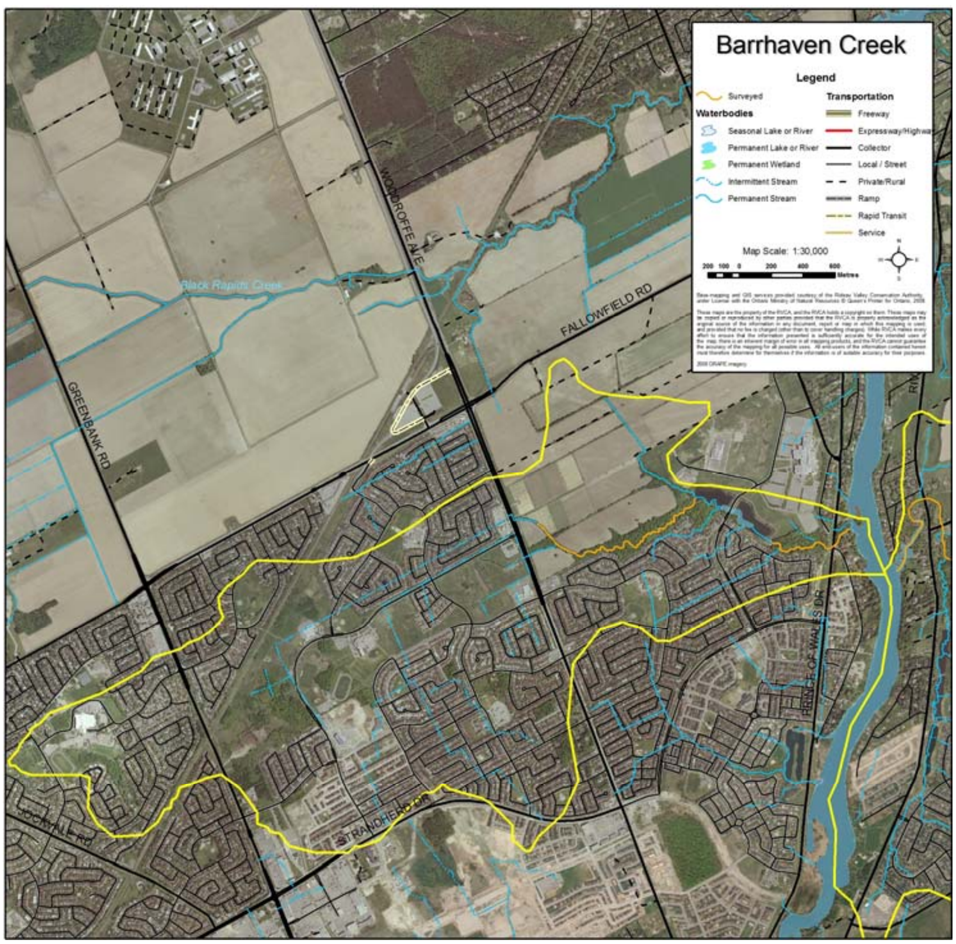

Figure 2. Air photo of Barrhaven Creek and Surrounding Area

Twenty sections or two kilometres of Barrhaven Creek were sampled in the 2009 season. The creek was surveyed in its entirety, with the exception of the stormwater treatment facility (SWTF) area. The surveyed sections are highlighted in orange in Figure 2. Although on the map it appears that the headwaters begin just east of Greenbank Road, the creek no longer exists in that area and begins where the survey areas are highlighted. The headwaters (between the SWTF and Woodroffe Road) were surveyed by staff in April, after the spring freshet. Water levels in the creek were quite low and there was concern the headwaters would dry up before CSW volunteers could complete the habitat surveys. The sections downstream of the SWTF were surveyed by volunteers. The following is a summary of the 20 macro-stream assessment forms completed by technicians and volunteers. Observations concerning anthropogenic alterations, land use, in-stream vegetation, bank stability, wildlife and pollution are discussed.

1. Observations of Anthropogenic Alterations and Land Use

Figure 3 illustrates the classes of anthropogenic alterations observed along Barrhaven Creek. Of the 20 sections sampled, only five percent of the stream remained without any anthropogenic alterations. Sections considered natural, but with some anthropogenic changes made up 65 percent of the sections sampled, and ten percent accounted for sections that were considered “altered” but still had natural features. Twenty percent of the samples 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. Most of these areas occurred in the headwaters, as well as the sections downstream and immediately upstream of Prince of Wales Drive.

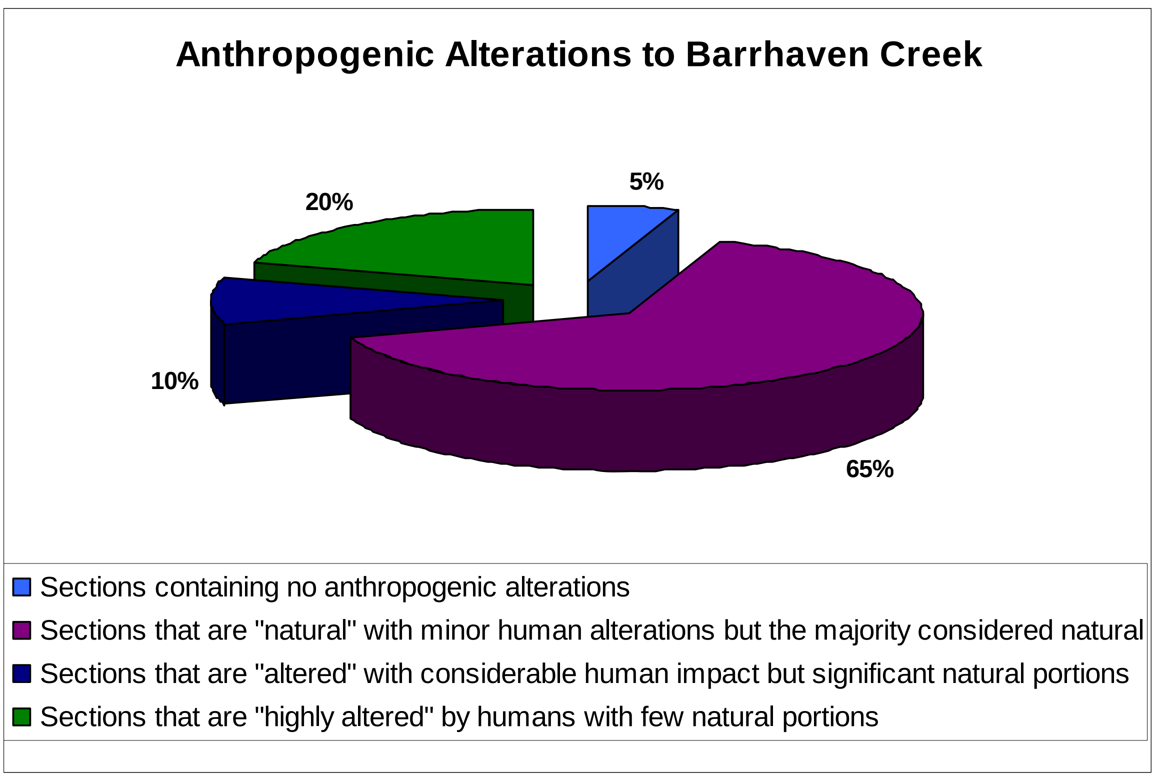

Figure 3. Classes of Anthropogenic Alterations Occurring Along Barrhaven Creek

2. Land Use Adjacent to Barrhaven Creek

Figure 4 demonstrates a number of different land uses identified along the banks adjacent to Barrhaven Creek. Natural areas made up 52 percent of the stream, characterized by forest, scrubland and a bit of meadow. The two other major land uses were agricultural and residential. Agricultural land use surrounding Barrhaven Creek accounted for 21 percent, mainly occurring from upstream of the SWTF to Woodroffe. Residential land use occurred on the left bank, from the mouth to the headwaters and accounted for 23 percent. Four percent of the land use was infrastructure, which included road crossings, stormwater outlets and the SWTF.

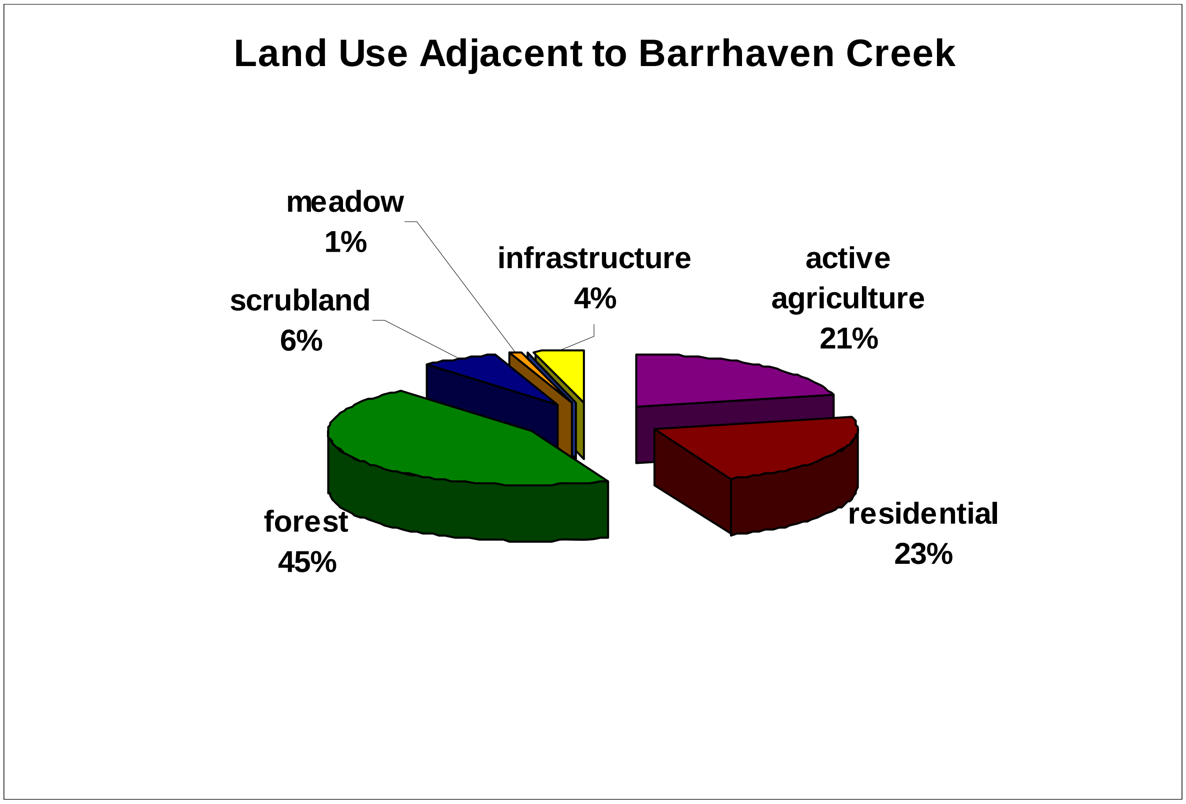

Figure 4. Land Use Identified by Volunteers along Barrhaven Creek

3. Instream Morphology of Barrhaven 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. Barrhaven Creek mainly consists of large runs with 25 percent pools and 11 percent riffles, illustrated in Figure 5.

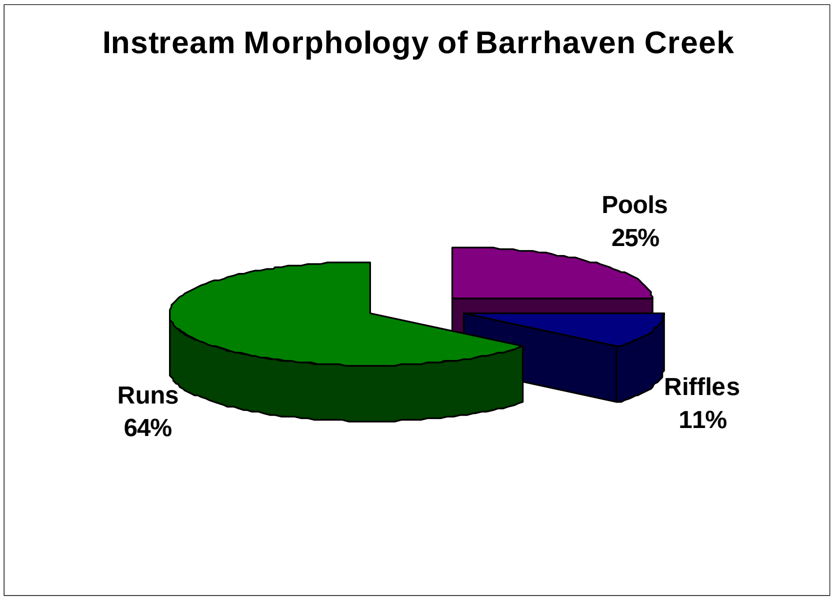

Figure 5. Instream Morphology of Black Rapids Creek

4. Types of Instream Substrate Along Barrhaven Creek

Diverse substrate is important for fish and benthic macroinvertebrate 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 macroinvertebrates. A variety of substrate can be found instream along Barrhaven Creek, although over half of the substrate observed was muck (mixture of clay, silt and sand) and detritus, most of which was found upstream of the SWTF. That area runs through a forested buffer, where the channel is quite small and filled with a large amount of woody material and fallen leaves, creating an abundance of organic matter.

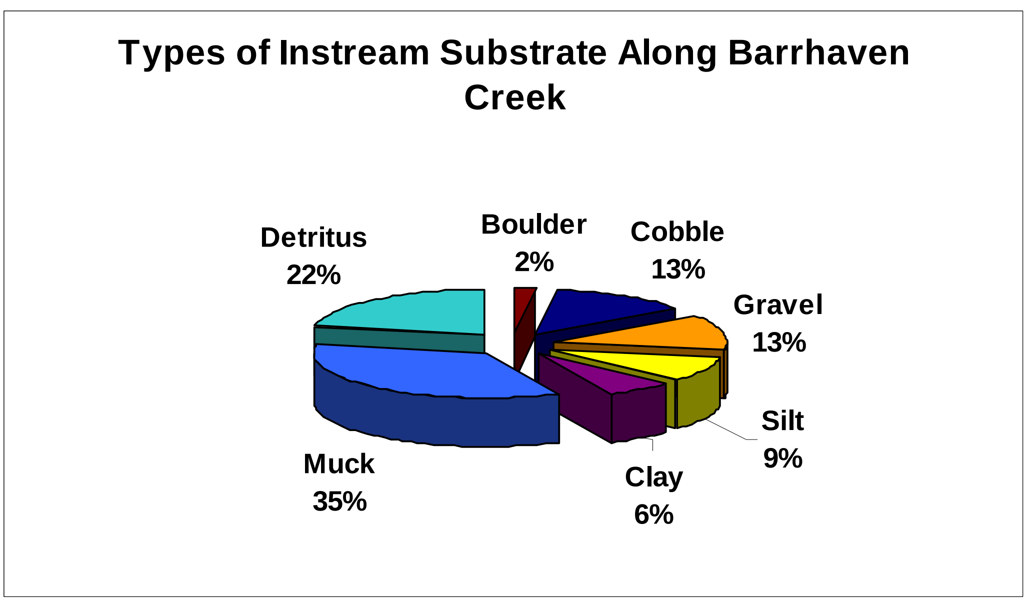

Figure 6. Types of Instream Substrate Along Barrhaven Creek

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 Barrhaven Creek.

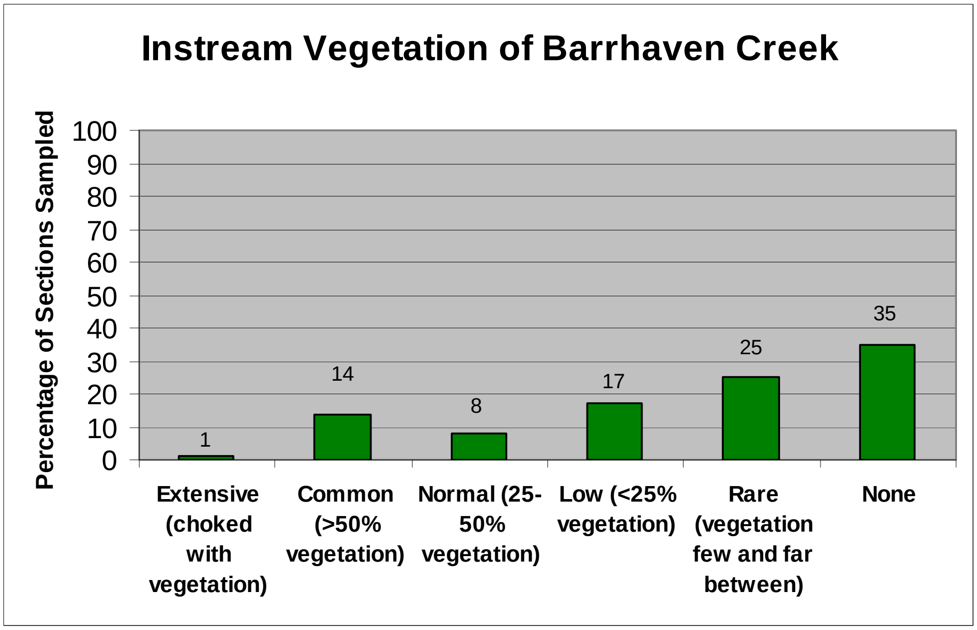

Figure 7. Frequency of Instream Vegetation in Barrhaven Creek

The instream vegetation in Barrhaven Creek varied throughout the stream. In 14 percent of sections sampled, vegetation was found to be common and eight percent found to be normal. The areas considered extensive (one percent) were areas with higher nutrient inputs, directly downstream of the SWTF. Areas choked with vegetation can negatively affect the stream due to increased biological oxygen demand (BOD) when the plants die off. Extensive vegetation can also restrict the mobility of aquatic organisms. Many sections had areas with low, rare or no vegetation due; however, this may have been because the headwater surveys were conducted in early spring, before aquatic vegetation had a chance to grow. These sections made up 77 percent of the sections sampled.

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.

For the past two years, City Stream Watch has recorded bank stability separately for left and right banks to obtain greater detail on the areas experiencing erosion. For Barrhaven Creek, stability ended up being the same for both banks. Figure 8 shows the overall bank stability of Barrhaven Creek. Seventy-three percent of sections sampled were identified as being stable. Although there were some banks showing exposed soil, direct slope stability did not appear to be compromised. Eroded sections were identified in 27 percent of surveyed sections, with some instability observed near the mouth, but the majority in the forested section between the SWTF and Woodroffe. Areas of erosion have been identified on an aerial photo of Barrhaven Creek and are detailed in Appendix E.

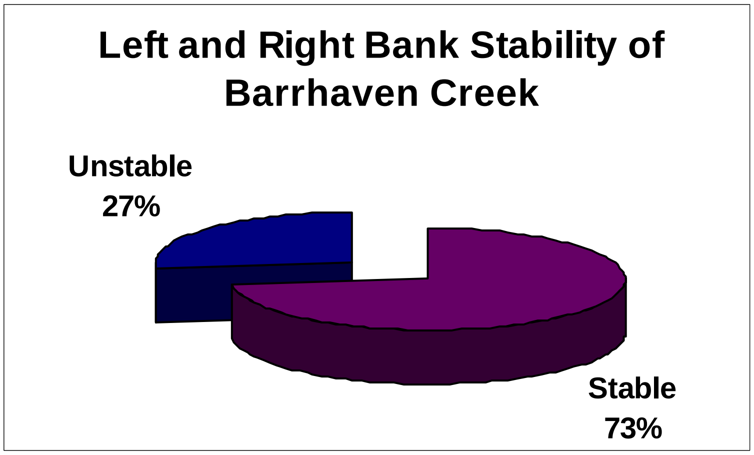

Figure 8. Left and Right Bank Stability of Barrhaven Creek

7. Buffer Evaluation of Barrhaven 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*, a stream should have riparian areas of 30 metres minimum or more, depending on the site conditions. Figure 9 demonstrates the buffer conditions between the left and right banks. Along Barrhaven, 14 to 18 percent had a buffer of only zero to five metres, six to 14 percent had a buffer of five to 15 metres and 12 to 31 percent had 15 to 30 metres. Sixty-eight percent of the right bank and 37 percent of the left bank had a buffer greater than 30 metres. Overall, the right bank had a better buffer, although in the first 400metres of the headwaters, both banks have little to no buffer. The left bank also has a very small buffer at the mouth of the stream.

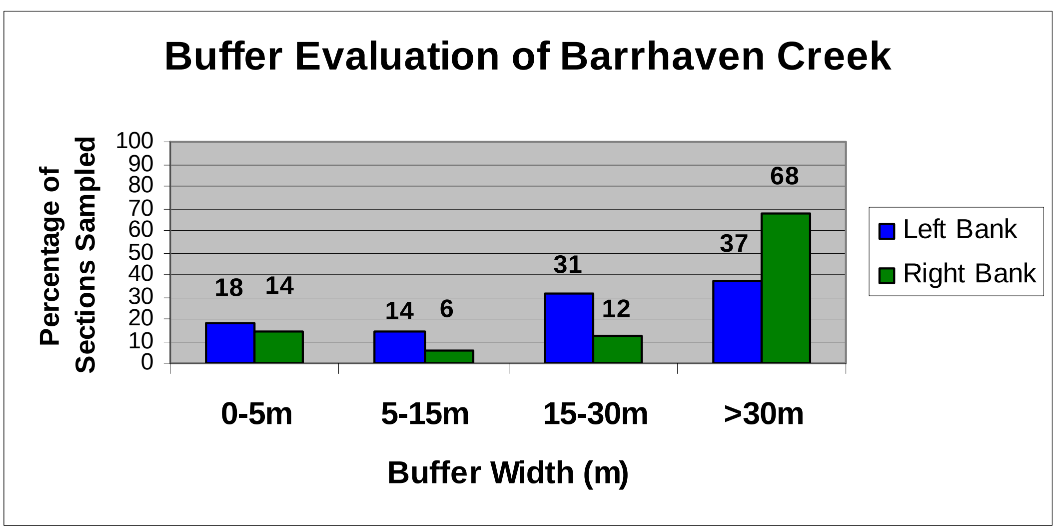

Figure 9. Buffer Evaluation of Barrhaven Creek

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	ducks, geese, mallards, red-winged blackbird, hawk, woodpecker, blackbird, starling, chickadee
Mammals	muskrat, raccoons, red squirrel
Reptiles/Amphibians	frogs, tadpoles
Aquatic Insects	water striders, leeches, molluscs
Fish (observed when walking)	*Cyprinid spp.*
Other	butterflies, mosquitoes, horseflies

Table 3. Wildlife Observed on Barrhaven Creek During Stream Surveys

9. Observations of Pollution/Garbage

Figure 10 demonstrates the incidence of pollution/garbage in Barrhaven Creek. Pollution and garbage in the stream is assessed visually and noted for each section where it is observed. Only ten percent of the stream surveyed was free of pollution or garbage. In the sections where pollution was observed, 65 percent was floating in the water and 40 percent was caught on the stream bottom. Five percent of the sections surveyed had oil and gas trails.

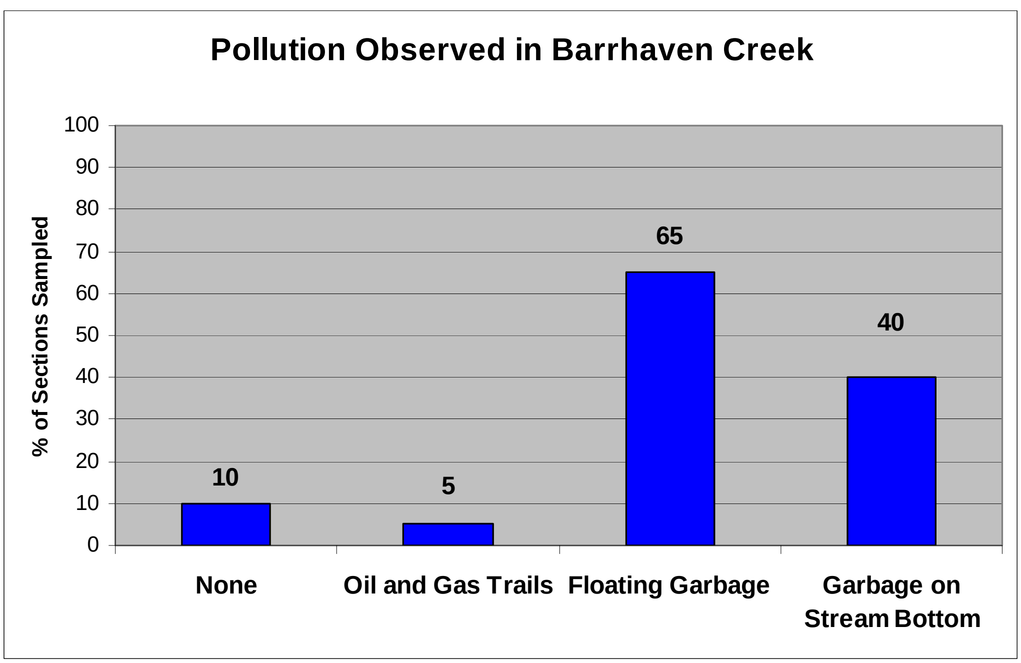

Figure 10. Frequency of Pollution/Garbage Occurring in Black Rapids Creek

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, recreational pathways or construction sites. There is a log jam downstream of Prince of Wales Drive where garbage has collected (tires, etc.) and should be removed next year.

10. Fish Community Sampling

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. Seine netting was only used near the mouth of Barrhaven Creek, at Site 1. Figure 11 shows the locations of the sampling sites, and Table 4 is a summary of the fish caught.

Fyke Net

A fyke net is a modified hoop net. The net consists of three round hoops with funnels leading to the next hoop, followed by a square hoop, all joined together with mesh (mesh size 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 tied to either a weight or an object. The net is tied together with a rope to allow for easy processing. The fish find the lead line or a wing and are led towards 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. A fyke net was used on Barrhaven at Site 1, in conjunction with seining. Table 4 is a summary of the fish caught.

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. A windemere trap was used at Site 2 and 3 on Barrhaven Creek in April. Table 4 is a summary of the fish caught.

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. RVCA staff electrofished Site 3 along Barrhaven Creek, just downstream of the SWTF.

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. 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. Table 4 summarizes the water chemistry for each fish sampling site.

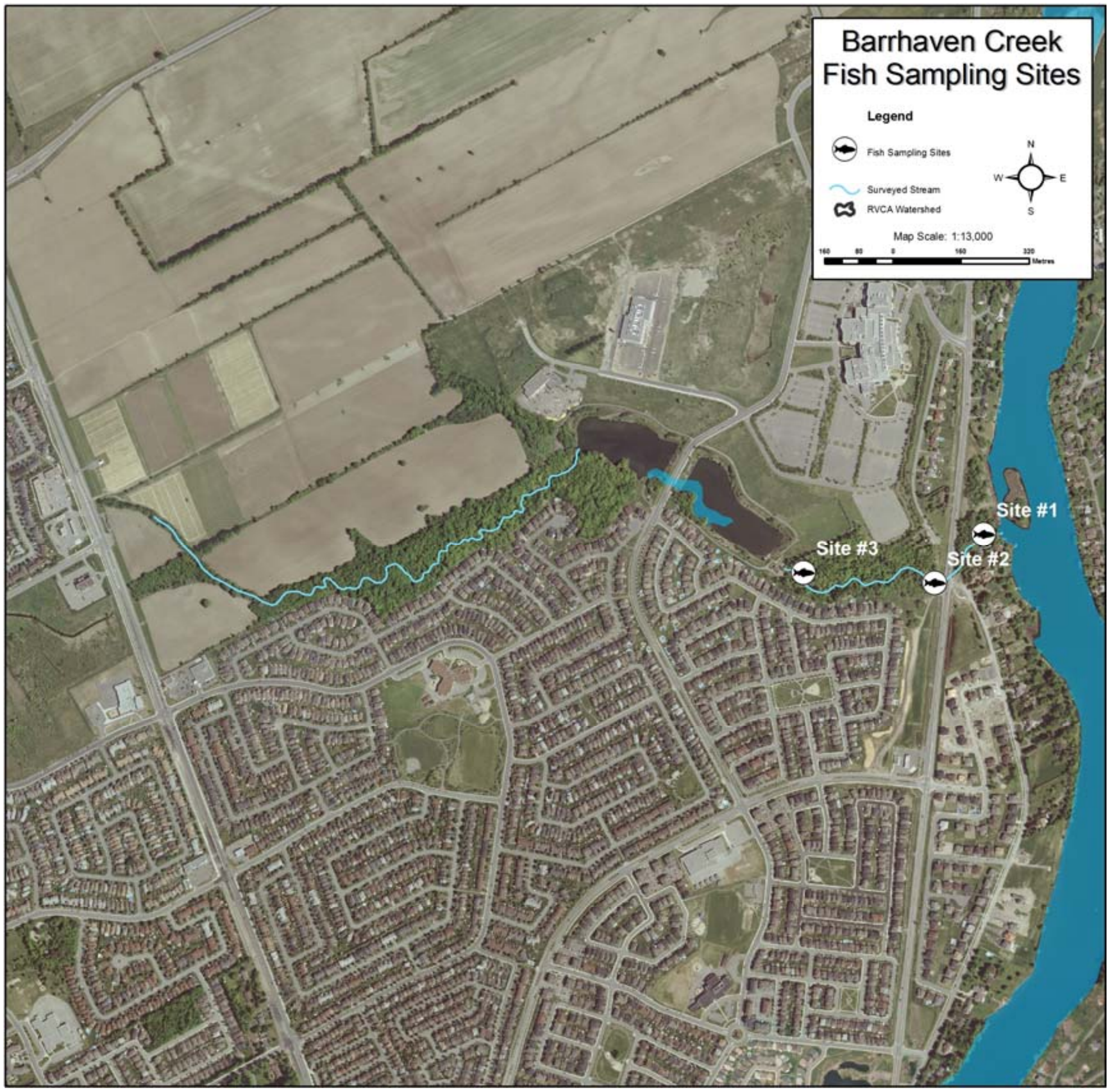

Figure 11. Air Photo of Barrhaven Creek Showing Sampling Sites

Table 4 summarizes the fish species captured at each sampling event on Barrhaven Creek. A total of 24 different fish species were collected. Top predators within the system are highlighted in bold. All fish were live released back to the stream after fish sampling, unless lab identification was necessary. Minnow species that were too small to identify are listed as *Cyprinid spp*. *Etheostoma spp* indicates that either Johnny Darter or Tessellated Darter (virtually identical) were captured. To differentiate between those species, each fish must be killed and brought back to lab; therefore, they are only identified to genus level. *Phoxinus spp.* refers to northern redbelly dace or finescale dace, both minnow species that are difficult to differentiate when small. Volunteers spent a total of 81 hours fish sampling on Barrhaven Creek.

Site #	Sampling Technique	Date (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	4/23/2009	5.51	8.83	7.46	8	931	clay, muck, detritus, boulders	none observed	bluegill, white sucker, brook stickleback, brassy minnow, creek chub, common shiner, bluntnose minnow, *Cyprinid spp*.	8
1	seining	5/28/2009	13.51	15.14	10.53	8.4	730	same as above	none observed	**yellow perch**, **walleye**, *Etheostoma spp.*, *Cyprinid spp*.	4
1	fyke net	6/23/2009	20.25	22.85	9.1	8.6	417	same as above	none observed	rock bass, **smallmouth bass**	2
1	fyke net	7/13/2009	16.56	21	8.63	7.8	323	same as above, boulders	none observed	**smallmouth bass**, **black crappie**, **yellow perch**, brook stickleback	4
1	seining	7/13/2009	16.56	21	8.63	7.8	323	same as above	none observed	logperch, **yellow perch**, **northern pike**, **smallmouth bass**, **largemouth bass,** white sucker, brassy minnow, *Etheostoma spp*.	8
2	windemere trap	4/23/2009	9.11	9.75	8.98	7.9	995	clay, muck, cobble, boulder, gravel	none observed	brook stickleback, creek chub, brassy minnow, bluntnose minnow, *Cyprinid spp*.	5
2	electrofishing	5/11/2009	10.5	10.69	12.07	8.1	723	same as above	none observed	white sucker, brook stickleback, fathead minnow, pumpkinseed, brassy minnow, creek chub, finescale dace, *Cyprinid spp*.	8
2	electrofishing	6/23/2009	21.03	22.64	10.16	8.5	550	same as above	thick submergents, filamentous algae	brook stickleback, fathead minnow, creek chub, pumpkinseed, bluntnose minnow, *Phoxinus spp.*, *Cyprinid spp*.	7

2	electrofishing	7/20/2009	19.22	18.7	9.59	7.6	870	clay, muck, cobble, boulder, gravel	thick submergents, filamentous algae	brook stickleback, creek chub, fathead minnow, brassy minnow, white sucker, **yellow perch**, **smallmouth bass**, northern redbelly dace, logperch	9
3	windemere trap	4/23/2009	8.61	9.07	9.45	8.1	965	clay, boulder, cobble	none observed	bluntnose minnow	1

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

Fish Species Status, Trophic and Reproductive Guilds-Barrhaven 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). The majority of the species within Barrhaven Creek are either significant to the recreational or baitfish fisheries. The fish community structure consists of a mix of warm and cool water species.

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	(nestspawners) Phytophils	cool	insectivore/ piscivore
314	bluegill	*Lepomis macrochirus*	X				(nest spawners) Lithophils	cool/warm	insectivore
208	bluntnose minnow	*Pimephales notatus*			X	none	(guarder) Speleophils	warm	omnivore
189	brassy minnow	*Hybognathus hankinsoni*			X	not at risk	Phytophils	cool	omnivore/herbivore
281	brook stickleback	*Culaea inconstans*			X	none	(guarders) Ariadnophils	Cool	insectivore
198	common shiner	*Luxilus comutus*			X	none	(guarders) Lithophils	cool	insectivore
212	creek chub	*Semotilus atromaculatus*	X		X	none	(brood hiders) Lithophils	cool	insectivore/ generalist
209	fathead minnow	*Pimephales promelus*			X	none	(guarder) Speleophils	warm	omnivore
183	finescale dace	*Phoxinus neogaeus*			X		(non guarder) Phyto-lithophils	cool	insectivore
317	largemouth bass	*Micropterus salmoides*	X	past		none	(nest spawners) Phytophils	warm	insectivore/piscivore
342	logperch	*Percina caprodes*			X		(non guarder) Psammophils	cool	insectivore
131	northern pike	*Esox lucius*	X				(non guarder) Phytophils	warm	piscivore

182	northern redbelly dace	*Phoxinus eos*			X	none	(non guarder) Phytophils	cool/warm	herbivore
313	pumpkinseed	*Lepoms gibbosus*	X			none	(nest spawners) Polyphils	cool/warm	insectivore
311	rock bass	*Ambloplites rupestris*	X			none	(nest spawners) Lithophils	warm	insectivore
316	smallmouth bass	*Micropterus dolomieui*	X	past		none	(nest spawners) Lithophils	cool	insectivore/piscivore
334	walleye	*Stizostedion vitreum*	X	X		none	(non guarder) Lithophils	cool	piscivore
163	white sucker	*Catostomus commersoni*				none	(non guarder) Lithophils	cool	insectivore/omnivore
331	yellow perch	*Perca flavescens*	X			none	(non guarder) Phyto-lithophils	cool	insectivore/piscivore

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

Table 6 summarizes the fish community structure found in Barrhaven Creek and their sensitivity to sediment and turbidity for reproduction, feeding, and respiration. The composition of the fish community in Barrhaven 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. Fish species such as bass, black crappie and walleye that are sensitive to sediment and turbidity for feeding were caught close to the Rideau River where food could be found elsewhere if ideal conditions did not exist. There were four young of the year smallmouth bass caught directly downstream of the SWTF in July.

Fish Species Sensitivity to Sediment/Turbidity for Barrhaven Creek

MNR Code	Common Name	Scientific Name	Reproduction	Feeding	Respiration
319	black crappie	*Pomoxis nigromaculatus*	L	H	unknown
314	bluegill	*Lepomis macrochirus*	L	M	unknown
208	bluntnose minnow	*Pimephales notatus*	L	M	unknown
189	brassy minnow	*Hybognathus hankinsoni*	M	L	unknown
281	brook stickleback	*Culaea inconstans*	L	M	unknown
198	common shiner	*Luxilus comutus*	M	M	unknown
212	creek chub	*Semotilus atromaculatus*	M	M	H
209	fathead minnow	*Pimephales promelus*	L	L	unknown
183	finescale dace	*Phoxinus neogaeus*	M	M	unknown
317	largemouth bass	*Micropterus salmoides*	L	H	H
342	logperch	*Percina caprodes*	M	M	H
131	northern pike	*Esox lucius*	M	H	L
182	northern redbelly dace	*Phoxinus eos*	M	L	L
313	pumpkinseed	*Lepoms gibbosus*	L	M	unknown
311	rock bass	*Ambloplites rupestris*	L	H	unknown
316	smallmouth bass	*Micropterus dolomieui*	M	H	unknown

334	walleye	*Stizostedion vitreum*	M	H	H
163	white sucker	*Catostomus commersoni*	M	L	H
331	yellow perch	*Perca flavescens*	M	H	unknown

Table 6. Fish Species Sensitivity to Sediment/Turbidity (High, Moderate, Low or Unknown) for Barrhaven 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 8. Water Temperature Classifications (Minns et al. 2001)

One temperature datalogger was set in Barrhaven Creek and placed just upstream of Prince of Wales Drive. The logger was set on April 2 at 2:58 p.m. and recorded temperatures until September 23 at 2:05 p.m., when it was removed from the stream. Figure 12 shows the location of the datalogger.

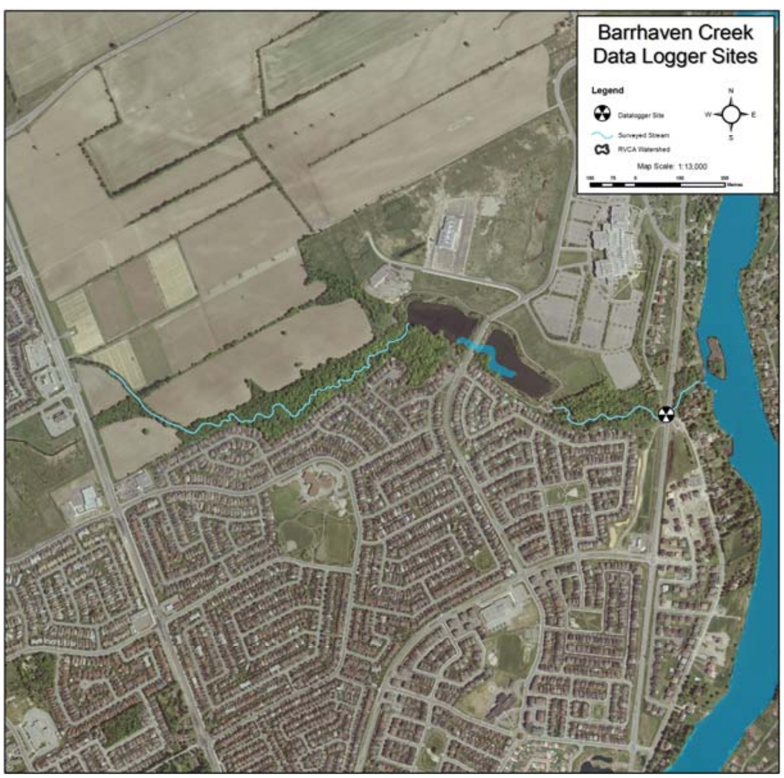

Figure 12. Datalogger Location Along Barrhaven Creek

Figure 13 shows the datalogger results.

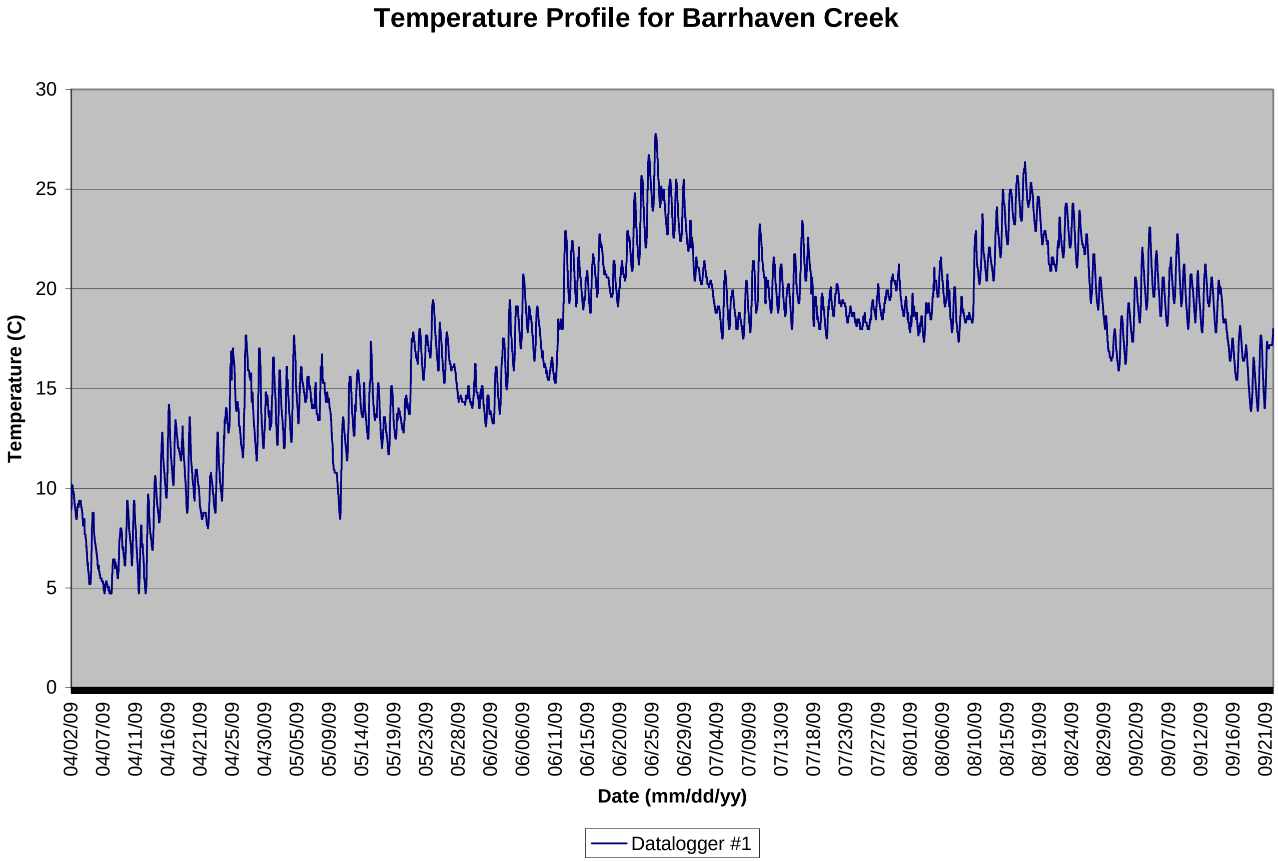

Figure 13. Temperature Profile for Datalogger 1 at Prince of Wales Drive

Figure 13 has a consistent trend of fluctuating temperatures throughout the stream. Over the testing period this stream reached a maximum temperature of 27.78°C and a minimum of 4.72°C. The stream rose over 25°C between June 23 and 29, during a hot week where air temperatures exceeded 30°C. In August, the temperature rose above 25°C for two days. For the remainder of the season, temperatures ranged between the cold and cool water range.

Based on the fish community structure and temperature data collected, Barrhaven Creek can be classified as a cool water system, but it appears as those it is on the cusp of a warm water system. Air temperatures in the summer of 2009 were quite cool, and given a hotter summer, the stream would potentially rise above 25°C more frequently and remain there for longer periods. The fish community results show a presence of mainly cool water species (11), three cool/warm water species and five warm water species.

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 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 Barrhaven Creek. Only one invasive species was found, which was rusty crayfish (*Orconectes rusticus*).

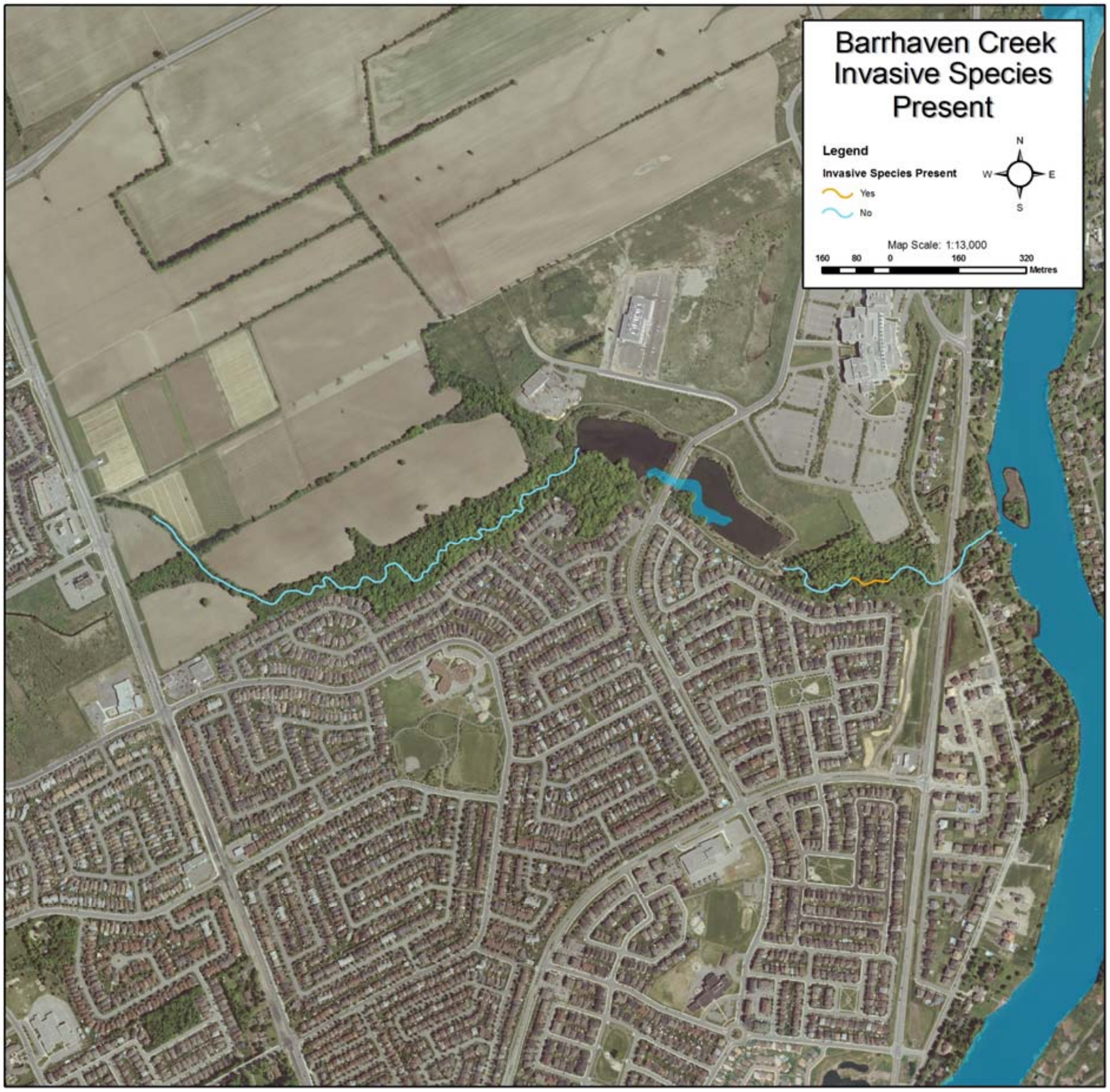

Figure 14. Air Photo Showing Location of Invasive Species Along Barrhaven Creek

3.2.1.1 Bilberry Creek

The headwaters of Bilberry Creek begin just north of Innes Road. From there, the creek runs though a forested ravine between housing subdivisions, crossing under St. Joseph, Highway 174 and Jeanne D'Arc prior to feeding into the Ottawa River. While the headwaters of Bilberry Creek run through a forested valley, the land use around the creek is intensive, putting a lot of pressure on the creek with stormwater runoff, especially during rain events. The main geology of the subwatershed is silt and clay deposits with outcrops of bedrock closer to the Ottawa River. Between 1945 and 2005, the forest cover around the creek has matured to include sugar maple, beech, hemlock, yellow birch, white pine, Norway spruce and balsam fir (Geomorphic Solutions, 2008).

In 1945, the main branch only had two major road crossings over the creek, and the land use was largely agricultural. Since then, most of the subwatershed has been developed and reaches have been greatly altered with piping, storm water drains, channelization and shoreline hardening (armourstone, rip rap, gabion baskets). An estimated 5.6 km of headwater channels have been lost (a 26% loss of stream length from 1945), and this does not include the diversion of West Bilberry Creek which would increase that loss (Geomorphic Solutions, 2008). This subwatershed development has resulted in channel widening and active erosion, and the stream is still in transition from those changes. During storm events, water is rapidly carried from the tributaries of Bilberry to the main branch, and water levels rise dramatically shortly after any precipitation. With such a rapid delivery of stormwater, contaminants from roadways and sewers are flushed directly into the creek and carried out into the Ottawa River.

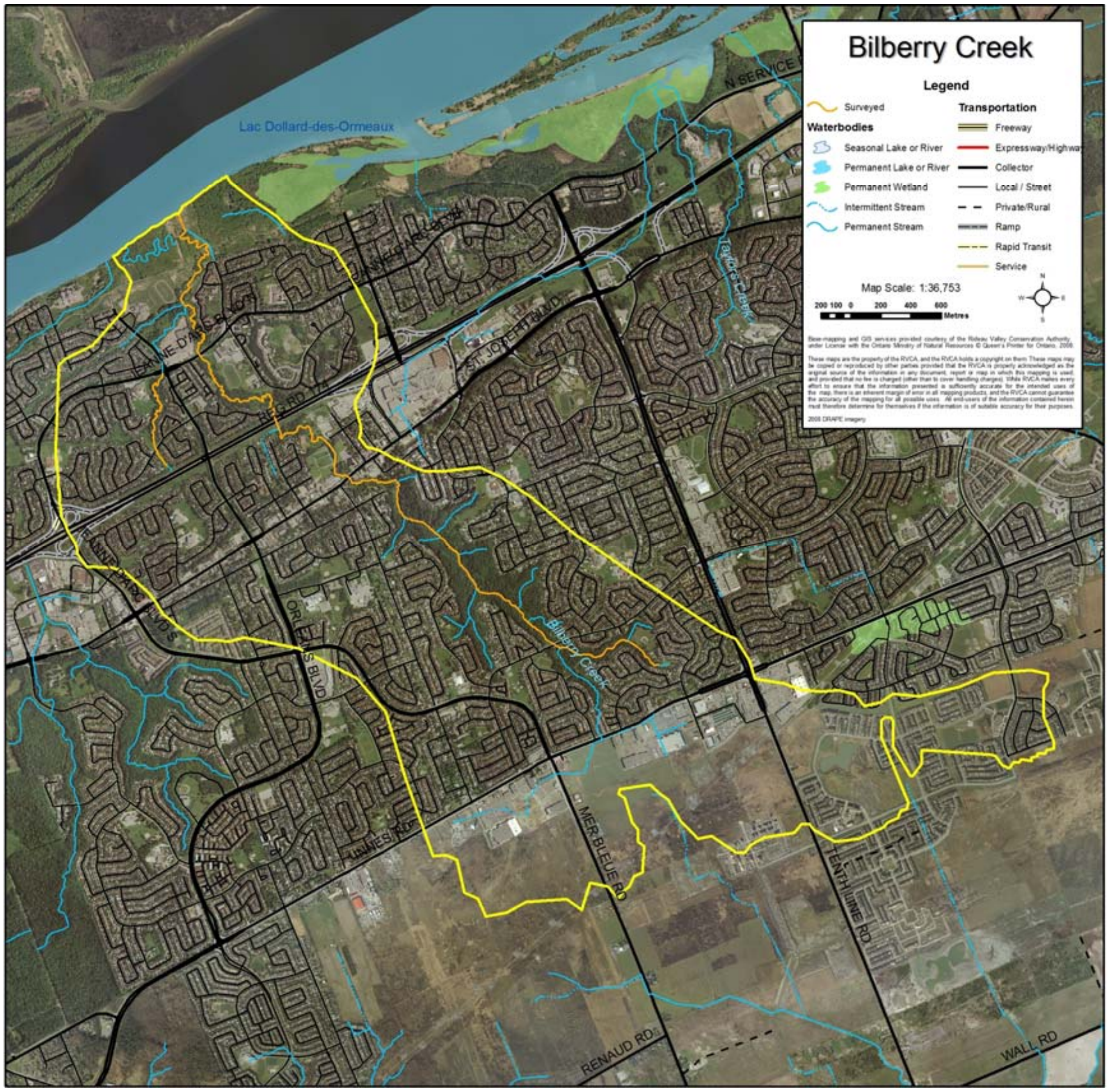

Figure 15. Air photo of Bilberry Creek (main branch and West branch) and surrounding area

Bilberry Creek was surveyed in its entirety, for a total of six and a half kilometres. Ten more surveys (one kilometre) were completed on the West branch of Bilberry Creek. The following is a summary of the 75 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. Where observations varied between the main branch and the West branch, either a separate chart is shown or the information is explained in the text.

Figure 16 illustrates the classes of anthropogenic alterations volunteers observed along the main branch of Bilberry Creek. Of the 65 sections of stream sampled, volunteers identified that 38 percent had no human alterations. These areas coincided with places that had larger buffers, from Des Epinettes to upstream of St. Joseph, as well as the mouth. Twenty-three percent of the sampled sections had some sort of alteration but were still considered natural and 30 percent of the sections were altered with considerable human impact. Nine 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 (especially the larger ones, such as St. Joseph and the 174), storm water outlets, shoreline modification and armouring. In the 65 sections surveyed, most of the road crossings occurred on the downstream half of the creek, closer to the mouth. West Bilberry Creek differed in that it had no sections without anthropogenic alterations and no sections that were highly altered. Eighty percent of the sections surveyed were altered (mainly loss of buffer) and 20 percent were considered natural.

1. Observations of Anthropogenic Alterations and Land Use

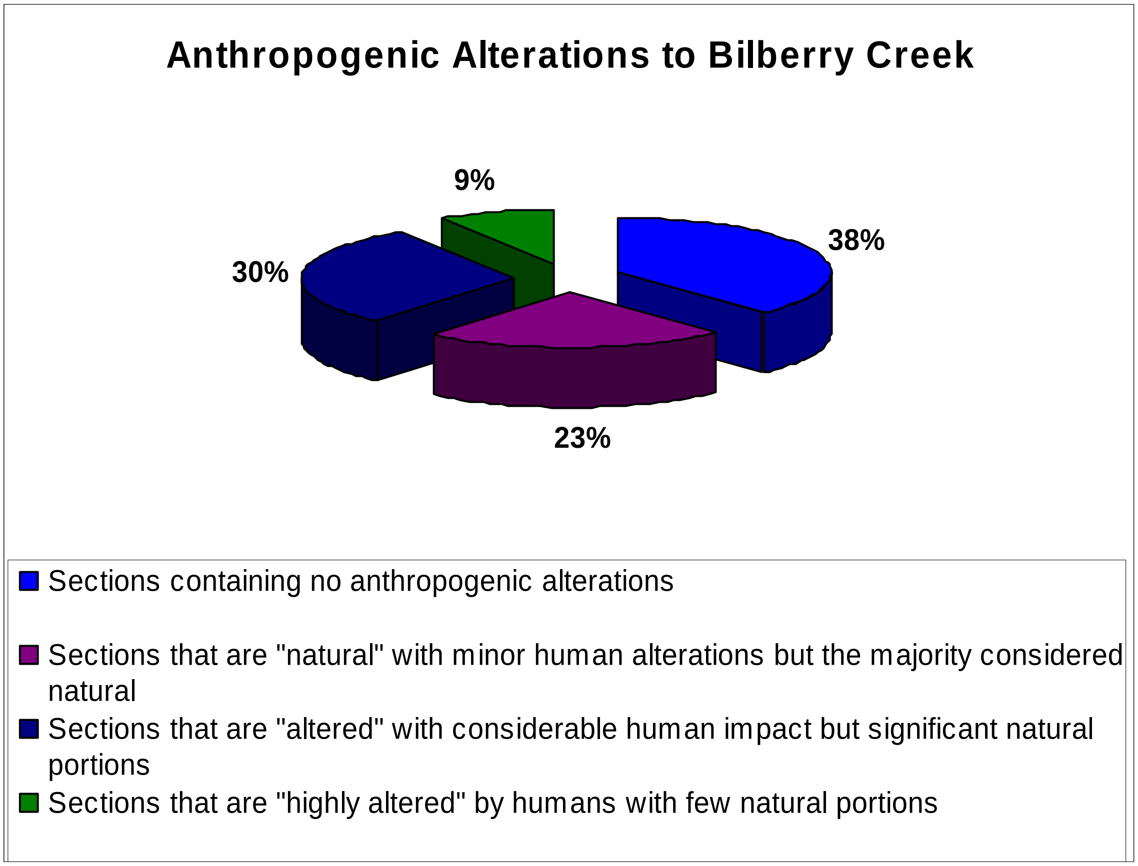

Figure 16. Classes of Anthropogenic Alterations Occurring Along Bilberry Creek

Figure 17 demonstrates the different land uses recognized adjacent to Bilberry Creek. Volunteers identified seven major land uses along the creek. As mentioned previously, there were areas of Bilberry that had large buffers, protecting the stream from the adjacent development occurring along the creek. Of the natural land use adjacent to the creek, 37 percent of the land use was forest, 14 percent meadow and 14 percent scrubland. Residential areas made up 17 percent of the land use, and recreational accounted for nine percent. The remaining land use was six percent infrastructure (roads, culverts, hydro lines, etc.) and three percent industrial/commercial, occurring mainly between Jeanne d'Arc and St. Joseph. The same land uses were found along the West branch of Bilberry Creek; however, there were less natural areas (forest, meadow, scrubland) and more residential, recreational and industrial/commercial. There was a large amount of mowed grass adjacent to the West branch, mostly on the right bank.

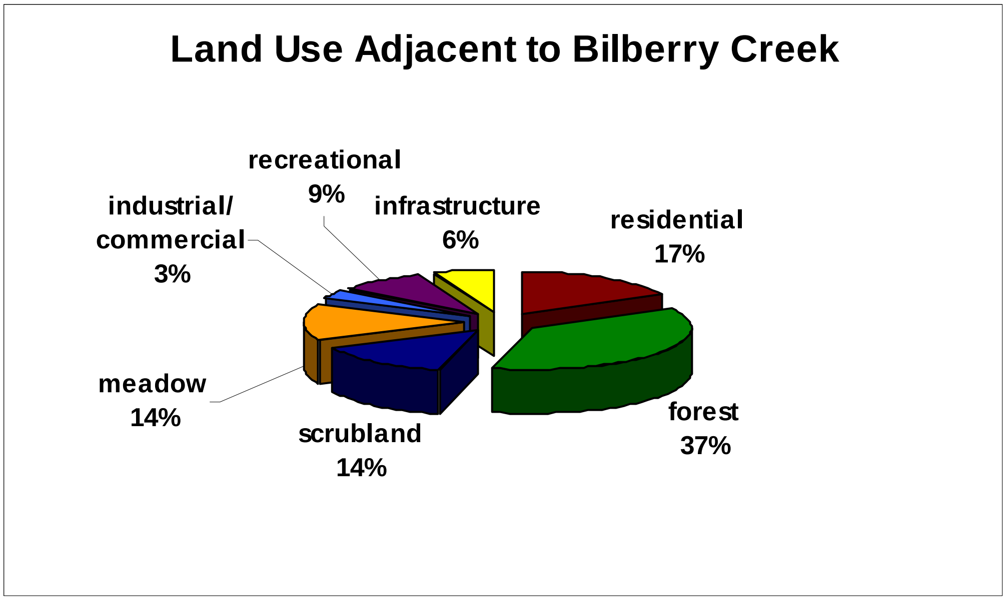

Figure 17. Land Use Identified Along Bilberry Creek

2. Instream Morphology of Bilberry Creek

Instream morphology of Bilberry Creek is fairly homogeneous and mainly consists of large runs (66 percent) with large pools and only ten percent riffles. This is illustrated in Figure 18. The most substantial riffle occurs near the mouth where the stream crosses under a walking path. A diverse variety of fish were sampled there. The other significant riffle is located upstream of St. Joseph. Overall along Bilberry Creek, banks are steep, sloping into the creek like the shape of a bowl. The morphology of the West branch was more homogeneous. Ninety percent of the sections were runs, and only three percent of the sections had pools and riffles.

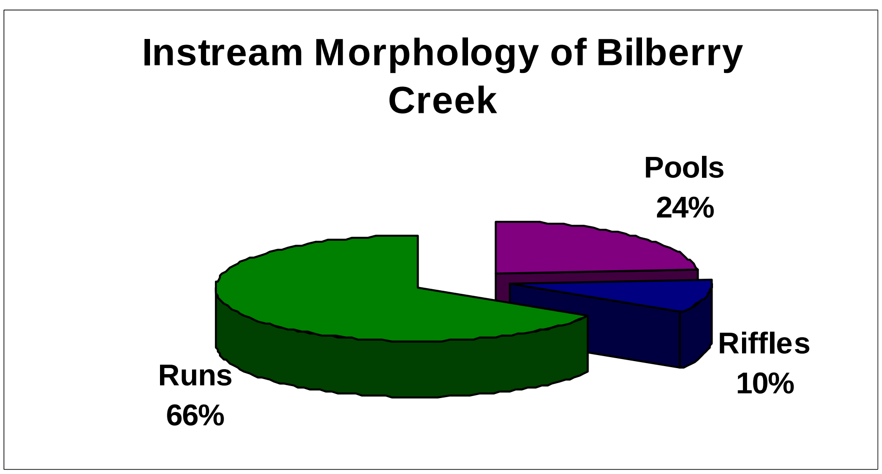

Figure 18. Instream Morphology of Bilberry Creek

3. Types of Instream Substrate Along Bilberry Creek

The substrate of Bilberry Creek is mainly clay with a diverse variety of other substrates. Diverse substrate is important for fish and benthic macroinvertebrate 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 macroinvertebrates. Figure 19 demonstrates the instream substrate that was observed along Bilberry Creek. Many areas, especially near the mouth of the creek, were homogeneous, with little cobble, boulder or gravel. Forty percent of the creek consisted of clay. The “other” category accounts for two percent of the substrate type. In this situation, “other” was used for sections running through metal culverts that had no accumulated substrate. The West branch is much shallower than the main branch and collects a large amount of woody material and leaf litter. In turn, the types of substrate found along the West branch were the same as the main branch, except that sixty percent of the sections were made up of muck (23), detritus (25) and clay (20). The remaining 40 percent was made up of boulder, cobble, gravel, silt and sand.

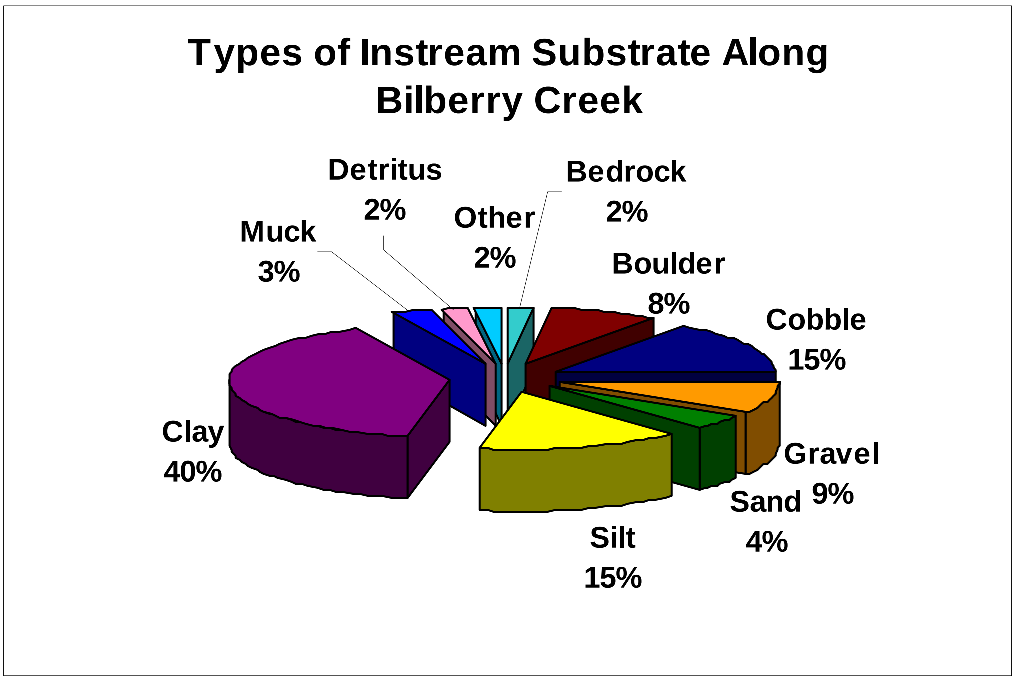

Figure 19. Types of Instream Substrate Along Bilberry Creek

4. Observations of Instream Vegetation

The instream vegetation observed in Bilberry Creek varied by location throughout the stream, although vegetation was mainly low to none. In seven percent of the sections surveyed, vegetation levels were common, nine percent were normal and 17 percent were low. In 67 percent of the sections surveyed, vegetation was either rare or none. The geology of Bilberry Creek is mainly clay and silt, making it very difficult to see instream vegetation. In the majority of areas, vegetation was felt by feeling or picking it up while walking along the creek. Very few types of aquatic vegetation were found along Bilberry Creek; the majority of the vegetation was non-filamentous algae, including areas where vegetation was considered to be normal or common. Bilberry Creek does not appear to have a healthy variety of instream vegetation which can limit fish habitat. In the West branch, a few emergents were observed, but in 88 percent of the sections, no vegetation was observed. The remaining 12 percent was rare and common, mainly consisting of non-filamentous algae. Due to its geology, Bilberry Creek is not clear, which makes it difficult for light to penetrate the water and encourage aquatic plant growth. Many sections of Bilberry Creek have steep, bowl-shaped, clay slopes which would also make it difficult for instream vegetation to take root.

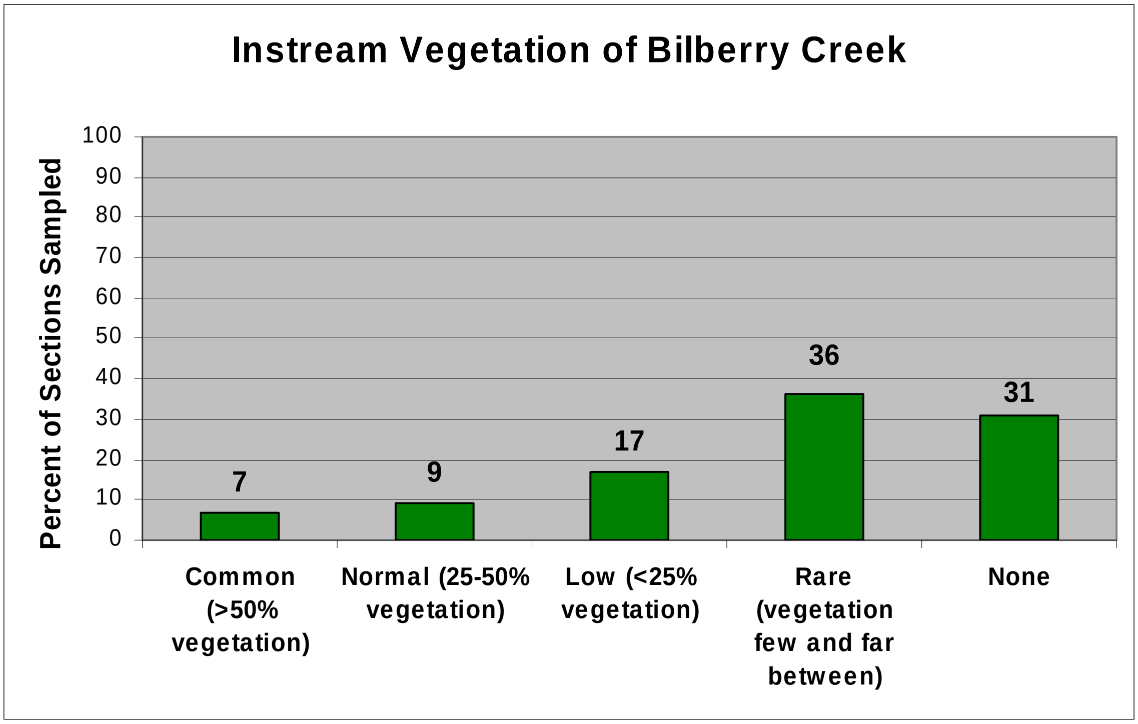

Figure 20. Frequency of Instream Vegetation in Bilberry Creek

5. Observations of Bank Stability

Figures 21 and 22 show the overall bank stability of Bilberry Creek. Stream sections close to the mouth are experiencing erosion, along with areas throughout the creek. Erosive forces have been excavating material from the banks, making them steep and bowl-shaped. The left bank of Bilberry Creek is slightly less stable than the right bank, with 55 percent of the sections considered stable and 45 percent considered unstable. For the right bank, 57 percent is considered stable and 43 percent unstable. Due to past development, very few controls for stormwater runoff have been implemented for the creek, and this is the main cause of the erosion issues. The lack of stormwater runoff management also affects the water quality of the stream after rain events. In the headwaters, during surveys in a rain event (where water levels do not typically fluctuate as greatly as areas farther downstream), the water levels rose dramatically over a period of a few hours, along with velocity levels. The West branch of Bilberry Creek is much more stable, mainly due to its smaller size and lower bank slopes. Ninety percent (900 metres) of the West branch is considered stable.

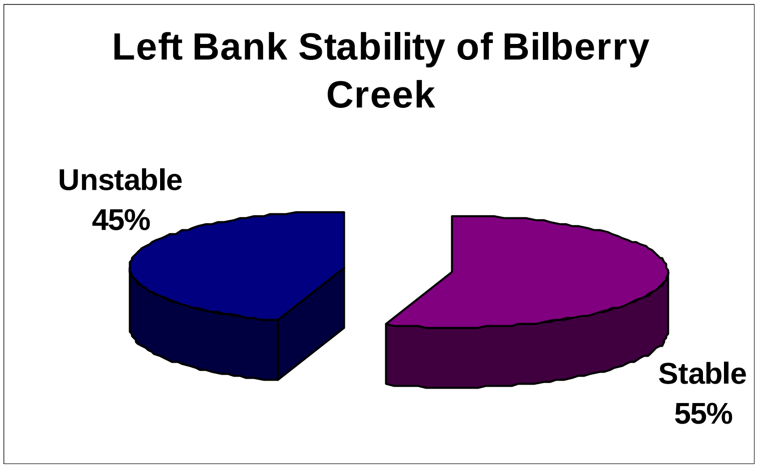

Figure 21. Left Bank Stability of Bilberry Creek

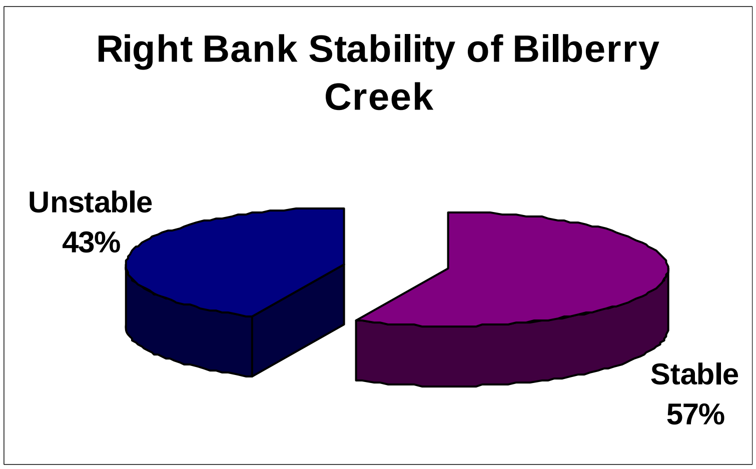

Figure 22. Right Bank Stability of Bilberry Creek

Areas of erosion have been identified on an aerial photo of Bilberry Creek and are detailed in Appendix E. Some of the more severe areas of erosion are listed in Appendix F on aerial photos as potential rehabilitation projects, either using bioengineering or riparian plantings.

6. Buffer Evaluation of Bilberry 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*, a stream should have riparian areas of 30 metres minimum or more, depending on the site conditions. Of the sections sampled, eight to nine percent had a buffer of only zero to five metres, seven to nine percent had a buffer of five to 15 metres and 22-24 percent had 15-30 metres of buffer. For the left bank, 61 percent had a buffer greater than 30 metres, and the right had 60 percent.

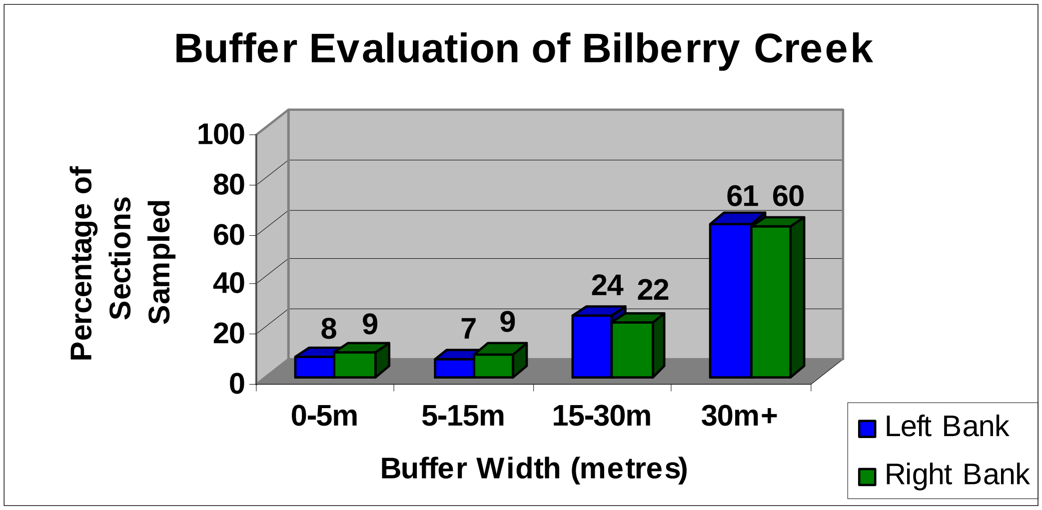

Figure 23. Buffer Evaluation of Bilberry Creek

Along the West branch of Bilberry Creek, buffer width varied greatly. There were large differences between the right and left banks. Five percent of the left bank and 24 percent of the right bank had a buffer of zero to five metres. Twenty-three to 31 percent of the sections had a buffer of five to 15 metres and nine (left bank) to 30 (right bank) percent had 15-30 metres of buffer. Sixty-three percent of the left bank had a buffer over 30 metres, whereas the right bank only had 15 percent.

7. Observations of Wildlife

Volunteers recorded the presence of many types of wildlife in and around Bilberry Creek. Table 7 is a summary of wildlife observed during stream surveys.

Wildlife	Observed While Sampling
Birds	cardinal, crows, robin, hummingbird, chickadees, woodpecker, ring-billed gulls, red-winged blackbird, goldfinches, grackle, sparrows, phoebe, nuthatch, bluejay, hawk, barred owl
Mammals	river otter, red squirrel, raccoon, deer, rabbit, beaver, chipmunk, muskrat, black squirrel, groundhog
Reptiles/Amphibians	dead garter snake, northern leopard frog, green frog, gray treefrog, tadpoles
Aquatic Insects	snails, leeches, molluscs, water strider, water spider, amphipods, aquatic earthworm
Fish (as observed by walking the creek)	white sucker, stickleback, *Cyprinid spp.*
Other	dragonflies, damselflies, butterfly, moth, mosquitoes, spiders, ants, cicadas, bumblebees

Table 7. Wildlife Observed Along Bilberry Creek

8. Observations of Pollution/Garbage

Unfortunately, Bilberry Creek had an extensive amount of garbage along its course. Only three percent of the stream was free of garbage. The majority of the garbage found was floating. There was also a large amount of garbage on the stream bottom, or embedded in the stream bottom, such as shopping carts and appliances such as a stove and fridge. In some of the areas where garbage was observed, access would be quite difficult for a stream cleanup. Garbage found included tires, plastic bottles, plastic wrappers, shoes, bicycles, lumber, a flowerpot, scrap metal, chairs, couches, cement objects, tin, a fence, plastic, an old metal drum, aerosol cans, construction refuse, a tarp, carpet, styrofoam and a shed. Figure 24 illustrates the incidence of pollution in Bilberry Creek. The West branch also displayed the same amount of garbage. Only one section was free of garbage. The other nine sections had garbage on the stream bottom and floating, many of the same objects described above, aside from the fridge, stove and shed.

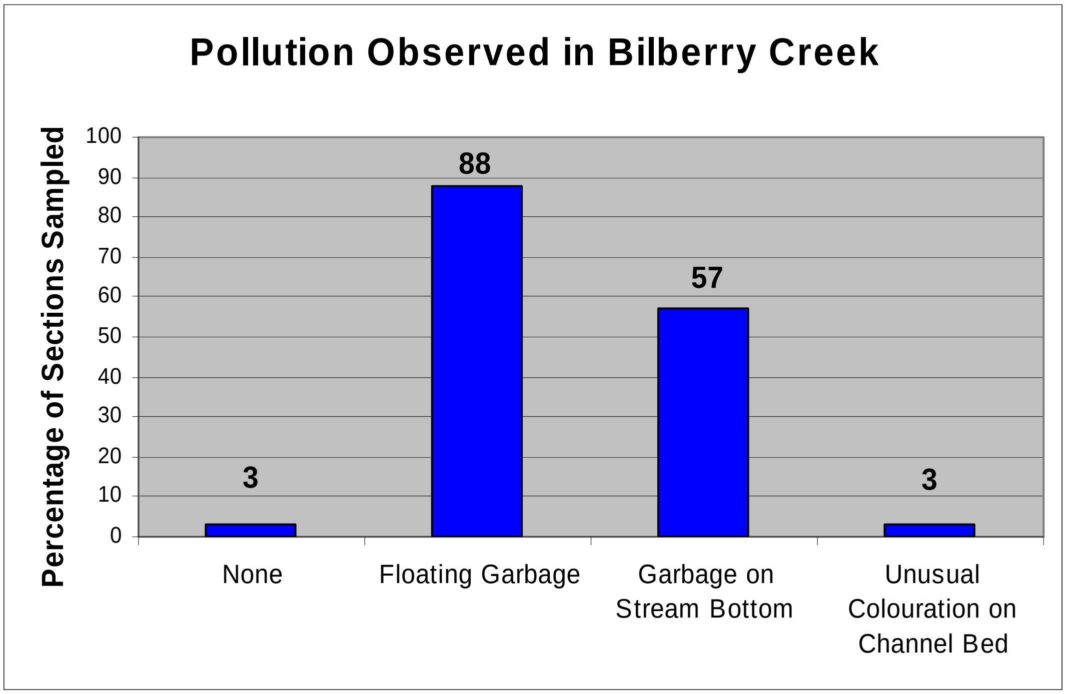

Figure 24. Frequency of Pollution/Garbage Occurring in Bilberry Creek

Sections have been listed in Appendix F as potential projects for a stream cleanup. One large cleanup should be done from St. Joseph to the mouth of the creek and a cleanup should be done along the West branch, as well. Another area that could be cleaned up is between the start of the creek and Des Epinettes. There is a walking trail along the creek in that section, making it more accessible for a stream cleanup. There are some community members that already work at picking up garbage surrounding Bilberry Creek, and Cairine Wilson Secondary School runs a cleanup along the creek every year.

9. Fish Community Sampling

Fish sampling was carried out at six sites along Bilberry Creek, and when possible, sampled multiple times between April and July. Capture methods included seine netting, electrofishing, fyke net and windemere traps. Two fish sampling demonstrations were held on Bilberry Creek. Volunteers contributed 49 hours to assist with these, along with other sampling days. Volunteers were introduced to fish sampling methods and instructed on how to identify and process the fish captured. Table 8 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. Figure 25 shows the sampling locations for Bilberry Creek. A total of 18 different fish species were collected. Top predators within the stream ecosystem are highlighted in bold. Burbot were caught on Bilberry Creek. Burbot are a coldwater fish and not found in many city streams.

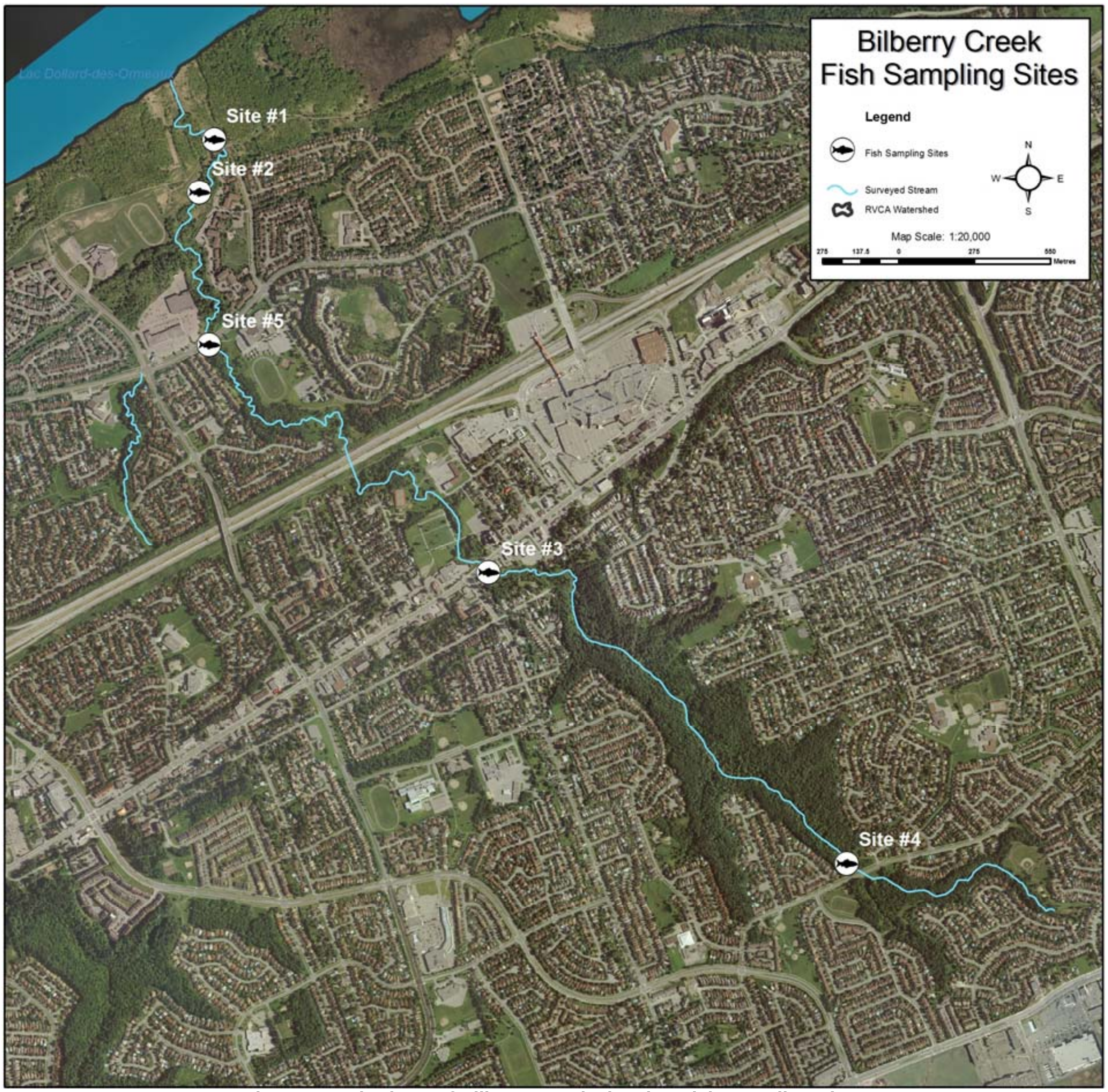

Figure 25. Air photo of Bilberry Creek showing Fish Sampling Sites

Site #	Sampling Technique	Date (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	7/15/2009	17.48	14.25	10.41	7.91	1609	clay with some cobble & woody debris	none observed	white sucker, pumpkinseed, brown bullhead, **black crappie**	4
2	electrofishing	5/26/2009	no YSI	no YSI	no YSI	no YSI	no YSI	cobble & clay	non-filamentous algae	longnose dace, white sucker, bluntnose minnow, **yellow perch**	4
2	electrofishing	6/23/2009	18.86	18.54	7.58	8.29	2119	same as above	non-filamentous algae	longnose dace, white sucker, spotfin shiner, emerald shiner, rock bass, **burbot**, *Cyprinid spp.*	7
2	seining	7/15/2009	15.90	14.25	10.59	7.93	1640	same as above	non-filamentous algae	white sucker, fallfish	2
2	electrofishing	7/29/2009	18.61	17.06	10.59	8.01	1382	same as above	non-filamentous algae	longnose dace, brook stickleback, rock bass, white sucker, spottail shiner, **smallmouth bass**, **burbot**	7
3	windemere trap	4/9/2009	6.00	4.77	11.09	7.94	980	clay with cobble & boulder	none observed	white sucker, central mudminnow, creek chub	3
3	electrofishing	5/21/2009	17.20	15.60	19.81	8.71	1211	same as above	none observed	creek chub, fathead minnow, brook stickleback, longnose dace, white sucker	5
3	windemere trap	6/30/2009	19.01	19.00	8.97	8.07	1130	same as above	non-filamentous algae	creek chub, brook stickleback, central mudminnow, white sucker, fathead minnow	5
3	electrofishing	7/29/2009	19.24	19.07	10.65	7.89	857	same as above	non-filamentous algae	creek chub, brook stickleback, white sucker, longnose dace, fathead minnow	5
4	seining	4/9/2009	8.50	5.05	11.49	8.00	1112	clay with detritus, a bit of cobble & boulder	grasses	brook stickleback, *Cyprinid spp.*	2
4	electrofishing	5/21/2009	17.60	15.30	13.77	8.42	1505	same as above	grasses	brook stickleback, fathead minnow, *Cyprinid spp.*	3
4	seining	6/23/2009	23.41	17.95	10.72	8.33	1780	same as above	grasses, non-filamentous algae, purple loosestrife	brook stickleback, fathead minnow, creek chub, central mudminnow, *Cyprinid spp.*	5
4	seining	7/31/2009	19.20	18.49	10.36	7.93	937	same as above	grasses, non-filamentous algae, purple loosestrife	brook stickleback, fathead minnow	2

5	windemere trap	4/9/2009	5.50	4.86	11.29	8.05	1376	clay with muck & gravel	none observed	brook stickleback, spotfin shiner	2

Table 8. Water Chemistry and Fish Community Results for Bilberry Creek

Fish Species Status, Trophic, and Reproductive Guilds – Bilberry Creek

Table 9 was generated by taking the fish community structure of Bilberry 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 Bilberry Creek are significant to the recreational or baitfish fisheries. The fish community structure consists of a mix of warm and cool water species, aside from burbot which is coldwater.

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	(nests pawners) Phytophils	cool	insectivore/ piscivore
208	bluntnose minnow	*Pimephales notatus*			X	none	(guarder) Speleophils	warm	omnivore
281	brook stickleback	*Culaea inconstans*			X	none	(guarders) Ariadnophils	Cool	insectivore
233	brown bullhead	*Ameiurus nebulosus*	X	limited		none	Speleophils	warm	insectivore
271	burbot	*Lota lota*	X			none	Litho-pelagophils	coldwater	piscivore
141	central mudminnow	*Umbra limi*			X	none	(non guarder) Phytophils	cool/warm	insectivore/omnivore
212	creek chub	*Semotilus atromaculatus*	X		X	none	(brood hiders) Lithophils	cool	insectivore/generalist
196	emerald shiner	*Notropis atherinoides*			X	none	(open substrate) Pelagophils	cool	insectivore
213	fallfish	*Semotilus corporalis*	X		X	none	Lithophils	cool	insectivore
209	fathead minnow	*Pimephales promelus*			X	none	(guarder) Speleophils	warm	omnivore
211	longnose dace	*Rhinichthys cataractae*			X	none	(non guarder) Lithophils	cool	insectivore
313	pumpkinseed	*Lepoms gibbosus*	X			none	(nest spawners) Polyphils	cool/warm	insectivore
311	rock bass	*Ambloplites rupestris*	X			none	(nest spawners) Lithophils	warm	insectivore
316	smallmouth bass	*Micropterus dolomieui*	X			none	(nest spawners) Lithophils	cool	insectivore/piscivore
203	spotfin shiner	*Cyprinella spiloptera*			X	none	Speleophils	warmwater	insectivore

210	spottail shiner	*Notropis hudsonius*			X	none	(non guarders) Litho-pelagophils	cool	insectivore
163	white sucker	*Catostomus commersoni*				none	(non guarder) Lithophils	cool	insectivore/omnivore
331	yellow perch	*Perca flavescens*	X			none	(non guarder) Phyto-lithophils	cool	insectivore/piscivore

Table 9. Fish Species Status, Trophic and Reproductive Guilds for Bilberry Creek (Source: *MTO Environmental Guide to Fish and Fish Habitat*, 2006)

Table 10 summarizes the fish community structure observed in Bilberry Creek and their sensitivity to sediment and turbidity for reproduction, feeding, and respiration. The composition of the fish community in Bilberry Creek ranges from species that are fairly 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.

Fish Species Sensitivity to Sediment/Turbidity for Bilberry Creek

MNR Code	Common Name	Scientific Name	Reproduction	Feeding	Respiration
319	black crappie	*Pomoxis nigromaculatus*	L	H	unknown
208	bluntnose minnow	*Pimephales notatus*	L	M	unknown
281	brook stickleback	*Culaea inconstans*	L	M	unknown
233	brown bullhead	*Ameiurus nebulosus*	L	L	L
271	burbot	*Lota lota*	M	H	N/A
141	central mudminnow	*Umbra limi*	M	M	L
212	creek chub	*Semotilus atromaculatus*	M	M	H
196	emerald shiner	*Notropis atherinoides*	M	L	H
213	fallfish	*Semotilus corporalis*	M	H	H
209	fathead minnow	*Pimephales promelus*	L	L	unknown
211	longnose dace	*Rhinichthys cataractae*	M	M	H
313	pumpkinseed	*Lepoms 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
210	spottail shiner	*Notropis hudsonius*	M	M	H
163	white sucker	*Catostomus commersoni*	M	L	H
331	yellow perch	*Perca flavescens*	M	H	unknown

Table 10. Fish Species Sensitivity to Sediment/Turbidity (High, Moderate, Low or unknown) for Bilberry Creek (Source: *MTO Environmental Guide to Fish and Fish Habitat*, 2006)

10. Temperature Profiling

Four temperature dataloggers were set in Bilberry Creek, but only three could be recovered in September. The dataloggers were deployed on April 2 and retrieved on September 22. Figure 26 shows the locations of dataloggers in Bilberry Creek.

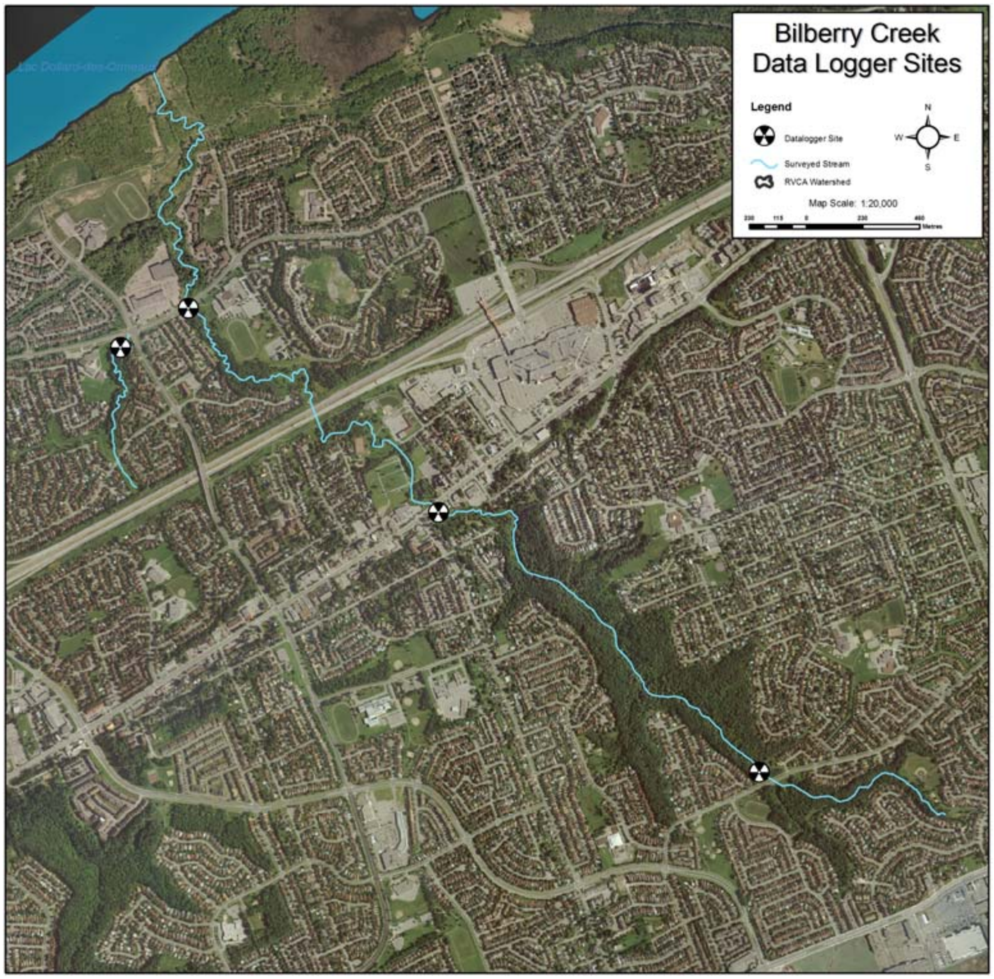

Figure 26. Datalogger Locations Along Bilberry Creek

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. Datalogger 1 was set on the West branch, just upstream of Jeanne d'Arc. Datalogger 2 was set on the main branch at Jeanne d'Arc. This was the datalogger that could not be recovered. Datalogger 3 was placed upstream of St. Joseph and Datalogger 4 downstream of Des Epinettes. Figure 27 shows results from Dataloggers 1, 3 and 4.

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

Table 19. Water Temperature Classifications (Minns et al. 2001)

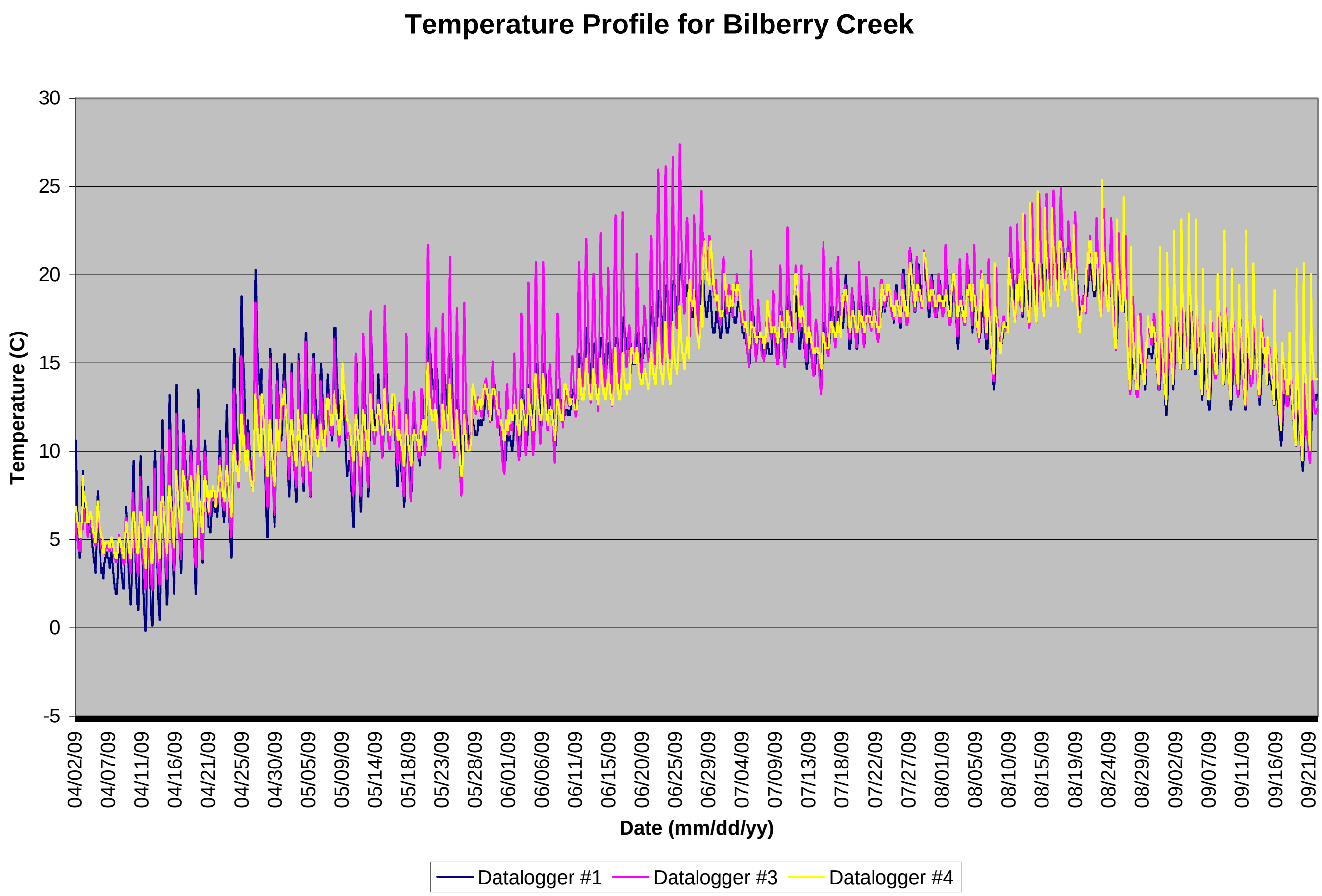

Figure 27. Temperature Profiles for Dataloggers 1, 3 and 4 on Bilberry

Dataloggers 1, 3 and 4 have fairly consistent trends of fluctuating temperatures throughout the stream, although datalogger 3 appears to have had greater fluctuations than the others. In comparison, datalogger 1 was placed in the West branch of Bilberry and its temperatures fluctuated within the cold and cool water range. The stream channel in the West branch is fairly small and shallow, but during field checks, it was always found submerged. The minimum temperature for datalogger 1 was -0.17°C and its maximum temperature was 22.46°C. Datalogger 3 had a minimum temperature of 2.15°C and a maximum temperature of 27.39°C. The maximum temperature occurred on June 25, during a hot week of weather with air temperatures above 30°C. Datalogger 4 temperatures remain low for most of the season and consistently lower than datalogger 3. Mid-August, the temperatures recorded for datalogger 4 rose above the others' and fluctuated by a large amount, indicating the logger was out of water. The logger was located in the headwaters, and water levels may have dropped in that area near the end of the season. The minimum temperature recorded was 3.37°C on April 12 and the maximum 25.39°C which occurred only between 10:47 and 11:11am on August 23.

Dataloggers 1 and 3 can be classified as cool water, and datalogger 3 as warm water (potentially out of water for the higher fluctuations). The fish community structure is made up of ten cool water species, two cool/warm species, five warm water species and one coldwater species. Based on the temperatures and the fish species, Bilberry Creek can be classified as a cool water system with potential cold water reaches (the coldwater species was only found near the mouth).

11. Invasive Species

The most common invasive species along Bilberry Creek is Purple Loosestrife (*Lythrum salicaria*); however, in most sections it does not appear to be outcompeting any native vegetation and is serving as a nectar source for pollinator species in areas where there are not many other sources. The other invasive species found along Bilberry Creek are Wild Parsnip (*Pastinaca sativa*), European Buckthorn (*Rhamnus catharticus*) and Garlic Mustard (*Alliaria petiolata*). Figure 28 shows the locations of invasive species found along Bilberry Creek. Sections where invasive species were observed are highlighted in orange.

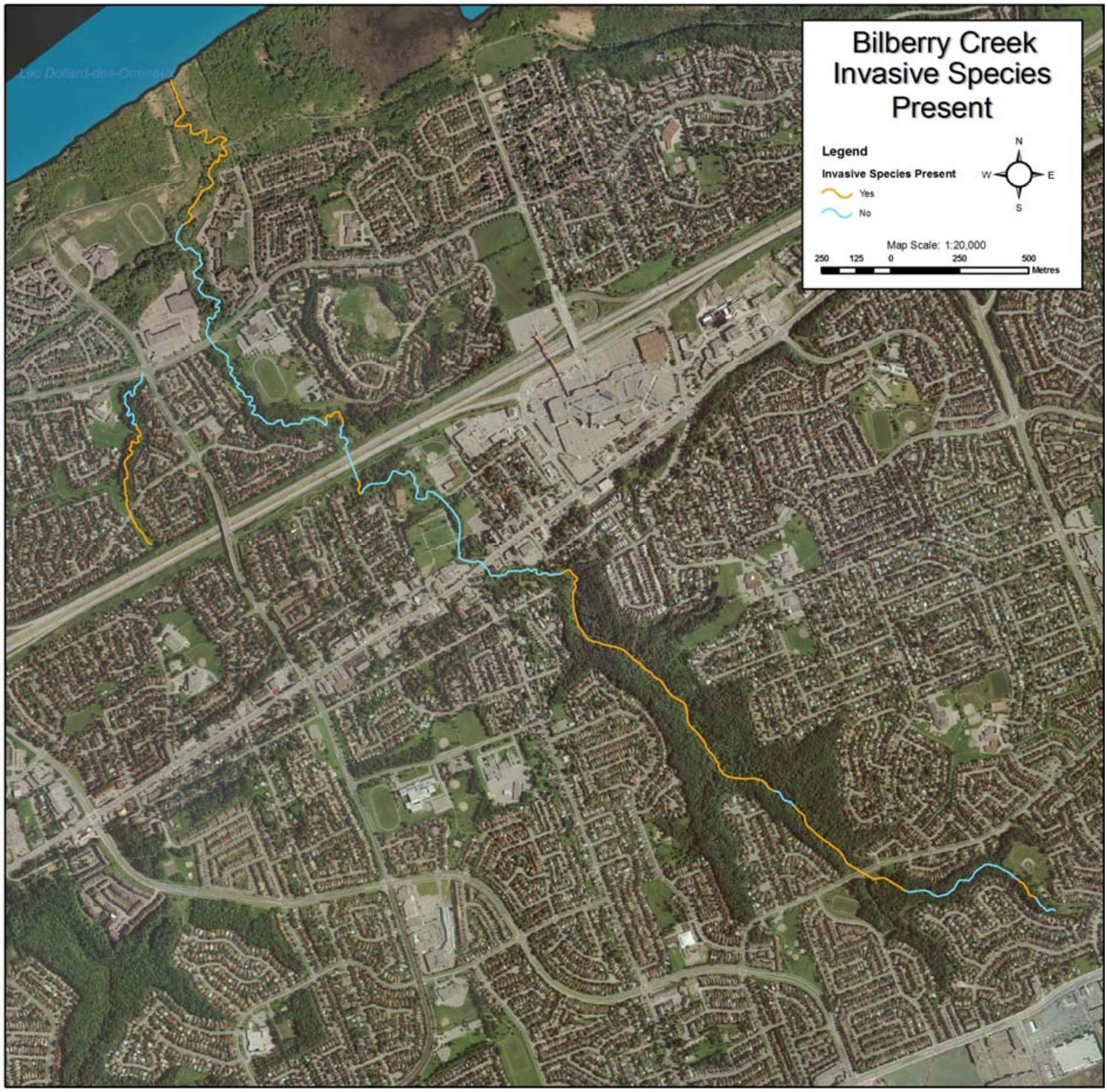

Figure 28. Locations of Invasive Species Observed Along Bilberry Creek

12. 2004/2009 Comparison of Bilberry Creek

Four and a half kilometres of Bilberry Creek were sampled in 2004 (45 sections) and to its entirety in 2009 (65 sections), along with the West branch (10 sections). Therefore, only the first 45 sections of the main branch have been compared between 2004 and 2009. The field sheets were modified in 2008 to include more variables in the assessment. Several of the questions have been modified and improved to provide more detail; therefore, direct comparisons difficult. The following tables are a comparison between 2004 and 2009.

Anthropogenic Alterations	2004 (%)	2009 (%)
none	58	40
"natural" conditions with significant alterations by man	29	18
"altered" with considerable human impact but with significant natural areas	13	31
"highly altered" with few areas that could be considered natural	0	11

Table 11. Comparison of Anthropogenic Alterations

Between 2004 and 2009, anthropogenic alterations have increased in all categories along Bilberry Creek. This could be due to loss of buffer and further shoreline modification, such as rip rap or armourstone.

Instream Vegetation	2004 (%)	2009 (%)
extensive	0	0
common	11	8
normal	11	13
low	18	21
rare	60	40
none	N/A	16

Table 12. Comparison of Instream Vegetation

Instream vegetation is difficult to compare, and the data can depend on when the stream was surveyed and what the weather patterns were that year. The category for "none" was also added after 2004 and cannot be reflected in the 2004 data. Instream vegetation appears to be similar, with the majority of the vegetation listed in the rare to normal category. In both 2004 and 2009, the most abundant type of instream vegetation was algae.

Bank Stability	2004 (%)	2009 (%)
stable	44	55LB, 57RB
unstable	56	45LB, 43RB

Table 13. Comparison of Bank Stability

Bank stability was fine tuned in 2008 to separate left and right banks. It appears that bank stability has slightly improved since 2004. When comparing photos, there is a noticeable difference in channel width. In 2004, the stream was narrower and banks appeared more unstable. As erosion has continued over the last five years, some of the unstable material has been excavated from the sides of the banks, resulting in channel widening.

Pollution/Garbage	2004 (%)	2009 (%)
none	2	2
oil or gas trails	0	0
floating garbage	69	91
garbage on stream bottom	93	58
unusual colouration	N/A	4

Table 14. Comparison of Pollution/Garbage

Sections without pollution/garbage have remained the same. No oil and gas trails were observed in either year. Incidents of floating garbage have increased, but garbage on the streambed has decreased by a fair amount.

Unusual colouration of the streambed was added after 2004 and was found in four percent of the sections surveyed in 2009.

Species Caught	2004	2009
black crappie	X	X
bluntnose minnow	X	X
brook stickleback	X	X
brown bullhead		X
burbot		X
central mudminnow		X
creek chub	X	X
emerald shiner	X	X
Etheostoma spp.	X	
fallfish		X
fathead minnow		X
golden shiner	X	
logperch	X	
longnose dace	X	X
mimic shiner	X	
pumpkinseed		X
rock bass	X	X
smallmouth bass		X
spotfin shiner	X	X
spottail shiner	X	X
white sucker	X	X
yellow perch	X	X
TOTAL SPECIES CAUGHT	**15**	**18**

Table 15. Comparison of Fish Species

Brown bullhead caught at mouth of Bilberry Creek, July 15, 2009

Volunteers measuring and weighing fish

Fish sampling was done on Bilberry Creek in 2004 and in 2009. In 2004, 15 species were captured, and in 2009, that number grew to 18. Most sites in 2009 were sampled four times, one time per month for April, May, June and July. This may increase the chances of capturing more species. Fish sampling methods have been expanded on as well. Five sites were seined on Bilberry Creek in 2004. Five sites were also sampled in 2009; however, methods of capture included seine netting, electrofishing, windemere traps and a fyke net. Four species caught in 2004 were not found in 2009, which were *Etheostoma spp*. (Johnny or tessellated darter), golden shiner, logperch and mimic shiner. This does not mean the species have disappeared but could be influenced by location, weather or time of sampling. Seven species were caught in 2009 which had not been in 2004, including brown bullhead, burbot, central mudminnow, fallfish, fathead minnow, pumpkinseed and smallmouth bass.

3.2.1.2 Mosquito Creek

The headwaters of Mosquito Creek begin at Rideau Road, at the confluence of the Spratt and Nolan municipal drains. Dancy and Downey municipal drains flow into Spratt and Nolan upstream of that confluence. Mosquito Creek then winds its way through agricultural fields north of Earl Armstrong Road, where land use changes from agricultural to residential. Halfway between Spratt Road and Leitrim Road, Mosquito Creek becomes deeper and requires a canoe or kayak to survey. Mosquito Creek winds around River Road, and becomes quite wide where it flows into the Rideau River. Figure 34 illustrates the stream's location.

There are eight significant woodlots in the Mosquito Creek subwatershed, each with different habitat features, such as amphibian breeding pools or channels, area sensitive breeding bird species (species that require a minimum area of cover to maintain a viable population), regionally rare plant species and locally rare plant species. Tree species along the banks and adjacent to Mosquito Creek include sugar maple, basswood, white ash, red Oak, American elm, hemlock, ironwood, yellow birch, bur oak and white oak (regionally rare). Regionally uncommon plants found include hog peanut, red baneberry, woodland strawberry, choke cherry, Bebb's sedge, white avens, hound's tongue and square-stemmed monkey flower. Least flycatcher and American redstart are two area sensitive birds that inhabit areas near the creek. A variety of reptiles and amphibians can also be found: wood frog, spring peeper, red-backed salamander and gray treefrog (Stantec, 2009), all which need forest pools in the spring for breeding, cover and forage.

Mosquito Creek provides significant spawning and rearing habitat for both baitfish and gamefish, which in turn, enhances the productivity of the Rideau River. Between the mouth of Mosquito Creek and the crossing at Leitrim Road, grassy banks provide important habitat for pike and muskellunge spawning during the spring freshet.

From speaking with local residents, much of the land surrounding Mosquito Creek between Earl Armstrong Road and Rideau Road has been bought by developers and is currently being rented out for agricultural purposes. Presently, the City limit boundary does not pass much farther south than Earl Armstrong Road, limiting urban expansion, but there is strong pressure to expand the urban boundary and develop that land into subdivisions.

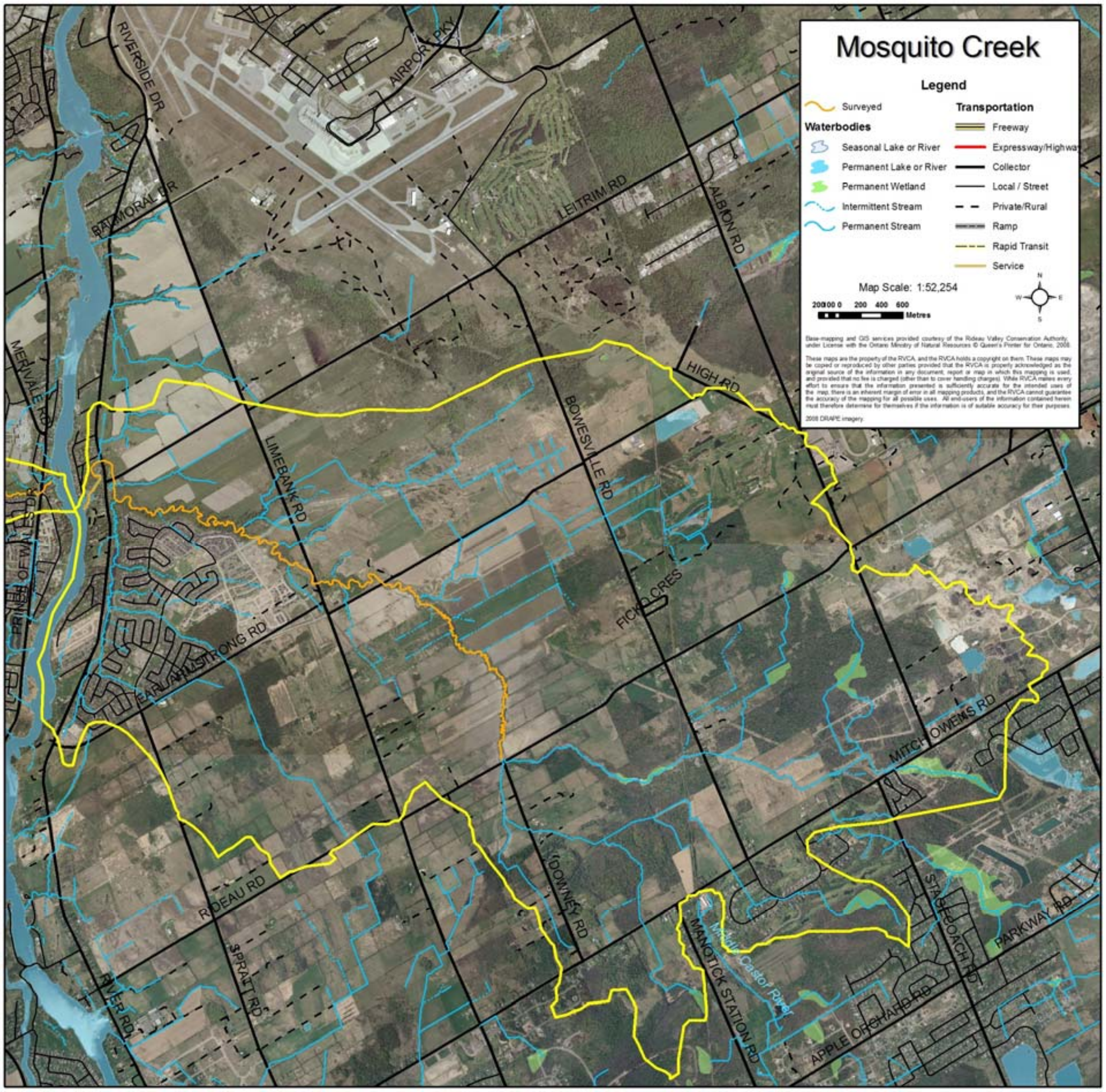

Figure 29. Air Photo of Mosquito Creek and Surrounding Area

1. Observations of Anthropogenic Alterations and Land Use

Figure 30 illustrates the classes of anthropogenic alterations that volunteers observed along Mosquito Creek. Mosquito Creek was surveyed in its entirety, for a total of eight and a half kilometers (85 surveys). Forty-seven percent of the surveys completed on Mosquito Creek had no anthropogenic alterations. These coincided with areas that had not been altered and had a healthy buffer between the creek and other land uses. Of the stream area sampled, 40 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. Twelve percent had were altered but still had some natural features, and these alterations were mainly road crossings, stormwater inputs and even greater buffer loss. One section was highly altered, and this was a section for which half was in a culvert.

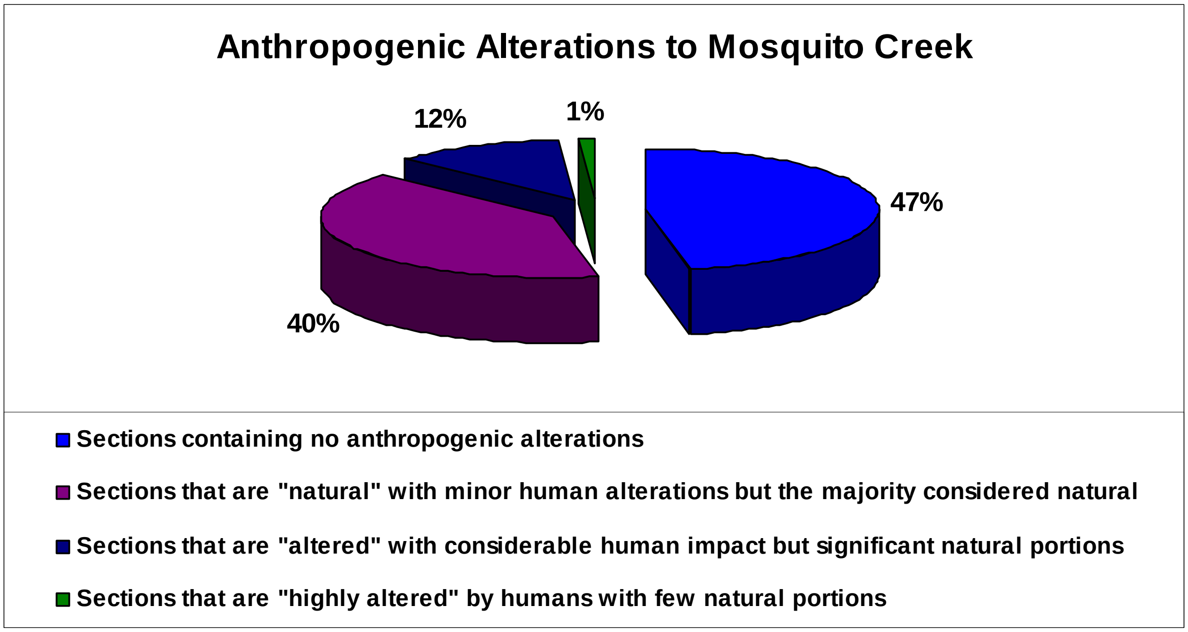

Figure 30. Classes of Anthropogenic Alterations Occurring Along Mosquito Creek

Figure 31 demonstrates the nine different land uses identified by volunteers occurring along the banks adjacent to Mosquito Creek. Over half of the land use adjacent to Mosquito Creek is considered natural, consisting of 22 percent meadow, 25 percent forest, 12 percent scrubland and four percent wetland. The wetland area runs along the sides of Mosquito Creek from the mouth to forested ravine, just upstream of the Leitrim Road crossing. Agricultural land use accounts for 23 percent, which begins to occur after the Leitrim crossing on the left bank. After the Earl Armstrong crossing, there is active agriculture on both sides of the creek. Residential land use was observed along eight percent of the creek, and this refers mainly to the residences at the mouth and the Spratt Road subdivision. The three other land uses occurring along Mosquito Creek are abandoned agriculture (one percent), recreational (one percent) and infrastructure (four percent).

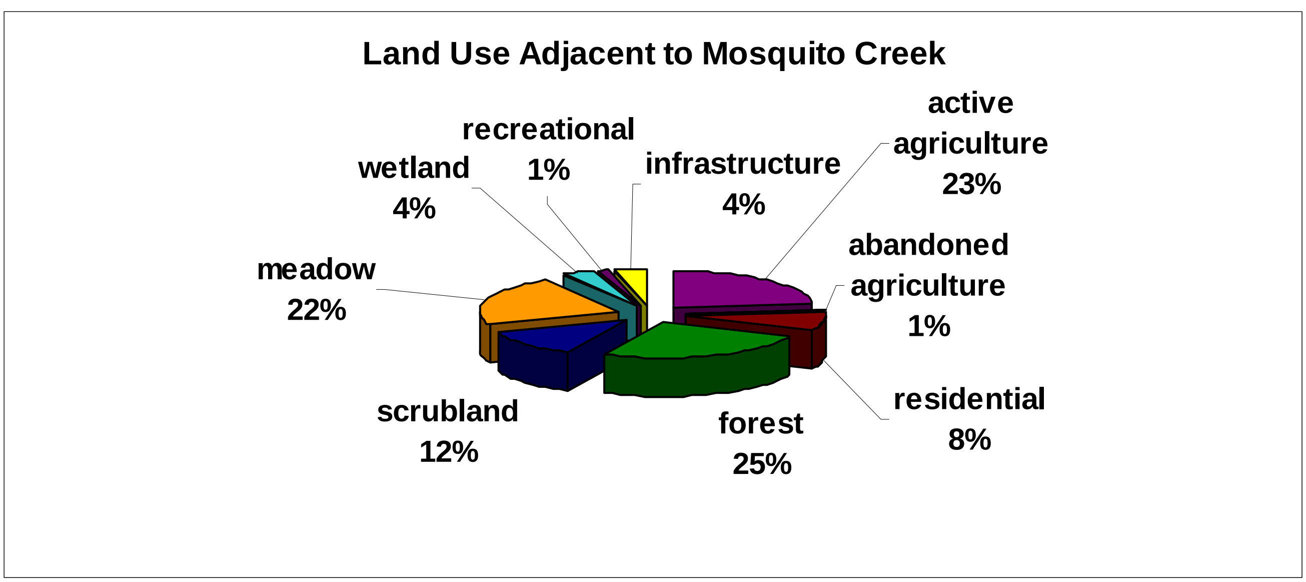

Figure 31. Land Use Identified by Volunteers Along Mosquito Creek

2. Instream Morphology of Mosquito 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. Mosquito Creek mainly consists of large runs with some pools and very few riffles, illustrated in Figure 32. More riffles could be introduced to the stream with cobble or woody material to enhance fish habitat.

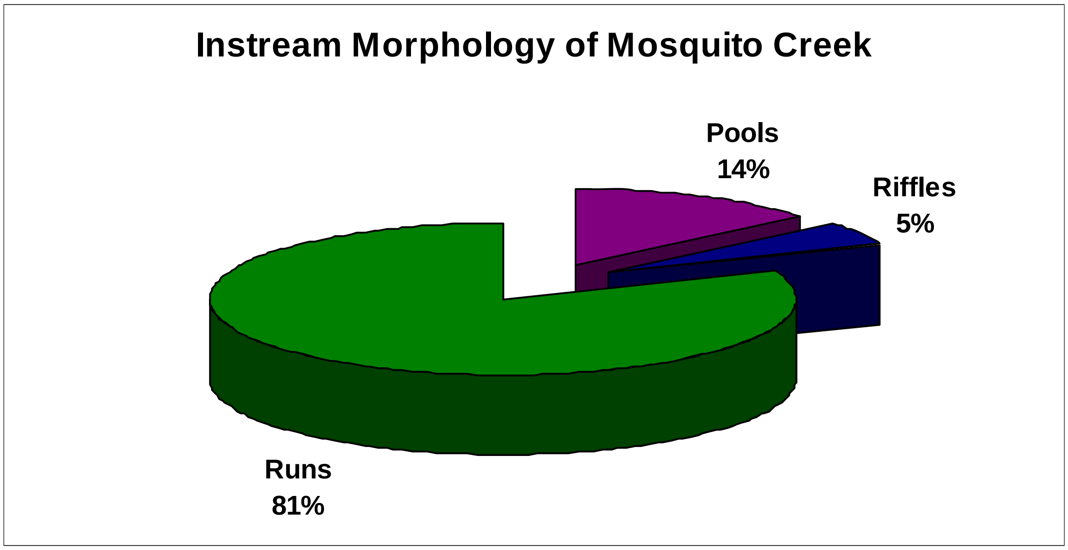

Figure 32. Instream Morphology of Mosquito Creek

3. Types of Instream Substrate Along Mosquito Creek

A variety of substrate can be found instream along Mosquito Creek, although the majority of the substrate is clay with some silt and sand. Diverse substrate is important for fish and benthic macroinvertebrate 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 macroinvertebrates. Many areas of Mosquito Creek are homogeneous, with little cobble, boulder and gravel. A small area of bedrock was observed behind the Spratt Road subdivision. Figure 33 demonstrates the types of substrate observed. “Other” refers to a section where the substrate type was the metal culvert of a road crossing.

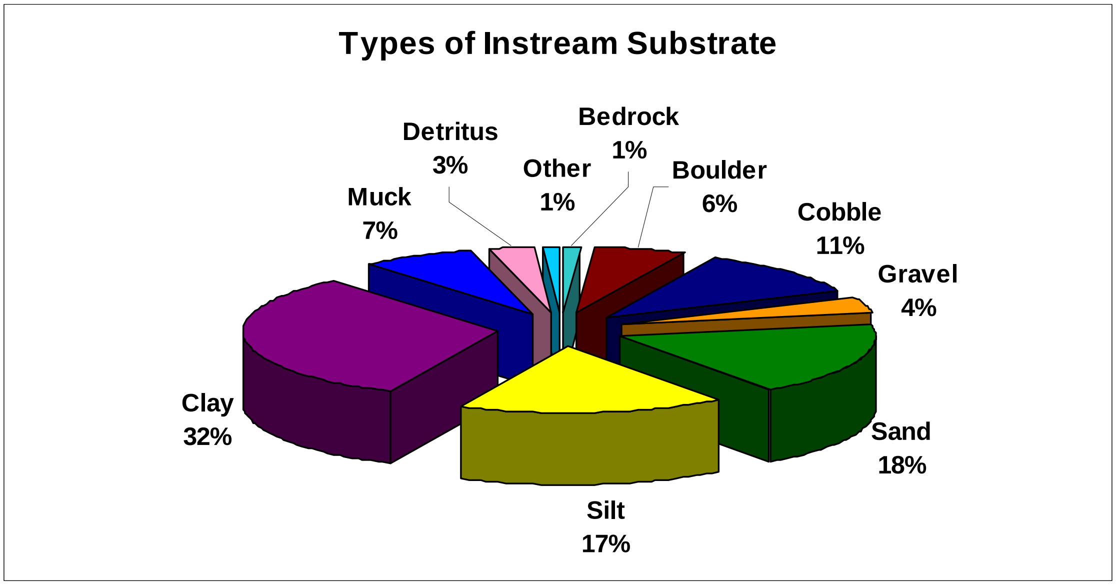

Figure 33. Types of Instream Substrate Along Mosquito Creek

4. Observations of Instream Vegetation

Volunteers found over half of Mosquito Creek contained rare or low amounts of vegetation. Only fifteen percent of the vegetation observed was considered normal and 22 percent noted common. Three percent of the sections surveyed had no vegetation observed. The mouth of Mosquito Creek was surveyed during a major algae bloom, and amounts were recorded as extensive. It was difficult to paddle due to the amount of algae in the stream. 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. After a storm event occurred, the algae bloom ceased. That was also the point in the summer where the weather turned cooler.

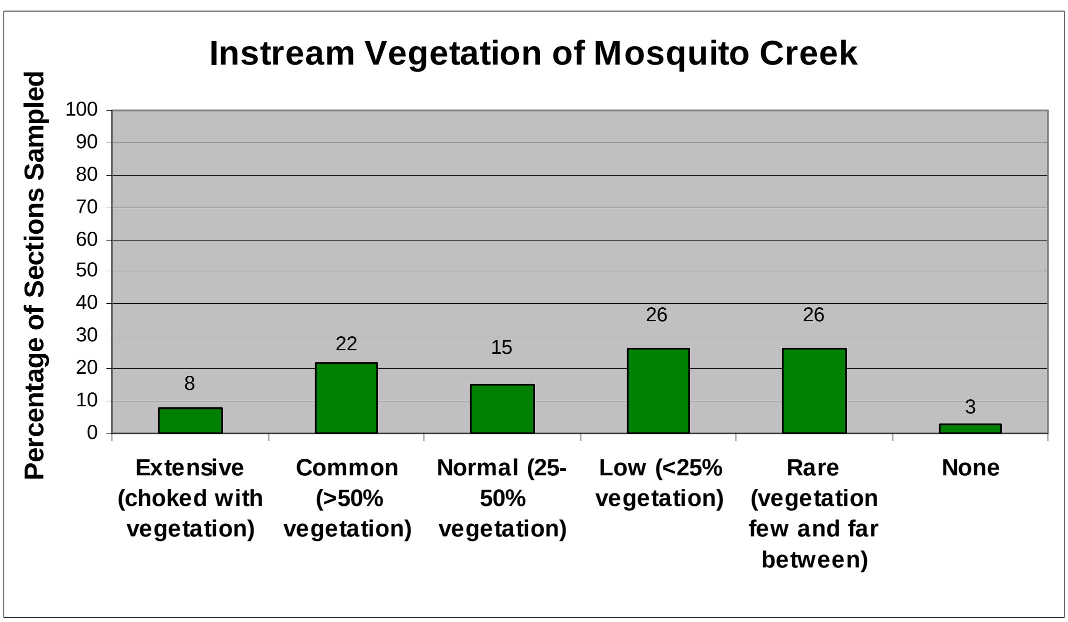

Figure 34. Frequency of Instream Vegetation in Mosquito Creek

5. Observations of Bank Stability

Figures 35 and 36 show the overall bank stability of Mosquito Creek for left and right banks. The left bank was found to be stable for 72 percent of the sections sampled and 28 percent unstable, compared to the right bank which was considered 71 percent stable. Many of the unstable areas coincided with areas that had smaller buffers or steep banks.

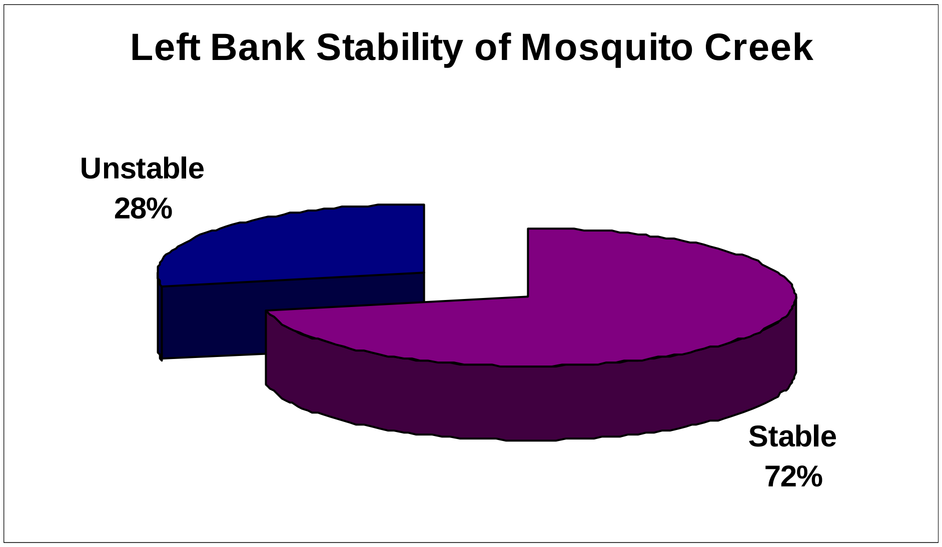

Figure 35. Left Bank Stability of Mosquito Creek

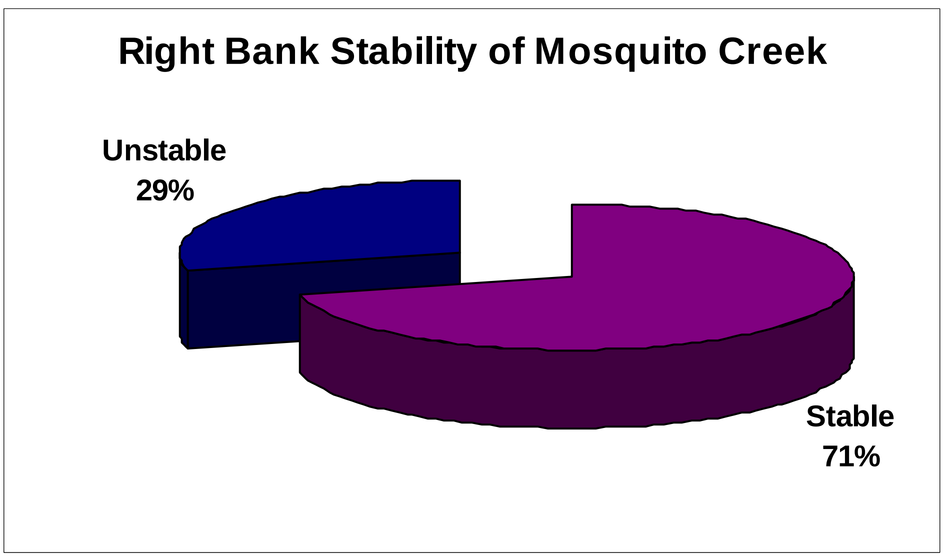

Figure 36. Right Bank Stability of Mosquito Creek

Areas of erosion have been identified on an aerial photo of Mosquito Creek and can be found in Appendix E.

6. Buffer Evaluation of Mosquito 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*, a stream should have riparian areas of 30 metres minimum or more, depending on the site conditions. Figure 37 compares the buffer width for both left and right banks along Mosquito Creek. Most areas achieve the 30 metre minimum recommendation; 66 to 70 percent of the sections surveyed had a buffer of over 30 metres. Five to seven percent of the sections had a buffer of only a zero to five metres. These areas included residential areas near the mouth and road crossing areas. Three to seven percent of the sections had a five to 15 metre buffer and 20 to 22 percent had a buffer of 15 to 30 metres.

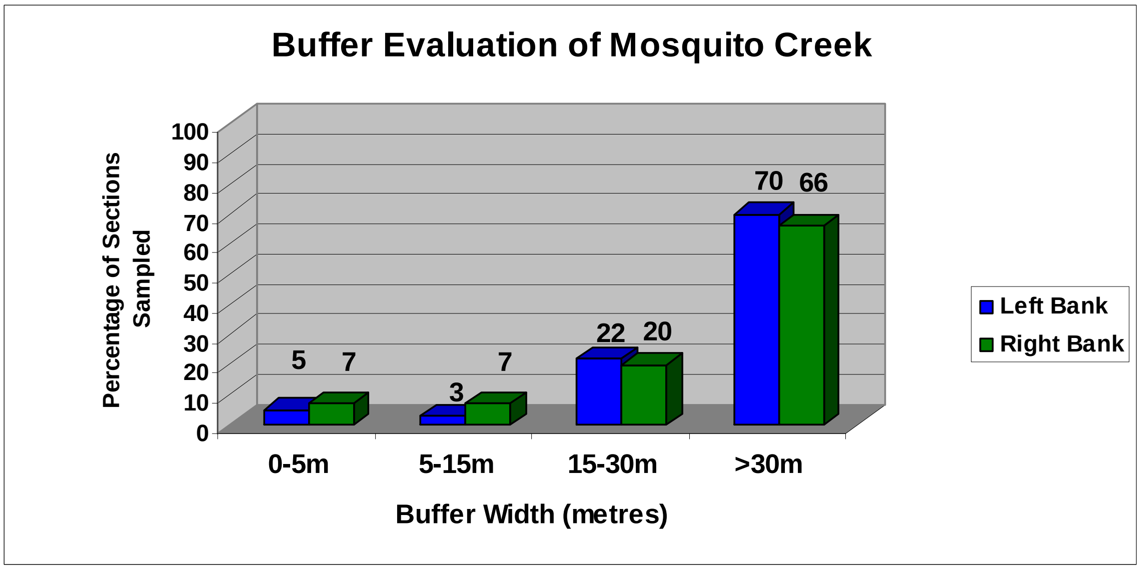

Figure 37. Buffer Evaluation of Mosquito Creek

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 Mosquito Creek.

Wildlife	Observed While Sampling
Birds	red-winged blackbird, morning dove, sparrow, blackbird, robin, flicker, swallow, phoebe, chickadee, cedar waxwing, crow, kingfisher, goldfinch, killdeer, hawk, oriole, Canada warbler, song sparrow, kingbird
Mammals	deer, beaver, raccoon, chipmunk, dead mouse, skunk, muskrat, otter
Reptiles/Amphibians	green frog, bullfrog, american toad, tadpoles, frog eggs, turtle
Aquatic Insects	water striders, snails, fishing spider, whirligig beetle, crayfish, amphipods, water penny, molluscs, caddisflies, chironomids, leeches
Fish (observed when walking)	*Cyprinid spp*., white sucker, *Etheostoma spp*., rock bass, smallmouth bass, *Centrarchid spp*., yellow perch

Other	damselflies (bluet spp., darner spp.), jewelwing, widow skimmer, monarch, viceroy, tiger swallowtail

Table 16. Wildlife Observed Along Mosquito Creek

8. Observations of Pollution/Garbage

Figure 38 demonstrates the incidence of pollution/garbage in Mosquito Creek. Garbage was not as much of an issue in Mosquito Creek compared to the other creeks surveyed in 2009. Most did not occur in large quantities. Thirty-four percent of the creek was free of garbage. In the sections where garbage was observed, 45 percent was floating and 20 percent was on the streambed. One percent of the sections had visible oil or gas trails in the water and six percent exhibited unusual colouration of the channel bed.

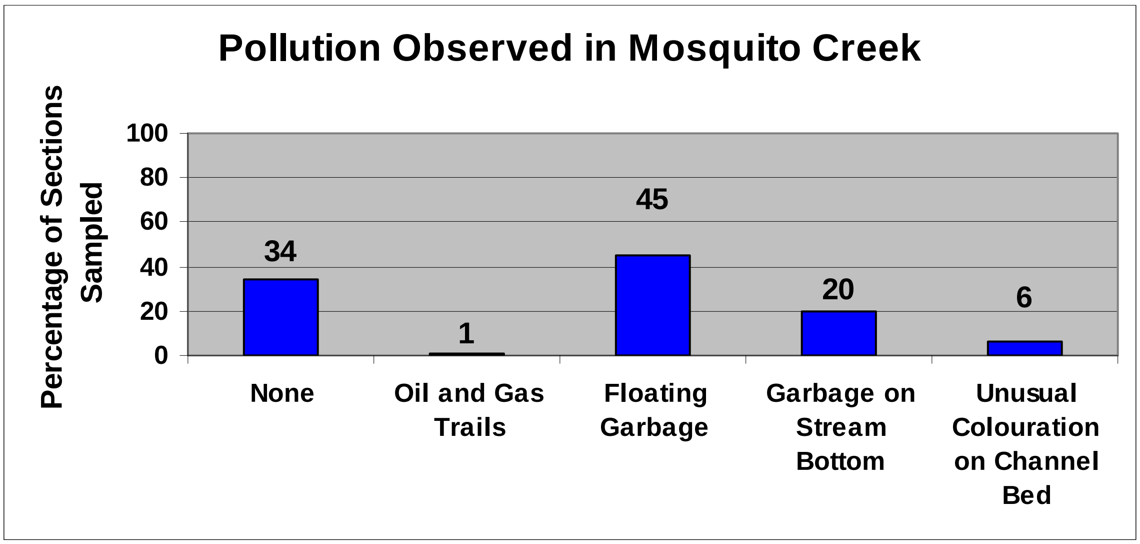

Figure 38. Frequency of Pollution/Garbage Occurring in Mosquito Creek

There was a large variety of garbage found along Mosquito Creek. The majority of the garbage found was construction waste and residential items. Items found included plastic bottles, plywood, glass bottles, a large metal culvert, a bookbag, lumber, inner tube, snow fences, scrap metal, an iron bar, furniture, paint cans, a stepladder, pylons and an abundance of styrofoam. Many of these items have a negative effect on wildlife and fish, especially if the paint cans are not fully empty. Over the winter, one of the contractors working in the area dumped a large load of sediment in part of the creek, completely blocking the flow. Landowners reported the dumping after paddling up the stream in the summer, and photos were taken by CSW staff and volunteers. Unfortunately, the timing window had passed where charges could actually be laid. The stream has worked its way around the side of the dumped sediment, but it is still a large obstruction.

9. Fish Community Sampling

A total of six sites were sampled on Mosquito Creek. Due to high water levels and the type of sampling method required, three sites were only sampled once. The first two sites sampled were near the mouth of the stream, where it is quite deep and wide. A small motorboat and a large seine net were used to seine these areas. Weather conditions and motor issues made it quite difficult to pull the seine, and they were not as successful as hoped. A fyke net was used on the third site, just upstream of River Road. On sites four to six, a combination of seining and windemere traps were used. No volunteer demonstrations were held on this creek but individuals assisted RVCA staff with seining and picking up windemere traps for a total of 12 hours. All fish were live released after the sampling was finished, unless taken back to the lab to confirm identification. In total, 22 fish species were caught. Sampling locations are shown in Figure 39.

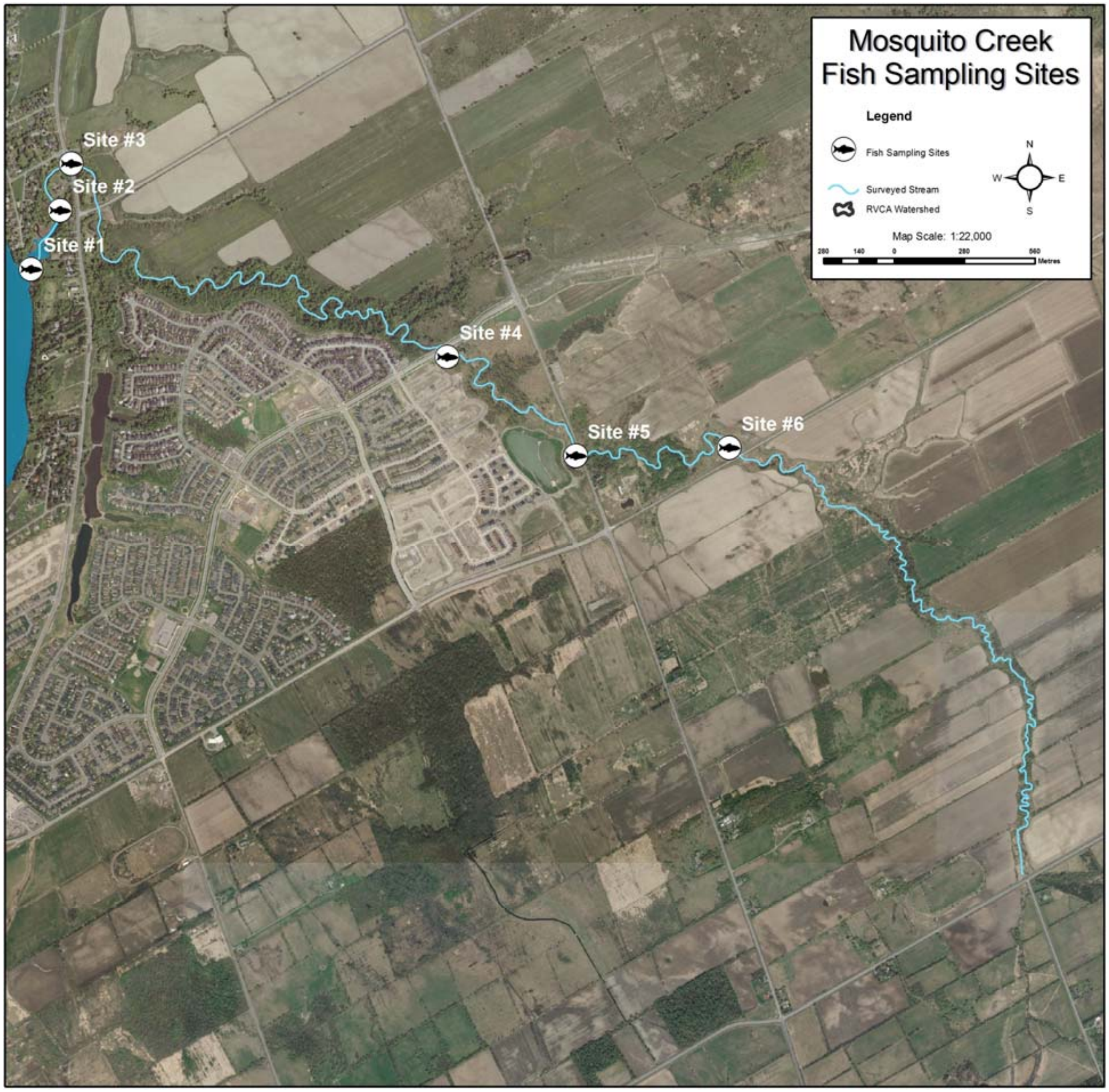

Figure 39. Air Photo of Mosquito Creek Showing Sampling Sites

Table 17 illustrates the water chemistry values obtained from each site at the time of sampling and the biological data obtained. *Cyprinid* (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 Darter or Tessellated Darter (virtually identical) were captured. To differentiate between those species, the fish must be killed and brought back to lab; therefore, they are only identified to genus level. *Phoxinus spp.* refers to northern redbelly dace or finescale dace, both minnow species that are difficult to differentiate when small.

Site #	Sampling Technique	Date (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	boat seine	7/24/2009	18.45	18.85	8.37	7.49	277	clay	pondweed, European frogbit, flowering rush, arrowhead, duckweed	**Northern pike**, logperch, rock bass, **yellow perch**, *Etheostoma spp*.	5
2	boat seine	7/24/2009	19.42	18.78	8.67	7.51	318	clay	pondweed, European frogbit, flowering rush, arrowhead, duckweed	**yellow perch**, brown bullhead, *Etheostoma spp*.	3
3	fyke net	4/15/2009	7.00	6.43	9.05	7.73	497	clay, muck, boulders	none observed	bluegill, brook stickleback, bluntnose minnow, *Etheostoma spp*.	4
4	windemere trap	4/15/2009	12.00	6.11	10.82	7.89	470	silty clay with muck, cobble, boulder	grasses	rock bass, common shiner, creek chub	3
4	seining	5/14/2009	14.31	14.00	10.24	8.22	604	same as above	none observed	creek chub, common shiner, bluntnose minnow	3
4	seining	6/27/2009	21.75	22.26	6.05	8.02	741	same as above	arrowhead, floating-leaved pondweed, abundant algae	blacknose shiner, creek chub, common shiner, white sucker, pumpkinseed, brassy minnow, mottled sculpin	7
4	windemere trap	7/14/2009	16.20	17.20	8.89	7.75	621	same as above	arrowhead, floating-leaved pondweed	pumpkinseed, common shiner, creek chub, **yellow perch**	4
5	seining	4/14/2009	13.00	5.40	10.64	8.06	432	clay with cobble, boulder and muck	none observed	white sucker, mottled sculpin, blackchin shiner, *Etheostoma spp*.	4
5	windemere trap	5/14/2009	14.67	13.20	9.82	8.11	553	same as above	non-filamentous algae	creek chub	1
5	windemere trap	6/26/2009	21.93	22.29	4.17	8.03	747	same as above	arrowhead, floating-leaved pondweed, abundant algae	pumpkinseed, rock bass, mottled sculpin, creek chub, common shiner, white sucker, *Phoxinus spp*., *Etheostoma*	8

										spp.	
5	windemere trap	6/27/2009	20.77	21.12	6.01	8.14	751	same as above	same	pumpkinseed, rock bass, mottled sculpin, creek chub, common shiner, blacknose shiner, *Etheostoma spp*.	7
5	windemere trap	7/14/2009	14.62	15.93	10.09	7.72	590	same as above	arrowhead, grasses, floating-leaved pondweed	pumpkinseed, rock bass, common shiner, white sucker, creek chub	5
6	windemere trap	4/15/2009	15.00	5.98	11.26	8.00	462	clay with muck, sand and gravel	few grasses	central mudminnow, creek chub, finescale dace, Northern redbelly dace, longnose dace, *Etheostoma spp*.	6
6	seining	5/14/2009	12.87	13.00	11.39	8.25	549	same as above	same	common shiner, creek chub, Northern redbelly dace, mottled sculpin, brook stickleback, fathead minnow, white sucker, blacknose shiner, golden shiner, *Phoxinus spp*., *Cyprinid spp*.	11
6	seining	6/22/2009	22.66	23.03	11.21	8.47	721	same as above	arrowhead, floating-leaved pondweed, abundant algae	pumpkinseed, common shiner, spottail shiner, brassy minnow, Northern redbelly dace, white sucker, mottled sculpin, *Etheostoma spp*.	8

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

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

The following table was generated by taking the fish community species of Mosquito 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 Mosquito Creek is made up of cold, cool and warm water species. The coldwater species found in Mosquito Creek was Mottled Sculpin. There is a good mix of fish from the recreational and bait fishery in Mosquito Creek. Although we did not capture any during the fish sampling, a landowner mentioned that muskellunge migrate up Mosquito to spawn in the grassy banks and that there are many bass in the system.

MNR Code	Common Name	Scientific Name	Recreational Fishery	Commercial Fishery	Bait Fishery	Status	Reproductive Guild	Thermal Classification	Trophic Guild
199	blackchin shiner	*Notropis heterodon*			X	none	(non guarder) Phytophils	cool/warm	insectivore
200	blacknose shiner	*Notropis heterolepis*			X	none	(non guarder) Phytophils	cool/warm	insectivore
314	bluegill	*Lepomis macrochirus*	X			none	(nest spawners) Lithophils	cool/warm	insectivore
208	bluntnose minnow	*Pimephales notatus*			X	none	(guarder) Speleophils	warm	omnivore
189	brassy minnow	*Hybognathus hankinsoni*			X	not at risk	Phytophils	cool	omnivore/ herbivore
281	brook stickleback	*Culaea inconstans*			X	none	(guarders) Ariadnophils	Cool	insectivore
233	brown bullhead	*Ameiurus nebulosus*	X	limited		none	Speleophils	warm	insectivore
141	central mudminnow	*Umbra limi*			X	none	(non guarder) Phytophils	cool/warm	insectivore/omnivore
198	common shiner	*Luxilus comutus*			X	none	(guarders) Lithophils	cool	insectivore
212	creek chub	*Semotilus atromaculatus*	X		X	none	(brood hiders) Lithophils	cool	insectivore/generalist
209	fathead minnow	*Pimephales promelus*			X	none	(guarder) Speleophils	warm	omnivore
183	finescale dace	*Phoxinus neogaeus*			X	none	(non guarder) Phyto-lithophils	cool	insectivore
194	golden shiner	*Notemigonus crysoleucas*			X	none	(non guarder) Phytophils	cool/warm	omnivore
342	logperch	*Percina caprodes*			X	none	(non guarder) Psammophils	cool	insectivore
381	mottled sculpin	*Cottus bairdi*			X	none	(guarders) Ariadnophils	cold	insectivore
131	northern pike	*Esox lucius*	X			none	(non guarder) Phytophils	warm	piscivore
182	northern redbelly dace	*Phoxinus eos*			X	none	(non guarder) Phytophils	cool/warm	herbivore
313	pumpkinseed	*Lepoms gibbosus*	X			none	(nest spawners) Polyphils	cool/warm	insectivore
311	rock bass	*Ambloplites rupestris*	X			none	(nest spawners) Lithophils	warm	insectivore

210	spottail shiner	*Notropis hudsonius*			X	none	(non guarders) Litho-pelagophils	cool	insectivore
163	white sucker	*Catostomus commersoni*				none	(non guarder) Lithophils	cool	insectivore/omnivore
331	yellow perch	*Perca flavescens*	X			none	(non guarder) Phyto-lithophils	cool	insectivore/piscivore

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

The following table summarizes the fish community structure found in Mosquito Creek and their sensitivity to sediment and turbidity for reproduction, feeding, and respiration. The composition of the fish community in Mosquito Creek ranges from species that are fairly tolerant to sediment and turbidity, to species that are intolerant, though the majority of the species are classified in the moderately tolerant range.

MNR Code	Common Name	Scientific Name	Reproduction	Feeding	Respiration
199	blackchin shiner	*Notropis heterodon*	M	M	L
200	blacknose shiner	*Notropis heterolepis*	M	M	H
314	bluegill	*Lepomis macrochirus*	L	M	unknown
208	bluntnose minnow	*Pimephales notatus*	L	M	unknown
189	brassy minnow	*Hybognathus hankinsoni*	M	L	unknown
281	brook stickleback	*Culaea inconstans*	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
209	fathead minnow	*Pimephales promelus*	L	L	unknown
183	finescale dace	*Phoxinus neogaeus*	M	M	unknown
194	golden shiner	*Notemigonus crysoleucas*	M	M	L
342	logperch	*Percina caprodes*	M	M	H
381	mottled sculpin	*Cottus bairdi*	M	M	unknown
131	northern pike	*Esox lucius*	M	H	L
182	northern redbelly dace	*Phoxinus eos*	M	L	L
313	pumpkinseed	*Lepoms gibbosus*	L	M	unknown
311	rock bass	*Ambloplites rupestris*	L	H	unknown
210	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 Mosquito Creek (Source: *MTO Environmental Guide to Fish and Fish Habitat*, 2006)

10. Temperature Profiles

Four temperature dataloggers were set in Mosquito Creek for a 173-day period beginning on April 3 and ending on September 22, 2008. Figure 40 shows the locations of the dataloggers. Datalogger 1 was placed just upstream of River Road, datalogger 2 placed upstream of Spratt Road, datalogger 3 placed upstream of Limebank Road and datalogger 4 downstream of Rideau Road.

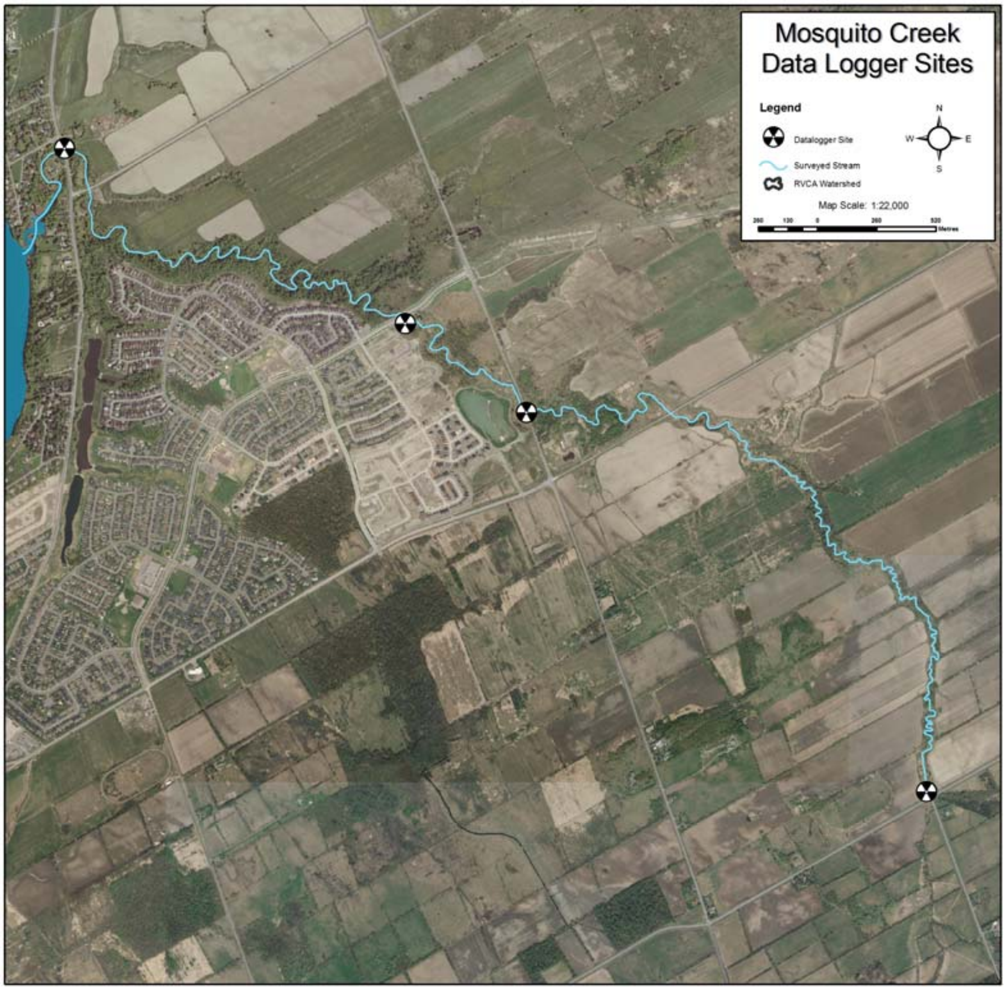

Figure 40. Datalogger Locations Along Mosquito Creek

Dataloggers were set in four different locations along the stream to give a representative sample of how temperature fluctuates and differs throughout the system. 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)

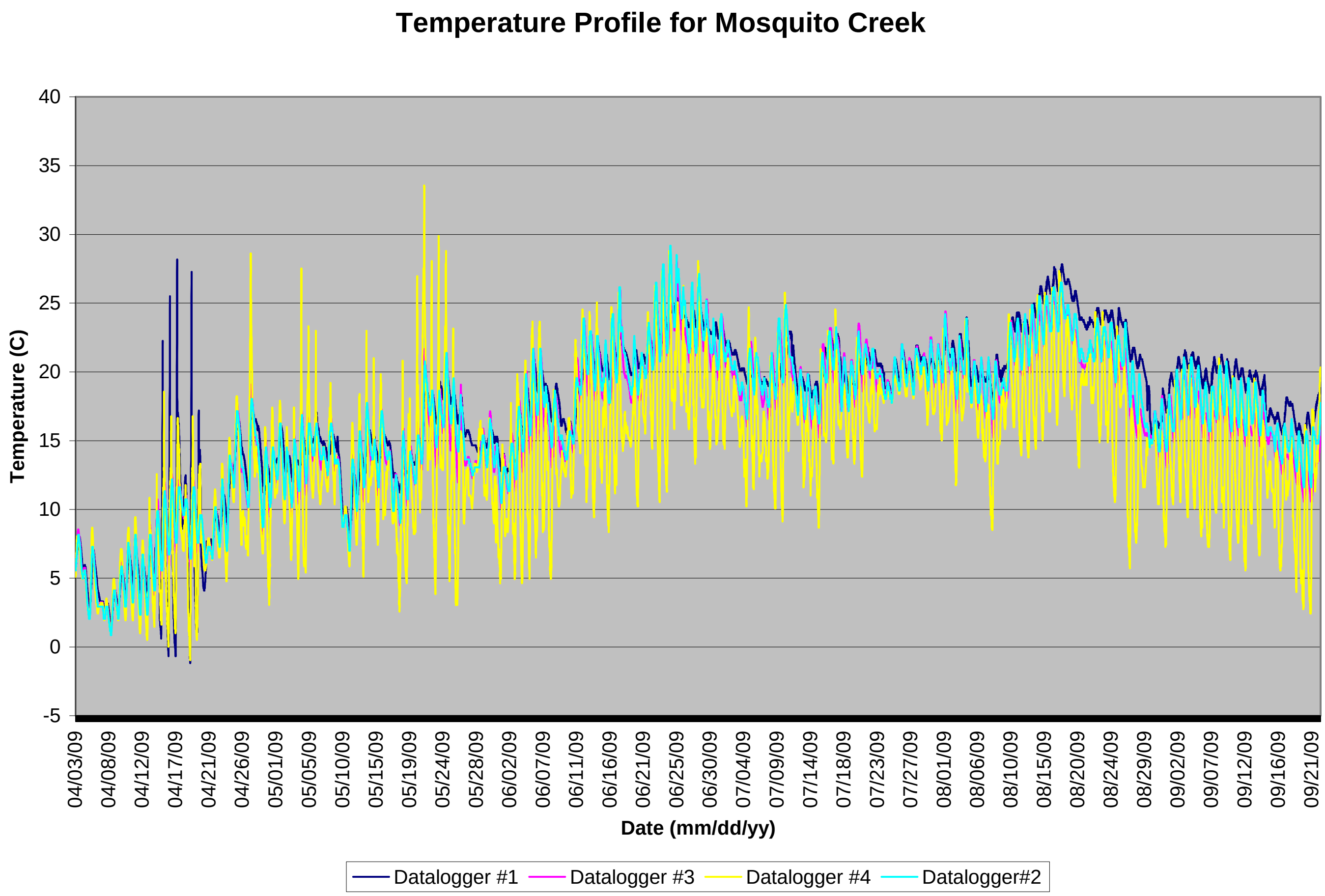

Figure 41. Temperature Profiles for Datalogger 1, 2, 3, 4

Although the dataloggers follow similar trends, dataloggers one and four appear to have been out of water for periods of time in April and May. Datalogger four also shows much larger fluctuations than the others. It was deployed in the headwaters in shallow water and was likely out of water often during the summer months. In comparison, datalogger 1 had a minimum temperature of 1.16°C on April 17 and a maximum temperature of 28.18°C on April 19, when it would have been out of water and recording air temperatures. Each temperature recorded over 25°C occurred on April 16, 17 and 19, all at 11am. Temperatures rose above 25°C for one day in June and seven days in July. Datalogger 2 reached a maximum of 29.17°C on June 24, during a week of hot summer temperatures, and between June 22 and 29, temperatures rose above 25°C. The lowest temperature recorded was 0.86°C. There were five days in August when the water temperature rose above 25°C. Datalogger 3 was similar to 2, but had a lower maximum temperature of 28.09°C which occurred at the same time as 2. The minimum temperature recorded was 1.02°C on April 8. There were four days in June and three days in August where temperatures rose above 25°C. The lowest temperature recorded for datalogger 4 was -0.95°C on April 19 and the maximum was 33.56 on May 21. Temperatures rose above 25°C for one day in April, six days in May, four days in June, one day in July and four days in August.

From the temperature data (excluding the periods where loggers may have been out of water) Mosquito Creek appears to be a cool water stream. The fish community is mainly made up of cool water species, with some cool/warm and warm water species. Mottled sculpin were found in Mosquito Creek, indicating there are cold water reaches along the creek.

11. Invasive Species

Figure 42 shows the locations of invasive species found along Mosquito Creek, highlighted in orange.

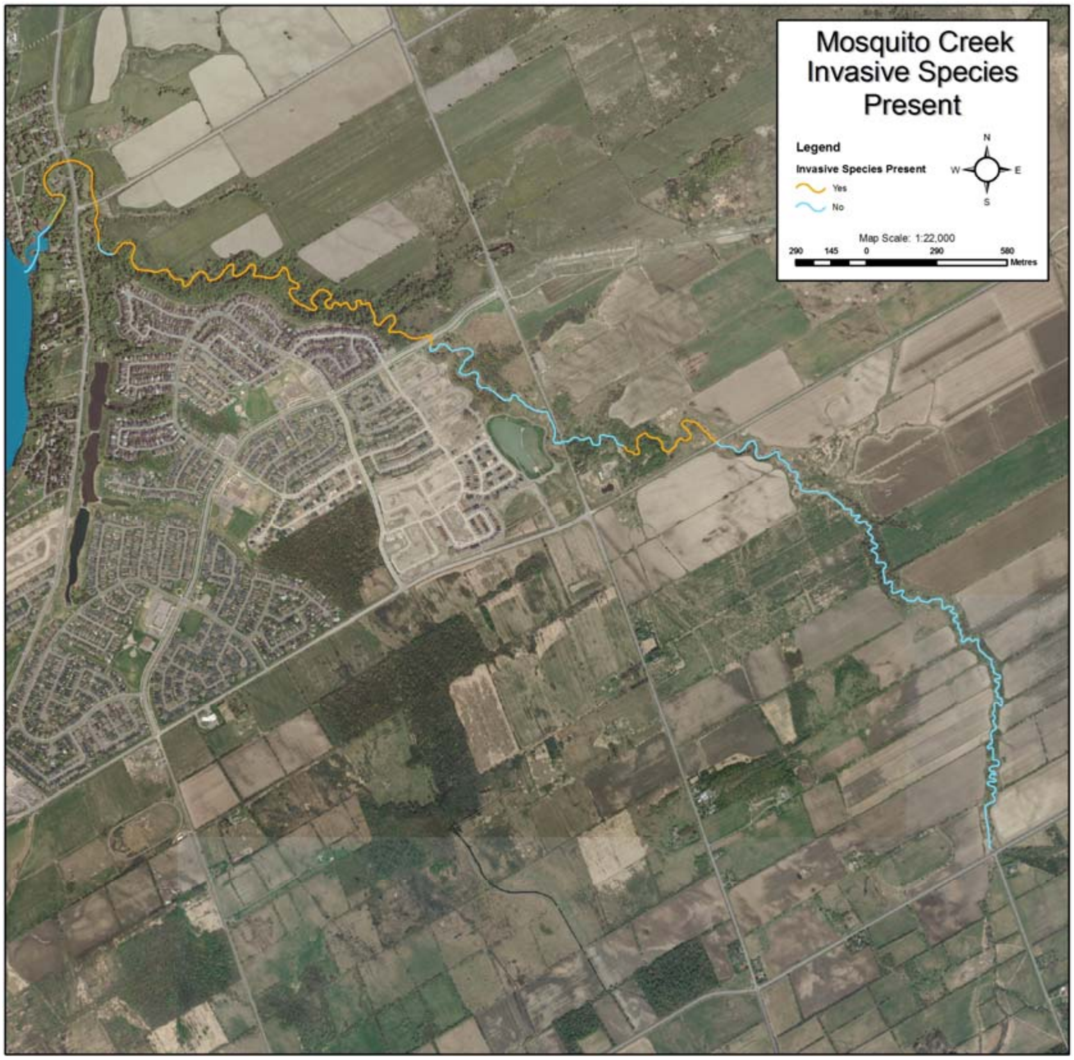

Figure 42. Air Photo of Mosquito Creek Showing Locations of Invasive Species

At the mouth of Mosquito Creek, flowering rush (*Butomus umbellatus*), European frogbit (*Hydrocharis morsus-ranae*), garlic mustard (*Alliaria petiolata*) and common reed (*Phragmites australis*) were observed. All of those species are aggressive growers that could outcompete the native vegetation in that area. 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. Currently the patch of *Phragmites* is only in one area, and it should be removed before it spreads any further. It was found growing in muskellunge and northern pike spawning habitat, which could destroy the habitat if it spreads. Its removal is listed in Appendix F under Potential Projects. The other invasive species present along Mosquito Creek was purple loosestrife (*Lythrum salicaria*). The purple loosestrife was found in many parts of the creek, but it did not seem to be out-competing the native vegetation.

12. 2004/2009 Comparison of Mosquito Creek

One third of Mosquito Creek was sampled in 2004 (28 sections). In 2009, 85 sections were completed. Therefore, only data from the first 28 sections have been compared. 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 2004 and 2009.

Anthropogenic Alterations	2004 (%)	2009 (%)
none	64	64
"natural" conditions with significant alterations by man	25	25
"altered" with considerable human impact but with significant natural areas	11	11
"highly altered" with few areas that could be considered natural	0	0

Table 21. Comparison of Anthropogenic Alterations

For the first 28 sections, areas without visual anthropogenic alterations on Mosquito Creek have remained the same over five years.

Instream Vegetation	2004 (%)	2009 (%)
extensive	0	8
common	18	22
normal	64	15
low	7	26
rare	11	26
none	N/A	3

Table 22. Comparison of Instream Vegetation

Instream vegetation is difficult to compare, and the data can depend on when the stream was surveyed. The category for “none” was also added after 2004 and cannot be reflected in the 2004 data. Instream vegetation data does differ, with increased extensive vegetation, common vegetation, low vegetation and rare vegetation. There was a large decrease in areas with normal levels of vegetation.

Bank Stability	2004 (%)	2009 (%)
stable	72	72LB, 71RB
unstable	28	28LB, 29RB

Table 23. Comparison of Bank Stability

Bank stability was fine tuned in the stream assessments this year to separate left and right banks. However, it can still be concluded that erosion has not changed in the last five years.

Pollution/Garbage	2004 (%)	2009 (%)
none	93	29
oil or gas trails	0	0
floating garbage	0	54
garbage on stream bottom	7	18
unusual colouration	N/A	0

Table 24. Comparison of Pollution/Garbage

Pollution has gotten much worse in the last five years. Sections without pollution/garbage have decreased quite significantly, from 93 percent to 29 percent. This could be attributed to increased residential development surrounding the creek; much of the garbage found was of domestic or construction origin. Floating garbage increased from zero to 54 percent, and garbage on the stream bottom increased by nine percent. Unusual colouration of the streambed was added after 2004 but was not observed in the first 28 sections in 2009.

Species Caught	2004	2009
blackchin shiner		X
blacknose shiner	X	X
bluegill	X	X
bluntnose minnow	X	X
brassy minnow		X
brook stickleback		X
brown bullhead		X
central mudminnow		X
common shiner	X	X
creek chub	X	X
emerald shiner	X	
fathead minnow	X	X
finescale dace	X	X
golden shiner		X
logperch		X
mottled sculpin		X
northern pike		X
northern redbelly dace		X
pumpkinseed		X
rock bass	X	X
spottail shiner		X
white sucker	X	X
yellow perch		X
TOTAL SPECIES CAUGHT	**10**	**22**

Table 25. Comparison of Fish Species

Juvenile pike with blackspot disease

CSW staff and a volunteer picking up a windemere trap

Fish sampling was done on Mosquito Creek in 2004 and in 2009. In 2004, ten species were captured, and in 2009, that number grew to 22. One species caught in 2004 that was not found in 2009, was emerald shiner. This does not mean the species have disappeared but could be influenced by location and time of sampling. Fish sampling methods for 2009 on Mosquito Creek included boat seining, seining, fyke net and windemere traps, whereas only seining was used in 2004. These methods target different types of habitat. Using a variety of methods may increase the chances of capturing more fish species. Sampling in 2004 occurred at one location (at Spratt Road) with no repetition, and in 2009 sampling took place at six sites, from early spring to July, and could also account for the increase in species captured.

3.2.1.3 Stillwater Creek

The headwaters of Stillwater Creek begin in Stony Swamp, owned by the NCC. Stony Swamp is almost 2000 hectares in size, and is a mix of woodland, wetland and regenerating fields. Over 700 plant species have been recorded in the conservation area. From Stony Swamp, Stillwater Creek runs through a heavily channelized and impacted area adjacent to Roberston Road. The creek returns to its natural morphology downstream of Robertson Road until the Highway 417 crossing. It then becomes channelized again, as it runs through the Equestrian Park on Corkstown Road. The creek flows through another large wetland before the Moodie Drive crossing, and from there runs parallel between the 417 and Corkstown Road until it turns north and empties into the Ottawa River between the Nepean Sailing Club and Andrew Haydon Park. There are some smaller sections in that stretch that have been channelized. Figure 48 illustrates the Stillwater Creek subwatershed.

Stillwater Creek is fortunate to still run through two extensive wetlands. Most city streams have lost any wetlands they may have been originally connected to, which would help control the water flows, levels and help filter contaminants entering the stream. Although parts of Stillwater Creek are quite natural, it still has many impacts, mainly road crossings. One of the crossings on Corkstown appears to have collapsed or is sunken, altering the stream flow. This has created pools on both sides of the crossing, and during high summer temperatures, the stream becomes stagnate and filled with extensive amounts of instream vegetation. The mouth of Stillwater is highly impacted, with little to no buffer.

The section of Stillwater Creek that flows between Corkstown Road and Highway 417 was designated a Life Science Site by the OMNR. Tree species found in that area include American elm (*Ulmus americanus*), white ash (*Fraxinus americana*), sugar maple (*Acer saccharum*), silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*), bur oak (*Quercus macrocarpa*), staghorn sumac (*Rhus typhina*) and regionally uncommon black maple (*Acer saccharum ssp nigrum*), some of which are greater than 100cm dbh. Regionally significant plant species also inhabit that location; foxtail sedge (*Carex slopecoides*) and slender wild rye (*Elymus villosus*) are regionally significant; black maple, red elm (*Ulmus rubra*), red pine (*Pinus resinosa*) and small-fruited bullrush (*Scirpus microcarpus*) are regionally uncommon; stinging nettle (*Urtica dioica*) is regionally rare (Ecoplans, DRAFT, 2009).

Wildlife observed in the Stillwater Creek area includes raccoon, white-tailed deer, Eastern cottontail, woodchuck, grey Squirrel, American robin, red-winged blackbird, song sparrow, Cooper's hawk (area sensitive species), pileated woodpecker (area sensitive species), savannah sparrow (area sensitive species), northern leopard frog and spring peeper (Ecoplans, DRAFT, 2009).

The City of Ottawa has completed benthos sampling at several different sites along Stillwater Creek. The results range from poor to very poor, implying very substantial to severe organic pollution is likely in that system (Ecoplans, DRAFT, 2009).

There is a transitway expansion that may cause further impacts to Stillwater Creek in the future. Out of four options, the most preferred may result in relocation of the stream channel, where the Life Science Site is located. This area is one of the least impacted areas of the stream, and measures should be taken to ensure this area is not negatively impacted, given that the majority of Stillwater is highly impacted by human activity.

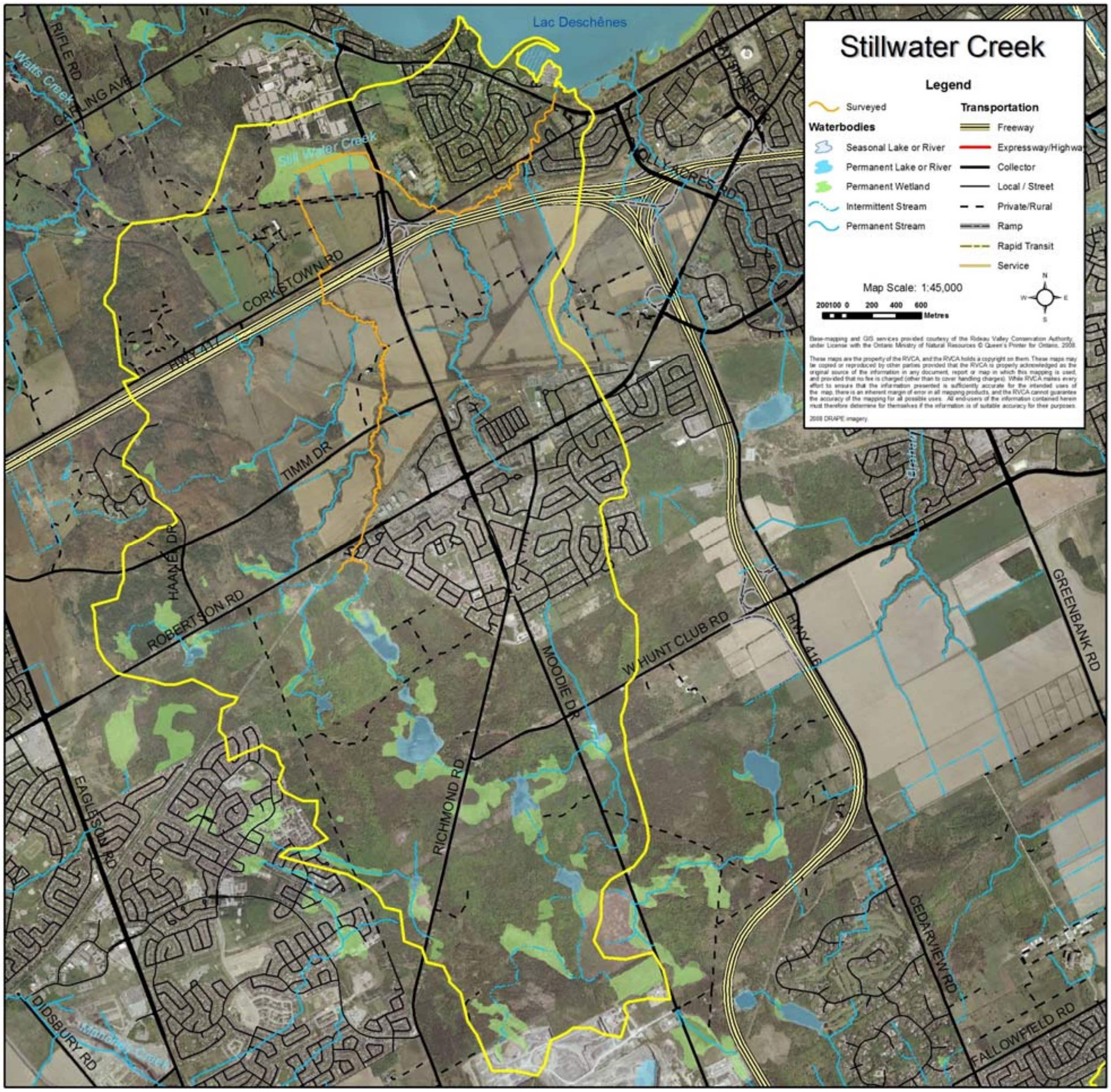

Figure 43. Air Photo of Stillwater Creek and Surrounding Area

1. Observations of Anthropogenic Alterations and Land Use

Figure 44 illustrates the classes of anthropogenic alterations observed by volunteers along Stillwater Creek. Of the 79 sections of stream surveyed, volunteers identified that 28 percent displayed no human alterations or disturbances. These areas include the headwaters in Stony Swamp and the large wetland west of Moodie Drive. Of the remaining sections, 18 percent were considered natural with some human alteration. 31 percent of the creek was considered altered but with some natural portions. The remaining 23 percent was considered highly altered with few natural portions. These areas were sections of Stillwater that had been straightened, armoured or had little or no buffer. The altered and highly altered areas include the sections from Stony

Swamp across Robertson Road, the Highway 417 crossing, the Equestrian Park and the area adjacent to Abbott Laboratories.

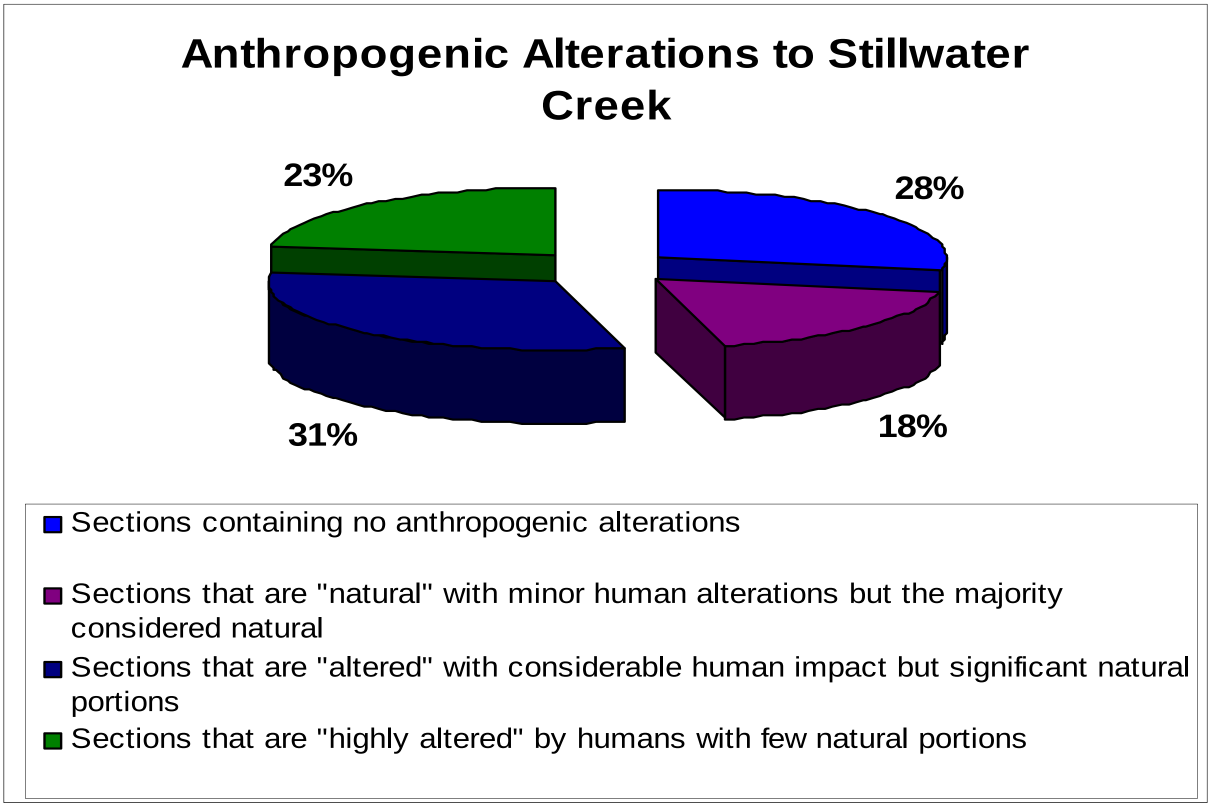

Figure 44. Classes of Anthropogenic Alterations Occurring Along Stillwater Creek

Figure 45 demonstrates the ten different land uses adjacent to Stillwater Creek observed by volunteers. Forty-seven percent of the area surveyed still consists of natural areas, which are classified as five percent scrubland, six percent wetland, 20 percent meadow and 16 percent forest. Ten percent of the creek is considered recreational, including the Equestrian Park and where NCC paths were observed along the banks of the creek (at the mouth, along Corkstown Road and on the west side of Moodie Drive). Residential areas made up seven percent of the land use adjacent to the creek and industrial/commercial accounted for four percent (Abbot Laboratories). Eighteen percent of the land use is active agriculture, observed between Highway 417 and Robertson Road, and three percent was horse pasture. Stillwater Creek has many road crossings; infrastructure accounts for 11 percent of the creek's surrounding land use.

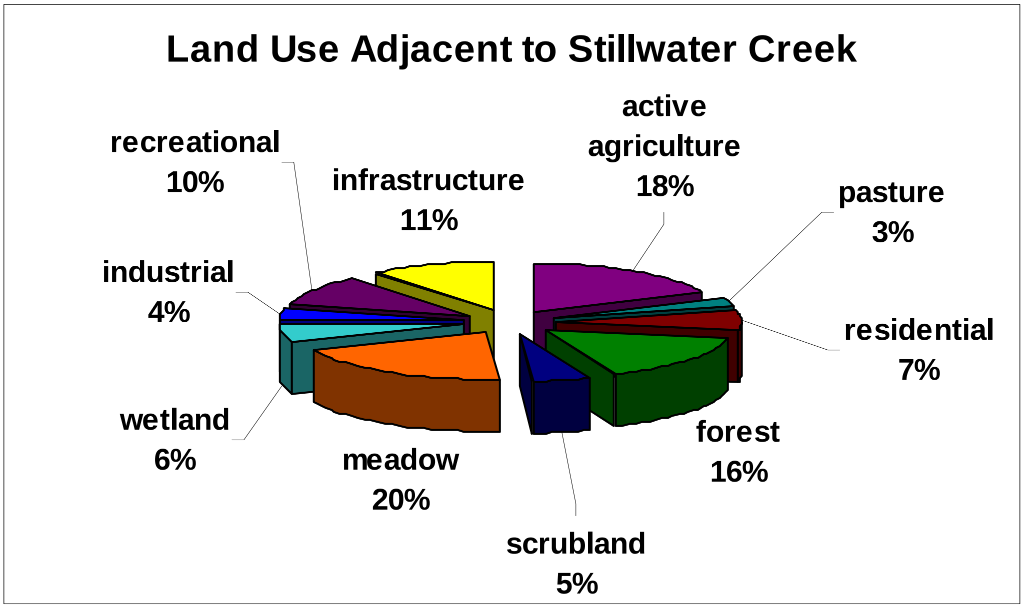

Figure 45. Land Use Identified by Volunteers Along Stillwater Creek

2. Instream Morphology of Stillwater 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. Stillwater Creek consists mainly of runs, with some pool and riffle features.

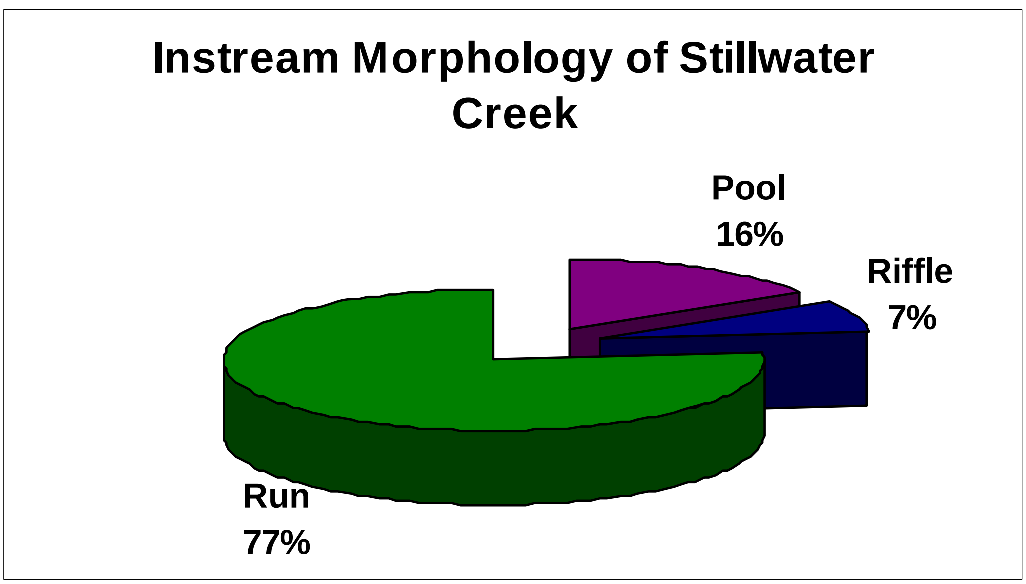

Figure 46. Instream Morphology of Stillwater Creek

3. Types of Instream Substrate Along Stillwater Creek

A variety of substrate can be found instream along Sawmill Creek and is demonstrated in Figure 47. Diverse substrate is important for fish and benthic macroinvertebrate 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 macroinvertebrates. Clay and muck were observed along many parts of Stillwater Creek, and muck was abundant in the sections surveyed in the wetland adjacent to Moodie Drive. Bedrock was observed in the section running north of Highway 417 and south of Corkstown Road. The “other” substrate noted was metal culvert, on which there was no other substrate deposited.

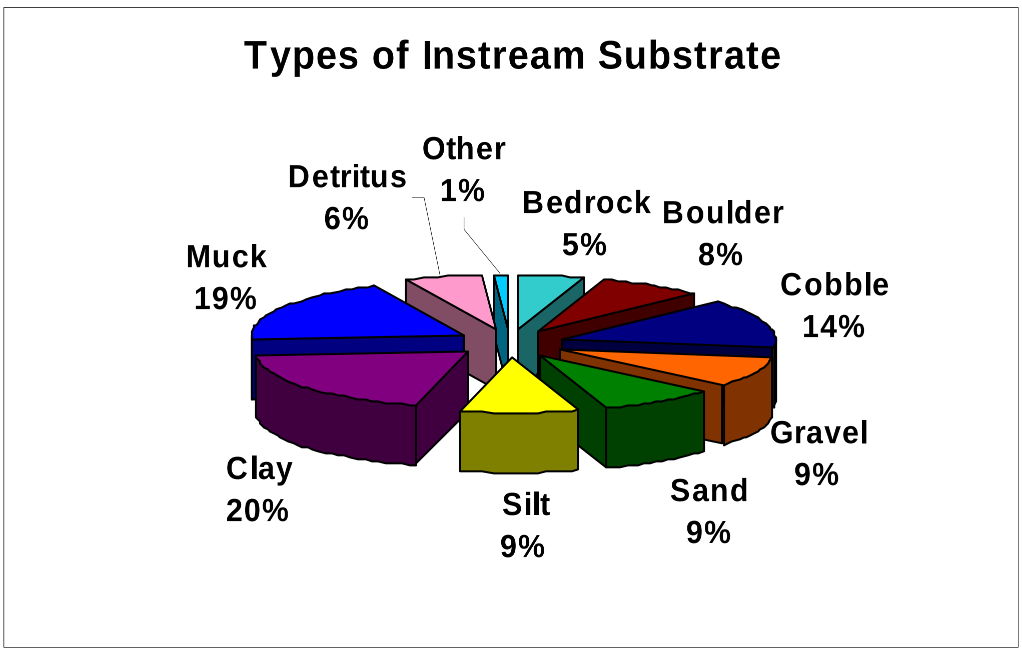

Figure 47. Types of Instream Substrate Along Stillwater Creek

4. Observations of Instream Vegetation

Figure 48 demonstrates the incidence of instream vegetation in Stillwater Creek. For the majority of its length, it did not have a healthy amount or variety of instream vegetation. Instream vegetation was categorized as being common for 16 percent of the stream and 19 percent normal. Low vegetation made up 18 percent of the creek. For 15 percent of the sections surveyed, vegetation was rare, and in 13 percent there was none. Nineteen percent of the creek was considered to have extensive vegetation; this occurred at the sunken Corkstown Road crossing and in the wetland adjacent to Moodie Drive.

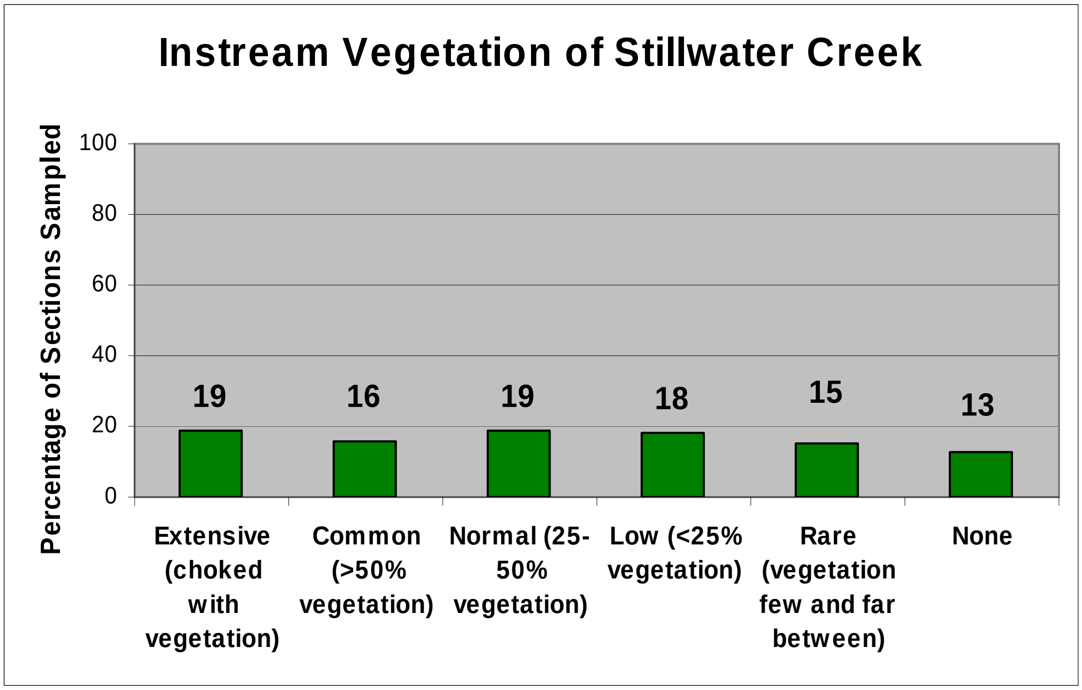

Figure 48. Frequency of Instream Vegetation in Stillwater Creek

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. In many sections of Stillwater the vegetation was common, however it was algae and was not providing the benefits of varied instream vegetation.

5. Observations of Bank Stability

The majority of Stillwater Creek was stable (90 percent), and left and right banks were equal. Although active erosion was observed in many areas, it did not appear to be threatening bank stability. Only some parts of Stillwater Creek have steep banks; many areas have a lower gradient. The mouth of Stillwater Creek is experiencing erosion, and it would be a good site to apply bioengineering methods to help mitigate those effects. Areas of erosion have been identified on an aerial photo of Stillwater Creek and can be found in Appendix E.

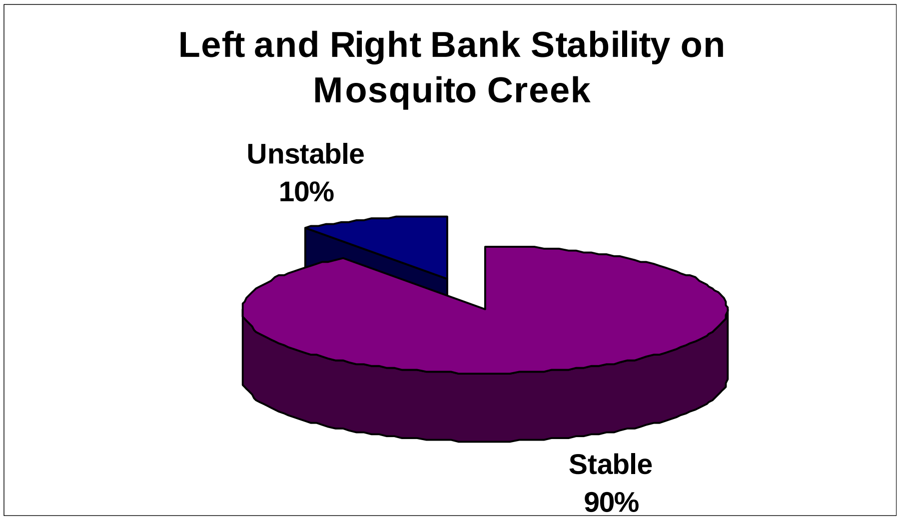

Figure 49. Left and Right Bank Stability of Stillwater Creek

6. Buffer Evaluation of Stillwater Creek

Buffer widths for both the left and right banks of Stillwater Creek are illustrated in Figure 50. Twenty percent of the left bank and 23 percent of the right bank had a buffer of only zero to five metres, 28-30 percent had a buffer of five to 15 metres and seven to ten percent had 15 - 30 metres. Forty-two percent of the left bank and 40 percent of the right bank had a buffer greater than 30 metres. 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*, riparian areas of a stream should be a minimum of 30 metres or more, depending on the site conditions. Stillwater only meets this requirement for 40-42 percent of its stream length.

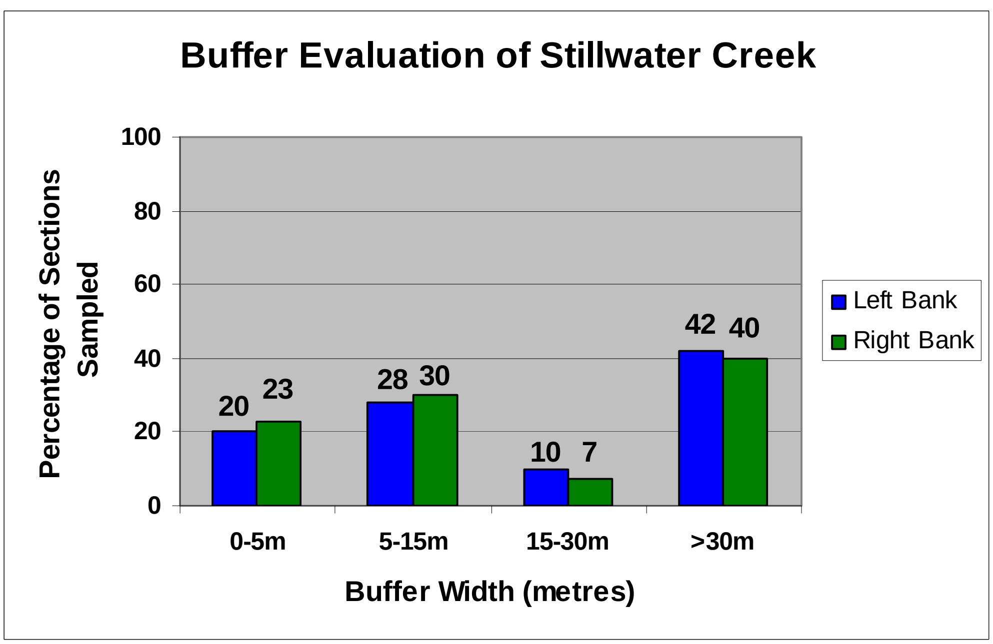

Figure 50. Buffer Evaluation of Stillwater Creek

7. Observations of Wildlife

Volunteers recorded the presence of types of wildlife in and around Stillwater Creek. Table 26 is a summary of the wildlife observed.

Wildlife	Observed While Sampling
Birds	ducks, mallards, Canada geese, green heron, great blue heron, grackle, crows, chickadee, red-winged blackbirds, phoebe, yellow finch, goldfinch, sparrows, song sparrows, woodpecker, cedar waxwing, robin
Mammals	red squirrel, chipmunk, raccoon, beaver, deer, muskrat
Reptiles/Amphibians	green frog, northern leopard frog, tadpoles
Aquatic Insects	crayfish, water striders, snails, leeches, amphipods, mollsucs
Fish (observed when walking)	white sucker, stickleback, *Cyprinid spp*.
Other	slugs, spiders, crickets, cicada, caterpillars, ants, dragonflies, damselflies, jewelwing spp., darner spp., meadowhawk spp., bluet spp., butterflies, monarch

Table 26. Wildlife Observed Along Stillwater Creek

8. Observations of Pollution/Garbage

Figure 51 demonstrates the incidence of pollution/garbage along Stillwater Creek. Pollution and garbage were observed in many sections of Stillwater. Only twenty-two percent of Stillwater did not have the occurrence of garbage. Oil and gas trails were recorded for one percent of the sections surveyed.

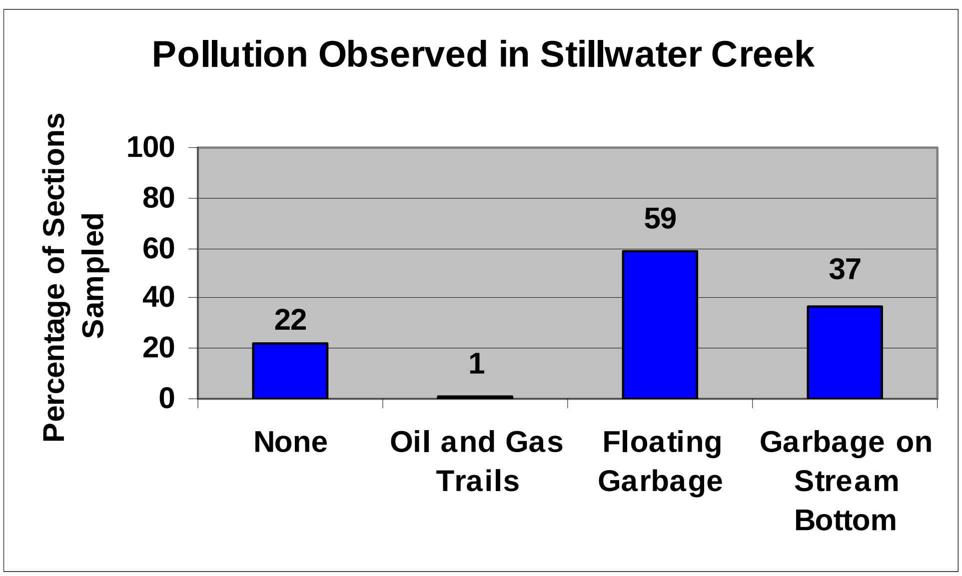

Figure 51. Frequency of Pollution/Garbage Occurring in Stillwater Creek

On many surveys, both floating garbage and garbage on the stream bottom were observed. A wide variety of pollution was recorded along Stillwater Creek, although the most abundant was plastic. Some of the items included tires, scrap metal, construction signs, pylons, bottles, sports equipment, broken glass, a workbench, soccer balls, rope, plywood, pop cans, styrofoam, bicycles, hubcap, kiddie pool, solar blanket, Plexiglas, aerosol cans, pitchfork, abandoned bridge, toys, sled, tarp, car parts, metal fence, steel drum, cardboard and paint cans. The amount of garbage along parts of Stillwater is a concern and can negatively impact fish and wildlife. A cleanup was organized for the fall as part of the TD Great Canadian Shoreline Cleanup, and some of the worst areas were addressed. A garbage cleanup is still needed around Robertson Road.

9. Fish Community Sampling

Fish sampling was completed at four sites along Stillwater Creek, and the same sites were sampled in April, May, June and July. A variety of fish capture methods were used. At the mouth (site one), a fyke net and seine net were used. At the site adjacent to the public pool (site two), a seine net was used for the first three months, and it was electrofished on the fourth month. At the third site, where the sunken culvert is located at Corkstown, only a seine net was used. Windemere traps were used on the fourth site, aside from July, when it was electrofished once. Figure 52 shows the locations of the sampling sites. A total of 16 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, and volunteers contributed a total of 72.5 hours to fish sampling.

Table 36 illustrates the water chemistry values and summarizes the biological data obtained from each site at the time of sampling. *Cyprinid* (minnow) species that were too small to be identified are listed as *Cyprinid spp*. Top predators are highlighted in bold. For a complete list of species sampled, including number of each species, weight, comments, etc., please see Appendix G. *Etheostoma spp* indicates that either Johnny Darter or Tessellated Darter (virtually identical) were captured. To differentiate between those species, the fish must be killed and brought back to lab; therefore, they are only identified to genus level. *Phoxinus spp.* refers to northern redbelly dace or finescale dace, both minnow species that are difficult to differentiate when small. *Centrarchid spp.* refers to sunfish species that were too small to identify and would either be bluegill or pumpkinseed.

Site #	Sampling Technique	Date (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	4/8/2009	1	2.15	8.86	8.1	781	silty clay, muck, detritus	grasses, purple loosestrife, cattails	spottail shiner, blackchin shiner, brook stickleback, *Cyprinid spp*.	4
1	seining	4/27/2009	13.39	14.42	9.06	8	325	same as above	grasses, purple loosestrife, cattails	spottail shiner, banded killifish, **yellow perch**, pumpkinseed/bluegill hybrid, *Centrarchid spp., Cyprinid spp., Etheostoma spp.*	7
1	seining	6/30/2009	17.8	18.47	6.23	7.5	1363	same as above	grasses, purple loosestrife, cattails, coontail, curly-leaved pondweed	**northern pike**, common shiner, creek chub, blacknose shiner, mottled sculpin, central mudminnow, **yellow perch**, *Etheostoma spp*., *Cyprinid spp*.	9
1	seining	7/11/2009	13.1	18.5	7.51	7.6	1066	same as above	grasses, purple loosestrife, cattails, coontail, curly-leaved pondweed	**yellow perch**, spottail shiner, *Etheostoma spp*.	3

1	fyke net	7/12/2009	13.1	18.5	7.51	7.6	1066	same as above	grasses, purple loosestrife, cattails, coontail, curly-leaved pondweed	spottail shiner, **northern pike**, blacknose shiner, **yellow perch**, mottled sculpin	5
2	windemere trap	4/8/2009	1	2.57	8.58	7.8	437	clay with muck, detritus and cobble	none observed	northern redbelly dace, spottail shiner	2
2	seining	5/27/2009	12.58	12.58	9.86	8.1	991	same as above	none observed	spottail shiner, **yellow perch**, *Etheostoma spp*., *Cyprinid spp*.	4
2	seining	6/25/2009	36.72	21.75	10.52	8.1	1162	same as above	purple loosestrife, non-filamentous algae	mottled sculpin, blacknose shiner, **yellow perch**, white sucker, brook stickleback, *Etheostoma spp*.	6
2	electrofishing	7/30/2009	16.04	17.3	9.77	7.7	805	same as above	purple loosestrife, non-filamentous algae	mottled sculpin, blacknose shiner, white sucker, fathead minnow, logperch, *Etheostoma spp*., *Cyprinid spp*.	7
3	seining	4/8/2009	3	1.83	9.68	7.8	380	clay, sand, gravel, interlocking brick	none observed	brook stickleback	1
3	seining	5/27/2009	12.28	13.44	8.22	7.9	761	same as above	grasses, filamentous algae	brook stickleback, common shiner, white sucker, creek chub, northern redbelly dace, central mudminnow, fathead minnow, blackchin shiner, *Cyprinid spp*.	9
3	seining	5/25/2009	39.71	28.09	13.19	8.3	1158	same as above	grasses, purple loosestrife, coontail, European frogbit, abundant filamentous algae	northern redbelly dace, central mudminnow, brook stickleback, creek chub	4
3	seining	7/23/2009	18.81	17.9	6.65	7.4	879	same as above	Canada waterweed, duckweed, coontail, European frogbit, filamentous algae	central mudminnow, common shiner, brook stickleback, northern redbelly dace, creek chub, fathead minnow, white sucker	7
4	windemere trap	4/8/2009	2	2.92	10.21	7.8	375	clay, a bit of cobble	grasses	creek chub	1
4	windemere trap	5/28/2009	12.56	11.3	11.25	8.3	601	same as above	grasses, filamentous and non-filamentous algae	creek chub	1
4	windemere trap	6/28/2009	17.74	18.02	8.32	7.8	1188	same as above	grasses	creek chub, central mudminnow	2

4	electrofishing	7/30/2009	18.89	17.03	10.85	7.8	598	same as above	grasses, non-filamentous algae	creek chub, central mudminnow, northern redbelly dace, brook stickleback	4

Table 36. Water Chemistry and Fish Community Results for Sampling Sites Along Stillwater Creek

Figure 52. Air photo of Stillwater Creek Showing Sampling Sites

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

The following table was generated by taking the fish community structure of Stillwater 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).

Most of the fish community in Stillwater Creek is made up of cool water species, with some warm water species. Mottled sculpin, a coldwater species, was caught at the first two sites. Spawning habitat requirements within Stillwater are fairly diverse and can been seen in the table below. Most fish captured are part of the bait fishery, but there are some that are also some classified as recreational, such as northern pike and yellow perch.

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	Phytophils	cool	piscivore/ herbivore
199	blackchin shiner	*Notropis heterodon*			X	none	(non guarder) Phytophils	cool/warm	insectivore
200	blacknose shiner	*Notropis heterolepis*			X	none	(non guarder) Phytophils	cool/warm	insectivore
281	brook stickleback	*Culaea inconstans*			X	none	(guarders) Ariadnophils	Cool	insectivore
141	central mudminnow	*Umbra limi*			X	none	(non guarder) Phytophils	cool/warm	insectivore/omnivore
198	common shiner	*Luxilus comutus*			X	none	(guarders) Lithophils	cool	insectivore
212	creek chub	*Semotilus atromaculatus*	X		X	none	(brood hiders) Lithophils	cool	insectivore/generalist
209	fathead minnow	*Pimephales promelus*			X	none	(guarder) Speleophils	warm	omnivore
342	logperch	*Percina caprodes*			X	none	(non guarder) Psammophils	cool	insectivore
381	mottled sculpin	*Cottus bairdi*			X	none	(guarders) Ariadnophils	cold	insectivore
131	northern pike	*Esox lucius*	X			none	(non guarder) Phytophils	warm	piscivore
182	northern redbelly dace	*Phoxinus eos*			X	none	(non guarder) Phytophils	cool/warm	herbivore
210	spottail shiner	*Notropis hudsonius*			X	none	(non guarders) Litho-pelagophils	cool	insectivore
163	white sucker	*Catostomus commersoni*				none	(non guarder) Lithophils	cool	insectivore/omnivore
331	yellow perch	*Perca flavescens*	X			none	(non guarder) Phyto-lithophils	cool	insectivore/piscivore

Table 28. Fish Species Status, Trophic and Reproductive Guilds for Stillwater Creek (Source: *MTO Environment Guide to Fish and Fish Habitat*, 2006)

The following table summarizes the fish community structure found in Stillwater Creek and their sensitivity to sediment and turbidity for reproduction, feeding, and respiration. The composition of the fish community in Stillwater Creek ranges from species that are fairly tolerant to sediment and turbidity to species that are intolerant, though the majority of the species are classified in the moderately tolerant range.

MNR Code	Common Name	Scientific Name	Reproduction	Feeding	Respiration
261	banded killifish	*Fundulus diaphanus*	M	H	unknown
199	blackchin shiner	*Notropis heterodon*	M	M	L
200	blacknose shiner	*Notropis heterolepis*	M	M	H

281	brook stickleback	*Culaea inconstans*	L	M	unknown
141	central mudminnow	*Umbra limi*	M	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
342	logperch	*Percina caprodes*	M	M	H
381	mottled sculpin	*Cottus bairdi*	M	M	unknown
131	northern pike	*Esox lucius*	M	H	L
182	northern redbelly dace	*Phoxinus eos*	M	L	L
210	spottail shiner	*Notropis hudsonius*	M	M	H
163	white sucker	*Catostomus commersoni*	M	L	H
331	yellow perch	*Perca flavescens*	M	H	unknown

Table 29. Fish Species Sensitivity to Sediment/Turbidity (High, Moderate, Low, unknown) for Stillwater Creek (Source: *MTO Environment Guide to Fish and Fish Habitat*, 2006)

10. Temperature Profiles

Four temperature dataloggers were set in Stillwater Creek. Dataloggers were set on April 2, 2009 and removed on September 22, 2009. Figure 53 shows the locations of dataloggers.

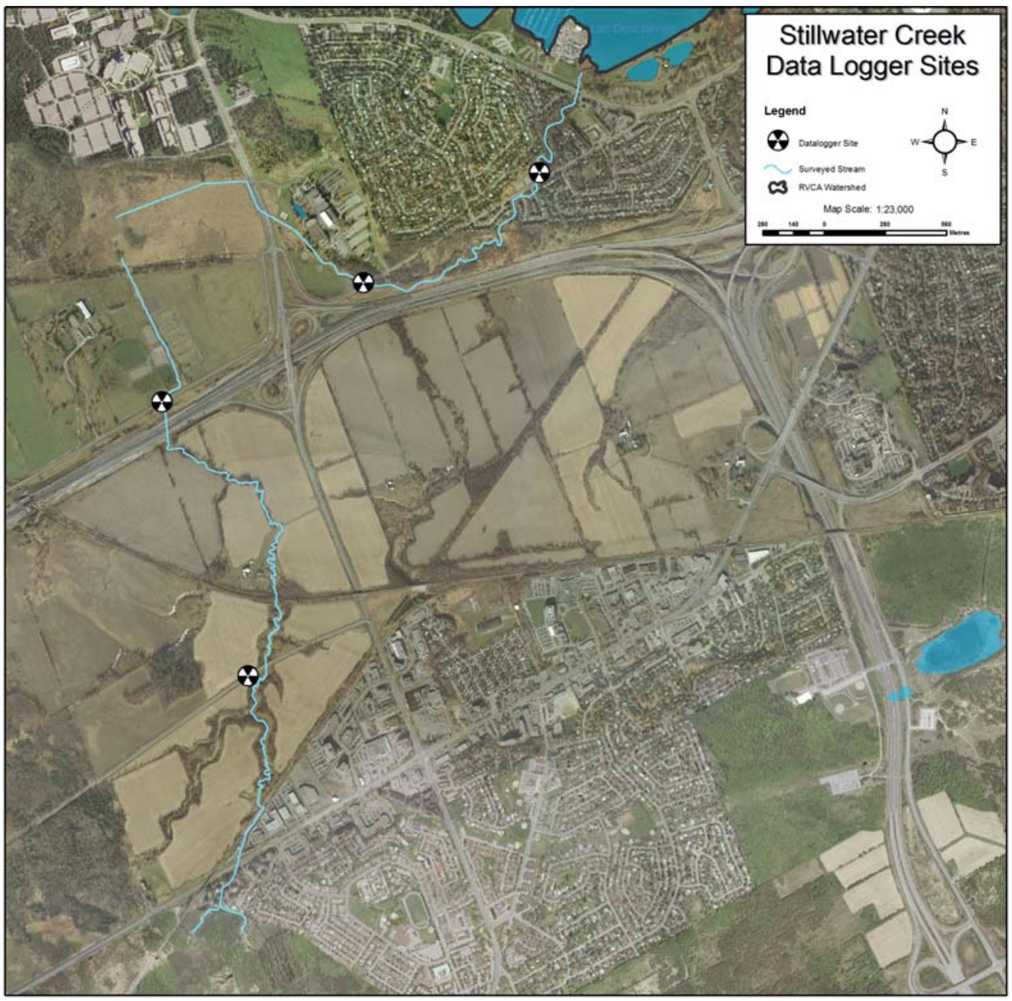

Figure 53. Datalogger Locations Along Stillwater Creek

Dataloggers were set in four 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. Due to high water levels, datalogger 1 was set farther upstream from the mouth, at Corkstown Road, adjacent to the public pool. Datalogger 2 was set downstream of Corkstown Road, where the culvert has sunken, and datalogger 3 was set downstream of Corkstown Road at the Equestrian Park. Datalogger 4 was placed upstream of Timm Road. Figures 54 show the results from the four dataloggers.

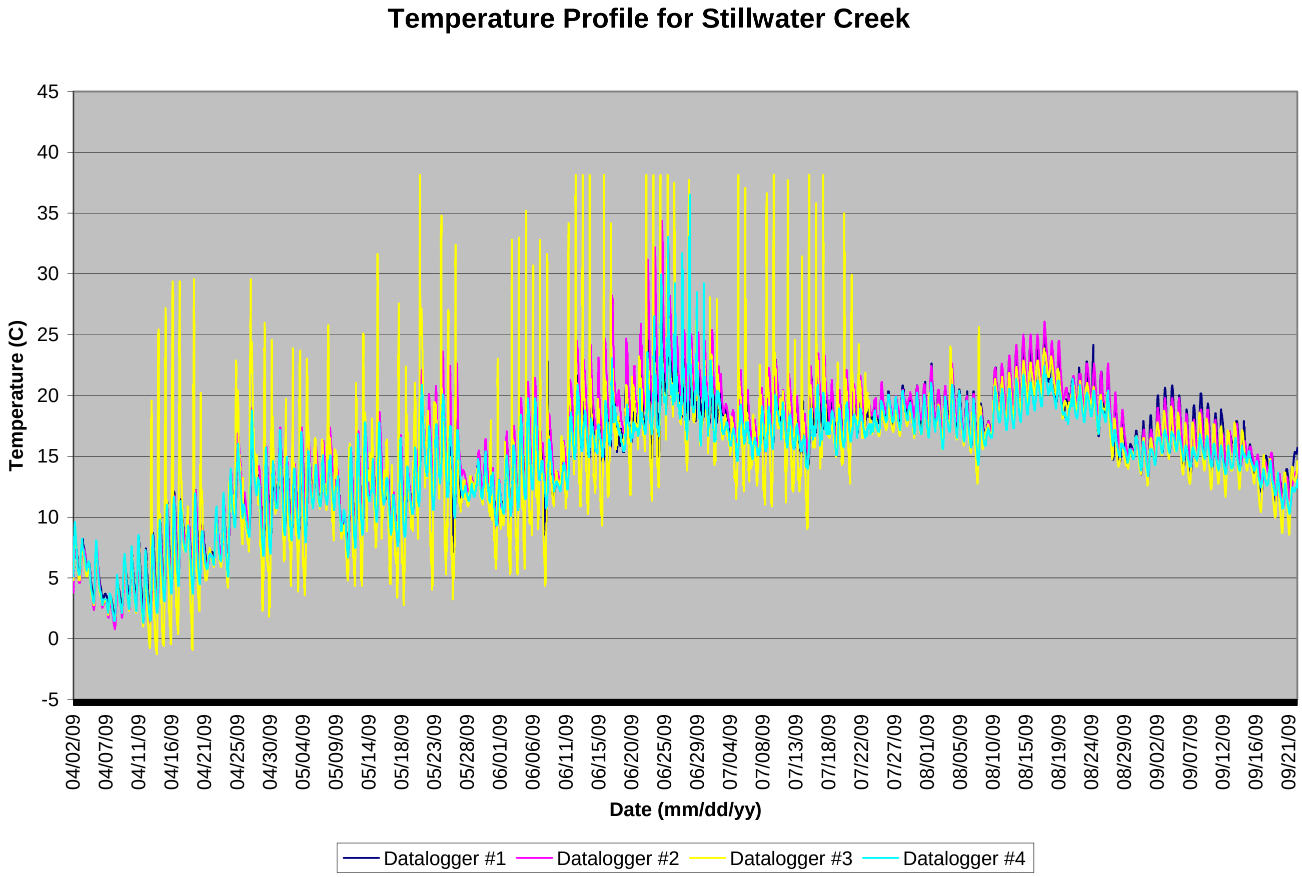

Figure 54. Temperature Profiles of Dataloggers 1, 2, 3, 4

Dataloggers 1, 2 and 4 show fairly consistent trends, with temperatures occurring mainly in the cool water range, aside from June, where temperatures exceeded 30°C during the week of June 25 when air temperatures also exceeded 30°C. Datalogger 3 has much greater fluctuations beginning in April and carrying through until July; it is very likely that datalogger 3 was out of water and recording air temperatures when those large fluctuations occurred. The stream in that location is very open and fairly narrow and shallow, surrounded by tall grass. Datalogger 1 recorded a minimum air temperature of 1.79°C on April 8 and a maximum of 33.86°C on June 25. It is likely that datalogger 1 was out of water on June 25. Water temperatures exceeded 25°C for four days in June and one day in August. Datalogger 2 reached a low of 0.78°C on April 8 and a maximum of 34.34 on June 24. Water temperatures rose above 25°C for nine days in June, one day in July and four days in August. Fish sampling occurred at the datalogger 2 location on June 25, and the datalogger was found out of water. Air temperature recorded with the YSI probe was 39.71°C, and water temperature was 28.09°C. The minimum temperature recorded at datalogger 3 was 1.27°C and a maximum of 38.15 on May 21, June 25 and July 17. Again, datalogger 3 was likely out of water frequently. Datalogger 4 recorded eight days above 25°C between June 23 and

30. The maximum temperature of 36.52°C was reached on June 28, and the minimum temperature was 1.32°C, recorded on April 12. It is difficult to determine how many of the days the dataloggers recording temperatures over 25°C were due to the dataloggers being out of water. From the fish community data, it appears that Stillwater Creek is a cool water stream, and the presence of mottled sculpin indicate there are cold water reaches. Only two warm water species were captured on Stillwater; one of those species was pike, caught only at the mouth of the stream.

11. Invasive Species

Figure 55 shows the locations of invasive species found along Stillwater Creek, highlighted in orange.

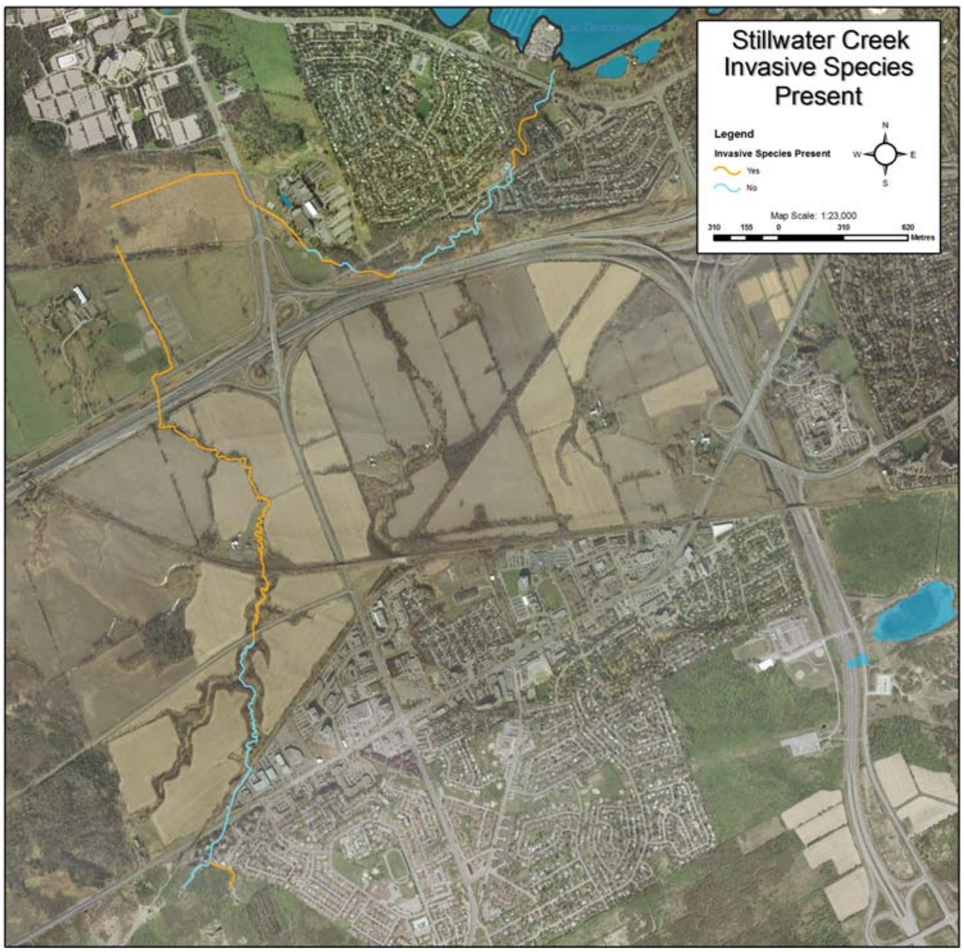

Figure 55. Air Photo of Stillwater Creek Showing Locations of Invasive Species

Invasive species were observed along Stillwater Creek for over half its length. The types varied in severity, though. The most common invasive species found along Stillwater was purple loosestrife (*Lythrum salicaria*), which did not seem to be having a negative effect on the surrounding vegetation in the majority of places. Near the mouth, common buckthorn (*Rhamnus cathartica*) was observed. Buckthorn presence is an issue because it forms large, dense canopies and crowds out native species, leading to a monoculture of buckthorn. Other invasive species found were common reed (*Phragmites australis*), European frogbit (*Hydrocharis morsus-ranae*), Eurasian milfoil *(Myriophyllum spicatum)*, and wild parsnip (*Pastinaca sativa*). All of these species are problematic, outcompeting native vegetation and forming monocultures.

12. 2004/2009 Comparison of Stillwater Creek

Stillwater Creek was sampled to Stony Swamp in 2004 (65 sections), and it was sampled to Stony Swamp in 2009 (79 sections). 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 2004 and 2009.

Anthropogenic Alterations	2004 (%)	2009 (%)
none	49	28
"natural" conditions with significant alterations by man	20	18
"altered" with considerable human impact but with significant natural areas	22	31
"highly altered" with few areas that could be considered natural	9	23

Table 30. Comparison of Anthropogenic Alterations

Overall, alterations to Stillwater Creek have increased over the last five years. Natural areas stayed relatively the same, while "altered" areas and "highly altered" areas increased. In 2009, these areas included channelized sections of the creek (Corkstown Road, Moodie Drive, Equestrian Park, Highway 417 crossing) and sections where the vegetation has been highly modified. Altered areas included shoreline armouring, stormwater outlets and less significant road crossings.

Instream Vegetation	2004 (%)	2009 (%)
extensive	22	19
common	12	16
normal	22	19
low	26	18
rare	18	15
none	N/A	13

Table 31. Comparison of Instream Vegetation

Instream vegetation is difficult to compare, and the data can depend on when the stream was surveyed. The category for "none" was also added after 2004 and cannot be reflected in the 2004 data. Instream vegetation data does differ in all categories, with slight decreases of extensive, normal, low and rare vegetation. Common levels of vegetation increased by four percent, and in 2009, 13 percent of the sections did not have any vegetation.

Bank Stability	2004 (%)	2009 (%)
stable	88	90
unstable	12	10

Table 32. Comparison of Bank Stability

Over the last five years, bank stability has not changed significantly, moving from 88 percent stable to 90 percent stable. Although water levels along Stillwater can fluctuate by large amounts, there does not appear to be much threat to shoreline stability.

Pollution/Garbage	2004 (%)	2009 (%)
None	28	22
oil or gas trails	1	1
floating garbage	46	59
garbage on stream bottom	48	37
unusual colouration	N/A	0

Table 12. Comparison of Pollution/Garbage

Sections without pollution/garbage decreased by six percent. Oil and gas trails remained the same, and there was an increase in both floating garbage. Less garbage on the stream bottom was observed in 2009. Unusual colouration of the streambed was added after 2004 but not observed in 2009.

Species Caught	2004	2009
banded killifish	X	X
black crappie	X	
blackchin shiner	X	X
blacknose shiner		X
bluegill	X	
bluntnose minnow	X	
brook stickleback	X	X
central mudminnow		X
common shiner		X
creek chub		X
emerald shiner	X	
Etheostoma spp.	X	X
fathead minnow		X
golden shiner	X	
largemouth bass		
logperch		X
mottled sculpin		X
muskellunge	X	
northern pike		X
northern redbelly dace		X
pumpkinseed	X	
rock bass	X	
spottail shiner	X	X
white sucker	X	X
yellow perch	X	X
TOTAL SPECIES CAUGHT	**16**	**16**

Volunteers bring in fyke net in pouring rain, July 11, 2009

Log perch caught at site two, July 30, 2009

Fish sampling was done on Stillwater Creek in 2004 and in 2009. The same number of species was captured in 2004 and 2009, although over half of the species caught were different. In 2004, five sites at the mouth of Stillwater Creek (all downstream of Carling Avenue) were sampled over two days. Four sites in 2009 were sampled four times, one time per month for April, May, June and July, and the sites were spread out between the mouth and Corkstown Road. Fish sampling methods changed over the five years. A seine net was used in 2004, and in 2009, sampling methods included seine netting, electrofishing, windemere traps and a fyke net. Nine species caught in 2004 were not found in 2009, which were black crappie, bluegill, bluntnose minnow, emerald shiner, golden shiner, largemouth bass, muskellunge, pumpkinseed and rock bass. This does not mean the species have disappeared but could be influenced by location, weather or time of sampling. Nine species were caught in 2009 which had not been in 2004, including central mudminnow, fathead minnow, blacknose shiner, common shiner, creek chub, logperch, mottled sculpin, northern pike and northern redbelly dace.

3.3 Special Events

Over the summer, City Stream Watch ran 12 special events outside of regular sampling. These events included two tree plants, two invasive species removal, garbage cleanups, fish sampling demos (using seining, electrofishing, a fyke net and windemere traps) and a benthic 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 2009 to help provide diverse habitat: highbush cranberry, nannyberry, red osier dogwood, white cedar, tamarack, silver 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 (red oak, white pine, etc.) were planted at the top of slope.

Invasive Species Removal: Dog-Strangling Vine

Dog-strangling vine (DSV) was observed by City Stream Watch in 2008 on Green's Creek and Sawmill Creek, both areas 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. One site on each creek was identified, and volunteers coordinated efforts to cut back the vine to help control its spread. For both removals, 25 volunteers spent a total of 81 hours cutting back the vine. 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 are hot enough to kill the seeds. The removals were held when the seed pods had formed to prevent further spread of the plant.

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

3.3.1 Bilberry Creek- Riparian Planting

The Bilberry Creek planting site was chosen in collaboration with the City of Ottawa. This site was an open meadow with few trees, sloping down to the creek. The shoreline in that area has been modified by armourstone. Land use adjacent to the stream is mainly residential and commercial, and the stream is crossed by St. Joseph Boulevard. Shrubs and trees were planted to improve habitat, slow runoff and to improve the buffer.

On May 9, 19 volunteers came out to plant for a total of 38 hours, including a few members of the 42nd Gloucester Pathfinders. The tree plant started well; however, the weather turned for the worst and the tree plant ended early. Three hundred trees and shrubs were planted at the site.

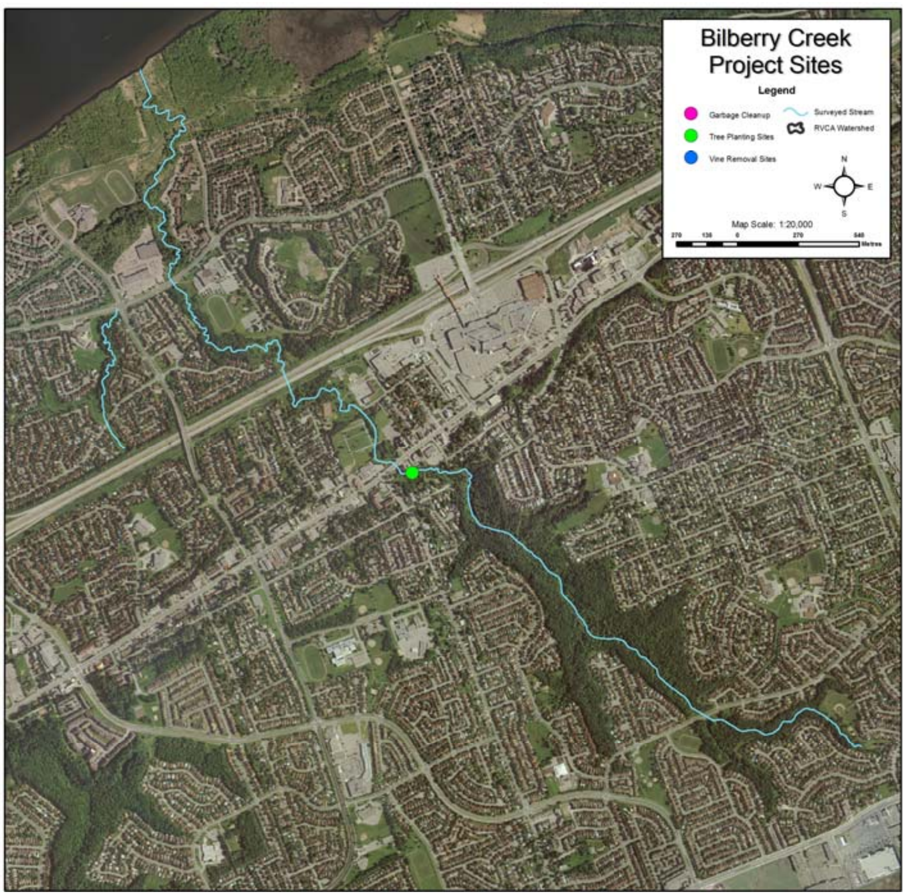

Figure 56. Air Photo of Sawmill Creek Showing Tree Planting Site

3.3.2 Green's Creek-Riparian Planting and Invasive Species Removal

The Green's Creek planting site was chosen in collaboration with the NCC. This site was an open meadow with few trees, sloping down to the creek. The immediate shoreline was quite compacted with fill, due to recent construction at the Montreal Road crossing. A section closest to the road was not planted on to allow access for future bridge maintenance. Shrubs and trees were planted to improve habitat, slow runoff and improve the buffer area. On May 3, 27 volunteers came out to plant for a total of 79 hours, including Councillor Rainier Bloess. The weather cooperated, and five hundred trees and shrubs were planted at the site. The 200 species left over from the Bilberry Creek tree plant were planted at Green's Creek later, by RVCA staff.

Figure 57. Air Photo of Green's Creek Showing Tree Planting Site and DSV Removal

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 we're hopeful that in future years we can control its spread and success. There are a few goldenrod plants already growing at the site which may show some resistance to the vine. The Ottawa Flyfishers Society assisted with the removal, and seven volunteers spent 21 hours clearing the site.

3.3.3 Sawmill Creek-Invasive Species Removal and Stream Garbage Cleanup

Dog-strangling vine was observed by City Stream Watch volunteers in 2008, from the Heron Park area and farther upstream, close to the Home Depot on Bank Street. Dog-strangling vine is thickest at Heron Park, where past riparian planting efforts have been focused, and that site was chosen for the demonstration. The dog-strangling vine is so established in that area, that although it was cutback, it realistically will not control it. The focus of the day was to discuss invasive species observed in the Ottawa area, their impacts on local environments and a hands-on experience with dog-strangling vine (identification and removal). With increased awareness of dog-strangling vine, it is hoped that more people will report it when they find it. The location of the removal is illustrated in Figure 66. It is the same location as one of the garbage cleanup locations, and therefore is represented as Site 1.

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 Heron Park Community Association and the National Defence Headquarters Fish and Game Club (NDHQ), 23 volunteers were recruited and spent 69 hours picking garbage out of Sawmill Creek. Some volunteers started at Heron Park (Site 1) and worked upstream, to the transit crossing. A small group of volunteers worked around the Bank St. crossing at Home Depot, where an extensive amount of garbage collects annually (Site 2). Two more groups concentrated on Sites 3 and 4, which typically collect quite a bit of garbage. The Monterey Inn Resort and Conference Center supplied delicious sandwiches for volunteers at lunchtime! Figure 66 shows the areas of Sawmill Creek that were cleaned.

Figure 58. Map of Sawmill Creek Garbage Cleanup and Vine Removal Sites

3.3.4 Stillwater Creek-Stream Garbage Cleanup

The TD Great Canadian Shoreline Cleanup happens each year across Canada in September. It started 16 years ago as a conservation initiative of the Vancouver Aquarium and has now grown into the second largest cleanup in the world. 2009 was another successful year for cleanup initiatives. Community members collectively removed 160,000 kg of litter from shorelines in one week across Canada! City Stream Watch takes part in this event every year, and this year the cleanup was held on Stillwater Creek. During the stream surveys throughout the summer, a large amount of garbage was recorded near the mouth of Stillwater and along Corkstown Road. This is the area that was focused on.

Twenty-five volunteers donated 75 hours of their time to help remove garbage, including the Stillwater Creek Riverwatcher and members from the 19th Nepean Scout Group. Volunteers were asked to record the type and amount of garbage they collected so that the organizers could identify and address the types of garbage found most often in Canada's waterways. The results from 2009 show that the most common types of garbage found for yet another year were cigarette butts, food wrappers and plastic bags. Recyclables such as plastic bottles and aluminum cans were also found in high numbers. Organizers asked participants to record the most unusual item found, and the ones they published included hair extensions, a mannequin wearing a bikini, a statue of the Hindu God Shiva and a Chewbacca toy. The most interesting piece of garbage found on Stillwater Creek by City Stream Watchers was not included on their list, but it should have been. It was the first blow-up doll found on a City Stream Watch cleanup! The meeting location for the cleanup is illustrated in Figure 67. From the meeting spot, volunteers worked south, past the Carling and Corkstown Road crossings for an approximate 1.5 kilometres.

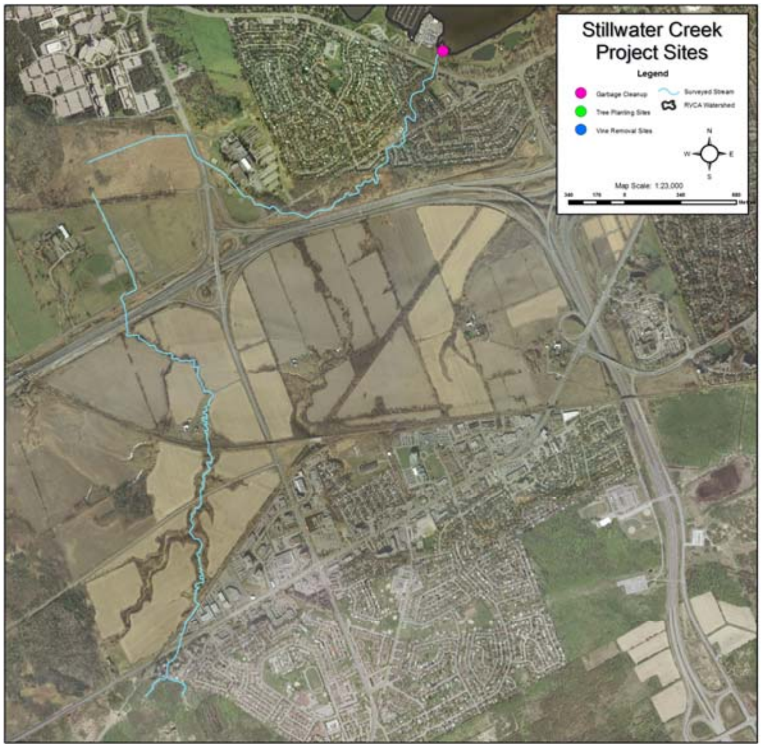

Figure 59. Map Showing the Stillwater Creek Garbage Cleanup Location

3.3.5 The Ultimate Aquatic Workshop

On October 3, 2009, 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 process and identify the benthos to the order level and provided different information on benthos and how they relate to fly fishing. 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. 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. 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.

3.3.6 Fish Sampling and Identification Sessions

A total of ten fish sampling demonstrations were held during the 2009 season, six of which were formal, with registration required, and four were informal demos with individual volunteers. Two sessions were held on Bilberry, two on Barrhaven, one on Mosquito and one on Stillwater. For three of the sessions, a fyke net was set for 24 hours before the demonstration. Volunteers participated in collecting the net, identifying, weighing and measuring the fish, as well as sampling with a seine net. The fyke net and seining demonstrations were conducted on Barrhaven Creek, Bilberry Creek and Stillwater Creek, both at sites close to the mouth of the streams. A total of 32 volunteers took part in those sessions, for a total of 94 hours. Electrofishing demonstrations were held on Barrhaven Creek and Bilberry Creek to show volunteers how the electrofisher works. Only certified RVCA staff collected the fish, while volunteers remained on the banks. Before beginning, all safety features of the electrofisher were explained to volunteers and all safety features tested before sampling began. Once the site was complete, volunteers were then able to participate in the remainder of the processing (identification, weight, measurement and release). A total of 23 volunteers attended the sessions, which amounted to 78 volunteer hours. There was a small fish demonstration held on Mosquito Creek with windemere traps. Due to last-minute cancellations, only one volunteer participated. Windemere traps were set at two locations and picked up 24 hours later. The volunteer participated for three hours in collecting the traps, sorting, identifying, weighing, measuring and recording the fish. The informal fish demos took place on all four creeks, and involved eight volunteers for a total of 37.5 hours.

3.4 Rideau River Cleanups

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 on May10th. 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. Seven City Stream Watch volunteers donated 24 hours to cleaning up litter along and in the Rideau River, by foot and canoe.

The 1st Manotick Scouts organized a cleanup on April 25 along the Rideau River between Manotick and the north end of Long Island. City Stream Watch provided gloves, garbage bags and garbage collection for the event. Part of the group went by canoe, picking up litter from the boat, and the rest of the group went on foot, picking up garbage between Rideau Valley Drive and the Rideau River. Both groups met on the island for a barbecue afterwards.

3.5 School Demonstrations

City Stream Watch had several requests from schools to provide hands-on education for students. With a packed field season, City Stream Watch and RVCA staff were not able to meet all requests, but did run three events for three different schools. The first school session was held for grade ten students from Cairine Wilson Secondary School in Orleans. Cairine Wilson backs onto Bilberry Creek, and Cairine Wilson runs a garbage cleanup along that creek annually. Approximate 80 students attended the school demonstration. It began with a garbage cleanup from St. Joseph Boulevard to the mouth of the creek. They were then split into smaller groups and rotated through five stations focusing on stream measurements, fish sampling and fish identification, benthos sampling and identification (benthos and fish stations had live species from Bilberry Creek), invasive species and water quality issues from a global to local perspective.

The second school demonstration was for 20 students from Bell High School. Students were taught about native plant species, invasive species, benthos identification and fish identification. They were able to participate in sampling for benthos and helping RVCA staff pull in windemere traps and a fyke net that had been set the day before.

The third demonstration was attended by approximately 100 students from Mother Teresa High School in Barrhaven. RVCA staff set up stations at the Jock River Landing focusing on invasive species, benthos sampling/identification, fish sampling/identification, water quality sampling methods, the value of natural shorelines and water quality issues overall. Students were able to participate in sampling for benthos and pulling a seine net. They were then able to look at live species.

City Stream Watch and RVCA staff also taught a morning session at Watson's Mills Day Camp in Manotick. Kids learned how benthos sampling is essential for monitoring water quality and were able to look at live specimens. They also had a chance to look at some local fish species, although the crayfish were the most popular.

4.0 A Look Ahead to 2010

The City Stream Watch program is currently planning projects for the 2010 season. Stream surveys run on a 5-year cycle, and in 2010, the program will be returning to the streams sampled in 2005, as well as adding an unsurveyed stream that has not yet been sampled. This allows managers to update data and determine if a creek has undergone major changes.

The streams to be re-surveyed in 2010 include Graham Creek, Green's Creek and Steven's Creek. McEwan Creek will be surveyed for the first time. Figure 68, below, illustrates the stream watersheds in relation to the City of Ottawa. Maps of 2010 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 2010 program, various projects have been identified and plan to be implemented beginning in the spring. Some projects include:

- Stream surveys on Graham, Green's, Steven's and McEwan Creeks

- Fish community sampling through seine netting, hoop netting and electrofishing
- Aquatic invertebrate sampling/identification
- Flyfishing demonstration by OFS members, along with invertebrate ID session
- Temperature profiling of 2010 streams
- Cleanups on city streams as part of Canadian Rivers Day and the TD Great Canadian Shoreline Cleanup (Sawmill Creek and another TBD)
- Riparian planting on two city streams in coordination with the City of Ottawa and the NCC
- One small-scale bioengineering project (Graham Creek or another site TBD)
- Invasive plant species removal on Green's Creek
- Migratory obstruction removal and garbage cleanup on Barrhaven 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.

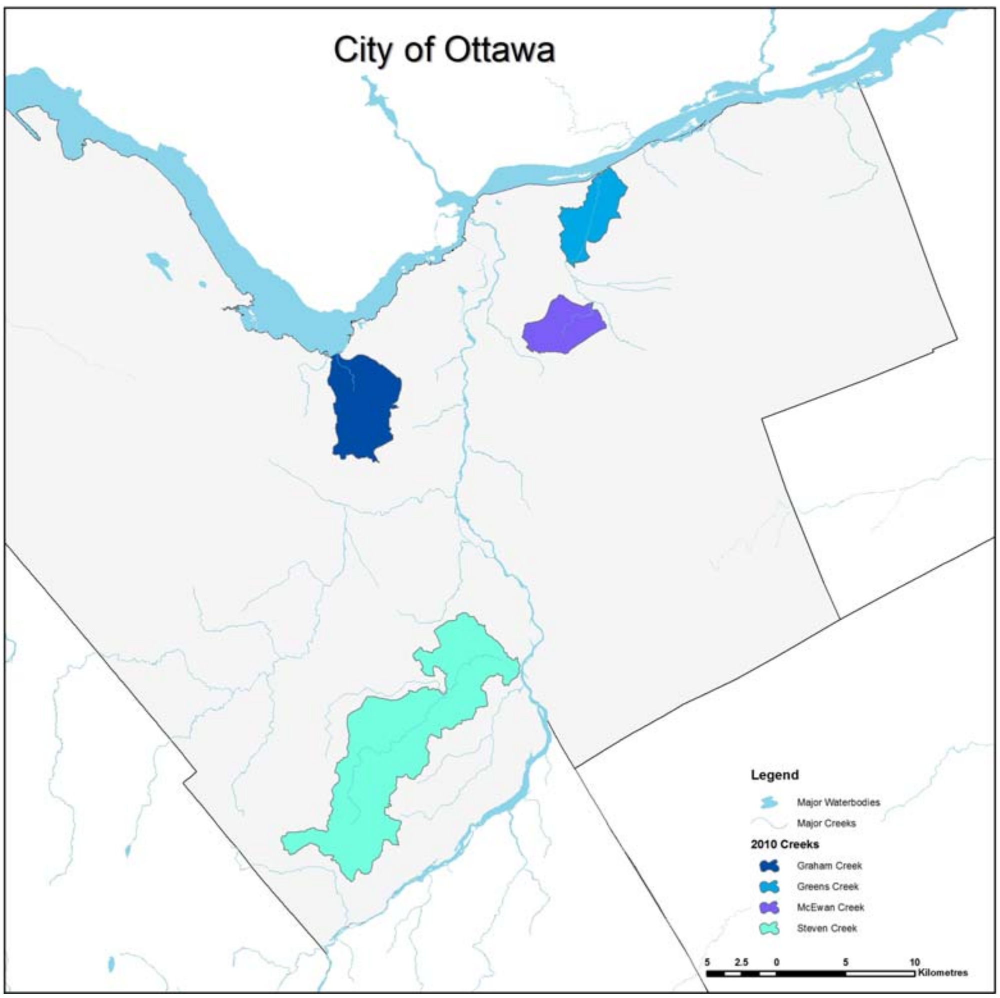

Figure 60. Locations of Streams and Their Watersheds to be surveyed in 2010

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 seven 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 Improvements

The following are recommendations to improve 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 two summer students 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.
- 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 attract students to participate to gain experience
- Every year, many seasonal migratory obstructions are observed and could be easily removed, for which City Stream Watch could take a more active role
- 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
- Expand the pilot project of Adopt-A-Stream to 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

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 35 identifies several possible rehabilitation projects that were developed through monitoring.

Table 44. City Stream Watch– Project Potentials

Location	Issue	Picture	Remediation Strategy	Expected Results
Sawmill Creek just north of Hunt Club Road.	A failed culvert has blocked the stream flow and woody material has accumulated upstream of the culvert area. The obstruction has dammed the stream, forcing the stream to alter its course around the sides of the culvert , creating an erosion and siltation problem. The cement wall is creating a flow deflector, which is severely eroding the east bank.		• Determine land ownership • Partner with the City of Ottawa with the culvert removal • Work with the NDHQ Fish and Game Club on the project and utilize existing volunteer base of the City Stream Watch program to participate in this rehabilitation effort by removing woody debris blocking the area • Plant shrubs and trees to stabilize banks to help stop erosion or use bioengineering, depending on the damage done to the shoreline	• Community involvement • Enhance fish and wildlife habitat • Reduce erosion of banks • Eliminate possibility of bank failure causing tree collapse into stream • Remove potential migratory obstruction
Location	**Issue**	**Picture**	**Remediation Strategy**	**Expected Results**
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
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 sides of the stream erode 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
Location	**Issue**	**Picture**	**Remediation Strategy**	**Expected Results**
Stillwater Creek, just downstream of Robertson Road.	In this location of Stillwater Creek, the stream is essentially treated as a ditch. Very little to no buffer exists and garbage has accumulated in the creek.		• Speak with landowners regarding the issue • Organize a garbage cleanup • If permission is granted, obtain funding to plant shrubs and trees along the shorelines • Involve local community members	• Effective stream bank protection • Create new partnerships • Enhance conditions for natural colonization of existing plant community • Produce streamside wildlife habitat • Enhancement of the creek's aesthetic qualities and create respect for the stream • Community involvement

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**
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 aggravates 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
Barrhaven Creek, just downstream of Prince of Wales Drive	A migratory obstruction has built up along Barrhaven Creek and is currently collecting garbage. Game fish were caught downstream of the obstruction. The obstruction should be removed so that fish can access potential spawning or rearing areas farther upstream.		• Determine land ownership • Apply for any necessary permits • Utilize existing volunteer base and remove the obstruction and garbage out of the creek and dispose of properly	• Enhance fish and wildlife habitat • Enhance the creek's aesthetic qualities. • Prevent further erosion

Location	Issue	Picture	Remediation Strategy	Expected Results
Green's Creek	Dog-strangling vine is growing along the shoreline and beginning to expand into the scrubland area on the left bank. The first removal was completed in 2009. Another removal will be necessary in 2010 to keep the vine contained.		• Utilize existing volunteer base to clear the vine away • Use RVCA trucks to take vine to the Trail Road facility where the vine can be composted properly • Partner with other groups working on invasive species removal	• Promote community involvement in rehabilitation projects • Enhance fish and wildlife habitat • 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	• 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

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Appendix A

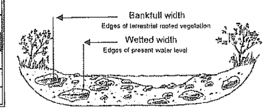
Name of Stream/River/Drain:

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
%	Abandonned 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

Dam #	Location (UTM) Easting	Northing	Photo Numbers US	CS	DS	Head (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 - O.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

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: YYYY-MM-DD

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 100 metres 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 100 metre 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 100 metre section.

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

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

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

Air temperature is measured in °C at the starting point of the 100 metre 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 100 metre 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 having a series of meanders, pools, and riffles, with a significant amount of riparian (transitional zone between aquatic and terrestrial habitats that contains moist soils and lush plant growth) area.

A natural stream can be altered in a number of ways:

- The shoreline can be armored to varying extents (retaining walls, rip-rap);
- The stream channel can be diverted or straightened;
- Riparian vegetation can be replaced by lawn, beaches, etc;
- Docks or other structures may extend into the stream.

An **altered section of stream** can be altered to varying degrees. It can be:

- **Natural** with minor human alterations but the majority considered natural.
- **Altered** with considerable human influences, but still featuring significant natural portions
- **Highly altered** by humans with areas that could be considered natural

2. **Land use:** Please note and record the land use patterns along this section of the stream. *Must total to 100percent*

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.

<u>Instream Substrate</u>

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*

<u>Morphology</u>

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 100percent*
      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 six 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 100percent*
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

Instream Habitat

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 100percent 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 100percent 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 100percent 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 (percent stream shaded):** The percent of the stream that is shaded by overhanging trees and tree canopy that is >1m above stream surface

Beaver Activity

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: >50percent
Normal: 25-50percent
Low: <25percent
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 100percent*

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?

<u>Bank Characteristics</u>

16. **Bank stability:** *Each bank must total 100percent*
Stable: No sign of erosion and banks are generally well vegetated or covered with boulders or cobble. Undercuts may be present but the bank is fully stable

Unstable: Signs of erosions are present and generally <50percent of banks are vegetated or covered with boulders/cobble. Bank could be slumping or sloughing and sever unstable undercutting is present

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

18. **Soil composition:** *Each bank must total 100percent*
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)

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

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

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

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

21. **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** (>20 metre of the stream bank in the 100 metre section), **moderate** (10-20 metre) or **low** (<10 metre).

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.

22. **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.

23. **Critical fish habitat** are 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.

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.

24. 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.

25. 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.**

26. **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 fingernailclam
-European frogbit	- Rusty crayfish
-Common carp	- Red-eared slider (turtle)

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

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:

The Rideau Valley Conservation Authority, in partnership with a collaborative of six other agencies

- City of Ottawa
- Heron Park Community Association
- National Defence Headquarters Fish and Game Club
- Ottawa Flyfishers Society
- Rideau River Roundtable

is conducting surveys that are designed to record basic stream characteristics, including information about the banks and the instream features. This year's focus is on Barrhaven Creek, Bilberry Creek, Mosquito Creek and Stillwater Creek. The survey examines and collects information regarding fish community/habitat, aquatic invertebrates, aquatic and riparian vegetation, bank stability, stream temperatures, etc.

The program is designed to increase public participation and awareness concerning the state of streams within the city. These efforts will provide officials with valuable information needed to better manage stream resources.

While we are completing the surveys, we may need to access the creek via 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 2-4 people working for approximately 1 hour on the site. We will respect all private property and leave the site clean and with minimal disturbance.

If you would like more information on the project or have any concerns, please contact me. To learn more about the program and view 2003 – 2008 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
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Rideau Valley Conservation Authority
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Rideau Valley Conservation Authority
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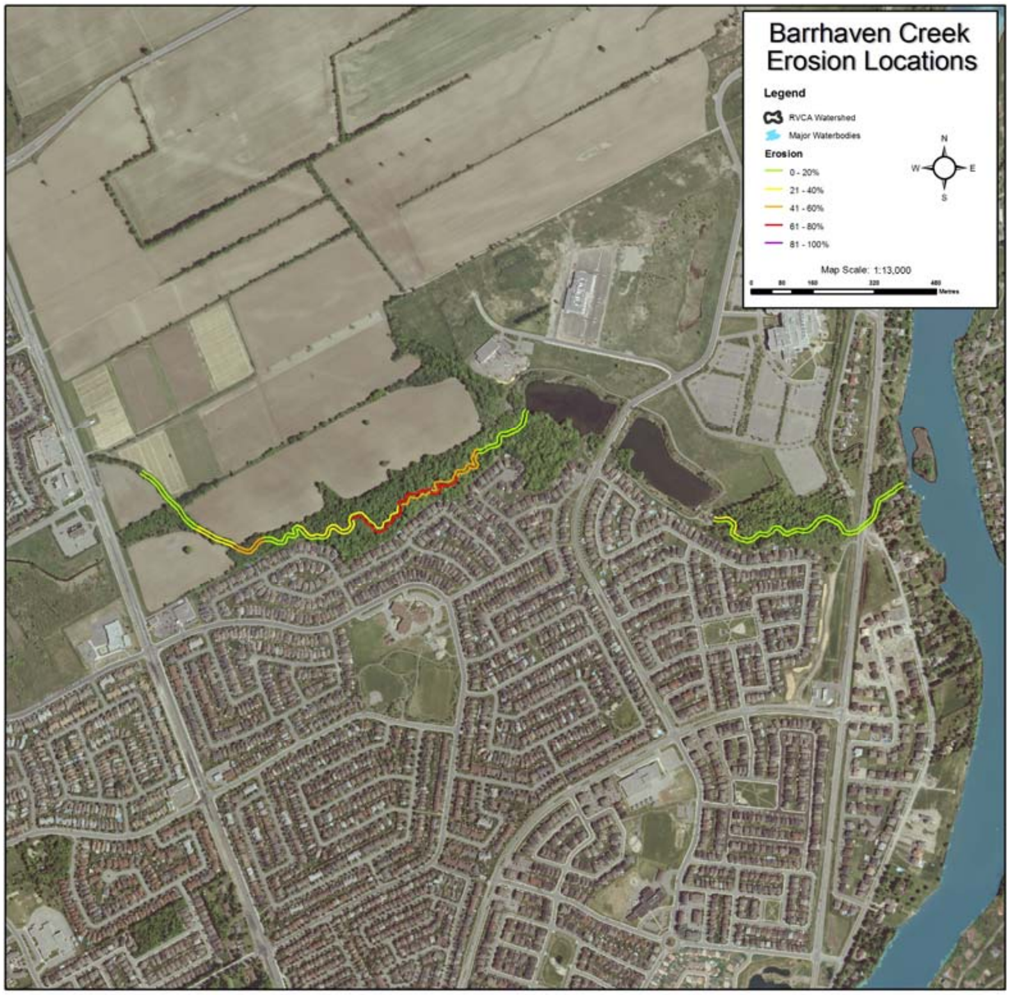
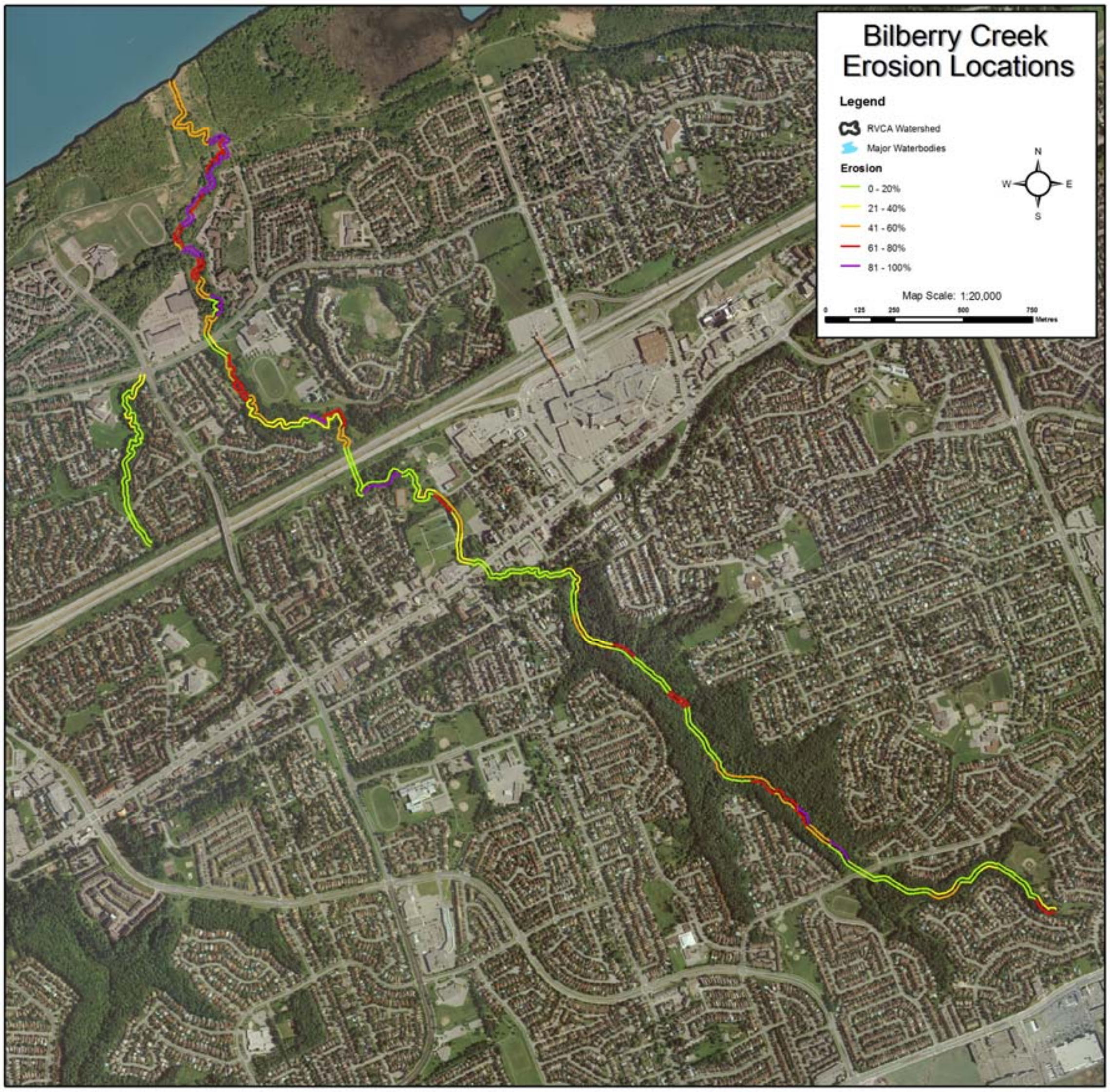
Appendix E

Maps of Erosion Sites

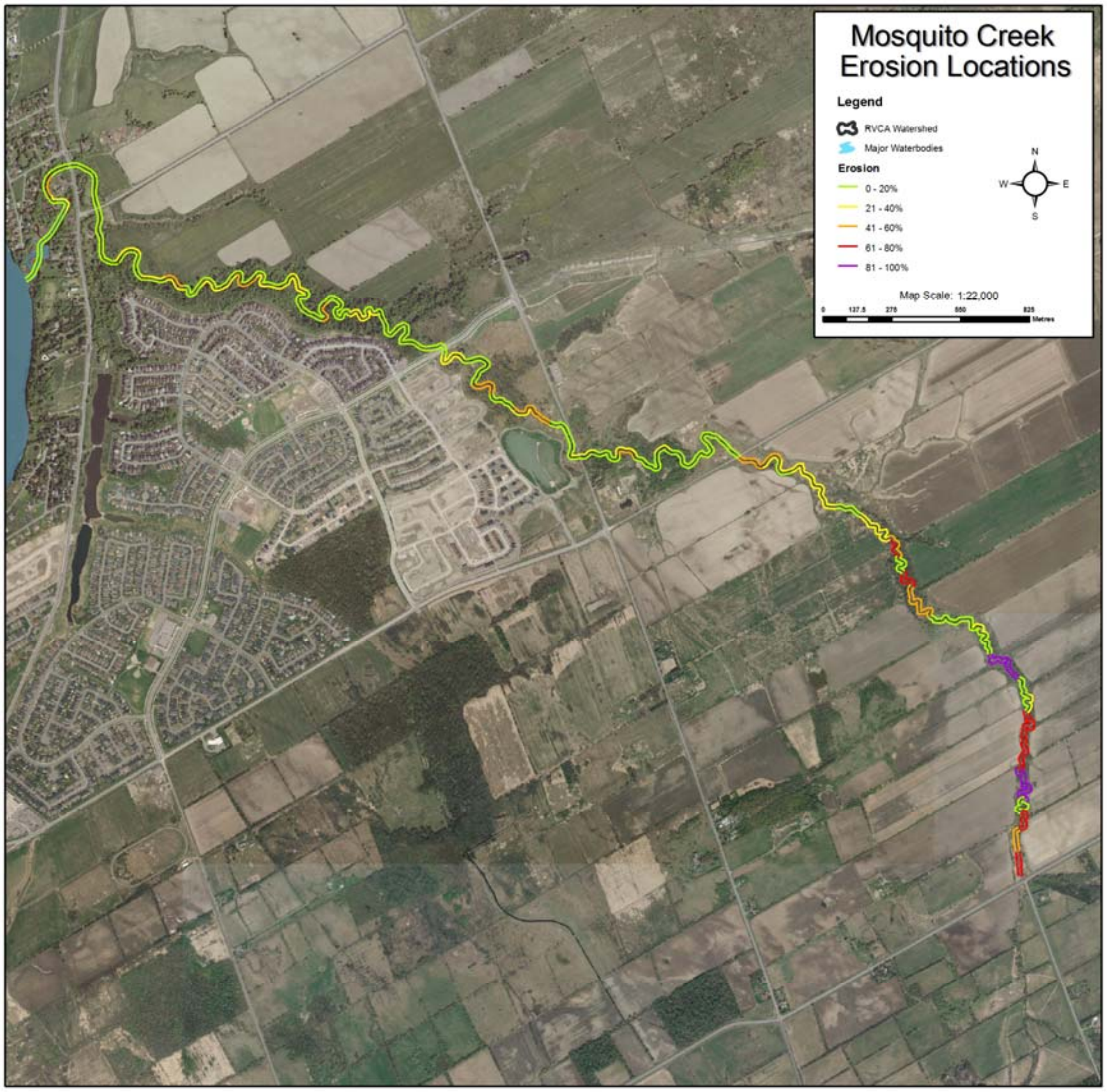
i) Barrhaven Creek Erosion



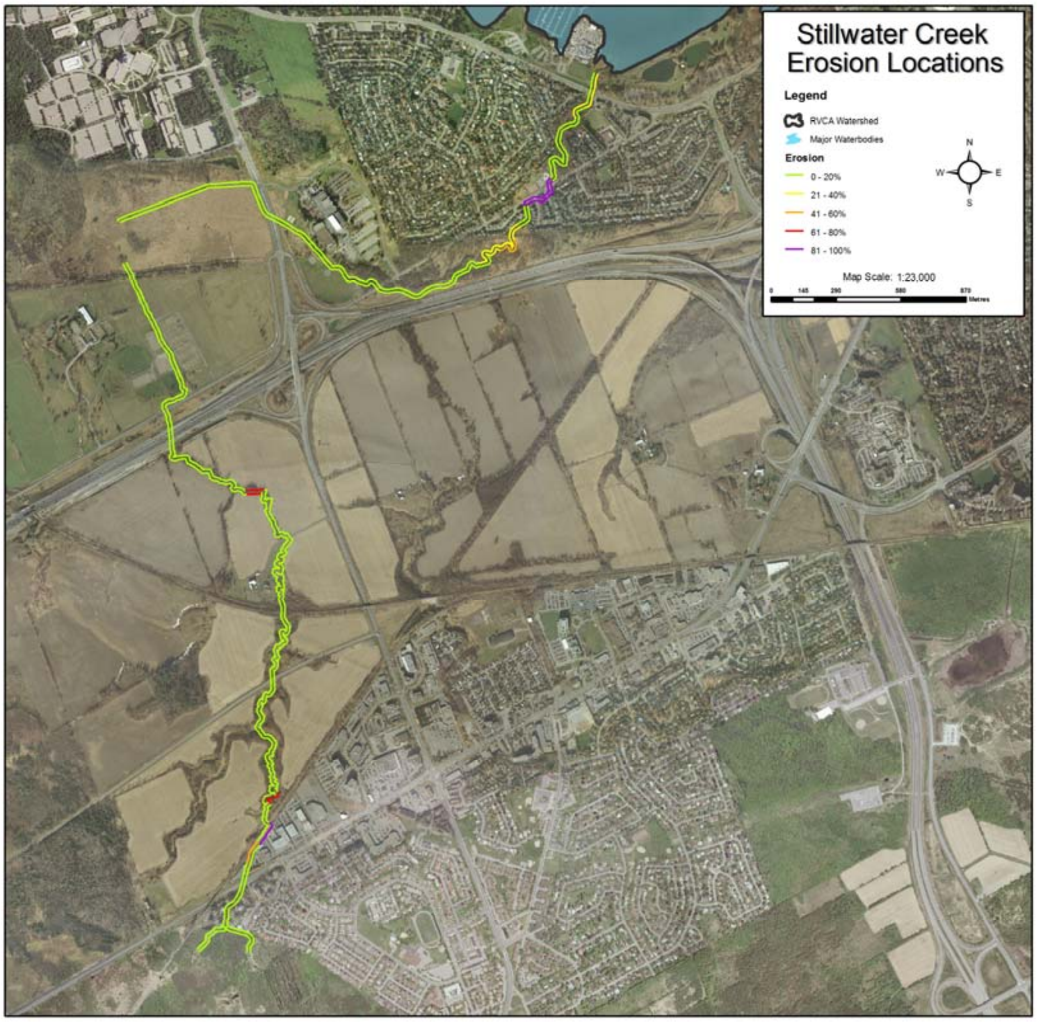
ii) Bilberry Creek Erosion



iii) Mosquito Creek Erosion



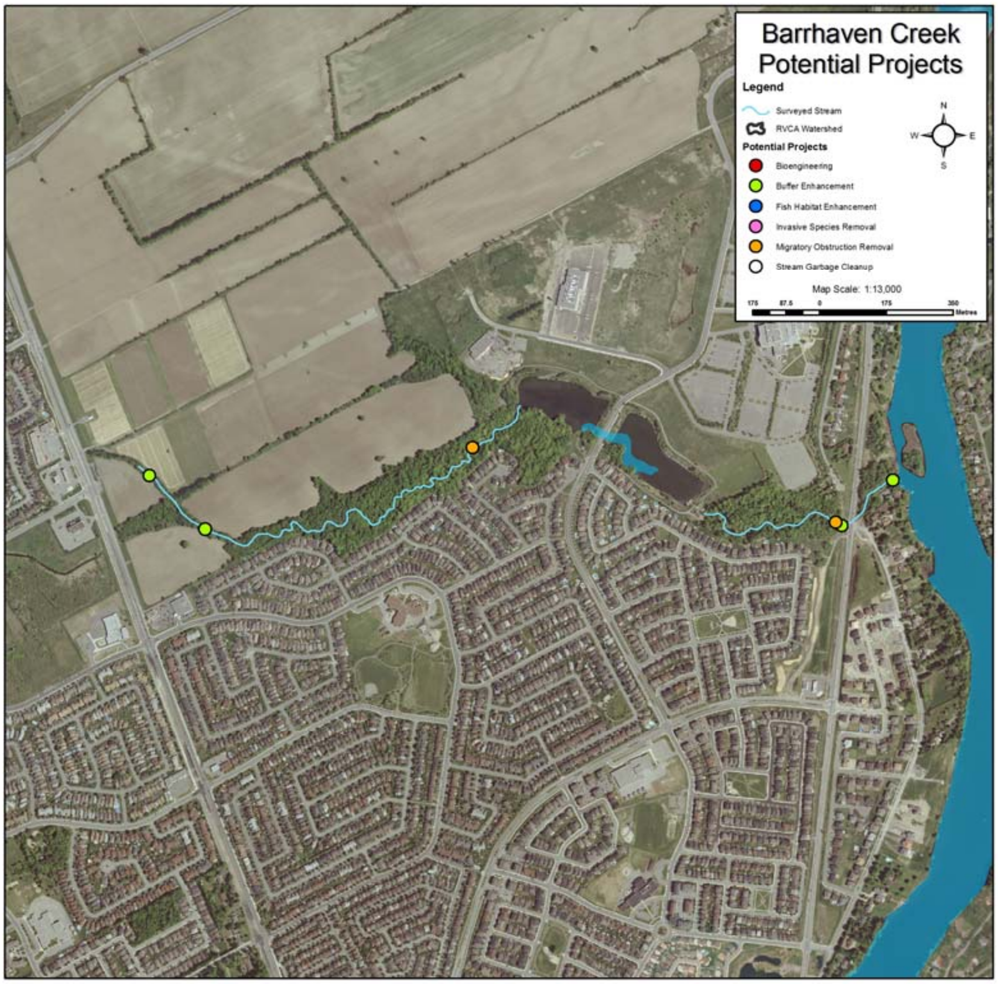
iv) Stillwater Creek Erosion



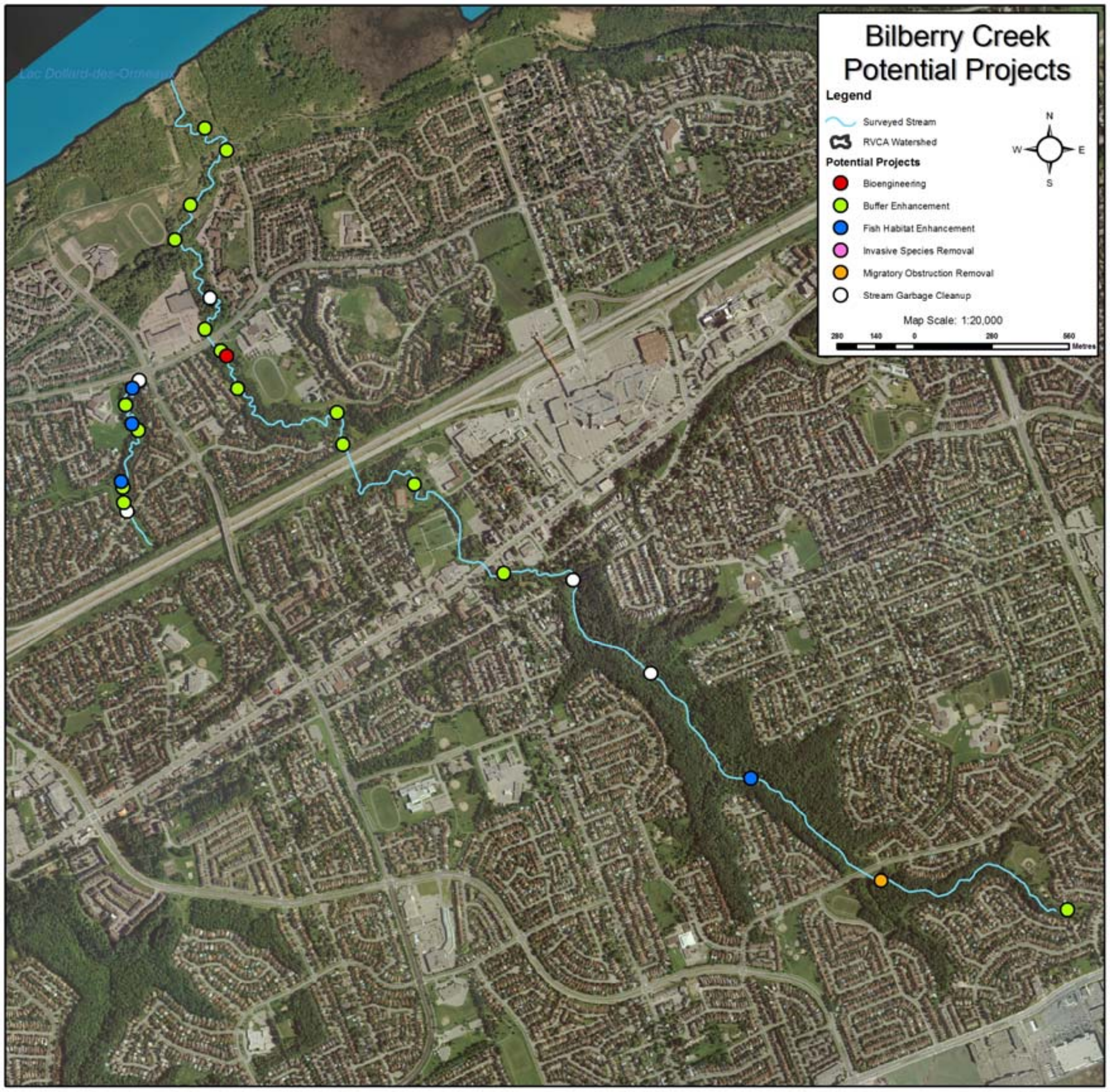
Appendix F

Maps of Potential Project Areas

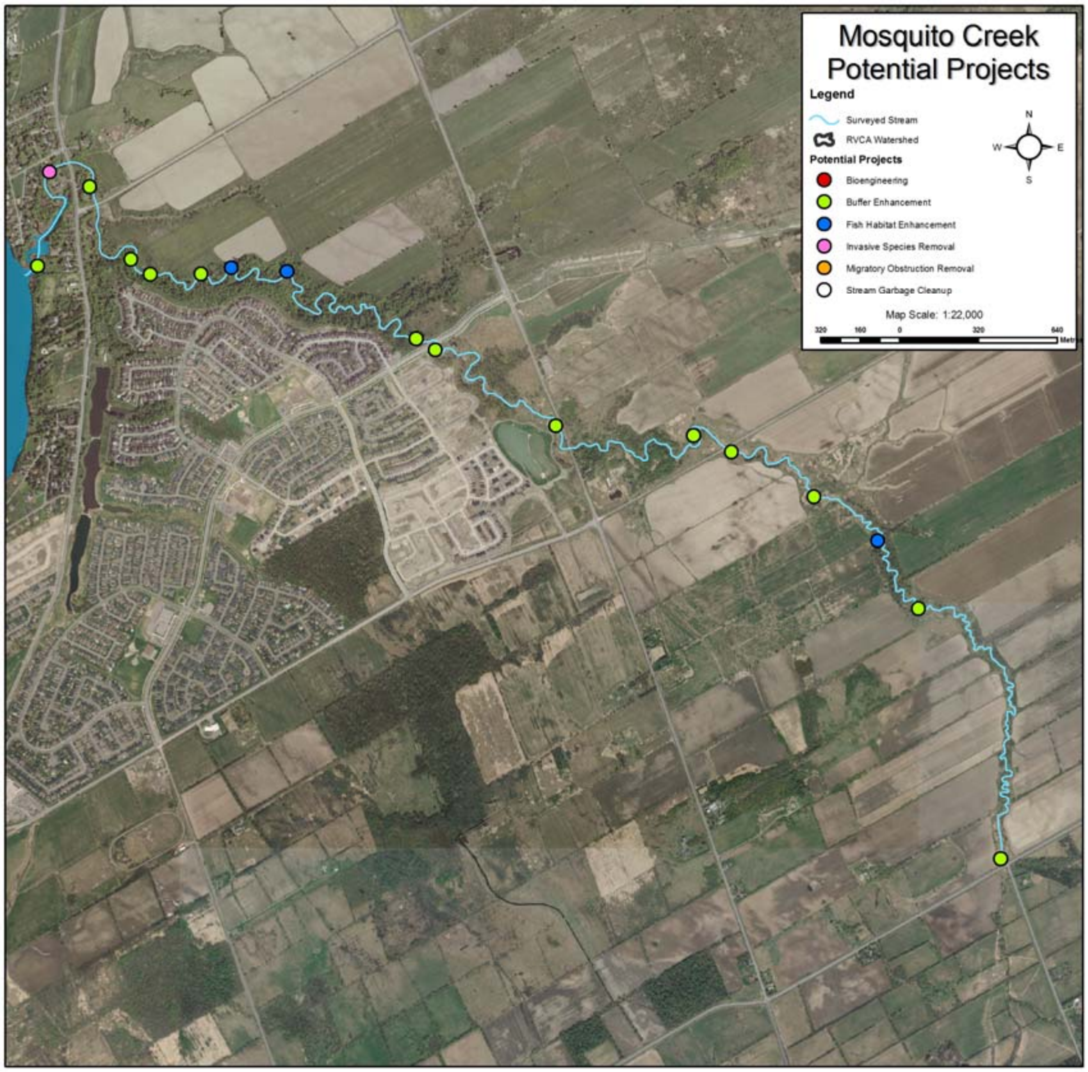
ii) Barrhaven Creek Projects



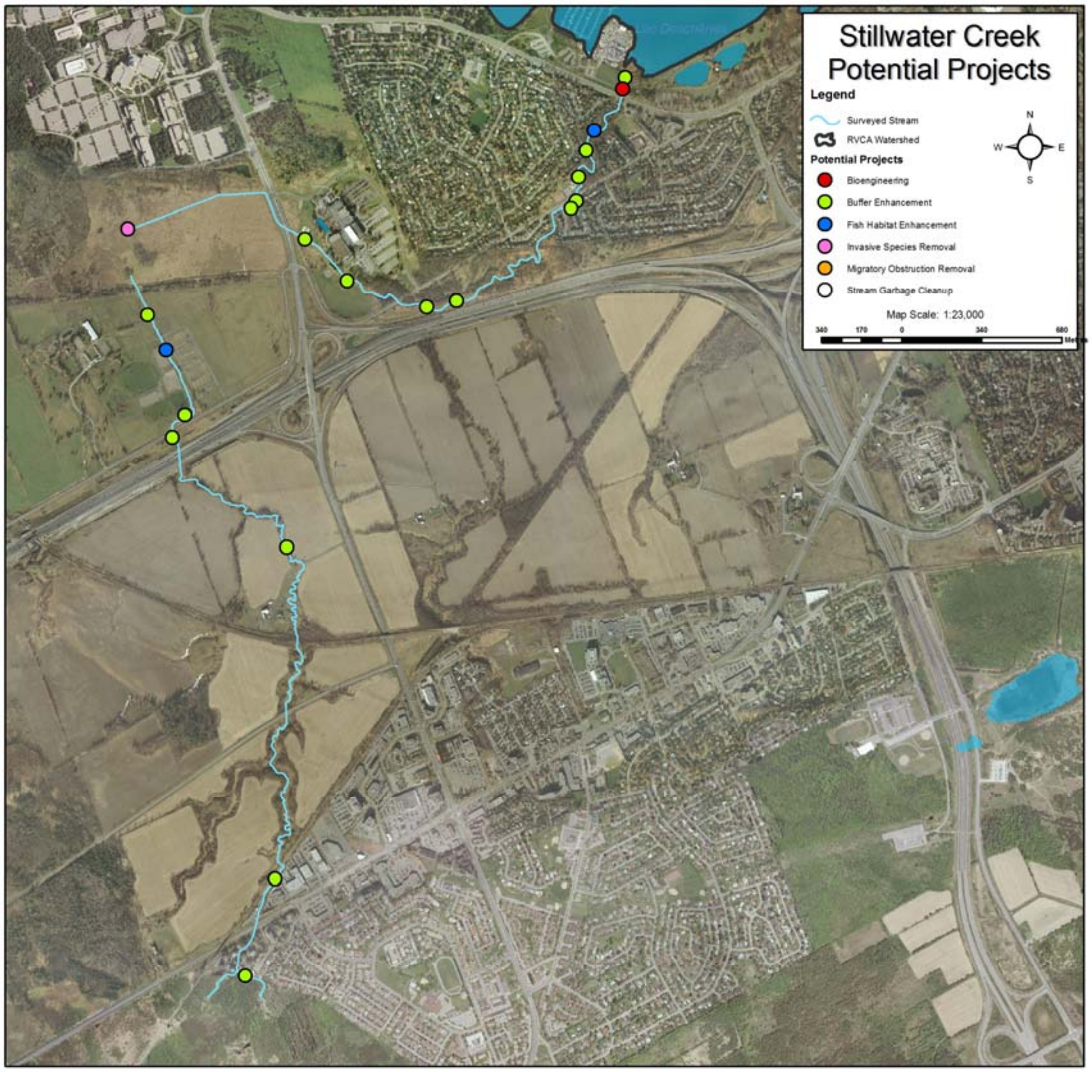
iii) Bilberry Creek Projects



iv) Mosquito Creek Projects



iv) Stillwater Creek Projects



Appendix G

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 H

City Stream Watch 2008 Organizational Chart