Rideau Lakes Subwatershed Report 2014
UPPER RIDEAU LAKE CATCHMENT

RIDEAU VALLEY CONSERVATION AUTHORITY

The RVCA produces individual reports for eight catchments in the Rideau Lakes subwatershed. Using data collected and analysed by the RVCA through its watershed monitoring and land cover classification programs, surface water quality conditions are reported for Upper Rideau Lake along with a summary of environmental conditions for the surrounding countryside every six years.

This information is used to help better understand the effects of human activity on our water resources, allows us to better track environmental change over time and helps focus watershed management actions where they are needed the most.

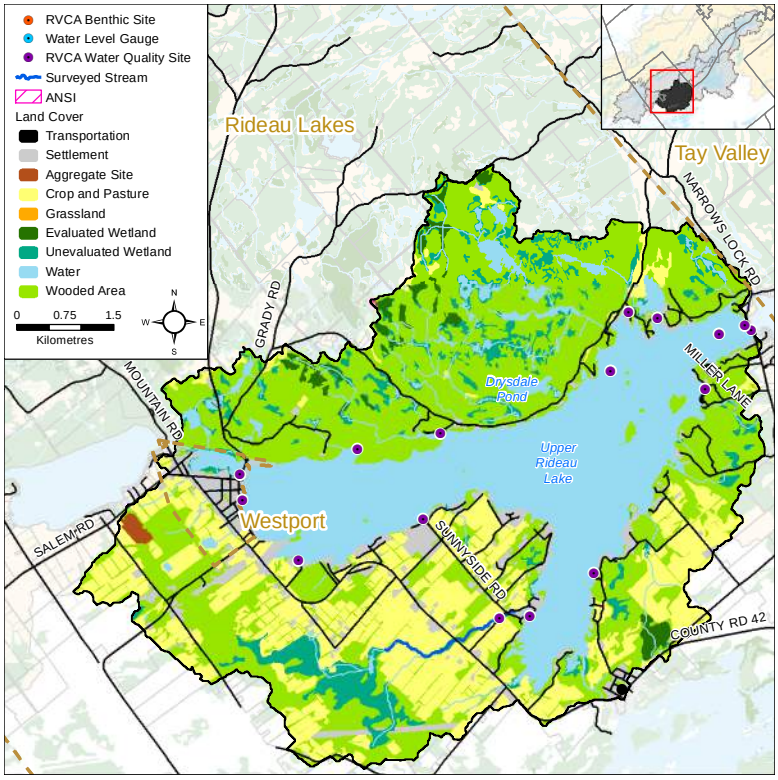
The following pages of this report are a compilation of that work. For other Rideau Lakes catchments and the Rideau Lakes Subwatershed Report, please visit the RVCA website at www.rvca.ca.

What's Inside

Catchment Facts

General Geography

- The Rideau Lakes are a very popular seasonal tourist and residential destination because of its diverse natural amenity, cultural history associated with the Rideau Waterway, close proximity to a number of large cities and towns and ease of access via the Rideau Canal. Residents and vacationers flock to the Rideau Lakes in the summer to take advantage of its natural heritage and recreational opportunities such as boating, fishing and swimming. Cottages, houses, campgrounds, B&Bs and marinas now stretch extensively along the shoreline that was once largely untouched, putting pressure on the natural resources that support the Rideau Lakes many uses and users
- Newboro, Portland, Rideau Ferry and Westport are the main settlement areas in the Rideau Lakes subwatershed. Newboro and Westport are located on Upper Rideau Lake and are service centres for local residents. Westport is a major tourist attraction for visitors to the Rideau Lakes and is known as the "The Heart of Rideau Lakes." It offers accommodations, shopping, restaurant and watercraft docking along with other water related recreational services
- Upper Big Rideau Lake has many embayments including Big, Duck, Kanes, McNallys, Mooneys, Moores, Mulvilles, Pipers and Stedmans Bay
- Parks Canada manages water levels for recreational purposes along the Rideau Canal/Waterway (also designated a National Historic Site and a Canadian Heritage River) that runs through the catchment, ensuring 1.5 metres of draft during the navigation season. In this managed system, water levels on the Rideau Canal are manipulated by operation of numerous dams. In the Rideau Lakes subwatershed, Parks Canada staff operate dams at Wolfe Lake, the Narrows on Upper Rideau and Poonamalie at the outlet of Lower Rideau Lake. The dams on Westport Sand Lake and Westport Pond are operated by the Ministry of Natural Resources and Forests in cooperation with Parks Canada. Water levels are lowered in October throughout the Canal system to the winter operating level that is maintained until early March when snow, ice and precipitation data are used to estimate spring snow melt conditions. At the onset of the spring freshet, water levels are targeted using a rule curve (i.e. a pre-determined estimate of water levels to ensure a "best fit" to prevent as much as possible high and low levels). In late May, levels are at the maximum for the beginning of the navigation season. Levels decline gradually throughout the summer until the winter level is reached once



again. The annual range of operational water levels on the lakes is in the order of one metre.
- Rideau Lakes form part of the Frontenac Arch Biosphere Reserve (Frontenac Axis), an important intra-regional landscape feature, which supports a wide variety of species and their movements between Algonquin Park in Central Ontario and Adirondack Park in Upper New York State

Physical Geography
- The northern half of Upper Rideau Lake catchment and the majority of the Rideau Lake subwatershed resides within the Algonquin Highlands, which is an ancient (Precambrian) hilly area made up of thin and variable glacial deposits overlying igneous and metamorphic rock ridges and knolls. In this catchment these rocks consist mainly of gneisses and marble. A geologic fault oriented roughly east-west follows the northern shore of the lake and rocks associated with geologic faults are also found here. The sediment overlying the bedrock in this area is very thin and composed primarily of mixed glacial sediment often referred to as drift
- The southern half of Upper Rideau Lake catchment is located within a transition area between the physiographic region known as the Smith Falls Limestone Plain and the Algonquin Highlands. In this area, the underlying bedrock consists of Paleozoic quartzose sandstone, some dolostone and possibly conglomerate. The sediment overlying the bedrock is variable and may consist of either mixed glacial sediment often referred to as drift, sandy glacial till, silt and clay, organic deposits or sand
- The only area within the Rideau Lakes subwatershed, where karstic terrain may be found is located at the western extent of this catchment at the boundary with the Westport Sand Lake catchment. Karstic terrain is very susceptible to land use impacts
- Ninety-seven percent of the catchment lies within the Township of Rideau Lakes and three percent within the Village of Westport
- Upper Rideau catchment drainage area is 61 square kilometres and occupies about 13 percent of the Rideau Lakes subwatershed and less than two percent of the Rideau Valley watershed
- Dominant land cover is woodland (39 percent) followed by water (26 percent), crop and pastureland (19 percent), wetland (eight percent), settlement areas (five percent) and transportation routes (three percent)

Vulnerable Areas
- Certain lands around Upper Rideau Lake are subject to flooding hazard during the regional storm flood (the 100 year flood) conditions in the area. Surveys and studies undertaken in accordance with provincial standards have determined that the 100 year flood elevation for the lake is 124.90 metres above mean sea level
- The Assessment Report developed under the Ontario *Clean Water Act* identified the catchment area as a Significant Groundwater Recharge Area and Highly Vulnerable Aquifer. A Wellhead Protection Area is delineated around the Westport municipal drinking water source and extends southwest from the village through this catchment

Development/Trends
- Given the proximity to the serviced communities of Perth, Portland, Smiths Falls and Westport (which have a mix of residential, commercial and institutional uses), there is added pressure for other residential development beyond existing settlement areas in the Rural zoned areas around Upper Rideau Lake
- Much of this development will continue to occur along waterfronts, as it has in the past. While many lakes have been developed to the extent that the physiography of the region will allow, others still have some development potential. In some cases, new lot development can occur only on marginal lands (steep slopes, shallow soils, narrow waterfronts, low lying poorly-drained lands) as the remaining lands have been fully developed
- Most development activity is focused around redevelopment, where cottages are being replaced with large permanent residences on small lots. This can put additional stress on the lake environment because large development envelopes on smaller lots leave less space for natural processes (e.g., runoff, infiltration and retention, nutrient uptake, erosion control and shading) and natural features (e.g., trees, shrubs and plants) that support a healthy lake environment. Minor variances are frequently triggered because the lots do not have sufficient area to provide for a minimum 30 metre development setback from the lake
- The Village of Westport is the largest urban area in the catchment and is a separate municipality from the Township of Rideau Lakes. Lands in Westport are primarily zoned Residential and Commercial along with some Institutional and Rural land-uses.
- Lands immediately adjacent to Westport in the Township of Rideau Lakes are predominately zoned Rural along with a mix of waterfront residential/tourist/commercial/industrial/open space land uses and are experiencing growth, including more intensified development
- Land use elsewhere in the Township of Rideau Lakes is also predominately Rural with the shoreline of Upper Rideau Lake zoned Waterfront Residential. A large area of the north shore of Upper Rideau Lake is zoned Open Space, which corresponds with the RVCA managed conservation lands at Foley Mountain
- Newboro also supports residential and commercial uses with the majority of waterfront properties zoned Waterfront Residential

Conditions at a Glance
- Surface water quality rating in Upper Rideau Lake and along Adrains Creek flowing into McNallys Bay near Newboro is ”Poor”
- In the Upper Rideau Lake catchment, the riparian buffer (30 metre wide strip along the shoreline of all lakes and streams) is comprised of woodland (52 percent), wetland (25 percent), settlement areas (ten percent), crop and pastureland (ten percent), and transportation routes (three percent). Along the **north shore of Upper Rideau Lake**, the shoreline buffer is made up of woodland (69 percent), settlement areas (22 percent), wetland (three percent), transportation routes (three percent) and crop and pastureland (three percent). Along the **south shore of Upper Rideau Lake**, the shoreline buffer is made up of woodland (42 percent), settlement areas (42 percent), wetland (six percent), transportation routes (six percent) and crop and pastureland (four percent). Around **Westport Pond**, the shoreline buffer is made up of wetland (48 percent), settlement areas (28 percent), woodland (15 percent) and transportation routes (nine percent). Along streams, the riparian buffer is comprised of woodland (44 percent), wetland (32 percent), crop and pastureland (17 percent), settlement areas (three percent) and transportation routes (three percent)
- Woodland cover proportion has changed/decreased by two percent (136 ha) from 2002 to 2008, due to a combination of changes in land cover/land uses and/or applied digital classification methods
- Wetland cover in the catchment has declined by 48 percent from pre-settlement levels to current levels; most of this reported loss has occurred off the Canadian Shield where 68 percent of wetlands have been estimated to have been lost
- 1992 Upper Rideau Lake Shoreline Survey (using the MAPLE shoreline classification method) revealed that 209 (49 percent of) properties had ornamental shorelines, 123 (29 percent of) properties had regenerative shorelines, 73 (17 percent of) properties had natural shorelines and 20 (5 percent of) properties had degraded shorelines
- Development on Upper Rideau Lake and in Newboro occurs on private wells (of which there are about 648 water well records in the catchment) and septic systems. Westport is serviced with a mixture of private wells and septic systems along with a municipal water supply and sewage treatment facility (that utilizes a Snowfluent wastewater treatment system)

- The only remaining Rideau Lakes stocking takes place on Westport Sand Lake where walleye is stocked annually by the Westport Area Outdoors Association
- Commercial fishery quotas and conditions for the last several years on Upper, Big and Lower Rideau Lakes have remained the same with one exception on Upper Rideau where MNR has increased the yellow perch quota based on the 2013 assessment. MNR fisheries research specialists confirm that inland commercial fishery quotas on the Rideau Lakes are sustainable

Catchment Care

- Since 2000, RVCA monitors Upper Rideau Lake surface water quality through its Watershed Watch Program. In 2006, the program was altered to gain consistent, year to year data for the set of lakes being monitored. In response to the 2009 Rideau Lakes Watershed Plan action to "Develop a more intensive and coordinated water quality monitoring program for the Rideau Lakes," RVCA monitors surface water quality four times of the year at two deep point sites and twice a year at 11 sites on Upper Rideau Lake. Three of the shoreline sites are monitored every year while the other eight sites are monitored every fifth year
- RVCA has been providing septic system re-inspection at the request of the Township of Rideau Lakes since 2007
- Township of Rideau Lakes septic system voluntary re-inspections were undertaken on 63 Upper Rideau Lake properties in the catchment by the Mississippi Rideau Septic System Office. Remedial/maintenance work was advocated for 28 of those properties, septic system replacements at another three properties with more information supplied to two other landowners with identified septic system concerns
- Thirty-one stewardship projects have been completed through RVCA's Private Land Forestry, Rural Clean Water, Shoreline Naturalization and Ontario Drinking Water Stewardship Programs (see Section 4 of this report for details)
- RVCA completed littoral zone mapping around Upper Rideau Lake in 2013, identifying substrate type, vegetation and habitat features along with opportunities for shoreline enhancements
- Upper Rideau Lake Association was founded in 1989 and is committed to protecting and improving the lake environment to ensure that it is safe for swimming, boating and fishing and that it is a healthy habitat for fish and other wildlife. Its mission is to promote a quality of social and ecological environment for property owners, residents and users within the Upper Rideau Lake and environs by identifying and facilitating the resolution of issues and undertaking initiatives for the common good. Areas of emphasis are water quality and use, lakeshore property, advocacy, liaison and public awareness (visit Upper Rideau Lake Association for more information)
- Upper Rideau Lake Association has been actively promoting shoreline naturalization for 25 years through their annual native plant giveaways to the lake community. Initially working with MAPLE, who provided URLA with thousands of plants, URLA now works with RVCA's Shoreline Naturalization Program to distribute native trees and shrubs each spring. Since 2010, they have handed out 3,450 native plant seedlings free of charge to the lake residents
- Three Permits to Take Water (PTTW) have been issued for the municipal drinking water supply wells in Westport, for a wetland conservation project and for golf course irrigation and water supply
- A watershed model developed by the RVCA in 2009 was used to study the hydrologic function of wetlands in the Rideau Valley watershed, including those found in the Upper Rideau Lake catchment
- RVCA provides flood forecasting and warning services throughout the Rideau Valley watershed. In the Upper Rideau subwatershed, only general flooding information has been made available historically for the lakes area. In 2014, lake levels were higher than most years and more attention was required from RVCA and municipal staff, resulting in the decision to review what the flood forecasting and warning program provides to the Upper Rideau Valley
- The Village of Westport and Rideau Lakes Township have land use planning policies and zoning provisions (on lake capacity, water setbacks, frontage and naturalized shorelines and wetland protection) and use site plan control to implement these policies and provisions. Together with RVCA and Parks Canada, they work with landowners on a case by case basis to achieve net environmental gains (particularly with respect to shoreline vegetation protection and rehabilitation) through the use of shoreline best management practices. Collectively, the Village and Township and the agencies request conditions on planning approvals to ensure that development and redevelopment is appropriate for the property, impacts on neighbours are minimized (particularly on very small lots) and development setbacks for the shoreline are maximized.
- Development in and adjacent to Provincially Significant Wetlands and some locally significant wetlands is subject to Ontario Regulation 174-06 (entitled "Development, Interference with Wetlands and Alterations to Shorelines and Watercourses") that protects the hydrologic function of the wetland and also protects landowners and their property from natural hazards (flooding, fluctuating water table, unstable soils) associated with them
- *Rideau Lakes Basin Carrying Capacity Study* (1992) evaluated the capacity of the Rideau Lakes to support development with respect to lake trophic state (level of phosphorus and chlorophyll a) and shoreline development. Results have been used to provide land-use planning policy direction and guidance (in the form of a site evaluation guideline) to the municipalities of Rideau Lakes and the Village of Westport and the Conservation Authority. Using phosphorus as the determinant for lake capacity, the study attempted to identify how much development was permissible to retain the "no net loss" in water quality principle (i.e., no net increase in phosphorus loading). Recommendations from it included the need to set water quality targets for each lake of concern, requiring buildings to be set no closer than 30 metres from water (with greater widths being recommended in areas with poor phosphorus retention based on soil type, slope and geological conditions), minimizing disturbance to shoreline vegetation and no alteration to the soil mantle within the protective setback area. An update to the abovementioned site evaluation guide is currently underway and is to be made available in 2015
- Parks Canada attempts to incorporate the breeding and habitat needs of fish and wildlife when determining water levels, flows and timing of drawdowns in the Rideau Lakes. For more information, please refer to the "Operating Rule Curve" for Upper Rideau Lake available (at www.rvca.ca) in the 2014 *Rideau Lakes Subwatershed Report* section on "Water Levels"
- *Rideau Canal National Historic Site of Canada Management Plan* (2005) update establishes the long term strategic direction for the management of the Rideau Canal
- *Rideau Canal World Heritage Site Management Plan* (2005) specifies how its world heritage values will be protected for present and future generations
- *Rideau Lake State of the Lake Report* prepared by the Centre for Sustainable Watersheds in 2002
- Much of the shoreline of Upper Rideau Lake is held in private ownership, so that the best opportunity for shoreline restoration/enhancement rests with private landowners. RVCA offers its Shoreline Naturalization Program to Rideau Lakes landowners to assist with shoreline re-vegetation (an enhanced delivery program has been put into place in response to the *2009 Rideau Lakes Watershed Plan* action to "Increase funding for the RVCA Shoreline Naturalization Program")

1. Surface Water Quality Conditions

Surface water quality conditions in the Upper Rideau catchment are monitored by the Rideau Valley Conservation Authority's (RVCA) Watershed Watch Program and Baseline Water Quality Monitoring Program. Watershed Watch monitors watershed lakes to assess nutrient concentrations, water clarity, dissolved oxygen availability and pH. The baseline water quality program focuses on streams; data is collected for 22 parameters including nutrients (total phosphorus, total Kjeldahl nitrogen and ammonia), *E. coli*, metals (like aluminum and copper) and additional chemical/physical parameters (such as alkalinity, chlorides, pH and total suspended solids). The locations of monitoring sites are shown in Figure 1 and Table 1.

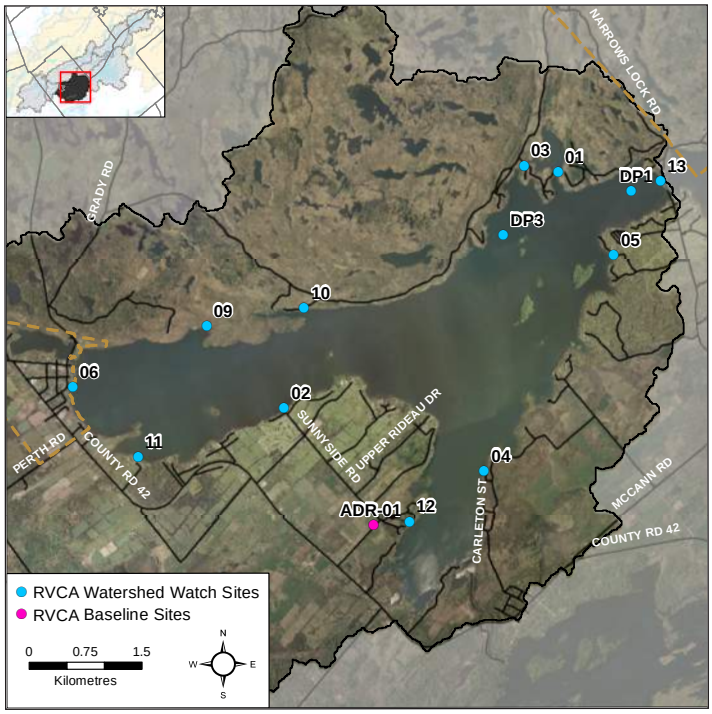


Figure 1 Water quality monitoring sites on Adrains Creek and Upper Rideau Lake in the Upper Rideau Lake catchment

The water quality rating for the Upper Rideau catchment is "Poor" (Table 1) as determined by the Canadian Council of Ministers of the Environment (CCME) Water Quality Index. Each parameter is evaluated against established guidelines to determine water quality conditions. Those parameters that frequently exceed guidelines are presented below. There is limited data available for Upper Rideau Lake prior to 2005; therefore, only the 2008-2013 data is considered in this report. Analysis of the data has been broken into two periods, 2002 to 2007 and 2008 to 2013, for the stream monitoring site located on Adrains Creek (ADR-01) to examine if conditions have changed between these periods. Table 1 shows the overall rating for the monitored surface water quality sites within the Upper Rideau catchment and Table 2 outlines the Water Quality Index (WQI) scores and their corresponding ratings.

Table 1 Water Quality Index Ratings for Upper Rideau catchment

Sampling Site	Location	2002-2007	Rating
RVL-37	Upper Rideau Lake (2 deep water sites)	NA	NA
ADR-01	Adrains Creek at Sunnyside Rd	63	Poor
Sampling Site	**Location**	**2008-2013**	**Rating**
RVL-37	Upper Rideau Lake (2 deep water sites)	53	Poor
ADR-01	Adrains Creek at Sunnyside Rd	60	Poor

Table 2 WQI Ratings and corresponding index scores (RVCA terminology, original WQI category names in brackets)

Rating	Index Score
Very good (Excellent)	95-100
Good	80-94
Fair	65-79
Poor (Marginal)	45-64
Very poor (Poor)	0-44

1) a. Upper Rideau Lake Water Quality

Surface water quality conditions in Upper Rideau Lake have been monitored by RVCA's Watershed Watch Program since 2005. Data from two deep point sites has been used to calculate the WQI rating for Upper Rideau Lake, which was determined to be "Poor" (Table 1). Elevated nutrient concentrations, periods of reduced oxygen availability, clear water and occasionally elevated pH levels contributed to the rating. The following discussion explains how each of the monitored water quality parameters contributes to the lake's water quality.

This report also considers data from 11 additional shoreline sites that are regularly monitored around the lake. These sites have not been included in the calculation of the CCME WQI rating, as they are not monitored with the same frequency as deep point sites. However, they do provide important information on water quality conditions in the near shore areas. For locations of shoreline sites please see Figure 1.

Previous reports have noted that persistently high nutrient concentrations are a concern in Upper Rideau Lake[1] which has enabled aquatic plants and algae blooms to flourish. The data presented in this report indicates that this continues to be the case and that a proactive program of best management practices around the lake's drainage area is critical to ensure the protection of the lake environment.

[1] Rideau Valley Conservation Authority (2009) Rideau Lakes Watershed Plan, Priorities and Recommendations, Manotick, Ontario. (Rideau Lakes Watershed Plan); Upper Rideau Lake Association (2010), Water Quality Reports, 2010 Report and Upper Rideau Lake Association (2007) Water Quality Reports, 2006/2007 Report; Rideau Valley Conservation Authority (2006) , State of the Lake Environment Report, Upper Rideau Lake 2005, Manotick, Ontario, (State of the Upper Rideau Lake Report)

Nutrients

Total phosphorus (TP) is used as a primary indicator of excessive nutrient loading and contributes to abundant aquatic vegetation growth and depleted dissolved oxygen levels. The Provincial Water Quality Objective (PWQO) is used as the TP Guideline and states that in lakes, concentrations greater than 0.020 mg/l indicate an excessive amount of TP within the water column.

Total Kjeldahl nitrogen (TKN) is used as a secondary indicator of nutrient loading. RVCA uses a guideline of 0.500 mg/l to assess TKN[2] within surface waters.

At the Deep Points

Two deep point sites are monitored within the lake. Average nutrient concentrations in the lake are summarized in Table 3, as well as the proportion of results that meet the guideline.

Table 3 Summary of nutrient results for Upper Rideau Lake, 2008-2013. Highlighted values indicate average concentrations exceed the guideline

Total Phosphorus 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-37	0.021	45%	22
Total Kjeldahl Nitrogen 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-37	0.420	91%	22

TP and TKN sampling results are presented in Figures 2 and 3. Only 45 percent of samples analyzed for TP were less than the TP guideline and the average concentration was 0.021 mg/l (Table 3). TKN concentration may be considered normal; 91 percent of results were below the TKN guideline and the average concentration was 0.420 mg/l (Table 3). Average year to year concentrations have varied for both TP and TKN (Figure 4 and 5). From 2008-2011 average TP concentrations exceed the TP guideline; in 2012 and 2013 average results dropped below the guideline (Figure 4). Average TKN results generally do not exceed the guideline. Despite the recent decline in average TP concentration, overall, the data presented indicates that elevated TP concentrations continue to be a concern in the mid-lake, deep water sites of Upper Rideau Lake.

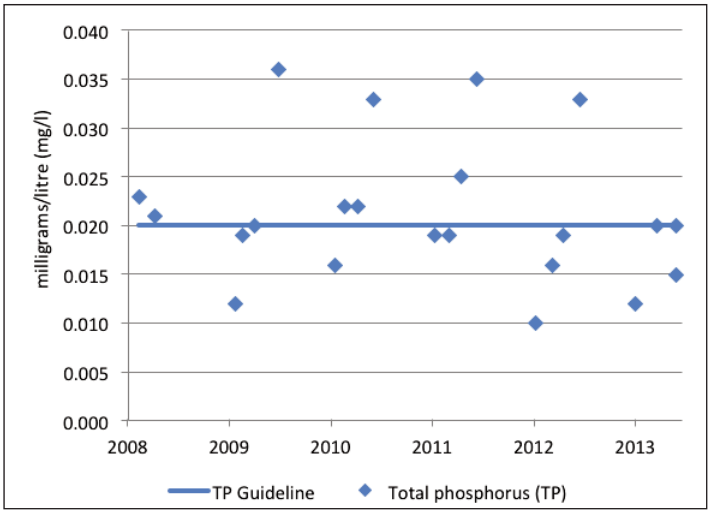


Figure 2 Total phosphorus sampling results at deep point sites in Upper Rideau Lake, 2008-2013

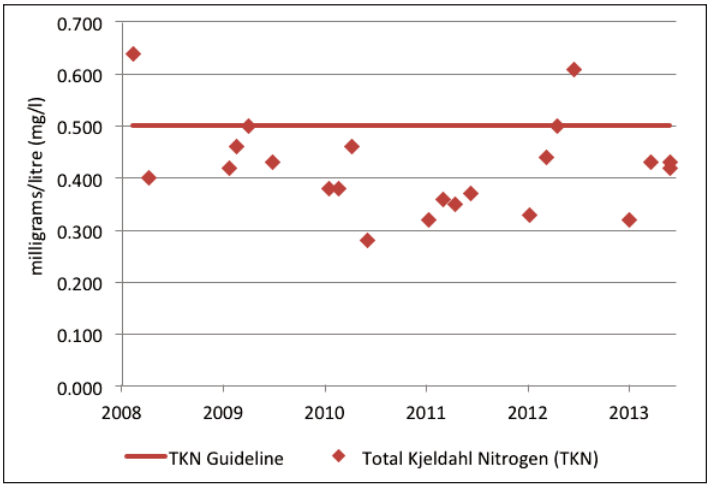


Figure 3 Total Kjeldahl nitrogen sampling results at deep point sites in Upper Rideau Lake, 2008-2013

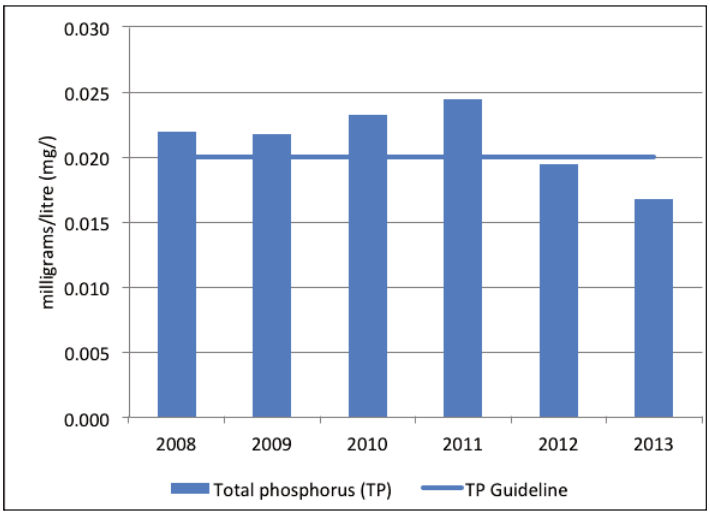


Figure 4 Average total phosphorus at deep point sites in Upper Rideau Lake, 2008-2013

[2] No Ontario guideline for TKN is presently available; however, waters not influenced by excessive organic inputs typically range from 0.100 to 0.500 mg/l, Environment Canada (1979) *Water Quality Sourcebook, A Guide to Water Quality Parameters,* Inland Waters Directorate, Water Quality Branch, Ottawa, Canada

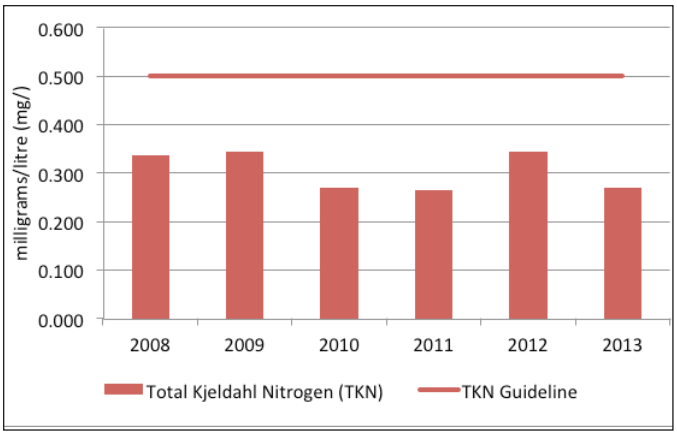


Figure 5 Average total Kjeldahl nitrogen at deep point sites in Upper Rideau Lake, 2008-2013

Around the Lake

The average nutrient concentrations at monitored sites around the lake vary from year to year (Figures 6 and 7). Please note that sites 3, 6, and 9 are monitored each year while other sites are monitored every fifth year.

Total phosphorous concentrations were above the TP guideline at the majority of sites with the exception of sites 5 and 10; all other sites have exceeded the guideline in more than one year (Figure 6). Site 6 is the only site that consistently exceeds the TP guideline. This site is located at the outflow of a drainage ditch through a developed portion of the Village of Westport. Action should be taken to determine what could be done to limit the impact of nutrient loadings at this site. Sites 3 and 9 reported fewer exceedances, even though concentrations are often high. These sites are largely located in more natural areas of the lake, but should be further investigated to determine the underlying, influencing factors. Additionally, the impacts of increased shoreline development, boat traffic and high levels of recreational use in shallow areas contribute to increased loading through runoff and re-suspension of sediment, which may be contributing to higher TP concentrations.

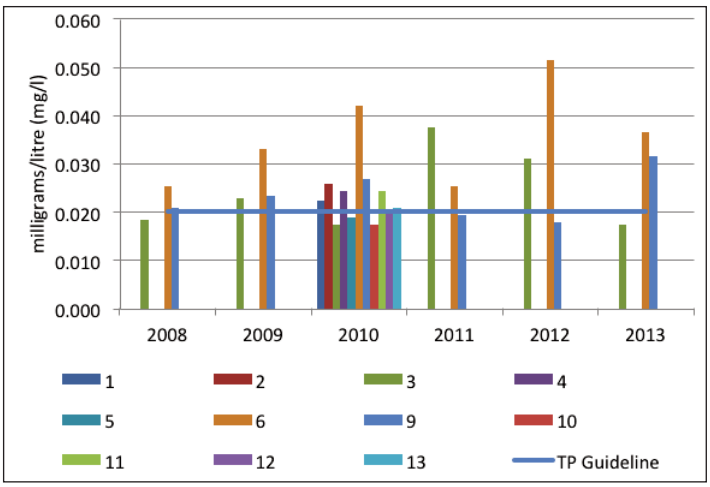


Figure 6 Average total phosphorus concentration at shoreline monitoring sites on Upper Rideau Lake, 2008-2013

TKN concentrations were below the guideline at the majority of shoreline sites with the exception of site 6. These results provide further evidence that nutrient loading through the drainage ditch is a problem, which may result in abundant plant or algal growth and low oxygen levels, particularly as both TP and TKN are persistently elevated at this site on the lake.

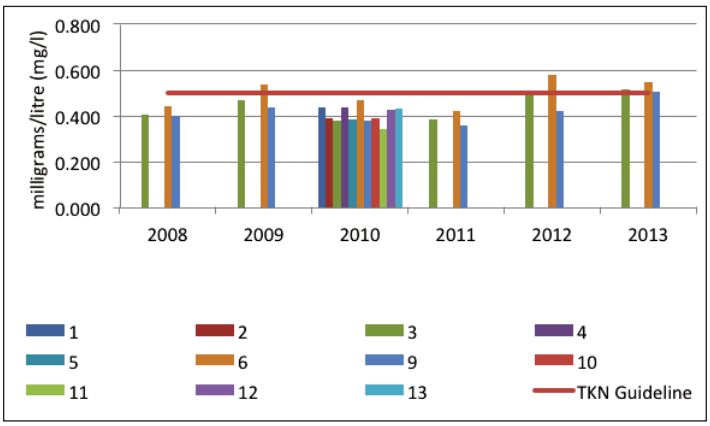


Figure 7 Average total Kjeldahl nitrogen concentration at shoreline monitoring sites on Upper Rideau Lake, 2008-2013

Summary

Within Upper Rideau Lake, nutrient concentrations, particularly TP concentrations, generally do not meet guidelines. TP concentrations are comparable to the *2005 Upper Rideau Lake State of the Lake Report* (Rideau Valley Conservation Authority, 2006), which noted that the majority of TP results exceeded the PWQO and also that the lake has had high concentrations of nutrients for many years. In 2014 a blue-green algae bloom was reported and confirmed in Upper Rideau Lake. While this occurrence is outside the data reporting range of this report, it highlights the vulnerability of the lake to water quality impairment.

Sites with particularly high results should be further investigated to determine if sources of nutrient inputs can be reduced through the diversion of runoff and enhanced shoreline buffers. Areas where high concentrations of nutrients are persistent may exhibit excessive aquatic plant growth, algae blooms and depleted oxygen concentrations.Nutrient exceedances may be partially attributed to the natural aging of a lake and its basin characteristics; the lake is shallow and comprised of areas containing drowned lands (resulting from the construction of the Rideau Canal), which have rich organic soils that hold high levels of phosphorus.

Aging of the lake can be slowed with the help of all catchment residents by reducing nutrient inputs through practices such as proper maintenance of septic systems, keeping shorelines natural and using phosphate free soaps and detergents.

Water Clarity

Water clarity is measured using a Secchi disk during each deep point sample. Table 4 summarizes the recorded depths and shows that all readings have exceeded the minimum PWQO of two metres, indicating good water quality with an average Secchi depth of 4.3 metres. Figure 8 shows that no individual reading has been below the guideline and measured depths range from 2.5 metres to 7.5 metres. It should also be

noted that Secchi depths in many waterbodies such as Upper Rideau lake have been influenced by the colonization of zebra mussels, resulting in clearer waters than prior to the introduction of this invasive species.

Table 4 Summary of Secchi depths recorded at deep points in Upper Rideau Lake, 2008-2013

Secchi depth 2008-2013			
Site	**Average (m)**	**Above Guideline**	**No. Samples**
RVL-37	4.3	100%	20

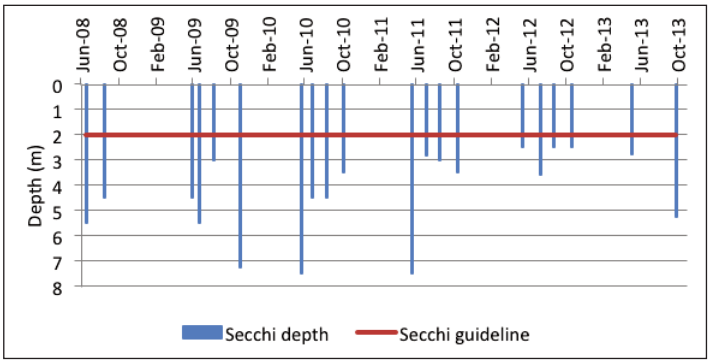


Figure 8 Recorded Secchi depths at deep point sites in Upper Rideau Lake, 2008-2013

Summary

This data indicates that waters are clear and adequate sunlight is able to penetrate the water column to support aquatic life and provide sufficient visibility for safe recreational use (i.e. boating, swimming).

Fish Habitat

Two other factors, dissolved oxygen/temperature and pH were also assessed to provide an overall sense of the health of Upper Rideau Lake from a fish habitat perspective.

Dissolved Oxygen and Temperature

The red bars in Figures 9 and 10 show the depths where suitable conditions exist for warm water fish species (temperature less than 25°C and dissolved oxygen greater than 4 mg/l) at the two monitored deep points. The vertical axis represents the total lake depth at each site where the profile is taken. Suitable oxygen temperatures exist over an average depth of 10 metres at site RVL-37-DP1 (Figure 9) and 14 metres at site RVL-37DP3 (Figure 10).

pH

pH is a basic water quality parameter used to assess the acidity of water, an important factor for aquatic life. Figure 11 shows pH concentrations in Upper Rideau Lake and Figure 12 summarizes average concentrations by year.

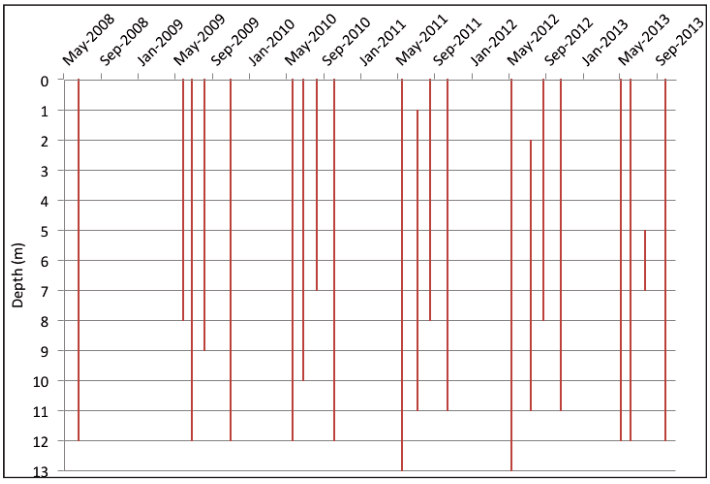


Figure 9 Depths suitable for warm water fish species at site RVL-37DP1 in Upper Rideau Lake, 2008-2013

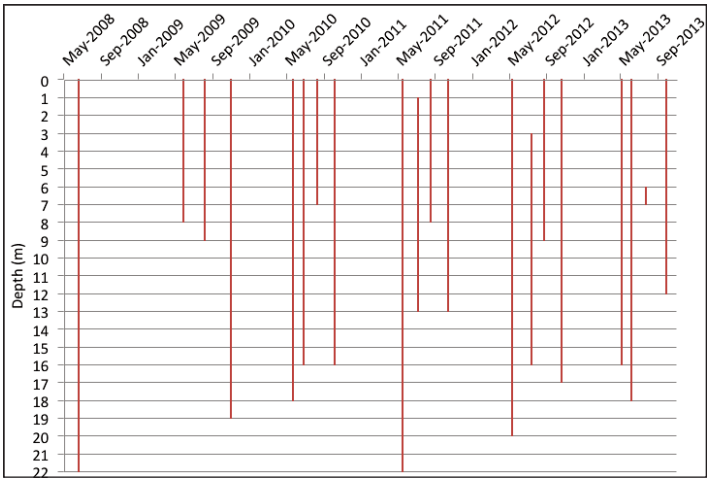


Figure 10 Depths suitable for warm water fish species at site RVL-37DP3 in Upper Rideau Lake, 2008-2013

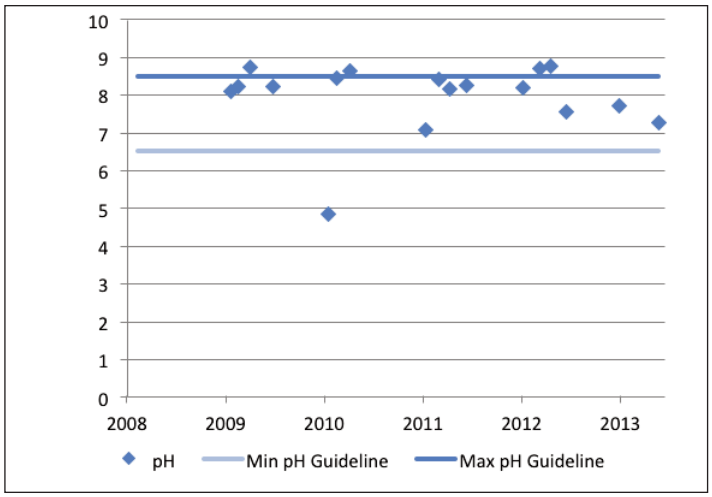


Figure 11 pH concentrations at the deep points in Upper Rideau Lake, 2008-2013

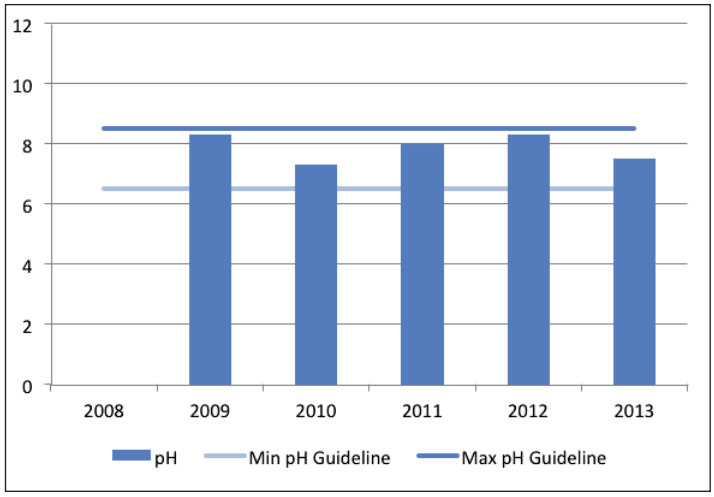


Figure 12 Average pH concentrations at the deep points in Upper Rideau Lake, 2008-2013

Seventy-one percent of samples (Table 5) were within guidelines established by the PWQO which state that pH should be between 6.5 and 8.5 to protect aquatic life and prevent irritation for anyone using the waters for recreational purposes.

Table 5 Summary of pH results at the deep points in Upper Rideau Lake, 2008-2013

pH 2008–2013			
Site	**Average**	**% that meet guideline**	**No. Samples**
RVL-37	7.97	71%	17

In some areas of the Rideau Lakes subwatershed, surface waters tend to be a bit more alkaline (higher pH) which can generally be attributed to geology rather than anthropogenic activities; biological activities such as photosynthesis may also affect pH.

Summary

Overall the water chemistry data at the deep points describes good habitat conditions for warm water fish species such as pickerel, bass and pike. There is some evidence that the warming of the water column and oxygen depletion in the summer months limits the amount of habitat available and causes stress to some aquatic communities. pH conditions are typically within the range recommended for the protection of aquatic life, indicating a healthy environment for aquatic species.

E. coli

E. coli is sampled at monitored shoreline sites twice each sampling season. *E. coli* data was not used in the calculation of the WQI rating for the lake due to differences in sampling frequency and site locations. All samples were below the *E. coli* guideline of 100 colony forming units (CFU) per 100 ml set by the PWQO. Across the lake the count at the geometric mean[3] was only 4 CFU/100ml (Table 6). Figure 13 shows that samples across all sites were well below the guideline.

Table 6 Summary of *E. coli* results for Upper Rideau Lake, 2008-2013

E. coli 2008–2013			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
RVL-37	4	100%	42

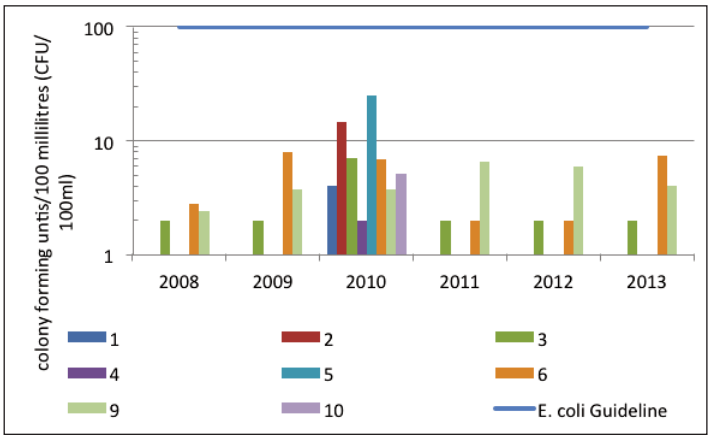


Figure 13 Geometric mean of shoreline sites monitored on Upper Rideau Lake, 2008-2013

Summary

The results presented above provide evidence that bacterial contamination is not a significant concern in Upper Rideau Lake and the water should be safe for recreational use such as swimming and boating.

[3] A type of mean or average, which indicates the central tendency or typical value of a set of numbers by using the product of their values (as opposed to the arithmetic mean which uses their sum). It is often used to summarize a variable that varies over several orders of magnitude, such as *E. coli* counts

1) b. Adrains Creek Water Quality

There is one stream site on Adrains Creek monitored in the Upper Rideau catchment (ADR-01, Figure 1). Analysis of the data has been broken into two periods, 2002-2007 and 2008-2013, to examine if conditions have changed within this timeframe. Water quality at this site is reported as "Poor" (Table 1). The score at this site is largely influenced by high nutrient concentrations, metals and high bacterial counts. For more information on the CCME WQI, please see the *Rideau Lakes Subwatershed Report 2014*.

Nutrients

Total phosphorus (TP) is used as a primary indicator of excessive nutrient loading and may contribute to abundant aquatic vegetation growth and depleted dissolved oxygen levels. The Provincial Water Quality Objective (PWQO) is used as the TP Guideline and states that in streams concentrations greater than 0.030 mg/l indicate an excessive amount of TP.

Total Kjeldahl nitrogen (TKN) and ammonia (NH_3) are used as secondary indicators of nutrient loadings. RVCA uses a guideline of 0.500 mg/l to assess TKN[4] and the PWQO of 0.020 mg/l to assess ammonia concentrations at the monitored site.

Tables 7, 8 and 9 summarize average nutrient concentrations at monitored sites within the Upper Rideau Lake catchment and show the proportion of results that meet the guidelines.

Table 7 Summary of total phosphorus results for Adrains Creek in the Upper Rideau catchment, 2002-2007 and 2008-2013 . Highlighted values indicate average concentrations exceed the guideline

Total Phosphorus 2002–2007			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
ADR-01	0.111	7%	29
Total Phosphorus 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
ADR-01	0.146	3%	35

Table 8 Summary of total Kjeldahl nitrogen results for Adrains Creek in the Upper Rideau catchment from 2002-2007 and 2008-2013. Highlighted values indicate average concentrations exceed the guideline

Total Kjeldahl Nitrogen 2002–2007			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
ADR-01	1.051	0%	29
Total Kjeldahl Nitrogen 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
ADR-01	1.355	3%	35

Table 9 Summary of ammonia results for Adrains Creek in the Upper Rideau catchment from 2002-2007 and 2008-2013. Highlighted values indicate average concentrations exceed the guideline

Ammonia 2002–2007			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
ADR-01	0.014	83%	29
Ammonia 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
ADR-01	0.023	74%	35

The majority of samples at ADR-01 exceeded the TP guideline; only seven percent of samples were below the guideline in the 2002-2007 period (Figure 14). This declined to only three percent of samples in the 2008-2013 period (Figure 15). The average TP concentration increased from 0.111 mg/l (2002-2007) to 0.146 mg/l (2008-2013).

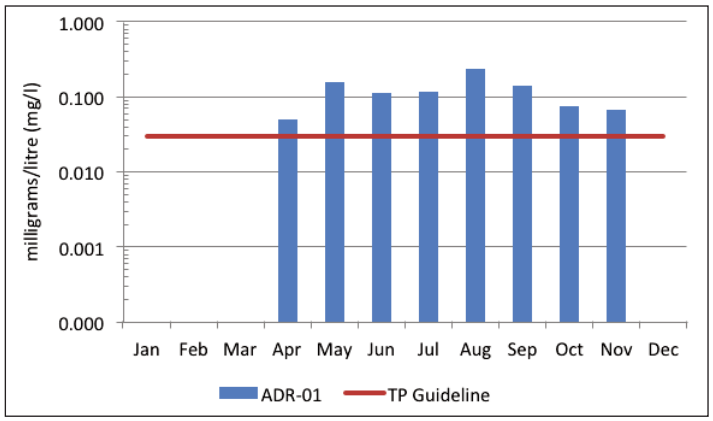


Figure 14 Total phosphorus concentrations in Adrains Creek, 2002-2007

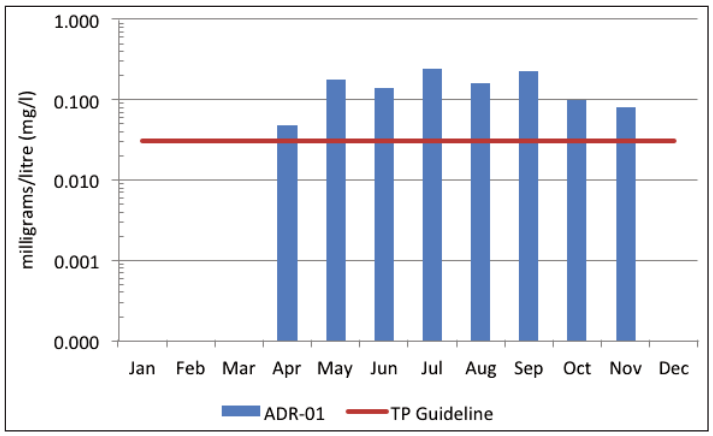


Figure 15 Total phosphorus concentrations in Adrains Creek, 2008-2013

TKN results show that the bulk of results exceeded the guideline (Figures 16 and 17). There were no samples below the guideline in the 2002-2007 period; this improved marginally to only three percent in the 2008-2013 period. The TKN average concentration was generally elevated and increased from 1.051 mg/l to 1.355 mg/l.

[4] No Ontario guideline for TKN is presently available; however, waters not influenced by excessive organic inputs typically range from 0.100 to 0.500 mg/l, Environment Canada (1979) *Water Quality Sourcebook, A Guide to Water Quality Parameters,* Inland Waters Directorate, Water Quality Branch, Ottawa, Canada

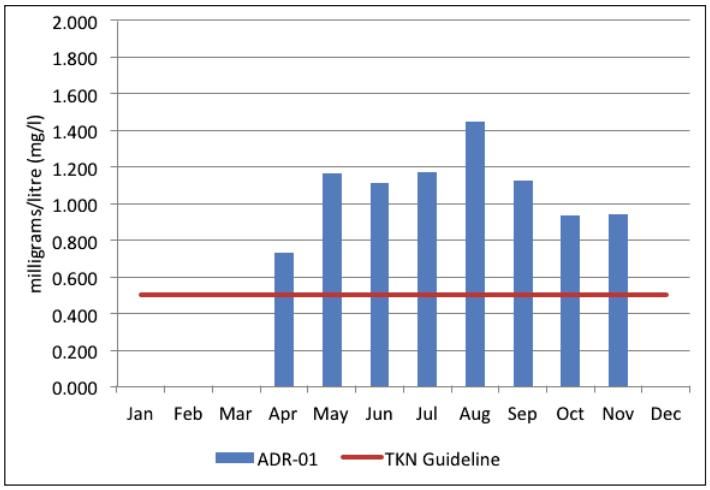


Figure 16 Total Kjeldahl nitrogen concentrations in Adrains Creek, 2002-2007

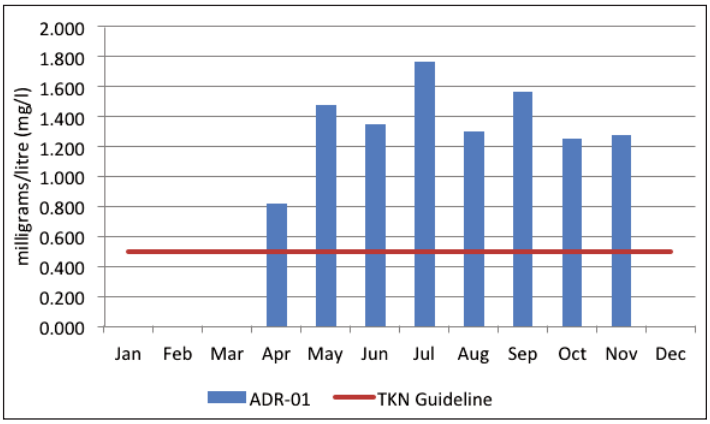


Figure 17 Total Kjeldahl nitrogen concentrations in Adrains Creek, 2008-2013

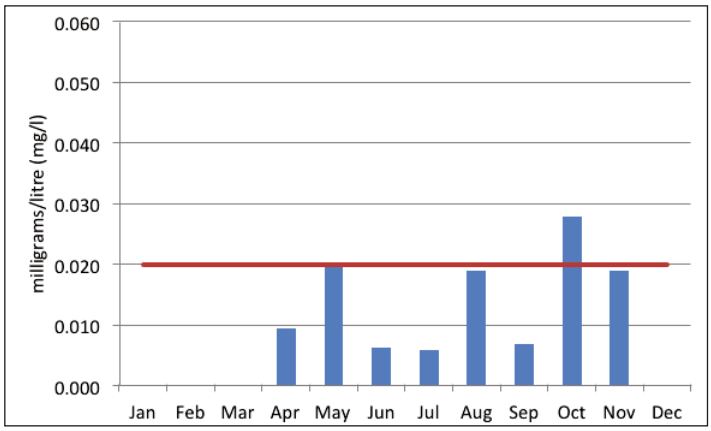


Figure 18 Ammonia concentrations in Adrains Creek, 2002-2007

The trend of elevated nutrients is also observed in NH_3 data, as results at this site were generally above the guideline of 0.020 mg/l (Figures 18 and 19). The proportion of samples below the guideline declined from 83 percent to 74 percent. As observed with TP and TKN results, this was accompanied by an increase in the average concentration from 0.014 mg/l (2002-2007) to 0.023 mg/l (2008-2013).

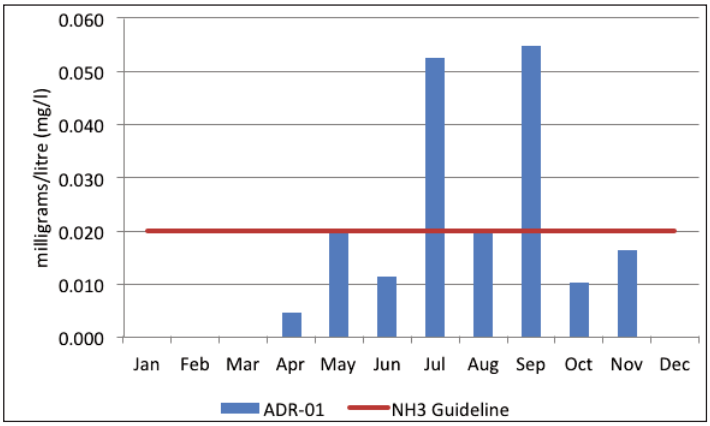


Figure 19 Ammonia concentrations in Adrains Creek, 2008-2013

Summary

The data shows that nutrient enrichment continues to be a concern in Adrains Creek. This creek was previously identified as having high TP concentrations (*Rideau Lakes Watershed Plan,* 2009) and elevated concentrations across all nutrient parameters, which continues to be observed. Elevated nutrients may result in nutrient loading to McNallys Bay on Upper Rideau Lake. High nutrient concentrations can help stimulate the growth of algae blooms and other aquatic vegetation in a waterbody, and deplete oxygen levels as the vegetation dies off. Given these particularly high results, this site should be further investigated to determine if sources of nutrient inputs can be reduced to improve water quality or if natural sources contribute to high background concentrations. Possible strategies to reduce nutrient inputs could include diverting surface water runoff away from Adrains Creek and enhancing the riparian buffer along it.

E. coli

E. coli is used as an indicator of bacterial pollution from human or animal waste; in elevated concentrations it can pose a risk to human health. The PWQO of 100 colony forming units/100 milliliters (CFU/100 ml) is used to assess *E. coli*. Counts greater than this guideline indicate that bacterial contamination may be a problem within a watercourse.

Table 10 summarizes the geometric mean[5] for the monitored site on Adrains Creek and shows the proportion of samples that meet the *E. coli* guideline of 100 CFU/100 ml. The geometric mean with respect to the guideline for the two periods (2002-2007 and 2008-2013) is shown in Figures 20 and 21 respectively.

Summary

The results indicate that bacterial contamination is a concern in Adrains Creek. Approximately half of sampled counts exceed the PWQO, and the count at the geometric mean has increased above the PWQO guideline.

[5] A type of mean or average, which indicates the central tendency or typical value of a set of numbers by using the product of their values (as opposed to the arithmetic mean which uses their sum). It is often used to summarize a variable that varies over several orders of magnitude, such as *E. coli* counts

Table 10 Summary of *E. coli* results for Adrains Creek, 2002-2007 and 2008-2013. Highlighted values indicate average concentrations exceed the guideline

E. coli 2002-2007			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
ADR-01	91	45%	29
***E. coli* 2008-2013**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
ADR-01	121	51%	35

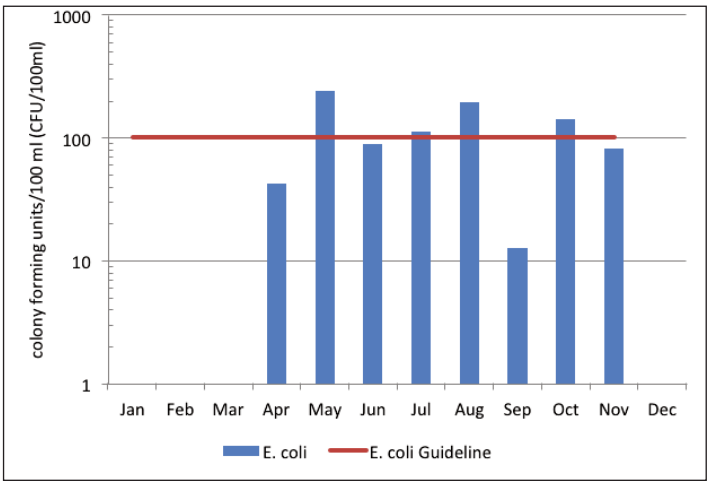


Figure 20 *E. coli* counts in Adrains Creek, 2002-2007

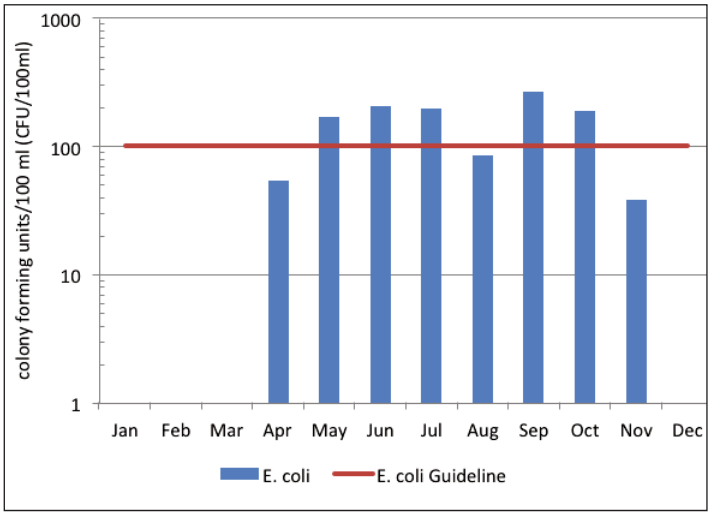


Figure 21 *E. coli* counts in Adrains Creek, 2008-2013

Metals

Of the metals routinely monitored in Adrains Creek, aluminum (Al) and iron (Fe) frequently reported concentrations above their respective PWQOs. In elevated concentrations, these metals can have toxic effects on sensitive aquatic species. Tables 11 and 12 summarize metal concentrations at the monitored site and show the proportion of samples that meet guidelines. Figures 22 to 25 show metal concentrations with respect to the guidelines for the two periods of interest, 2002–2007 and 2008–2013. For Al, the PWQO is 0.075 mg/l and for Fe it is 0.300 mg/l.

Results from ADR-01 shows that Al concentrations were typically elevated; 35 percent of samples were below the guideline in the 2002-2007 period (Figure 22). This improved to 43 percent of samples in the 2008-2013 period (Figure 23). However, the average Al concentration continues to exceed the guideline and increased from 0.299 mg/l (2002-2007) to 0.441 mg/l (2008-2013).

Table 11 Summary of aluminum results for Adrains Creek in the Upper Rideau catchment, 2002-2007 and 2008-2013. Highlighted values indicate average concentrations exceed the guideline

Aluminum 2002-2007			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
ADR-01	0.299	35%	23
Aluminum 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
ADR-01	0.441	43%	14

Table 12 Summary of iron results for Adrains Creek in the Upper Rideau catchment, 2002-2007 and 2008-2013. Highlighted values indicate average concentrations exceed the guideline

Iron 2002-2007			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
ADR-01	0.897	22%	23
Iron 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
ADR-01	1.266	15%	13

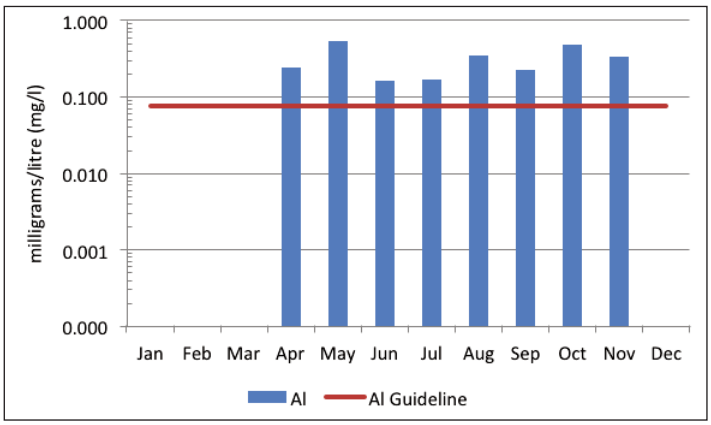


Figure 22 Average aluminum concentrations in Adrains Creek, 2002-2007

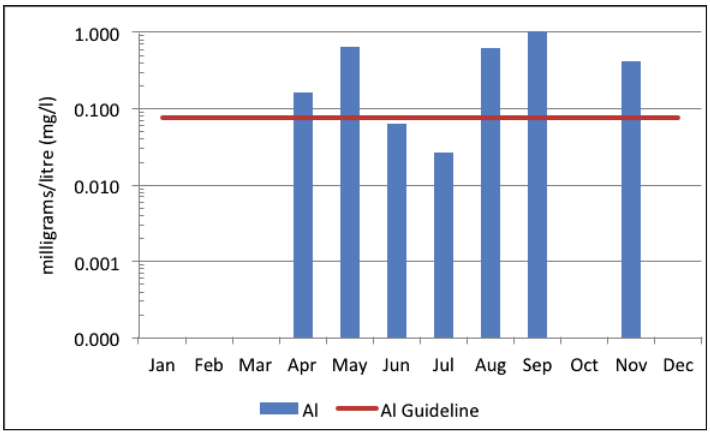


Figure 23 Average aluminum concentrations in Adrains Creek, 2008-2013

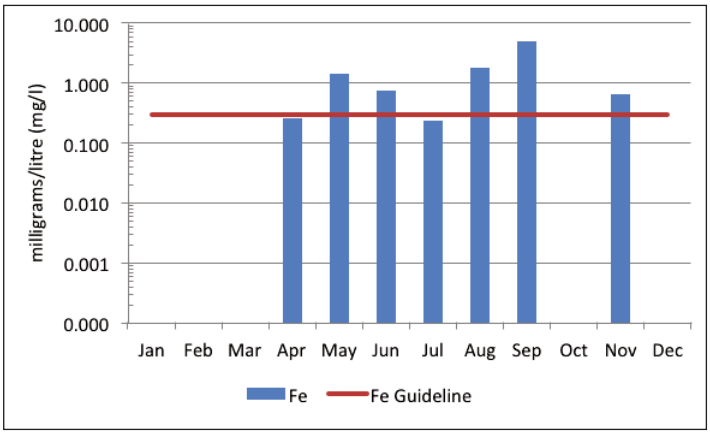


Figure 25 Average iron concentrations in Adrains Creek, 2008-2013

Iron concentrations also exceeded guidelines. The proportion of samples below the guideline declined from 22 percent to 15 percent (Figures 24 and 25); similarly, the average concentration exceeded the guideline and increased from 0.897 mg/l (2002-2007) to 1.266 (2008-2013).

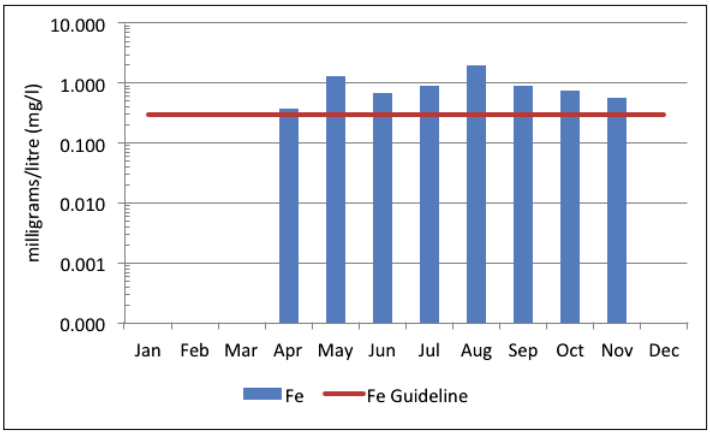


Figure 24 Average iron concentrations in Adrains Creek, 2002-2007

Summary

Overall, a general increase in metal concentrations was observed between the two periods of interest.

The data indicates that surrounding land uses are likely impacting the system and deteriorating water quality; efforts should be made to identify pollution sources and implement agricultural best management practices (i.e., buffer strips, no-till, nutrient/soil management, livestock waste management) to improve overall stream health and lessen downstream impacts to Upper Rideau Lake.

2. Riparian Conditions

Shoreline Buffer Land Cover Evaluation

The riparian or shoreline zone is that special area where the land meets the water. Well-vegetated shorelines are critically important in protecting water quality and creating healthy aquatic habitats, lakes and rivers. Natural shorelines intercept sediments and contaminants that could impact water quality conditions and harm fish habitat in streams. Well established buffers protect the banks against erosion, improve habitat for fish by shading and cooling the water and provide protection for birds and other wildlife that feed and rear young near water. A recommended target (from Environment Canada's Guideline: *How Much Habitat is Enough?*) is to maintain a minimum 30 metre wide vegetated buffer along at least 75 percent of the length of both sides of rivers, creeks and streams.

Figure 26 shows the extent of the naturally vegetated riparian zone in the catchment, 30 meters along the shoreline of waterbodies and watercourses. This analysis from the RVCA's Land Cover Classification Program (derived from 2008 DRAPE imagery) shows that the riparian buffer (30 m. wide strip) in the catchment is comprised of woodland (52 percent), wetland (25 percent), settlement areas (ten percent), crop and pastureland (ten percent) and transportation routes (three percent).

Around **Upper Rideau Lake** itself, the shoreline buffer is made up of woodland (54 percent), settlement areas (34 percent), wetland (five percent), transportation routes (four percent) and crop and pastureland (three percent). This can be further broken down as follows: the **north (on-Shield) shore** is comprised of woodland (69 percent), settlement areas (22 percent), wetland (three percent), transportation routes (three percent) and crop and pastureland (three percent); in contrast, the **south (off-Shield) shore** is comprised of settlement areas (42 percent), woodland (42 percent), transportation routes (six percent), wetland (six percent) and crop and pastureland (four percent).

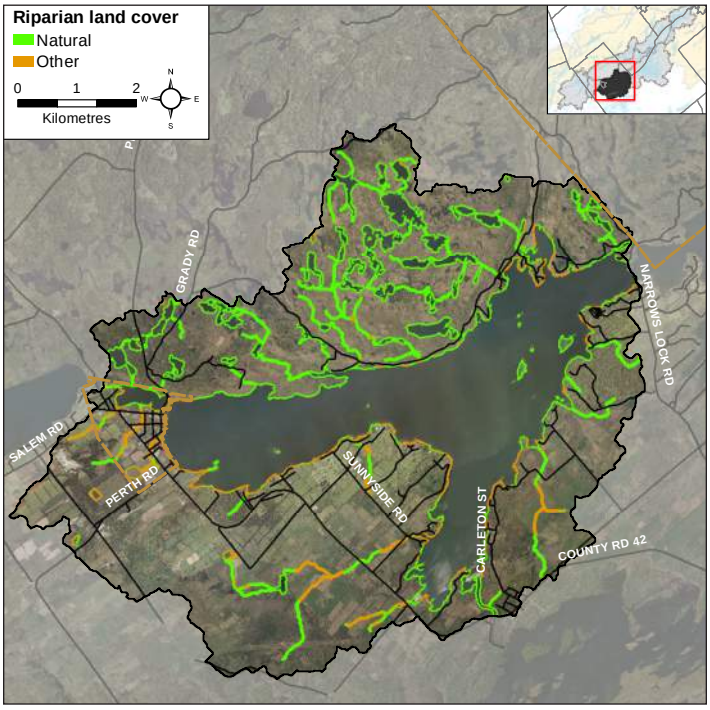


Figure 26 Natural and other riparian land cover around Upper Rideau Lake

Around **Westport Pond**, the shoreline buffer is made up of wetland (48 percent), settlement areas (28 percent), woodland (15 percent) and transportation routes (nine percent). Around **Drysdale Pond**, the shoreline buffer is made up of woodland (96 percent) and wetland (four percent).

Along streams in the catchment, the riparian buffer is comprised of woodland (44 percent), wetland (32 percent), crop and pastureland (18 percent), settlement areas (three percent) and transportation routes (three percent).

Adrains Creek Overbank Zone

Riparian Buffer Width Evaluation

Figure 27 shows buffer conditions along the left and right banks of Adrains Creek. Using data from the 2013 Stream Characterization Program, Adrains Creek had a buffer of greater than 30 meters along 82 percent of the right bank and 83 percent along the left bank.

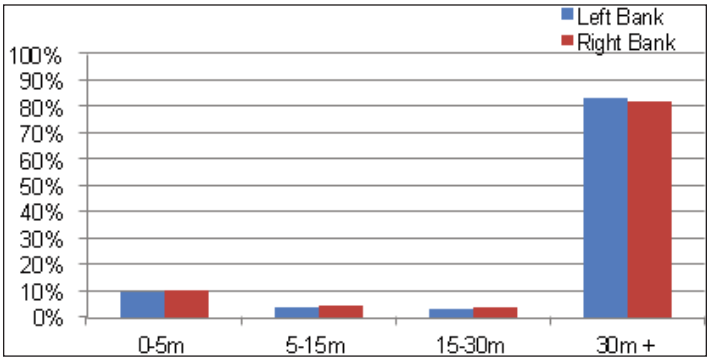


Figure 27 Riparian buffer evaluation along Adrains Creek

Adjacent Land Use

The RVCA's Stream Characterization Program identifies seven different land uses beside Adrains Creek (Figure 28). Surrounding land use is considered from the beginning to end of the survey section (100m) and up to 100 metres on each side of the creek. Land use outside of this area is not considered for the surveys but is nonetheless part of the subwatershed and will influence the creek. Natural areas made up 85 percent of the stream, characterized by wetland, forest, scrubland and meadow. The remaining land use consisted of pasture, agriculture and infrastructure.

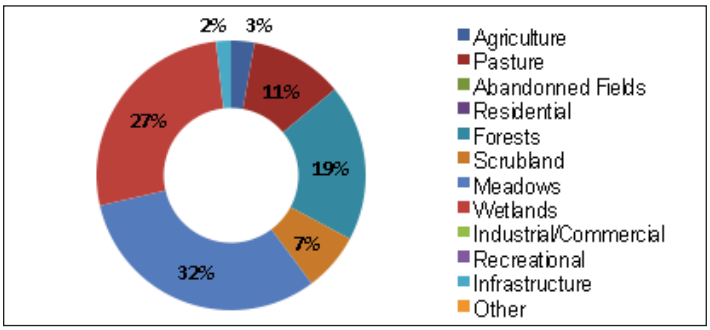


Figure 28 Land use along Adrains Creek

Adrians Creek Shoreline Zone

Instream Erosion

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 a detrimental effect on important fish and wildlife habitat. 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 potential to impact instream migration. Figure 29 shows limited and low levels of erosion along Adrains Creek.

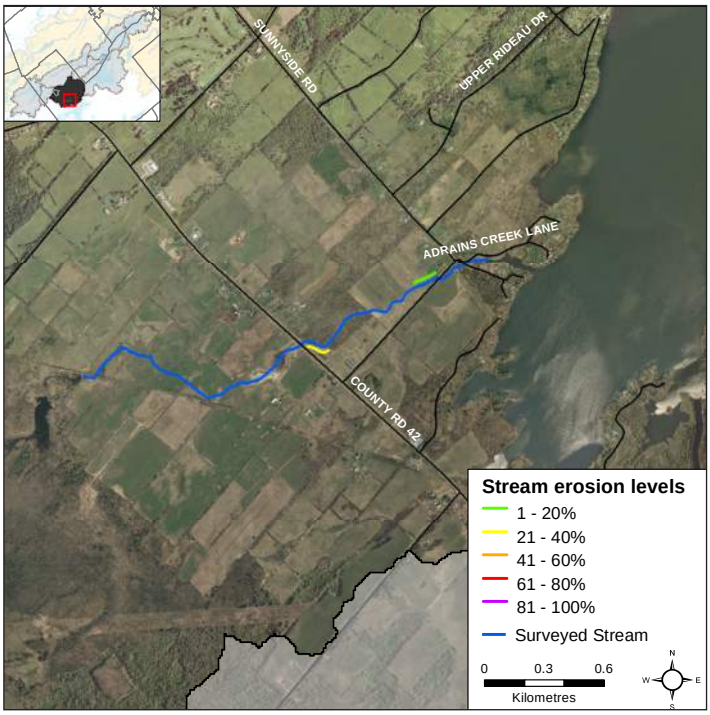


Figure 29 Erosion along Adrains Creek

Undercut Stream Banks

Undercut banks are a normal and natural part of stream function and can provide excellent refuge areas for fish. Figure 30 shows that Adrains Creek had low levels of undercut banks.

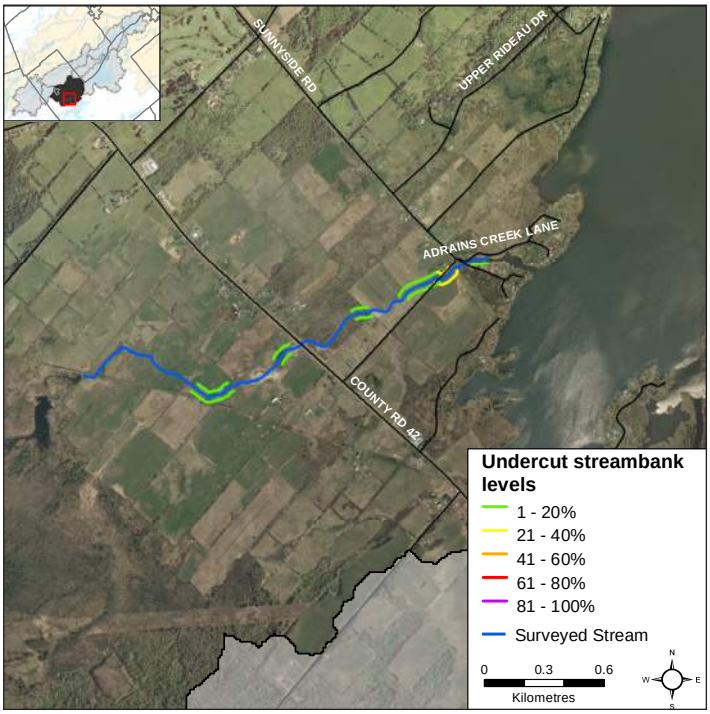


Figure 30 Undercut stream banks along Adrains Creek

Stream Shading

Grasses, shrubs and trees all contribute towards shading a stream. Shade is important in moderating stream temperature, contributing to food supply and helping with nutrient reduction within a stream. Figure 31 shows highly variable stream shading conditions ranging from low to high levels along Adrains Creek.

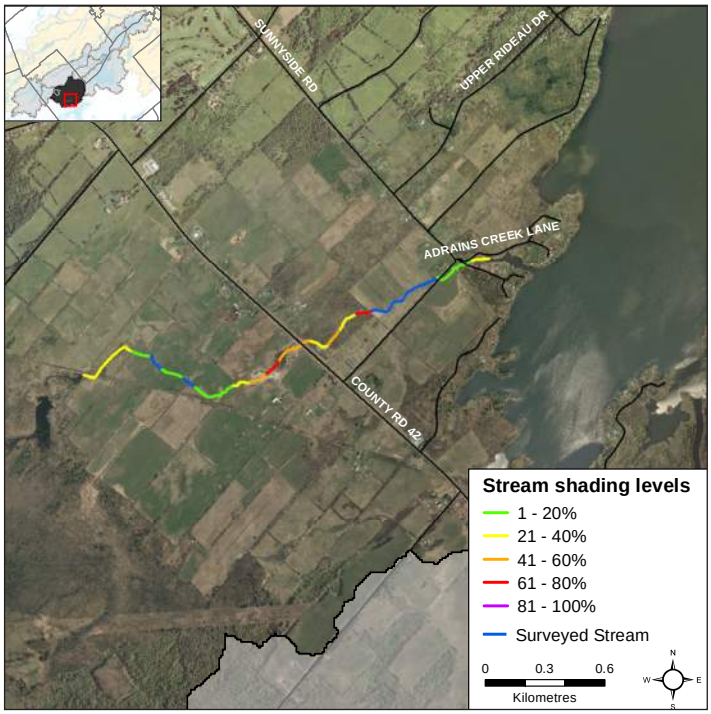


Figure 31 Stream shading along Adrains Creek

Instream Woody Debris

Figure 32 shows that the majority of Adrains Creek had low levels of instream woody debris in the form of branches and trees. Instream woody debris is important for fish and benthic habitat, by providing refuge and feeding areas.

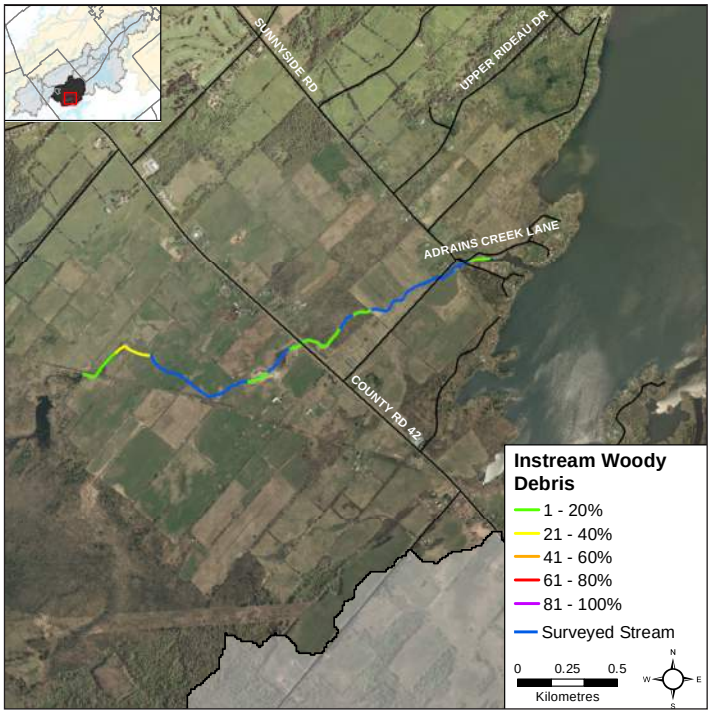


Figure 32 Instream woody debris along Adrains Creek

Overhanging Trees and Branches

Figure 33 shows that the majority of Adrains Creek had low levels of overhanging branches and trees. Overhanging branches and trees provide a food source, nutrients and shade which helps to moderate instream water temperatures

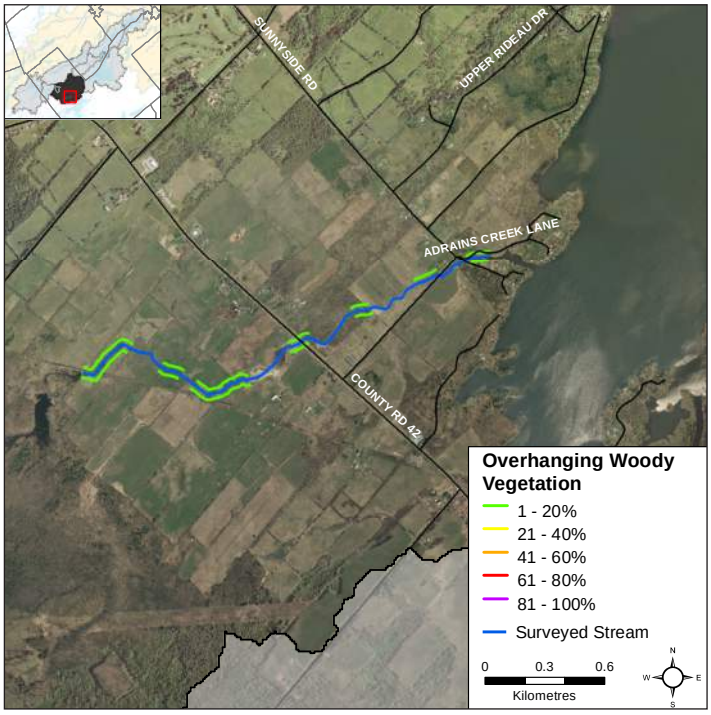


Figure 33 Overhanging trees and branches along Adrains Creek

Anthropogenic Alterations

Figure 34 shows 68 percent of Adrains Creek remains "unaltered" with no anthropogenic alterations. Thirty two percent of Adrains Creek was classified as natural with minor anthropogenic changes in the form of buffers of less than 15 meters along the banks and road crossings.

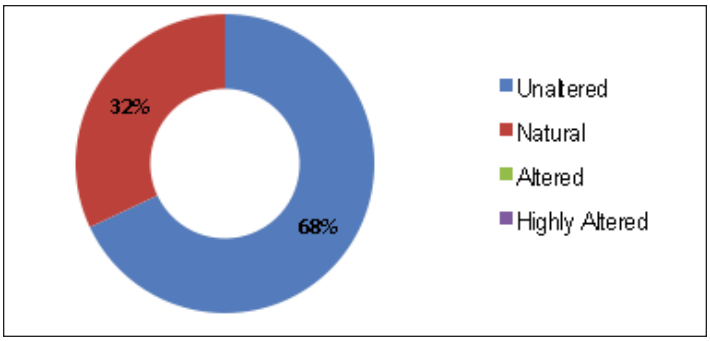


Figure 34 Anthropogenic alterations along Adrains Creek

Adrains Creek Instream Aquatic Habitat

Habitat Complexity

Streams are naturally meandering systems and move over time; there are varying degrees of habitat complexity, depending on the creek. Examples of habitat complexity include variable habitat types such as pools and riffles as well as substrate variability and woody debris structure. A high percentage of habitat complexity (heterogeneity) typically increases the biodiversity of aquatic organisms within a system. Sixty-eight percent of Adrains Creek was considered heterogeneous, as shown in Figure 35.

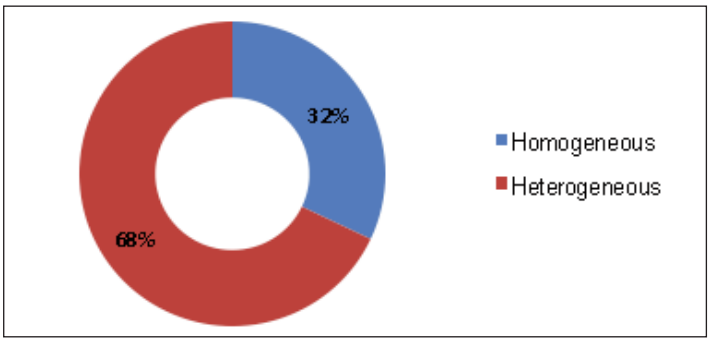


Figure 35 Habitat complexity along Adrains Creek

Instream Substrate

Diverse substrate is important for fish and benthic invertebrate habitat because some species have specific substrate requirements and for example will only reproduce on certain types of substrate. Boulders create instream cover and back eddies for large fish to hide and/or rest out of the current. Cobble provides important spawning habitat for certain fish species like walleye and shiners who are an important food source for larger fish. Cobble can also provide habitat conditions for benthic invertebrates that are a key food source for many fish and wildlife species. Figure 36 shows where cobble and boulder substrate are found in Adrains Creek.

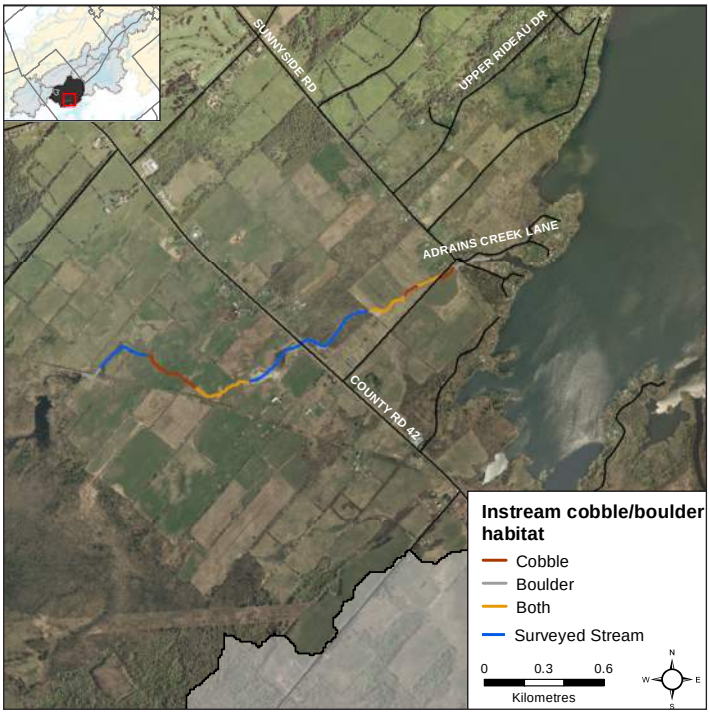


Figure 36 Instream substrate along Adrains Creek

Instream Morphology

Pools and riffles are important habitat features for fish. 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. Pools also provide important over wintering areas for fish. 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.

Figure 37 shows that Adrains Creek is fairly uniform; 96 percent consists of runs, 2 percent pools and 2 percent riffles.

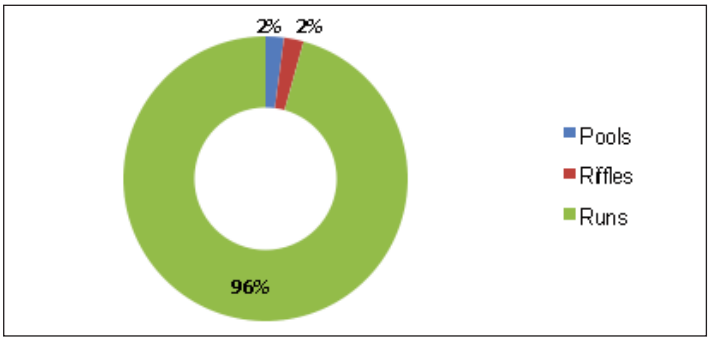


Figure 37 Instream morphology along Adrains Creek

Vegetation Type

Instream vegetation provides a variety of functions and is a critical component of the aquatic ecosystem. For example emergent plants along the shoreline can provide shoreline protection from wave action and important rearing habitat for species of waterfowl. Submerged plants provide habitat for fish to find shelter from predator fish while they feed. Floating plants such as water lilies shade the water and can keep temperatures cool while reducing algae growth. Adrains Creek had moderate levels of diversity of instream vegetation. The dominant vegetation type recorded at forty-nine percent consisted of narrow leafed emergents. Figure 38 depicts the plant community structure for Adrains Creek.

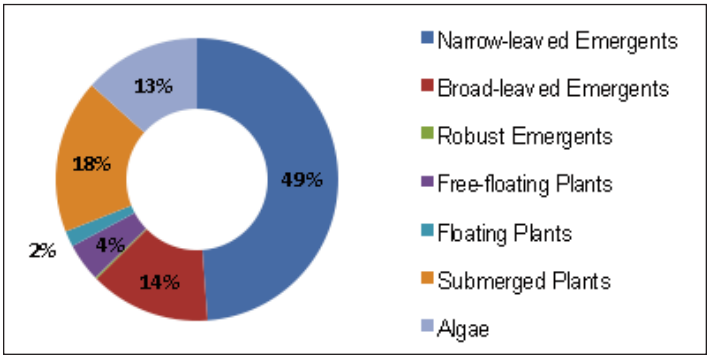


Figure 38 Vegetation type along Adrains Creek

Instream Vegetation Abundance

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. Too much vegetation can also be detrimental. Figure 39 demonstrates that Adrains Creek has variable levels of instream vegetation for most of its length.

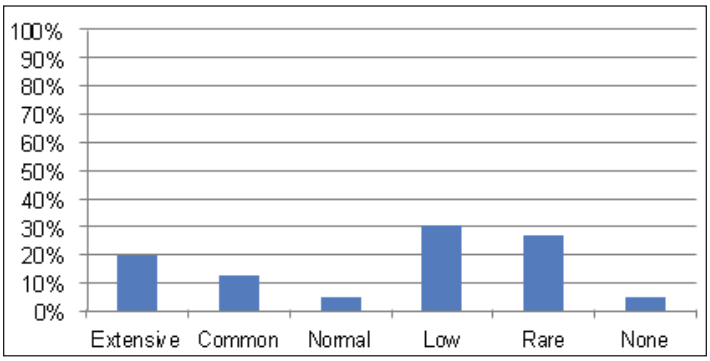


Figure 39 Instream vegetation abundance along Adrains Creek

Invasive Species

Invasive species can have major implications on streams and species diversity. Invasive species are one of the largest threats to ecosystems throughout Ontario and can outcompete native species, having negative effects on local wildlife, fish and plant populations. Forty-two percent of the sections surveyed along Adrains Creek had invasive species (Figure 40). The invasive species observed in Adrains Creek were common buckthorn, European frogbit and purple loosestrife.

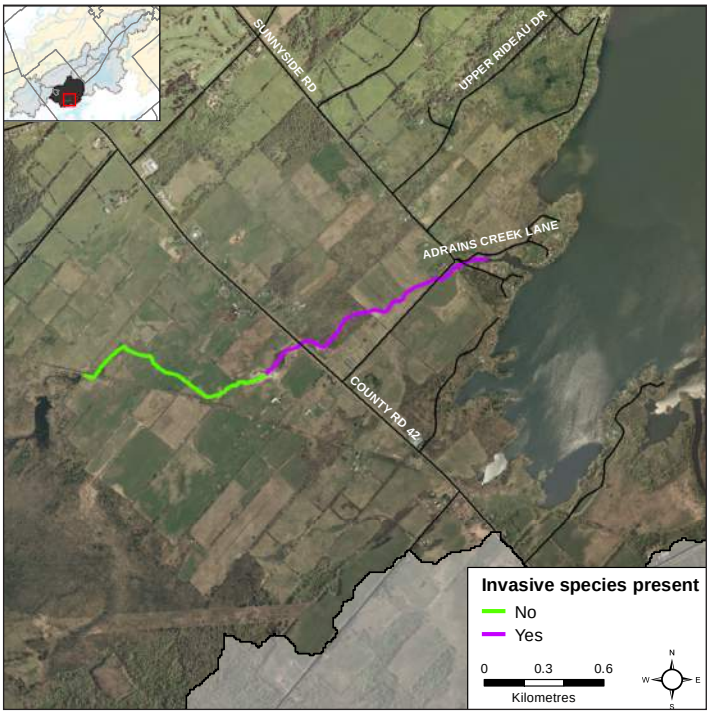


Figure 40 Invasive species along Adrains Creek

Thermal Regime

Many factors can influence fluctuations in stream temperature, including springs, tributaries, precipitation runoff, discharge pipes and stream shading from riparian vegetation. Water temperature is used along with the maximum air temperature (using the Stoneman and Jones method) to classify a watercourse as either warm water, cool water or cold water. Figure 41 shows the location of temperature loggers at two sampling locations along Adrains Creek. Analysis of the data collected indicates that Adrains Creek is classified as a cool water system (Figure 42).

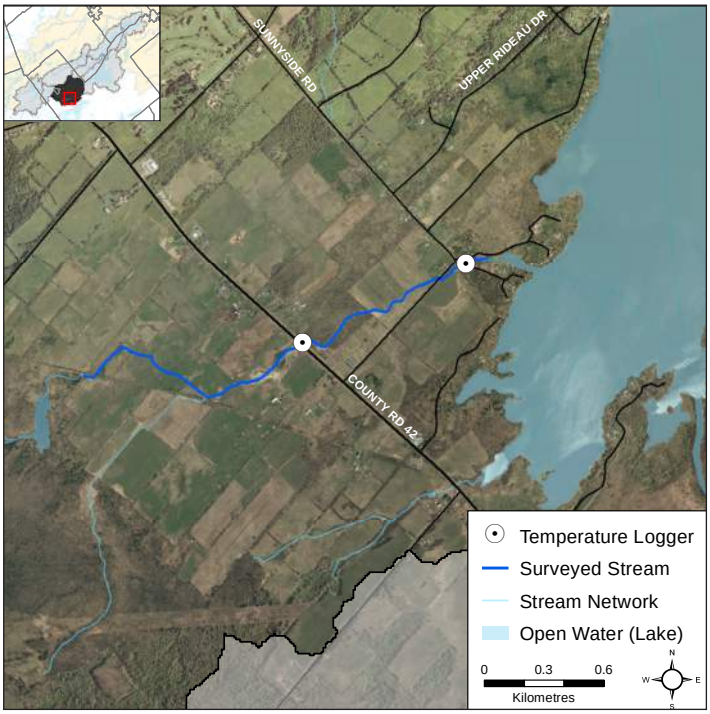


Figure 41 Temperature loggers in Adrains Creek

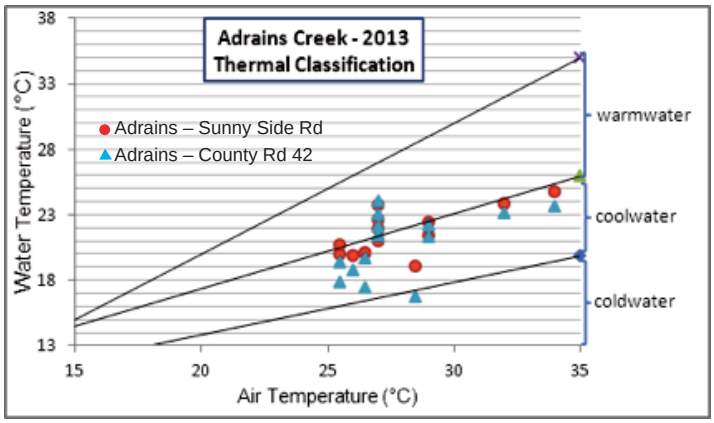


Figure 42 Temperature logger data for two sites on Adrains Creek

Headwaters Drainage Features Assessment

The RVCA Stream Characterization program assessed Headwater Drainage Features for the Rideau Lakes subwatershed in 2013. This protocol measures zero, first and second order headwater drainage features (HDF). It is a rapid assessment method characterizing the amount of water, sediment transport, and storage capacity within headwater drainage features (HDF). RVCA is working with TRCA and the MNR to implement the protocol with the goal of providing standard datasets to support science development and monitoring on both the interim guideline for headwater drainage features and existing mitigation strategies. An HDF is a depression in the land that conveys surface flow. Additionally, this module provides a means of characterizing the connectivity, form and unique features associated with each HDF (OSAP Protocol, 2013). An initiative is underway to evaluate how these data can help understand the cumulative contributions of individual headwater drainage features on the downstream watershed state (see Stanfield et al., 2013). In 2013 the program sampled 17 sites in the Upper Rideau Lake catchment area. Figure 43 shows the headwater drainage features sampling locations in the catchment.

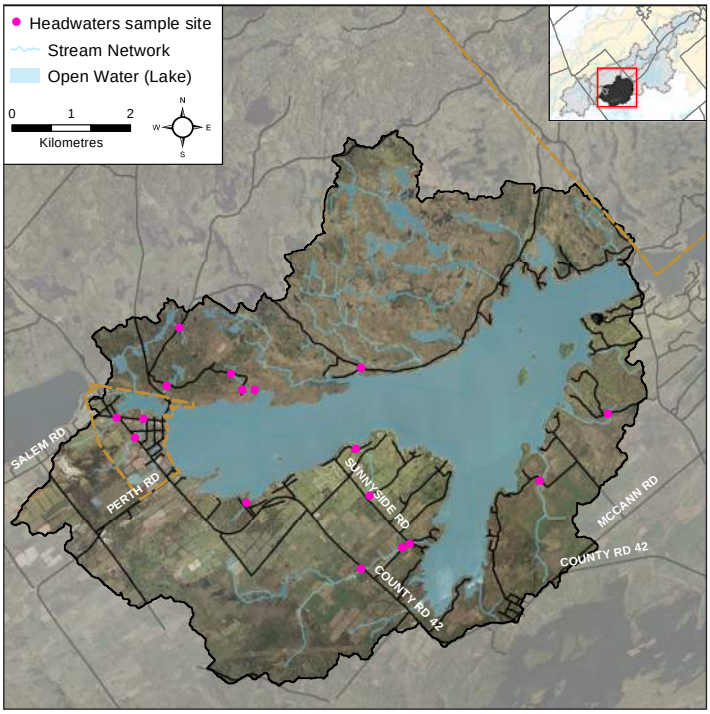


Figure 43 Headwater drainage feature sampling locations around Upper Rideau Lake

Two headwater drainage features sampled in the Upper Rideau Lake catchment

Fisheries

The Upper Rideau Lake catchment is classified as a mixed community of warm, cool and cold water recreational and baitfish fishery with 29 species observed. The following is a list of species observed in the watershed (Source: MNR/RVCA). Fish sampling sites are shown in Figure 44.

alewife
banded killifish
black crappie
blackchin shiner
blacknose shiner
bluegill
bluntnose minnow
brook stickleback
brown bullhead
burbot
central mudminnow
common carp
creek chub
darter spp.
fathead minnow
finescale dace
golden shiner
lake herring
largemouth bass
northern pike
northern redbelly dace
pumpkinseed
rock bass
shorthead redhorse
smallmouth bass
walleye
white sucker
yellow bullhead
yellow perch

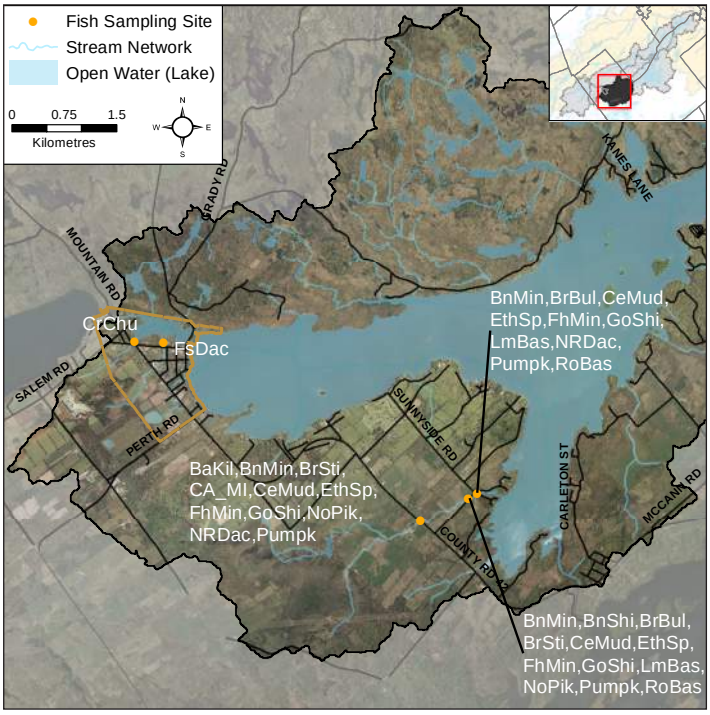


Figure 44 Fish sampling on Upper Rideau Lake

Young of the year northern pike *(Esox lucius)* captured on Adrains Creek

Riparian Restoration

Figure 45 depicts the locations where various riparian restoration activities can be implemented as a result of observations made during the stream survey assessments.

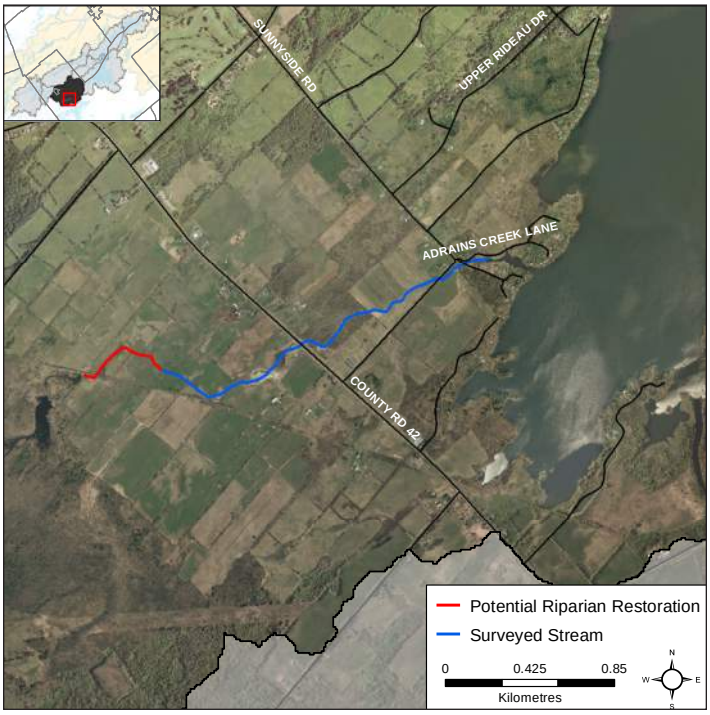


Figure 45 Riparian restoration along Adrains Creek

Migratory Obstructions

It is important to know the locations of migratory obstructions because they can prevent fish from accessing important spawning and rearing habitat (Figure 46). Migratory obstructions can be natural or manmade, and they can be permanent or seasonal. There was one debris dam on Adrains Creek at the time of the survey.

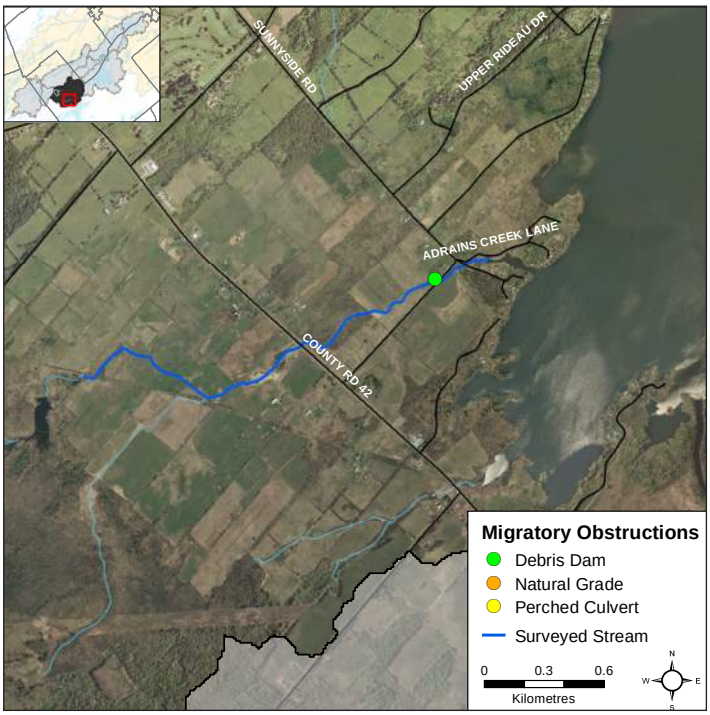


Figure 46 Migratory obstructions along Adrains Creek

Adrains Creek

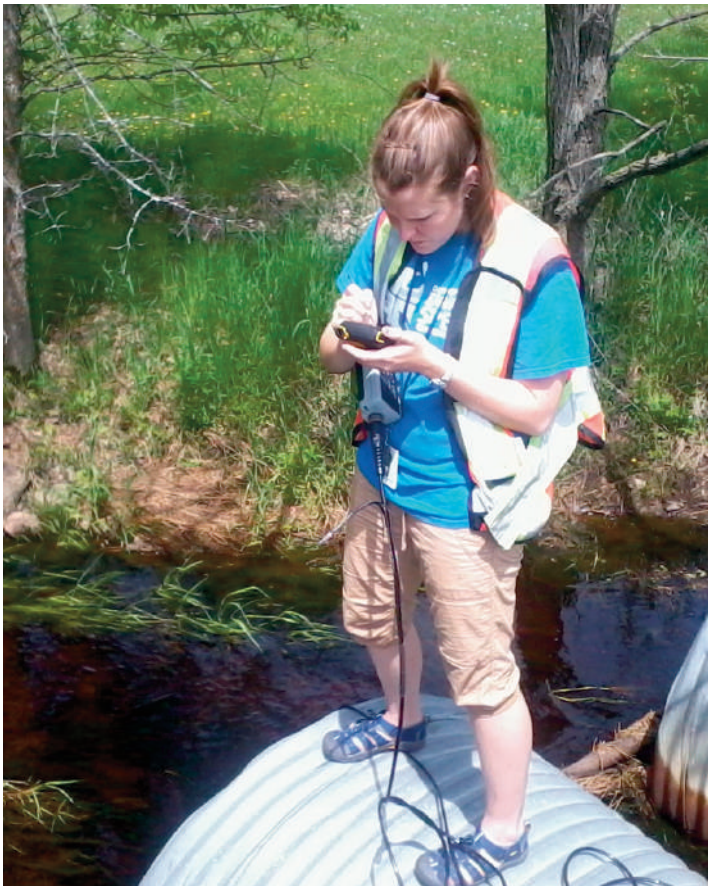
Water Chemistry

During the stream characterization survey, a YSI probe is used to collect water chemistry, as follows:

- Dissolved Oxygen is a measure of the amount of oxygen dissolved in water. The lowest acceptable concentration of dissolved oxygen is 6.0 mg/L for early stages of warm water fish and 9.5 mg/L for cold water fish (CCME, 1999). A saturation value (concentration of oxygen in water) of 90 percent or above is considered healthy. Saturation levels above one hundred percent are not uncommon in sections of stream where there are high amounts of algae and other aquatic plants.
- Conductivity is the ability of a substance to transfer electricity. This measure is influenced by the presence of dissolved salts and other ions in the stream.
- pH is a measure of relative acidity or alkalinity, ranging from 1 (most acidic) to 14 (most alkaline/basic), with 7 occupying a neutral point. 2013 data for these four parameters is summarized in Table 13.

Table 13 Water chemistry in Adrains Creek

Month	Range	DO (mg/L)	DO(%)	Conductivity (µs/cm)	pH
May 2013	Low	5.6	56.3	194	7.2
	High	11.3	113.5	212	7.6
June 2013	Low	3.3	31.5	175	7.2
	High	7.0	67.4	198	7.6



3. Land Cover

Woodland is the dominant land cover type in the catchment along with water, as shown in Table 14 and displayed in the map on the front cover of the report.

Table 14 Catchment land cover type

Cover Type	Area (ha)	Area (% of Cover)
Woodland*	2,380	39
Water	1,556	26
Crop & Pasture	1,174	19
Wetland**	448	8
Settlement	309	5
Transportation	183	3

* Does not include treed swamps ** Includes treed swamps

Woodland Cover

The Upper Rideau Lake catchment contains 2380 hectares of upland forest and 22 hectares of lowland forest (treed swamps) (Fig.47) that occupies 40 percent of the drainage area (versus the 44 percent of woodland cover in the Rideau Lakes subwatershed). This figure is greater than the 30 percent of woodland area required to sustain forest birds, according to Environment Canada's Guideline: *How Much Habitat Is Enough?* When forest cover declines below 30 percent, forest birds tend to disappear as breeders across the landscape.

One hundred and two (53 percent) of the 194 woodland patches in the catchment are very small, being less than one hectare in size. Another 74 (38 percent) of the wooded patches ranging from one to less than 20 hectares in size tend to be dominated by edge-tolerant bird species. The remaining 18 (nine percent of) woodland patches range between 21 and 757 hectares. Fourteen of these patches contain woodland between 20 and 100 hectares and may support a few area-sensitive species and some edge intolerant species, but will be dominated by edge tolerant species. Conversely, four (less than one percent) of the 194 woodland patches in the drainage area exceed the 100 plus hectare size needed to support most forest dependent, area sensitive birds and are large enough to support approximately 60 percent of edge-intolerant species. Two of these patches top 200 hectares, which according to the Environment Canada Guideline will support 80 percent of edge-intolerant forest bird species (including most area sensitive species) that prefer interior forest habitat conditions.

Forest Interior

The same 194 woodlands contain 87 forest interior patches (Fig.47) that occupy two percent (390 ha.) of the catchment land area (versus the five percent of interior forest in the Rideau Lakes subwatershed). This is below the ten percent figure referred to in the Environment Canada Guideline that is considered to be the minimum threshold for supporting edge intolerant bird species and other forest dwelling species in the landscape. Most patches (76) have less than 10 hectares of interior forest, 50 of which have small areas of interior forest habitat less than one hectare in size. Another eight patches contain between 10 and 30 hectares of interior forest. Conversely, three patches have greater than 30 hectares of interior forest (at 36, 53 and 55 ha).

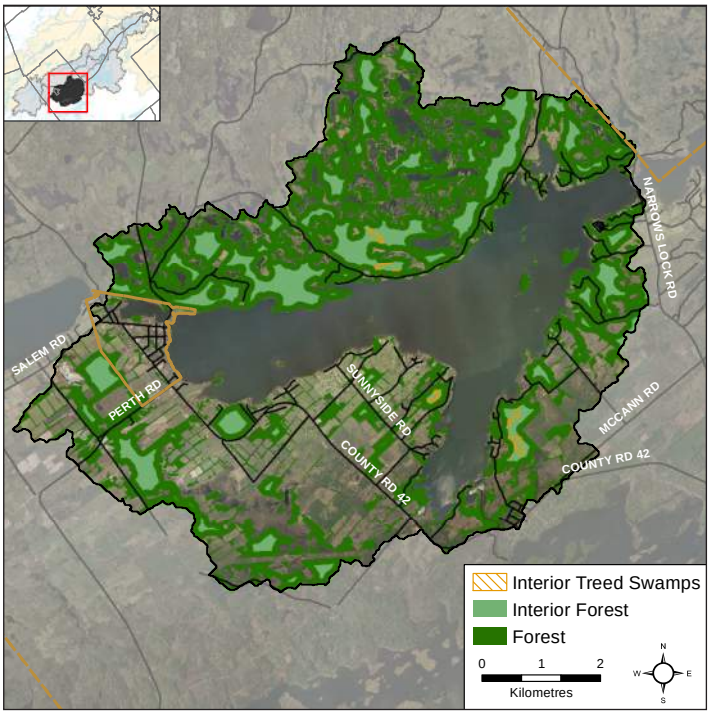
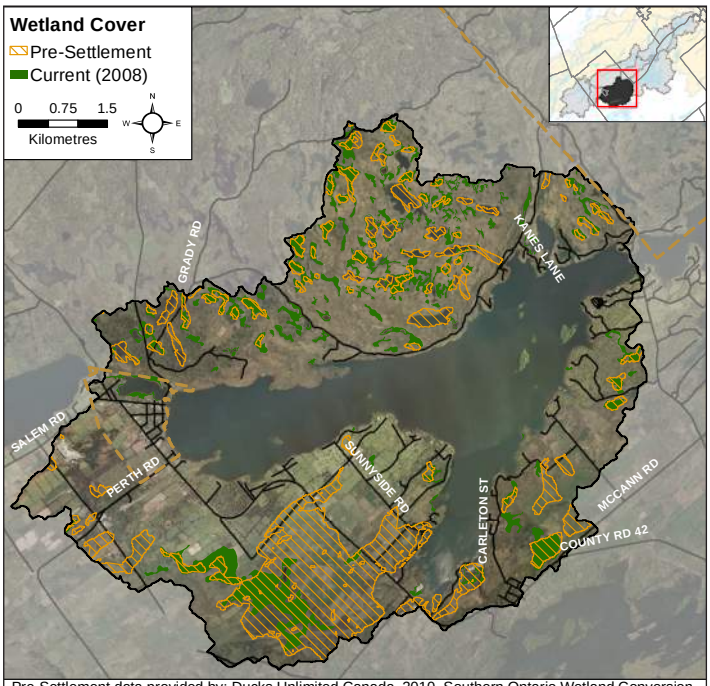


Figure 47 Catchment woodland cover and forest interioror

Wetland Cover

Figure 48 shows pre-settlement wetland cover (Ducks Unlimited Canada 2010) versus current wetland cover (DRAPE 2008) in the catchment. Analysis of these two datasets reveals that there has been a 48 percent loss in the amount of wetland on the landscape through this period; most of this reported loss has occurred off the Canadian Shield where 68 percent of wetlands have been estimated to have been lost.



Pre-Settlement data provided by: Ducks Unlimited Canada, 2010. Southern Ontario Wetland Conversion Analysis, http://www.ducks.ca/aboutduc/news/archives/prov2010/pdf/duc_ontariowca.pdf, (March 2010)

Figure 48 Catchment wetland cover

4. Stewardship and Protection

The RVCA and its partners are working to protect and enhance environmental conditions in the Rideau Lakes subwatershed.

Rural Clean Water Projects

Figure 49 shows the location of all Rural Clean Water Projects in the Upper Rideau Lake drainage area. From 2008 to 2013, landowners completed seven projects: three well upgrades, two well decommissionings, one septic system repair and one erosion control project. RVCA contributed $5,572 in grant dollars towards the total project cost of $25,426.

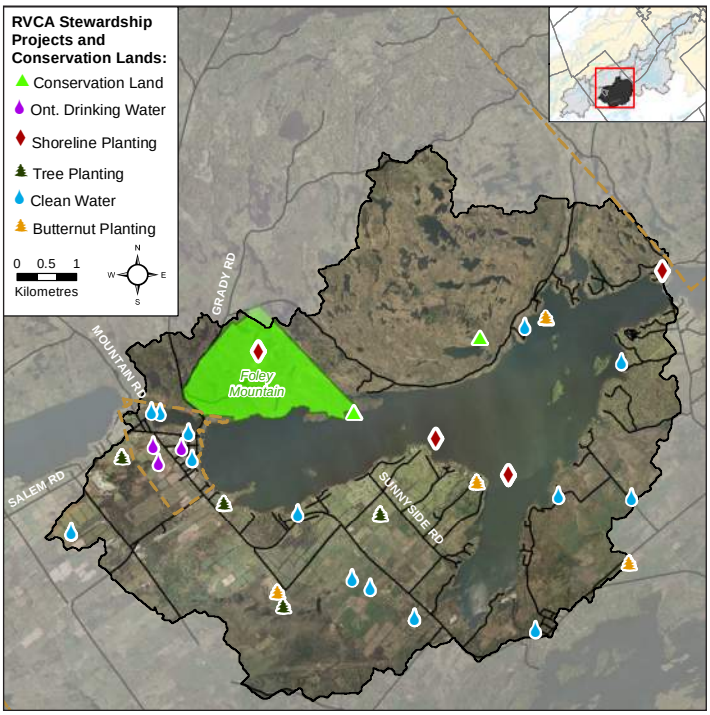


Figure 49 RVCA stewardship program project locations

Prior to 2008, the RVCA completed ten projects in the area consisting of three well upgrades, two septic system repairs, two livestock fencing projects, one erosion control project, one fuel storage and handling facility and one well decommissioning. In total, RVCA contributed $16,192 in grant dollars to projects valued at $86,435.

Ontario Drinking Water Stewardship Projects

Figure 49 shows the location of all Ontario Drinking Water Stewardship Program (ODWSP) projects in the Upper Rideau Lake drainage area. This Ministry of the Environment funded program has supported three projects between 2008 and 2013. Total project value is $22,146 with landowners receiving $15,934 to support two septic system repairs/replacements and one fuel handling and storage facility.

Tree Planting Projects

The location of all tree planting projects is also shown in Figure 49. From 2008 to 2013, 10,550 trees were planted at three sites through the RVCA Tree Planting Program. Project value is $25,769 with $14,765 of that amount coming from other fundraising sources.

Before that, landowners helped plant 3,400 trees, valued at $7,259, at one project site, using the RVCA Tree Planting Program; fundraising dollars accounted for $1,919 of that amount.

Shoreline Naturalization Projects

With the assistance of the RVCA's Shoreline Naturalization Program, 2,823 trees and shrubs were planted at seven project locations to create 488 metres of shoreline buffer at a total project value of $7,077.

The RVCA also works with the Upper Rideau Lake Association to assist it with the distribution of native trees and shrubs each spring. Since 2010, 3,450 native plant seedlings have been provided through the program at no charge to the lake community.

Septic System Re-Inspections

From 2007 to 2014, the Mississippi Rideau Septic System Office performed 63 septic system re-inspections (44 cottages and 19 houses) on Upper Rideau Lake in Rideau Lakes Township. Remedial/maintenance work (i.e. pump outs, baffle replacement, work that generally does not require a permit) was recommended for 28 (or 44 percent) of those properties that were inspected, septic system replacements at another three (or five percent of) properties with more information provided to a further two landowners with identified septic system concerns.

Valley, Stream, Wetland and Hazard Land Regulation

Three and a half square kilometres or six percent of the catchment drainage area is within the regulation limit of Ontario Regulation 174/06 (Fig.50), giving protection to wetland areas and river or stream valleys that are affected by flooding and erosion hazards.

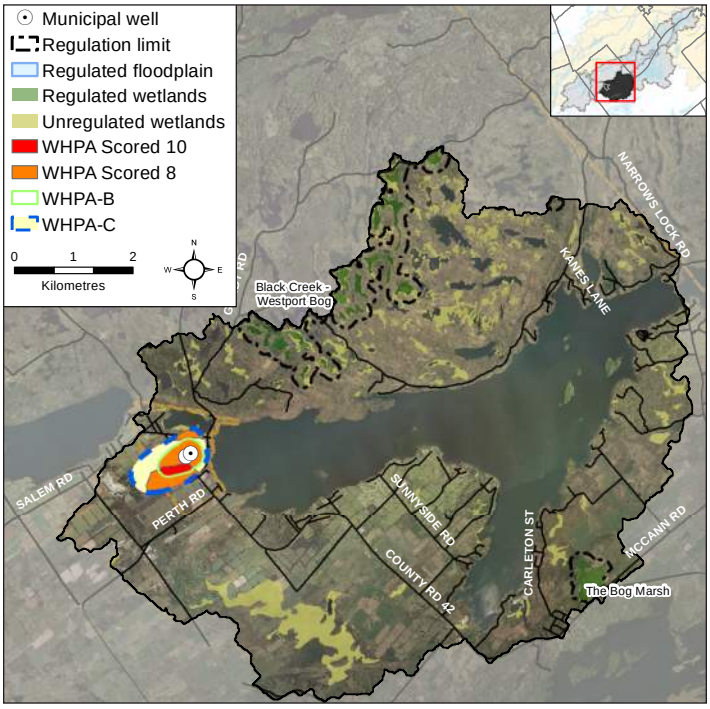


Figure 50 RVCA regulation limits and Westport Wellhead Protection Area

Natural features within the regulation limit include 0.8 sq. km. of wetlands (representing 19 percent of all wetlands in the catchment) and 7.9 kilometers of streams (representing nine percent of all streams in the catchment). Some of these regulated watercourses (4.9 km or six percent of all streams) flow through regulated wetlands.

Regulation limit mapping has been plotted along 2.9 km (or 37 percent) of the streams that are outside of wetlands. Plotting of the regulation limit on the remaining 79.4 km (or 91 percent) of streams requires identification of flood and erosion hazards and valley systems.

Within the regulation limit, “development” and “site alteration” require RVCA permission. The “alteration to waterways” provision of Ontario Regulation 174/06 applies to all watercourses.

Vulnerable Drinking Water Areas

The Wellhead Protection Area (WHPA) around the Westport municipal drinking water source is located within the catchment drainage area (Fig.50). The Wellhead Protection Area is subject to mandatory policies in the *Mississippi-Rideau Source Protection Plan* developed under the *Clean Water Act.* These policies specifically regulate land uses and activities that are considered drinking water threats, thereby reducing the risk of contamination of the groundwater that feeds the municipal wells.

The catchment area is considered to have a Highly Vulnerable Aquifer. This means that the nature of the overburden (thin soils, fractured bedrock) does not provide a high level of protection for the underlying groundwater making the aquifer more vulnerable to contaminants released on the surface. The Mississippi-Rideau Source Protection Plan includes policies that focus on the protection of groundwater region-wide due to the fact that most of the region, which encompasses the Mississippi and Rideau watersheds, is considered Highly Vulnerable Aquifer.

The catchment area is also considered a Significant Groundwater Recharge Area. This means that there is a volume of water moving from the surface into the ground and groundwater serves either as a municipal drinking water source or supplies a cool/cold water stream. The Plan was not required to include policies to specifically address Significant Groundwater Recharge Areas.

For detailed maps and policies that have been developed to protect Westport’s water supply, please go to the Mississippi-Rideau Source Protection Region website at www.mrsourcewater.ca to view the approved *Mississippi-Rideau Source Protection Plan.*

Adrains Creek

5. Issues

Water Quality

- Historically, persistent high nutrient concentrations have been a concern in Upper Rideau Lake from inflows of nutrients (from private septic systems, from agricultural/commercial/residential stormwater runoff and from sewage lagoon discharge) which has enabled aquatic plants and algae blooms to flourish
- Recent findings from the RVCA's surface water quality monitoring program show that Upper Rideau Lake has a "Poor" surface water quality rating (for the 2008-2013 period) and is generally characterized by elevated nutrient concentrations along with a history of algal bloom occurrences
- Adrains Creek has a "Poor" surface water quality rating (for the 2002-2007 and 2008-2013 periods) due to consistently high nutrient, bacteria and metal concentrations
- RVCA's 2013 Algae and Aquatic Plant Survey for Eastern Ontario Lakes and Rivers notes that a majority of the respondents in the Rideau Lakes subwatershed have noticed an increase in algae blooms and aquatic plants on their lake. During the summer of August 2014, blue-green algae blooms were identified on Upper Rideau Lake. This has been followed up with concerns being expressed (via the Township of Rideau Lakes) by those who live and recreate on the Upper Rideau Lake, downstream property owners, local businesses and the wider community that run the full spectrum from public health, to ecosystem health, to aesthetics, to property values
- Thirty-three (of 63) Rideau Lakes Township septic system voluntary re-inspections conducted from 2007 to 2014 revealed the need for additional maintenance/remedial/replacement works to be performed. Those properties with concerns are identified in the yearly report submitted by the Mississippi Rideau Septic System Office to the Township

Development

- Traditional cottage character of the Rideau Lakes is being slowly altered by the scale of development and the trend toward larger year-round dwellings. This transition is taking place either through re-development of an existing cottage lot or incremental alterations (additions, sleeping cabins, gazebos, decks, sheds, boat houses, garages, lawns, docks)
- Many waterfront properties contain existing non-complying dwellings with respect to minimum water frontage and lot area and are often located within 30 metres of the water that require minor variances for expansion and/or reconstruction of dwellings where standard development setbacks from water are difficult to achieve. In these cases, of which there are many, municipal staff and the Conservation Authority often meet with resistance and push back when attempts are made to implement standards for development setbacks, vegetated shorelines and septic systems
- Monitoring implementation of conditions of planning and regulatory approvals is challenging due to a lack of resources
- Access to waterfront properties along private roads/right-of-way is becoming more of a municipal liability for emergency vehicle access (ambulance, fire and police)

Shorelines

- Along the south shore of Upper Rideau Lake (off the Canadian Shield), the majority of the 30 metre wide riparian, shoreline buffer contains (51 percent) non-natural land cover (comprised of village/waterfront settlement areas, roads and crop and pastureland) and 49 percent natural land cover (made up of woodland and wetland), which is below the recommended 75 percent naturally vegetated riparian, shoreline buffer target. By comparison, the shoreline cover on the north shore of Upper Rideau Lake (on the Canadian Shield) is comprised of 75 percent natural land cover (made up of woodland and wetland) and 25 percent non-natural land cover (comprised of waterfront settlement areas and crop and pastureland)
- Around Westport Pond, the 30 metre wide riparian, shoreline buffer contains (37 percent) non-natural land cover (comprised of waterfront residential/commercial properties and roads) and 63 percent natural land cover (made up of wetland and woodland), which is below the recommended 75 percent naturally vegetated riparian, shoreline buffer target
- The 1992 Upper Rideau Lake Shoreline Survey revealed that the majority of properties had some type of altered shoreline (229 out of 425 properties surveyed)
- Emerald ash borer poses a significant threat to the ecology of the subwatershed, given the prominence of ash trees along shorelines and in riparian and wetland areas. Many tree stands are predominantly ash and with their anticipated loss, it is unclear what will replace them and the overall effect of their collective demise on the physical and natural functions/values they provide for erosion, water quality and fish and wildlife habitat protection

Water Levels

- Fluctuations above/below the expected/typical range in water levels due to cool and wet or hot and dry conditions cause concern amongst property owners around the Rideau Lakes. Information about water level management is available on various websites; however, timely communication about the manipulation of water level control structures and specific conditions is not always forthcoming during high water events

Fisheries

- There is limited information available about the state of the fisheries resource in this catchment. Fisheries studies were completed on most Rideau Lakes in the late 1960's or early 1970's revealing a diverse fishery resource with cold, cool and warm aquatic habitats present. Since then, no other studies have been completed on the local lakes with the exception of Big Rideau Lake where landscape level, broad-scale, creel surveys are conducted by MNR on a five year cycle

Lake Planning

- This report outlines some issues and concerns regarding the health of the Upper Rideau Lake catchment. However, there is limited knowledge of the overall issues and concerns about natural resource management, use and the health of the Upper Rideau Lake and its subwatershed
- The Upper Rideau Lake community might consider working together to undergo the lake planning process. The lake planning process allows for valuable information about the current health of the lake and its watershed, as well as an overview of all the issues and concerns facing the lake to be collected together. The lake planning process requires involvement and input from the whole lake community which includes lake residents, users, businesses, municipalities, non-governmental organizations, agency partners and other stakeholders. The process ensures that the lake community's issues and concerns are gathered into one action-oriented document, which can guide the many stakeholders that care about Upper Rideau Lake to help tackle lake health concerns in partnership

6. Opportunities

Water Quality

- Further investigate reported high nutrient levels in Adrains Creek and Upper Rideau Lake to determine if nutrients inputs can be reduced to improve water quality and downstream impacts on McNally's Bay in Upper Rideau Lake
- Reduce pollutant loadings to Upper Rideau Lake and Adrains Creek through application of shoreline, stormwater and agricultural best management practices; also consider using low impact development (LID) methods to improve the quality and reduce the amount of stormwater runoff reaching the lake ecosystem. This may be particularly benificial in areas of high density development with extensive impervious surfaces (i.e., asphalt, concrete, buildings and severely compacted soils) or on sensitive waterfront properties (with steep slopes/banks, shallow/impermeable soils)
- Continue to promote the protection of the Rideau Lakes water resources through implementation of municipal and agency land use and development policies and practices
- Continue to promote septic sytem re-inspections by the Mississippi Rideau Septic System Office to ensure that sewage disposal systems are functioning properly and advocate for the replacement of faulty septic systems in accordance with current *Ontario Building Code* standards
- Continue to offer septic repair/replacement project funding provided by the Rideau Valley Rural Clean Water Program to waterfront landowners
- Continue efforts to educate boaters about the need to properly dispose of on-board grey and black water and the availability of environmentally conscious marinas with sewage pump-out facilities that have been certified by the Clean Marinas Program
- Review monitoring of surface water quality in Upper Rideau Lake, along with other Rideau Lakes before the next round of the Watershed Watch monitoring cycle begins in 2016 to determine if there is a need to "develop a more intensive and coordinated water quality monitoring program for all Rideau Lakes" (an identified action in the 2009 Rideau Lakes Watershed Plan)

Development

- Collectively work with approval authorities (Township of Rideau Lakes, Village of Westport, Conservation Authority, Parks Canada, the Health Unit, and Mississippi-Rideau Septic System Office) to consistently implement current land use planning and development policies for water quality and shoreline protection adjacent to lakes and streams (e.g., a minimum 30 metre development setback from water)
- Explore ways and means to more effectively enforce and implement conditions of land-use planning and development approval to achieve net environmental gains (particularly with respect to rehabilitating or protecting naturally vegetated shorelines and water quality)
- Encourage Committees of Adjustment to take advantage of technical and environmental information and recommendations forthcoming from planning and environmental professionals
- Municipal and agency planners together with development proponents are to continue using the *Rideau Lakes Basin Carrying Capacity Study* (1992) and associated *Site Evaluation Guidelines* (2014)[6] to inform decision-making about the application of development setbacks on lots with shallow soils/bedrock, steep slopes and sparse vegetation cover along with the use of the appropriate, development related, best management practices
- Utilize RVCA subwatershed and catchment reports to help develop/revise official plan policies to protect surface water resources and the natural environment (including woodlands, wetlands and shoreline cover)
- New development around Upper Rideau Lake should take into account a first floor elevation of 125.2 metres (using the 124.9 metre 100 year flood elevation plus 0.3 metre freeboard) above sea level so as to ensure the safety and integrity of buildings and their contents; this figure should also be taken into account in the design and placement of septic systems and well heads so that they are not adversely impacted during flood events

Shorelines

- RVCA and its partners (including the municipalities of Rideau Lakes and Westport and the Upper Rideau Lake Association) are to continue educating landowners about waterfront property best management practices with respect to shoreline use and development, septic system installation/maintenance and shoreline vegetation retention and enhancement
- Protect the riparian buffer along the shoreline of Upper Rideau Lake and its tributaries during the development approvals process through adherence to and enforcement of municipal land-use policies and zoning standards
- Utilize the findings of the 2014 MAPLE Shoreline Classification of Upper Rideau Lake, prepared by the Centre for Sustainable Watersheds in conjunction with the Upper Rideau Lake Association, to target (degraded and ornamental) shoreline properties that could benefit from shoreline re-vegetation/naturalization applications
- Target riparian and instream restoration at sites identified in this report (as shown in Figure 26 as "Other" riparian cover and Figure 45) and explore other restoration and enhancement opportunities along the Adrains Creek riparian corridor
- Upper Rideau Lake Association and the RVCA are to continue working together to promote the Shoreline Naturalization Program and other similar initiatives to encourage landowners to enhance vegetation cover around the lake
- Continue to educate boaters about the effect of excessive speeding and ensuing boat wake on the shoreline and wildlife of Upper Rideau Lake; also consider enforcement of speeding watercraft in close proximity to the shoreline

Water Levels

- Forge connections amongst water resources management agencies, businesses, municipalities and lake residents to continually improve water level management activities. This will include the pooling of resources where possible and regular communications about how, when and why water levels are manipulated and what the impacts will be on navigation, fisheries, recreation and flood attenuation
- In 2014, lake levels were higher than most years and more attention was required from RVCA and municipal staff. Only general flood

[6] Hutchinson Environmental Sciences Ltd. 2014. *Assessment of Municipal Site Evaluation Guidelines in Eastern Ontario's Lake Country.* Prepared for Mississippi Valley Conservation Authority, Rideau Valley Conservation Authority and Cataraqui Region Conservation Authority

information was available for Tay Valley Township and the Township of Rideau Lakes to address landowner concerns. In response, a review of the RVCA Flood Forecasting and Warning Program in the Upper Rideau Valley is underway to address this need

Lake Planning

A Lake Plan:

- Is an action plan developed by a lake community (which includes lake residents, users, businesses, municipalities, non-governmental organizations, agency partners and other stakeholders) that identifies and preserves the natural and social characteristics that are valued by the lake community for future generations
- Helps to promote community discussion, education and action
- Sets goals and objectives for the protection and enhancement of the lake
- Recommends land use policies/practices that influence development on the lake
- Promotes stewardship actions to improve the environmental conditions of a lake so it can be enjoyed by future generations

Consider the need for a community-driven lake management plan for Upper Rideau Lake that can:

- Bring the lake community together
- Engage the community beyond the lake residents and lake association members and develop partnerships
- Identify and bring together common values and concerns
- Provide a baseline of data on water quality, land-use activities, shoreline development, fisheries management, etc., that can help to inform water resources management, land use planning and stewardship actions
- Range in complexity from a comprehensive living document to a simplified list of priorities that can be carried out by the lake community to protect the lake environment

Upper Rideau Lake