Rideau Lakes Subwatershed Report 2014
WOLFE 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 Wolfe Lake and other lakes in the catchment area, 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.

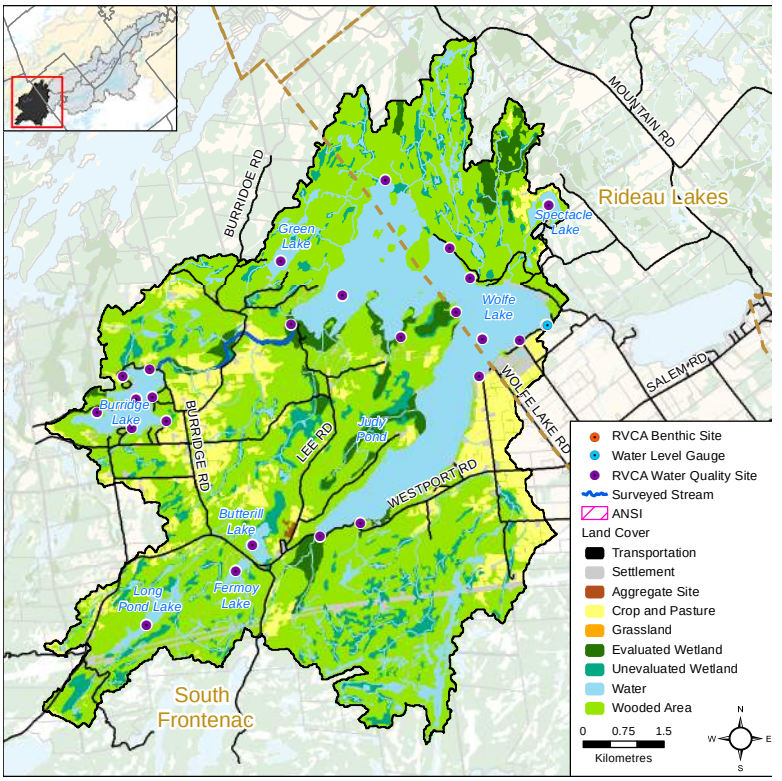
The following pages of this report are a compilation of that work. For other Rideau Lakes catchments and the *Rideau Lakes Subwatershed Report,* please visit the RVCA website at www.rvca.ca

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
- Wolfe and Green Lakes along with other lakes in the catchment (Burridge, Butterill, Fermoy, Long Pond and Spectacle) are essentially recreational areas, dedicated to activities such as fishing, boating, water skiing, swimming, hiking, cross-country skiing or simply the enjoyment of the surrounding natural world. A growing number of permanent residents are either retired or, as a result of recent improvements in communications, able to work from their lakeside homes or cottages
- 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



- The Rideau Lakes (including Wolfe and Green Lakes and other catchment 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 Wolfe 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. These rocks consist mainly of granitic gneisses throughout the northern and southern parts of the catchment and marble throughout the centre of the catchment. However, some sandstone is located in the eastern parts, near Hannah Road North. The sediment overlying the bedrock is very thin and composed primarily of mixed glacial sediment often referred to as drift. Organic deposits are also found within the catchment where bogs, swamps and marshes are situated. Geologic faults runs northeast through the southern lobe of and roughly east-west through the northern part of Wolfe Lake
- Eighty-one percent of the catchment lies within the Township of South Frontenac and 19 percent within the Township of Rideau Lakes
- Wolfe Lake catchment drainage area is 73 square kilometres and occupies about 16 percent of the Rideau Lakes subwatershed and less than two percent of the Rideau Valley watershed
- Dominant land cover is woodland (53 percent) followed by water (19 percent), wetland (13 percent), crop and pastureland (10 percent), settlement areas (three percent) and transportation routes (two percent)

Vulnerable Areas

- The Assessment Report developed under the Ontario *Clean Water Act*, identified the catchment area as Highly Vulnerable Aquifer and a portion of the area is considered to be a Significant Groundwater Recharge Area

Development/Trends

- Given the proximity to the serviced communities of Perth, Portland 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 Wolfe 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) or in back-lot areas, as the remaining lands have been fully developed
- *Wolfe and Green Lakes Vision & Overview* (June 30, 2013) states that waterfront development accounts for 70 percent of all development in Rideau Lakes Township. Development can be defined as the construction, expansion or renovation of any type of building, including boat houses, docks, decks, sheds, etc. It also includes shoreline development, tree removal, the establishment of lawns and other measures that could have a serious adverse impact on lake water quality and the growth of weeds and algae in the lakes. These changes place increasing pressures on the lake environment. When development exceeds the capacity of the lakes to adapt, it can have a negative impact on the lake environment and quality of life for present and for future generations
- 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
- Land use in the catchment is predominately Rural (RU) within the Townships of South Frontenac and Rideau Lakes. Around Burridge Lake and Green Lake, the majority of properties are zoned Waterfront Residential (RW) and Limited Service Residential - Waterfront Zone (RLSW). In addition to these zones, Wolfe Lake also has areas of Limited Service Residential (RLS) and Recreational Resort Commercial (RRC), which is comprised of a fractional ownership resort, a trailer park and a number of cottage rental properties

Conditions at a Glance

- Surface water quality rating in Burridge Lake, Green Lake, Fermoy Lake, Spectacle Lake and Wolfe Lake is “Fair,“ Poor” in Butterill Lake and Long Pong Lake
- Woodland cover proportion has changed/decreased by less than two percent (114 hectares) from 2002 to 2008, due to a combination of changes in land cover/land uses and/or applied digital air photo classification methods
- In the Wolfe Lake catchment, the riparian buffer (30 metres 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)
- Around Wolfe Lake itself, the shoreline buffer is made up of woodland (73 percent), settlement areas (11 percent), wetland (nine percent), transportation routes (six percent) and crop and pastureland (one percent)
- Around Spectacle Lake, the shoreline buffer is made up of woodland (83 percent), crop and pastureland (15 percent), settlement areas (one percent) and wetland (one percent)
- Around Long Pond Lake, the shoreline buffer is made up of woodland (84 percent), wetland (13 percent) and settlement areas (three percent)
- Around Green Lake, the shoreline buffer is made up of woodland (92 percent), wetland (four percent) and settlement areas (four percent)
- Around Fermoy Lake, the shoreline buffer is made up of woodland (87 percent), wetland (six percent), transportation routes (five percent) and settlement areas (two percent)
- Around Butterill Lake, the shoreline buffer is made up of woodland (52 percent), wetland (47 percent) and transportation routes (one percent)
- Around Burridge Lake, the shoreline buffer is made up of woodland (69 percent), settlement areas (17 percent), transportation routes (10 percent), wetland (four percent), and crop and pastureland (one percent)
- Along streams in the catchment, the riparian buffer is comprised of woodland (45 percent), wetland (45 percent), crop and pastureland (seven percent), transportation routes (two percent) and settlement areas (one percent)
- Development in the Wolfe Lake catchment occurs on private wells (of which there are about 221 water well records in the catchment) and septic systems
- *Wolfe and Green Lakes Vision and Overview* identifies three invasive species that are currently found in Wolfe Lake — Eurasian milfoil,

rainbow smelt and zebra mussels - and four invasive species requiring preventative measures in Wolfe and Green Lakes - giant hogweed, round goby, rudd and spiny water fleas

Catchment Care

- RVCA has monitored surface water quality on a number of waterbodies in the Wolfe Lake catchment through its Watershed Watch Program since 2005. 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 in: Burridge Lake four times of the year at one deep point site (four samples annually) and twice a year at two shoreline sites (four samples annually) and twice at an additional four shoreline sites every fifth year (eight samples in total); Butterill Lake four times of the year at one deep point site (four samples annually); Fermoy Lake four times of the year at one deep point site (four samples annually); Green Lake four times of the year at one deep point site (four samples annually); Long Pond Lake four times of the year at one deep point site (four samples annually); Spectacle Lake four times of the year at one deep point site (four samples annually); Wolfe Lake four times of the year at two deep point sites (eight samples annually), twice a year at four shoreline sites (eight samples annually) and twice at an additional seven shoreline sites every fifth year (14 samples in total)
- RVCA has been providing septic system re-inspection at the request of the Township of Rideau Lakes since 2007 and on Wolfe Lake from 2009
- Township of Rideau Lakes septic system voluntary re-inspections were undertaken on 27 Wolfe Lake properties in the catchment by the Mississippi Rideau Septic System Office. No septic system issues were identified at 11 of those properties; remedial/maintenance work was advocated for another 14 sites with more information supplied to two other landowners with identified septic system concerns
- Two tree planting projects have been completed through RVCA's Private Land Forestry Program (see Section 4 of this report for details)
- RVCA completed littoral zone mapping around Wolfe Lake in 2013, identifying substrate type, vegetation and habitat features along with opportunities for shoreline enhancements
- The Wolfe Lake (Westport) Association is a volunteer organization initially formed in 1988 "for the protection of Wolfe Lake" and has since expanded to include neighbouring Green Lake. Its mandate is to maintain and enhance the natural beauty and pristine state of Wolfe and Green Lakes, to protect their natural areas, fish and wildlife and to promote their welfare, by providing information on environmental issues, working to prevent pollution, improve fishing and ensure responsible development and assisting in the conservation and protection of the lake waters, shoreline, vegetation and wildlife. Two high-level objectives of the association are to 1) Foster a strong lake community and 2) Monitor and act on issues that threaten the sustainable enjoyment and health of the lakes and their surroundings. Visit Wolfe Lake (Westport) Association (http://wolfelakeassociation.org/) to see its *Wolfe and Green Lakes — Vision and Overview* document (June 30, 2013) and to obtain more information about its activities. Some of the Association's water resources management and aquatic/terrestrial habitat protection efforts include:
  - Continuing monitoring of lake water quality for over two decades in cooperation with the RVCA and Ontario's Lake Partner Program with results being distributed to all property owners around the lakes (a number of whom have subsequently updated their septic systems)
  - Initiating action to promote timely septic tank inspections by municipal authorities
  - Educating property owners about the ways human activity affects water quality and the use of water quality best practices to mitigate those effects
  - Liaising with Rideau Canal authorities regarding the maintenance of water levels in Wolfe Lake
  - Successful rehabilitation of a fish spawning site at Scanlon Creek
  - Continuing participation in Bird Studies Canada's Southern Ontario Bald Eagle Monitoring
  - Baseline surveys of local geology, plant life, bird life and wildlife, and videotape survey of the entire shoreline of Wolfe Lake for reference purposes
  - Removal of Purple Loosestrife from a badly-infested area of Wolfe Lake, resulting in successful repopulation by native species
  - Long-term participation in the Canadian Lakes Loon Survey
  - Testing for spiny waterflea and zebra mussels along with subsequent zebra mussel monitoring and landowner education of control methods in Wolfe Lake
  - Identification/monitoring of Eurasian water milfoil infestation; research/education on control methods and initiation of a control program
- 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 Wolfe Lake catchment
- RVCA provides flood forecasting and warning services throughout the Rideau Valley watershed. In the Upper Rideau watershed, 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
- Rideau Lakes and South Frontenac Townships 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 Townships 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, South Frontenac 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 Wolfe 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
- Much of the shoreline of Wolfe Lake, Burridge Lake, Green Lake, Spectacle Lake and other catchment lakes 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 Wolfe Lake catchment are monitored by the Rideau Valley Conservation Authority's (RVCA) Watershed Watch Program. Watershed Watch monitors watershed lakes to assess nutrient concentrations, water clarity, dissolved oxygen availability and pH. The locations of monitoring sites are shown in Figure 1 and Table 1. Within this catchment the following waterbodies are monitored: Burridge Lake, Butterill Lake, Fermoy Lake, Green Lake, Long Pond Lake, Spectacle Lake and Wolfe Lake.

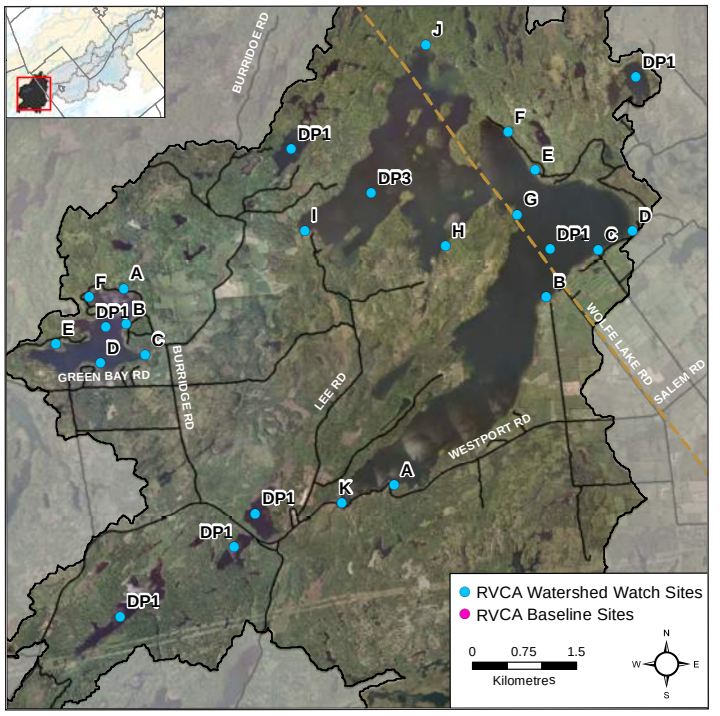


Figure 1 Water quality monitoring sites in the Wolfe Lake catchment

The water quality ratings range from "Poor" to "Fair" (Table 1) as determined by the Canadian Council of Ministers of the Environment (CCME) Water Quality Index (WQI). 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 the majority of lakes prior to 2006; therefore, this report only considers data from 2008 to 2013. Table 1 shows the overall rating for the monitored surface water quality sites within the Wolfe Lake catchment and Table 2 outlines the Water Quality Index (WQI) scores and their corresponding ratings.

Table 1 Water Quality Index Ratings for the Wolfe Lake catchment, 2008-2013

Sampling Site	Location	2008-2013	Rating
RVL-12	Burridge Lake	77	Fair
RVL-27	Wolfe Lake	65	Fair
RVL-40	Spectacle Lake	65	Fair
RVL-42	Butterill Lake	53	Poor
RVL-44	Green Lake	77	Fair
RVL-46	Fermoy Lake	65	Fair
RVL-47	Long Pond Lake	52	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. Long Pond Lake Water Quality

Surface water quality conditions for Long Pond Lake (RVL-47) have been monitored by RVCA's Watershed Watch Program since 2005. Data from the deep point site has been used to calculate the WQI rating for Long Pond Lake, which was determined to be "Poor" (Table 1). Moderate nutrient concentrations, occasional limited conditions for fish habitat, clear water and rarely 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.

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 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[1] within surface waters.

At the Deep Point

One deep point site is monitored within this lake. Average nutrient concentrations are summarized in Table 3 as well as the proportion of results that meet the guideline.

[1] 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

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

Total Phosphorus 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-47	0.034	74%	23
Total Kjeldahl Nitrogen 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-47	0.521	78%	23

TP and TKN sampling results are presented in Figures 2 and 3. The majority of samples (74 percent) analyzed for TP were less than the TP guideline and the average concentration exceeds the guideline at 0.034 mg/l (Table 3). TKN concentration also generally met the guideline with 78 percent of results below the TKN guideline; as with TP, the average concentration was elevated at 0.521 mg/l (Table 3). Average year to year concentrations have varied for both TP and TKN but both are continually below their respective guidelines with the exception of TP in 2011 (Figure 4 and 5). Overall, the data presented indicates that moderate nutrient concentrations, particularly TP, are a feature of Long Pond Lake.

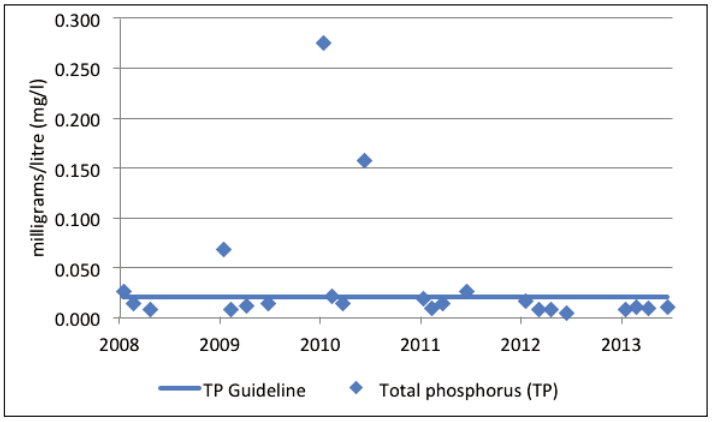


Figure 2 Total phosphorus sampling results at the deep point in Long Pond Lake, 2008-2013

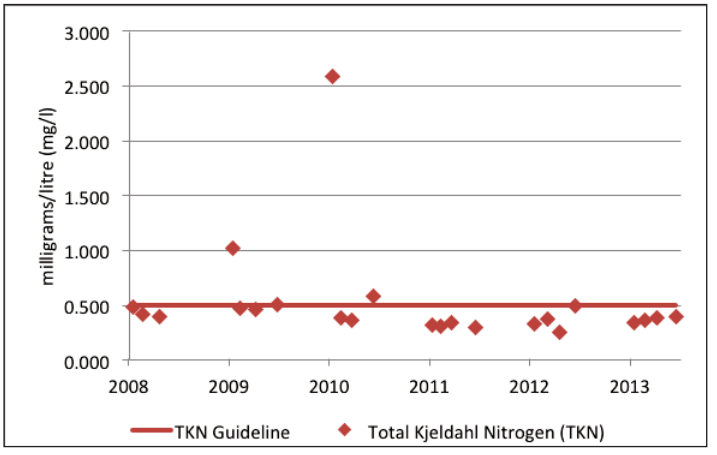


Figure 3 Total Kjeldahl nitrogen sampling results at the deep point in Long Pond Lake, 2008-2013

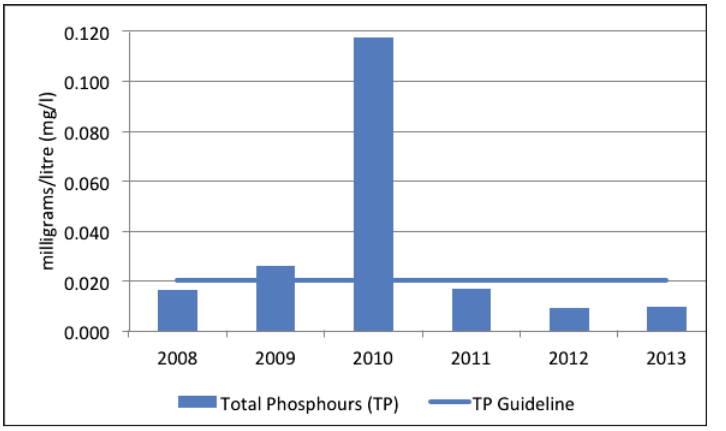


Figure 4 Average total phosphorus at the deep point in Long Pond Lake, 2008-2013

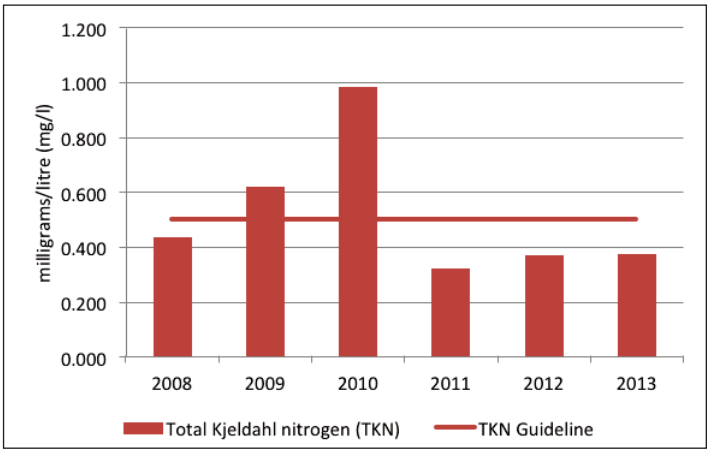


Figure 5 Average total Kjeldahl nitrogen at the deep point in Long Pond Lake, 2008-2013

Summary

There is very little development around the lake. A large wetland that drains to the lake may be a source of some of the nutrient inputs to the lake, particularly following periods of high flows. The shallow nature of the lake basin may also be contributing to elevated nutrient concentrations. During periods of high winds and rough waters, sediment may be churned up, resulting in higher nutrient levels in the water column. Periods of low oxygen near the bottom of the lake may also cause the release of nutrients from sediments that are distributed through the water column. Natural aging (nutrient enrichment) of the lake will also occur over time; this can be slowed with the help of all residents living around Long Pond by reducing nutrient inputs through best management practices such as the proper maintenance of septic systems, keeping shorelines natural, minimizing runoff 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 2 metres, indicating good water clarity; the average Secchi depth is 4.4 metres. Figure 6 shows that no individual reading has been below the guideline and measured depths range from 2.5 to 5.5 metres. In many lakes around the subwatershed, water clarity has been influenced by the colonization of zebra mussels; however at this time there is no evidence of an established population in Long Pond Lake.

Table 4 Summary of Secchi depths recorded at the deep point in Long Pond Lake, 2008-2013

Secchi depth 2008-2013			
Site	**Average (m)**	**Above Guideline**	**No. Samples**
RVL-47	4.4	100%	23¬

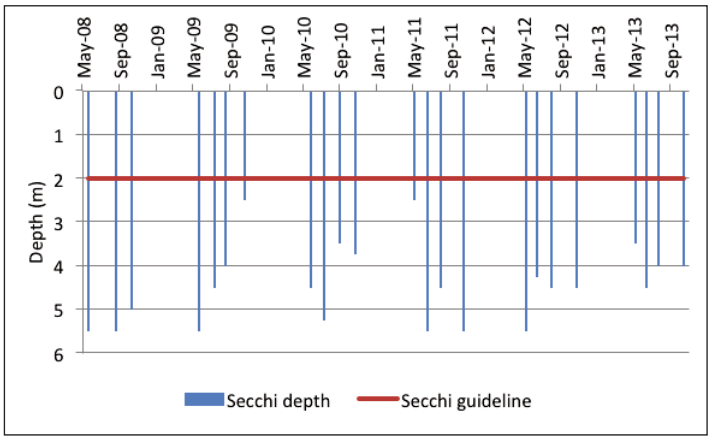


Figure 6 Recorded Secchi depths at the deep point in Long Pond Lake, 2008-2013

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 Long Pond Lake from a fish habitat perspective.

Dissolved Oxygen and Temperature

The red bars in Figure 7 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 monitored point. The vertical axis represents the total lake depth at each site where the profile is taken. Suitable oxygen and temperatures exist over an average depth of seven metres.

There is some evidence of a reduction of suitable habitat conditions in the summer-early fall due to limited oxygen availability at deeper depths and the warming of surface waters (Figure 7).

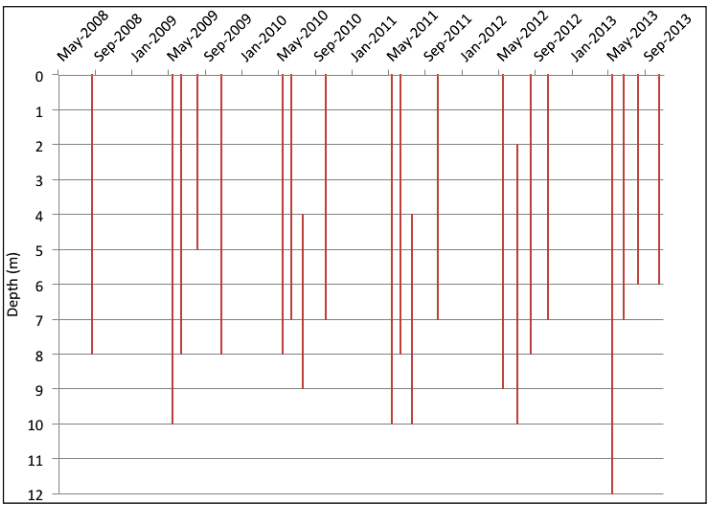


Figure 7 Depths suitable for warm water fish species at the deep point in Long Pond Lake, 2008-2013

pH

pH is a basic water quality parameter used to assess the acidity of water, an important factor for aquatic life. Figure 8 shows pH concentrations in Long Pond Lake and Figure 9 summarizes average concentrations by year.

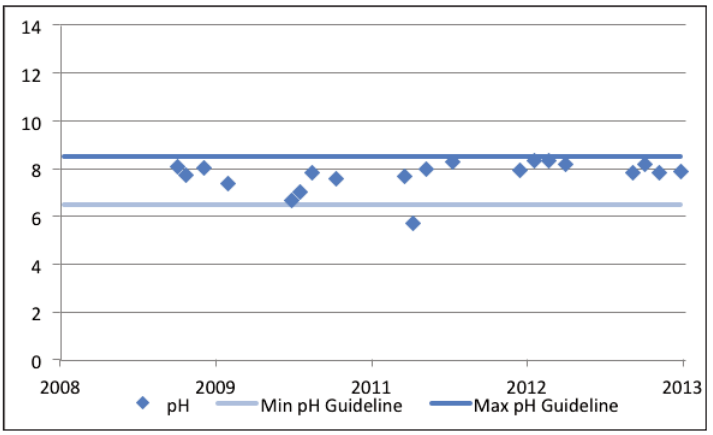


Figure 8 pH concentrations at the deep point in Long Pond Lake, 2008-2013

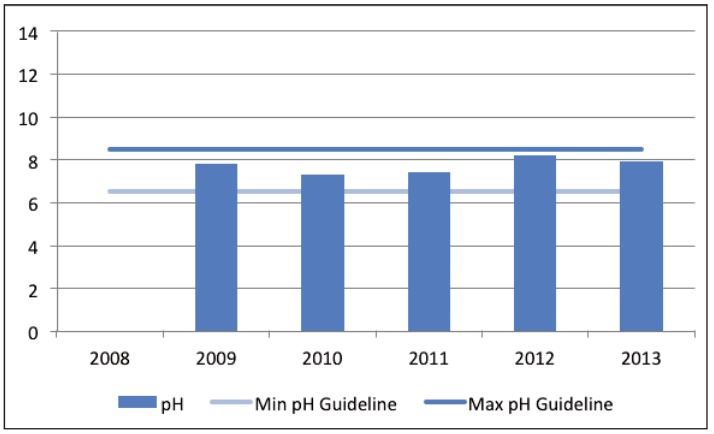


Figure 9 Average pH concentrations at the deep point in Long Pond Lake, 2008-2013

Ninety-five 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 for the deep point site in Long Pond Lake, 2008-2013

pH 2008-2013			
Site	**Average**	**Within Guideline**	**No. Samples**
RVL-47	7.8	95%	18

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 point describes good habitat conditions for warm water fish species such as pickerel, bass and pike. The warming of the water column in summer months may limit the amount of habitat available and cause 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.

1) b. Fermoy Lake Water Quality

Surface water quality conditions in Fermoy Lake (RVL-46) have been monitored by RVCA's Watershed Watch Program since 2006. Data from one deep point site has been used to calculate the WQI rating of "Fair" (Table 1). Occasional nutrient exceedances, good oxygen conditions for fish habitat, 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.

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 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 Point

One deep point site is monitored on the lake. Average nutrient concentrations at this site are summarized in Table 6 as well as the proportion of results that meet the guideline.

Table 6 Summary of nutrient results for Fermoy Lake, 2008-2013

Total Phosphorus 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-46	0.012	91%	22
Total Kjeldahl Nitrogen 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-46	0.348	95%	22

TP and TKN sampling results are presented in Figures 10 and 11. Ninety-one percent of samples analyzed for TP were less than the TP guideline, the average concentration was also well below the guideline at 0.012 mg/l. TKN concentrations were also relatively low; 95 percent of reported results were below the TKN guideline and the average concentration was 0.348 mg/l (Table 6). Average year to year concentrations have varied for both TP and TKN (Figures 12 and 13). All average results are below guidelines. Overall the data presented indicates that nutrient concentrations may be considered low to moderate in the mid-lake, deep water sites of Fermoy Lake.

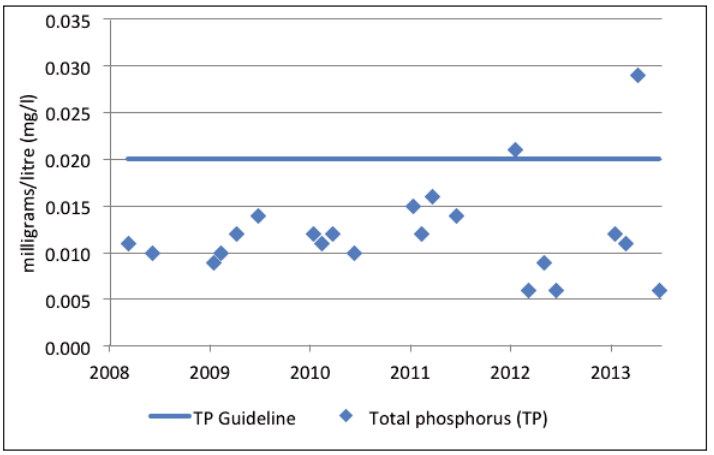


Figure 10 Total phosphorus sampling results at the deep point site in Fermoy Lake, 2008-2013

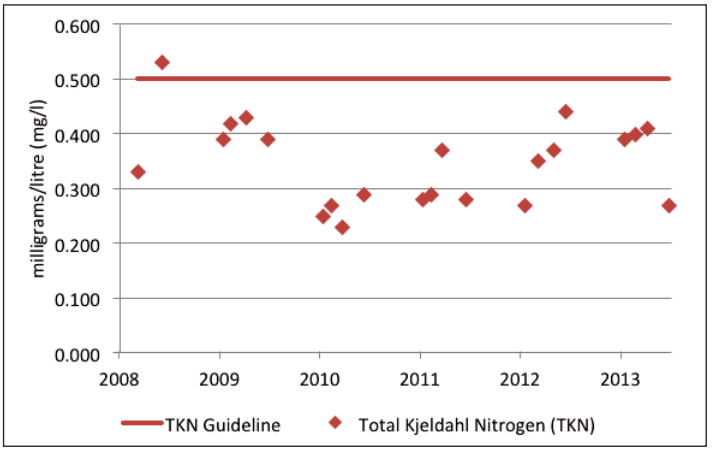


Figure 11 Total Kjeldahl nitrogen sampling results at the deep point in Fermoy Lake, 2008-2013

[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

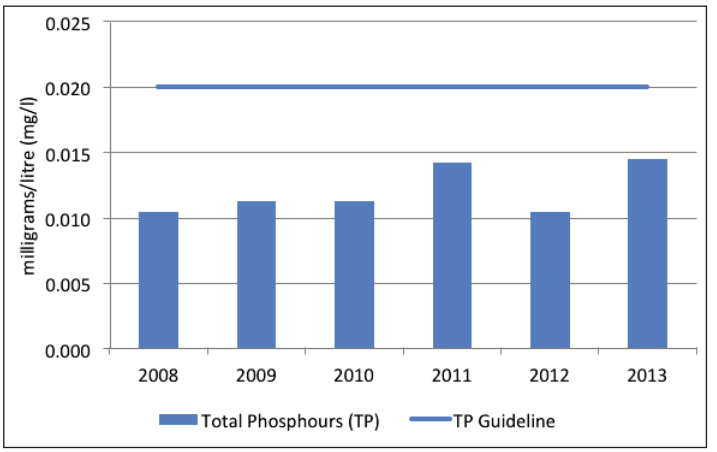


Figure 12 Average total phosphorus at the deep point in Fermoy Lake, 2008-2013

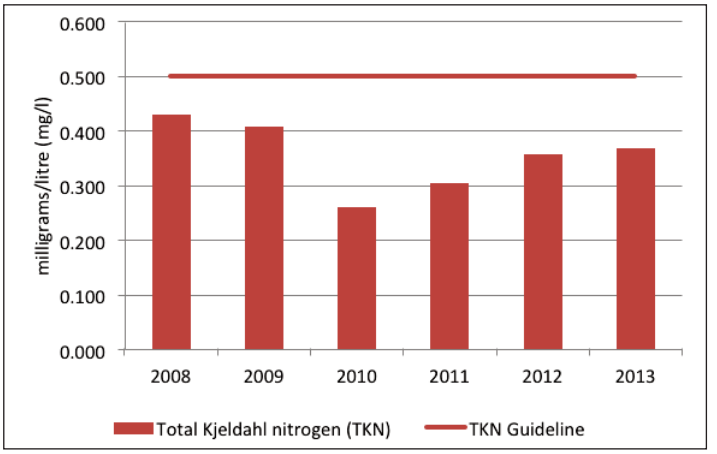


Figure 13 Average total Kjeldahl nitrogen at the deep point in Fermoy Lake, 2008-2013

Summary

Within Fermoy Lake nutrient concentrations typically meet guidelines. Efforts such as the diversion of runoff and enhanced shoreline buffers are important to continue to protect and enhance water quality and reduce the frequency of future nutrient exceedances. Nutrient exceedances may be partially attributed to the natural aging of a lake and its basin characteristics. The lake is fairly shallow; the shallow basin and organic rich soils make internal loading of nutrients possible as oxygen becomes depleted from the deep waters. All residents can help reduce their impact on the lake by reducing nutrient inputs through practices such as the proper maintenance of septic systems, keeping shorelines natural with adequate, vegetated buffers and using phosphate free soaps and detergents.

Water Clarity

Water clarity is measured using a Secchi disk during each deep point sample. Table 7 summarizes the recorded depths and shows that all readings have exceeded the minimum PWQO of 2 metres indicating good water clarity; the average Secchi depth is 4.5 metres. Figure 14 shows that no individual reading has been below the guideline and measured depths range from 2.5 metres to 6 metres. It should be noted that Secchi depths in many waterbodies have been influenced by the colonization of zebra mussels resulting in clearer waters than may have been seen prior to the introduction of this species; however at this time zebra mussels have not been identified in Fermoy Lake.

Table 7 Summary of Secchi depths recorded at the deep point in Fermoy Lake, 2008-2013

Secchi depth 2008-2013			
Site	**Average (m)**	**Above Guideline**	**No. Samples**
RVL-46	4.5	100%	21

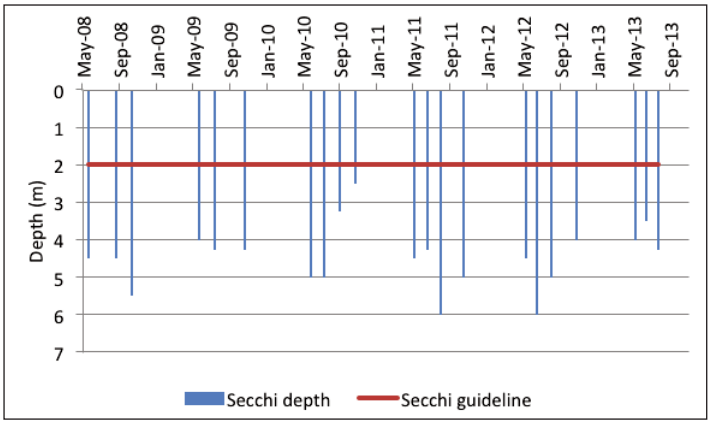


Figure 14 Secchi depths recorded at the deep point in Fermoy Lake, 2008-2013

Summary

This data indicates that waters are clear and sufficient 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 Fermoy Lake from a fish habitat perspective.

Dissolved Oxygen and Temperature

The red bars in Figure 15 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 monitored deep point. The vertical axis represents the total lake depth at each site where the profile is taken. Suitable oxygen temperatures exist over an overage depth of 6 metres.

There are typically good conditions for fish habitat, but as temperatures increase throughout the summer available habitat becomes limited in some years due warming of the surface waters and oxygen depletion at the deeper depths.

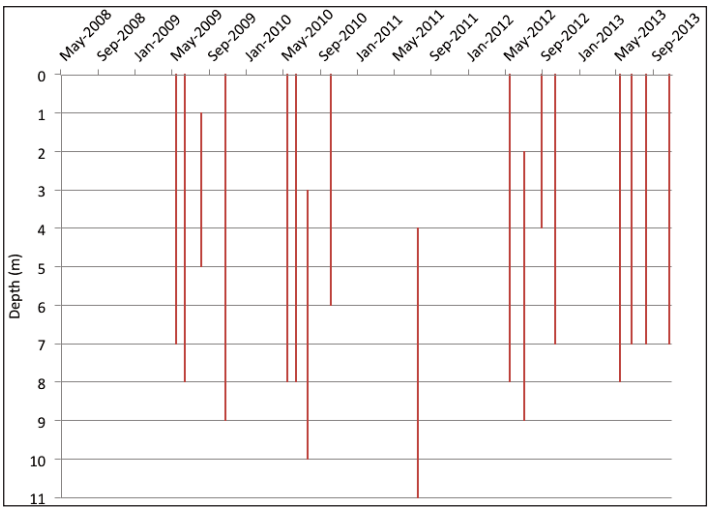


Figure 15 Suitable depths for warm water fish species in Fermoy Lake, 2008-2013

pH

pH is a basic water quality parameter used to assess the acidity of water, an important factor for aquatic life. Figure 16 shows pH concentrations in Fermoy Lake and Figure 17 summarizes average concentrations by year.

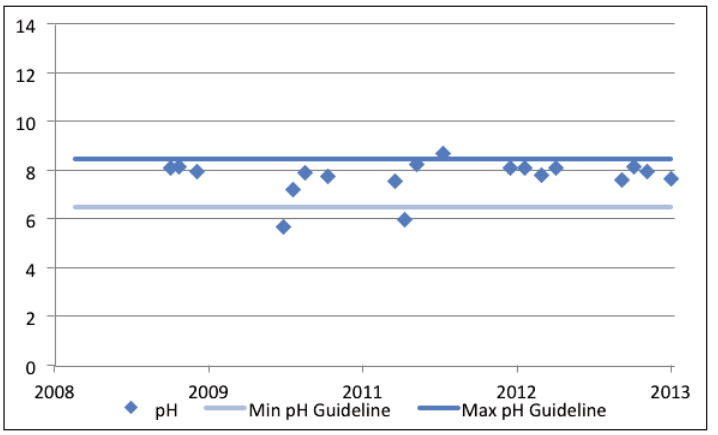


Figure 16 pH concentration at the deep point site in Fermoy Lake, 2008-2013

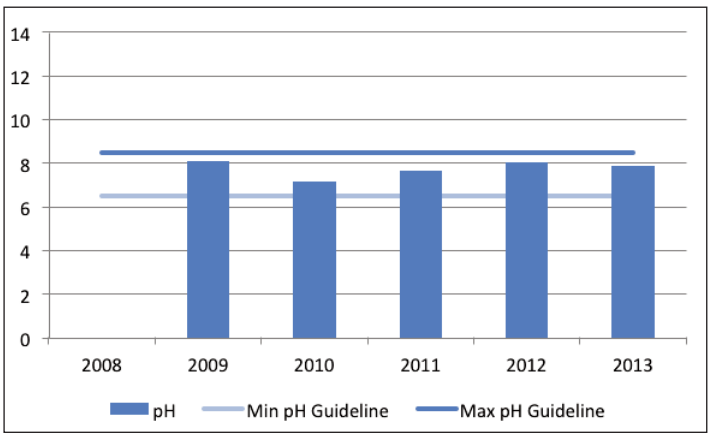


Figure 17 Average pH concentration at the deep point in Fermoy Lake, 2008-2013

Eighty-four percent of samples (Table 8) 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 8 Summary of pH results at the deep point in Fermoy Lake, 2008-2013

pH 2008-2013			
Site	**Average**	**Within Guideline**	**No. Samples**
RVL-46	7.8	84%	19

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 point describes good habitat conditions for warm water fish species. There is some evidence that the warming of the water column in the mid-summer may limit the amount of habitat for some sensitive species. pH conditions are within the range recommended for the protection of aquatic life. However, overall the data indicates a healthy environment for aquatic species.

1) c. Butterill Lake Water Quality

Surface water quality conditions in Butterill Lake (RVL-42) have been monitored by RVCA's Watershed Watch Program since 2005. Data from the deep point site has been used to calculate the WQI rating for Butterill Lake, which was determined to be "Poor" (Table 1). Occasional nutrient exceedances, periods of limited oxygen availability, clear water and occasionally elevated pH levels all contributed to the rating. The following discussion explains how each of the monitored water quality parameters contributes to the lake's water quality.

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 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[3] within surface waters.

At the Deep Point

One deep point site is monitored within this lake. Average nutrient concentrations are summarized in Table 9 as well as the proportion of results that meet the guideline.

Table 9 Summary of nutrient results for Butterill Lake, 2008-2013

Total Phosphorus 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-42	0.015	91%	22
Total Kjeldahl Nitrogen 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-42	0.471	77%	22

[3] 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

TP and TKN sampling results are presented in Figures 18 and 19. The majority of samples (91 percent) analyzed for TP were less than the TP guideline, as was the average concentration at 0.015 mg/l (Table 9). TKN concentrations were more likely to be elevated; 77 percent of results were below the TKN guideline with an average concentration at 0.471 mg/l (Table 9). Average year to year concentrations have varied for both TP and TKN since 2010; average concentrations of both variables have been below respective guidelines (Figure 20 and 21). Overall, the data presented indicates that moderate concentrations, particularly TKN are a feature of Butterill Lake.

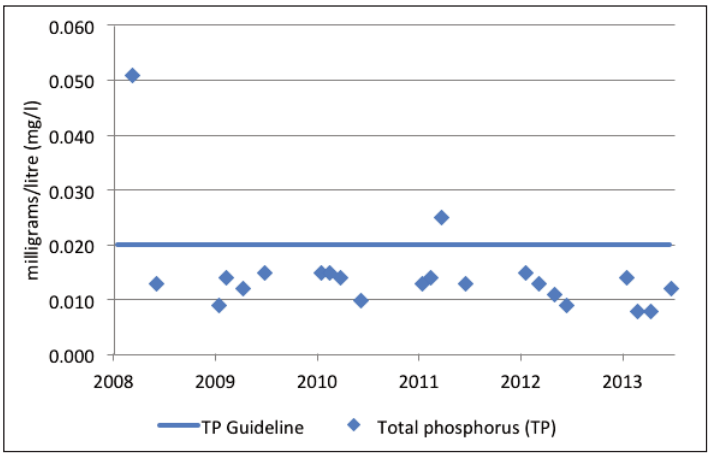


Figure 18 Total phosphorus sampling results at the deep point in Butterill Lake, 2008-2013

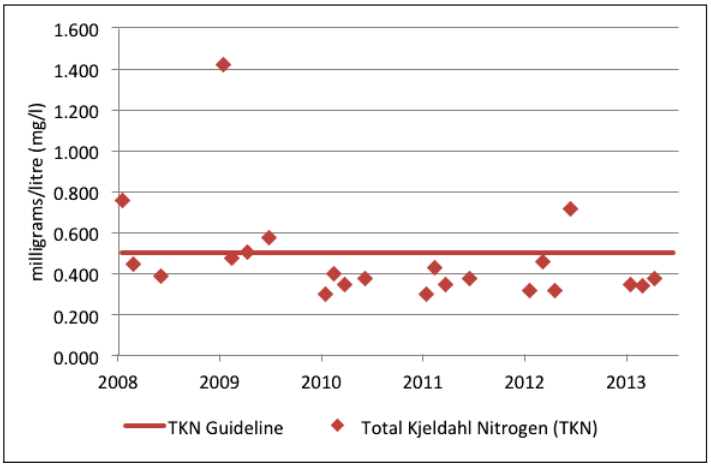


Figure 19 Total Kjeldahl nitrogen sampling results at the deep point in Butterill Lake, 2008-2013

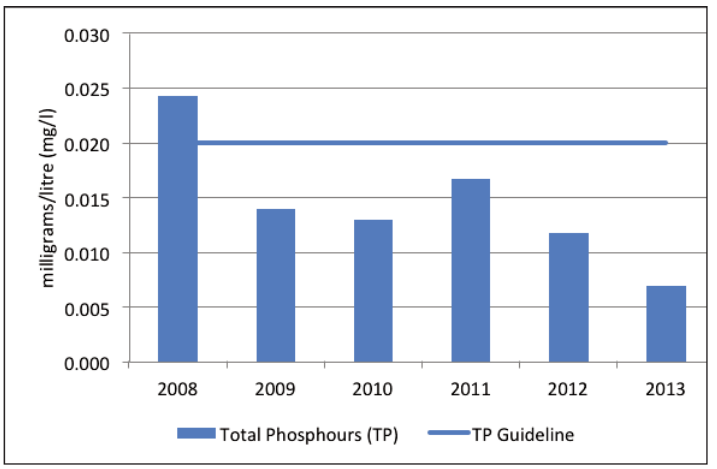


Figure 20 Average total phosphorus at the deep point in Butterill Lake, 2008-2013

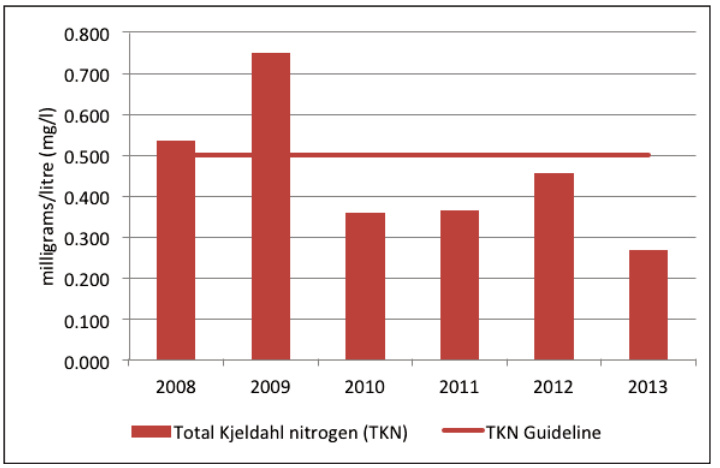


Figure 21 Average total Kjeldahl nitrogen at the deep point in Butterill Lake, 2008-2013

Summary

There is very little development around the lake and what does exist is isolated to the south-east shore. There is a small stream that does drain to the lake which may be the source of some nutrient inputs, particularly during periods of high flows. Also, the shallow basin and nutrient rich soils of this lake make it susceptible to internal nutrient loading, a process where nutrients are released from the sediments in low oxygen conditions. Aging of the lake can be slowed with the help of all catchment residents by reducing nutrient inputs through practices such as the proper maintenance of septic systems, keeping shorelines natural, minimizing runoff and using phosphate free soaps and detergents.

Water Clarity

Water clarity is measured using a Secchi disk during each deep point sample. Table 10 summarizes the recorded depths and shows that all readings have exceeded the minimum PWQO of 2 metres indicating good water clarity; the average Secchi depth is 4.4 metres. Figure 22 shows that no individual reading has been below the guideline and measured depths range from 2.75 to 6.25 metres. In many cases around the watershed, water clarity has been influenced by the colonization of zebra mussels; however, at this time, there is no evidence of an established population in Butterill Lake.

Table 10 Summary of Secchi depths recorded at the deep point in Butterill Lake, 2008-2013

Secchi depth 2008-2013			
Site	**Average (m)**	**Above Guidelines**	**No. Samples**
RVL-42	4.4	100%	23

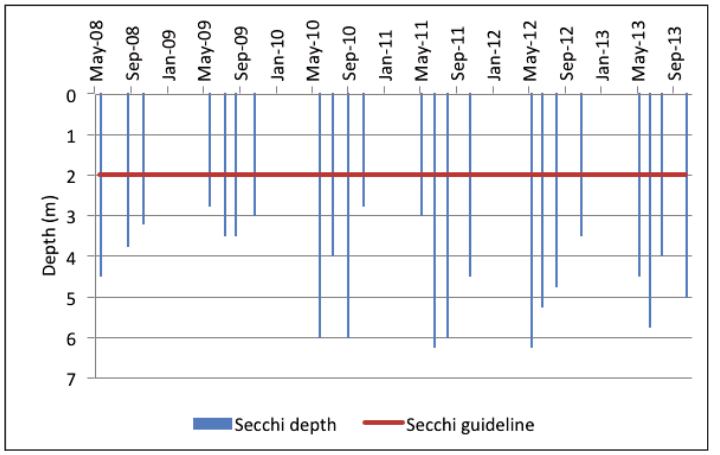


Figure 22 Recorded Secchi depths at the deep point in Butterill Lake, 2008-2013

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 Butterill Lake from a fish habitat perspective.

Dissolved Oxygen and Temperature

The red bars in Figure 23 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 monitored point. The vertical axis represents the total lake depth at each site where the profile is taken. Suitable oxygen and temperatures exist over an average depth of approximately 4 metres.

There is some evidence of a reduction of suitable habitat conditions, particularly due to limited oxygen availability in the deeper waters (below 5 metres).

pH

pH is a basic water quality parameter used to assess the acidity of water, an important factor for aquatic life. Figure 24 shows pH concentrations in Butterill Lake and Figure 25 summarizes average concentrations by year.

Ninety percent of samples (Table 11) 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.

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

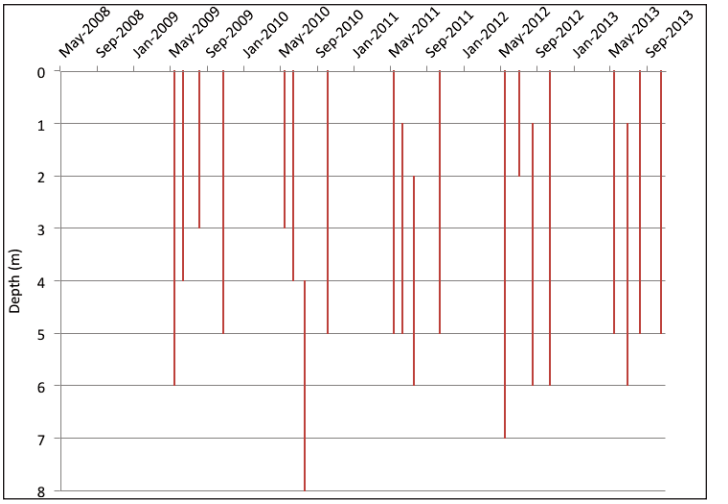


Figure 23 Depths suitable for warm water fish species at the deep point in Butterill Lake, 2008-2013

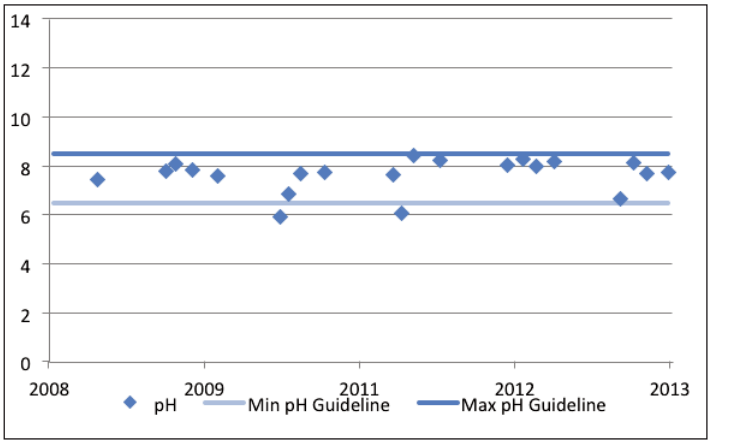


Figure 24 pH concentrations at the deep point in Butterill Lake, 2008-2013

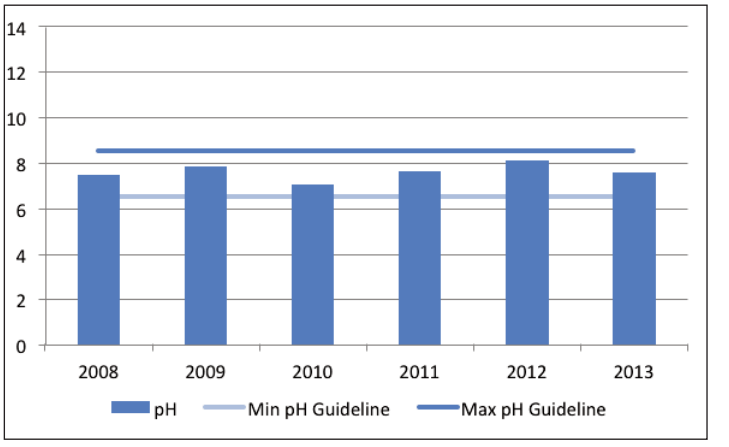


Figure 25 Average pH concentrations at the deep point in Butterill Lake, 2008-2013

Table 11 Summary of pH for results for the deep point in Butterill Lake, 2008-2013

pH 2008-2013			
Site	**Average**	**Above Guidelines**	**No. Samples**
RVL-42	7.7	90%	21

Summary
Overall, the water chemistry data at the deep point describes suitable habitat conditions for warm water fish species such as pickerel, bass and pike. The limited oxygen availability in the water column may limit the amount of habitat available and cause stress to some aquatic communities. pH conditions are generally within the range recommended for the protection of aquatic life, indicating a healthy environment for aquatic species.

1) d. Burridge Lake Water Quality

Surface water quality conditions in Burridge Lake (RVL-12) were initially monitored by RVCA's Watershed Watch Program in 2002; regular monitoring began in 2006. Data from one deep point site has been used to calculate the WQI which was determined to be "Fair" (Table 1). Few nutrient exceedances, good fish habitat conditions, 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 six additional sites that are 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.

The 2002 *Burridge Lake State of the Lake Environment Report* (Rideau Valley Conservation Authority, 2004) noted that Burridge Lake had a moderate concentration of nutrients, generally suitable fish habitat conditions and good water clarity. The data presented in this report indicates that this continues to be the case and that a proactive cautionary program of best management practices is important to ensure the protection of the lake environment.

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 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[4] within surface waters.

At the Deep Point
One deep point site is monitored on the lake. Average nutrient concentrations at this site are summarized in Table 12 as well as the proportion of results that meet the guideline.

Table 12 Summary of nutrient results for Burridge Lake, 2008-2013

Total Phosphorus 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-12	0.009	95%	21
Total Kjeldahl Nitrogen 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-12	0.361	90%	21

TP and TKN sampling results are presented in Figures 26 and 27. Almost all (95 percent of) samples analyzed for TP were less than the TP guideline. The average concentration was also below the guideline at 0.009 mg/l (Table 12). TKN concentrations were fairly minimal; 90 percent of reported results were below the TKN guideline, the average concentration was 0.361 mg/l (Table 12). Average year to year concentrations have varied for both TP and TKN (Figures 28 and 29). All average results were below the guidelines with the exception of TKN concentrations in 2009; since that year results have been relatively consistent (Figure 29). Overall, the data presented indicates that nutrient concentrations may be considered low in the mid-lake, deep water sites of Burridge Lake.

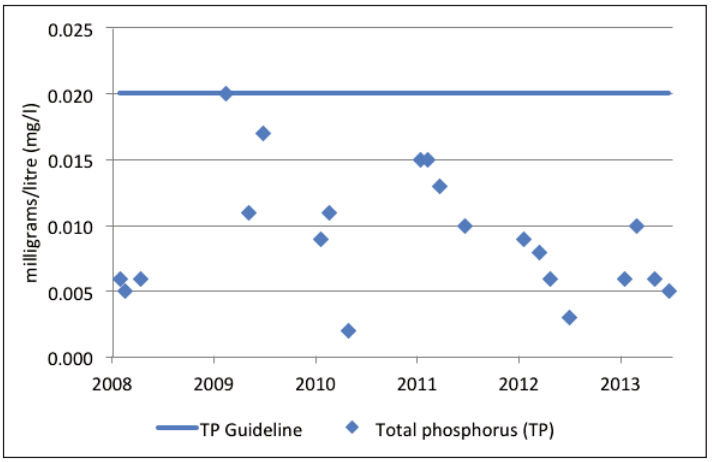


Figure 26 Total phosphorus sampling results at the deep point in Burridge Lake, 2008-2013

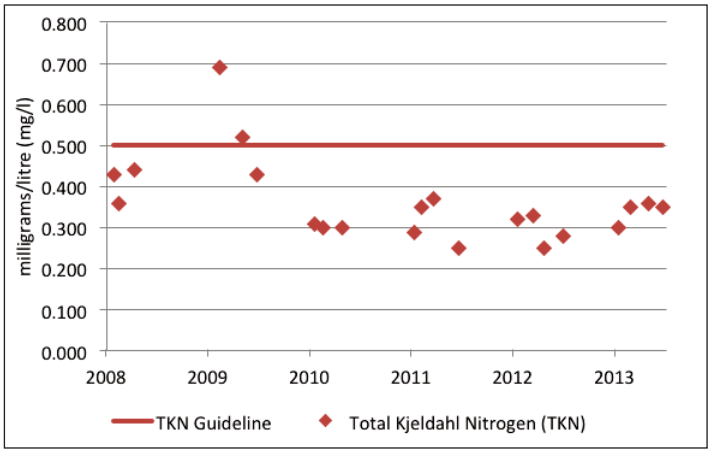


Figure 27 Total Kjeldahl nitrogen sampling results at the deep point in Burridge Lake, 2008-2013

[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

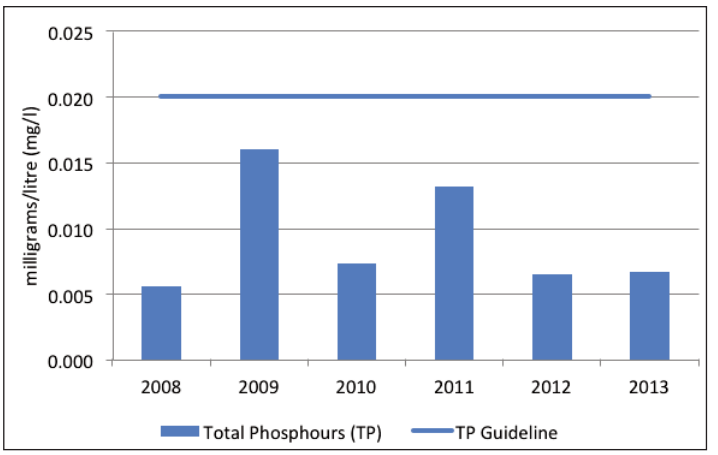


Figure 28 Average total phosphorus at the deep point in Burridge Lake, 2008-2013

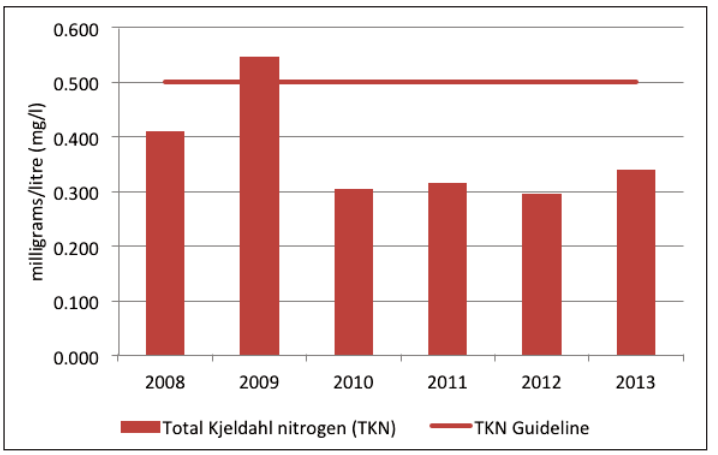


Figure 29 Average total Kjeldahl nitrogen at the deep point in Burridge Lake, 2008-2013

Around the Lake

The average nutrient concentrations at monitored sites around the lake vary from year to year (Figures 30-31). Please note that sites A and C are monitored each year while other sites (B, D, E, and F) are monitored every fifth year.

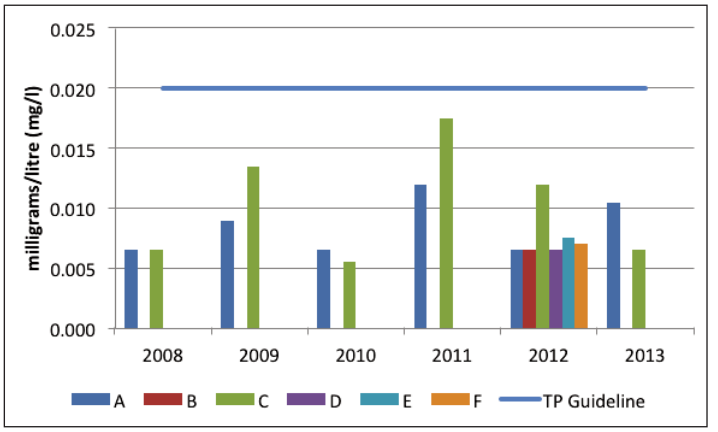


Figure 30 Average total phosphorus concentrations at shoreline monitoring sites on Burridge Lake, 2008-2013

Average total phosphorous concentrations are below the TP guideline at all sites, indicating nutrient enrichment does not appear to be a problem in the monitored nearshore areas. Minimal TP and TKN concentrations at shoreline sites were also noted previously in the *2002 Burridge Lake State of the Lake Environment Report.*

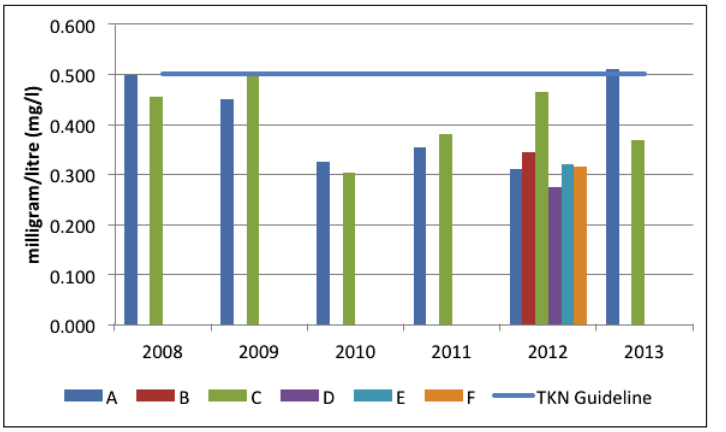


Figure 31 Average total Kjeldahl nitrogen concentrations at shoreline sites on Burridge Lake, 2008-2013

TKN concentrations were also at or below the guideline at the majority of sites; in 2008 and 2013 marginally elevated results were noted at site A. These results provide further support that nutrient enrichment is generally limited along the shoreline.

Summary

Within Burridge Lake nutrient concentrations generally meet guidelines. Average TP concentrations (Table 12) are slightly less than those reported in the *2002 Burridge Lake State of the Lake Environment Report* which reported TP concentrations of about 0.012 mg/l.

Efforts such as the diversion of runoff and enhanced shoreline buffers are important to continue to protect and enhance water quality. Nutrient exceedances may be partially attributed to the natural aging of a lake and basin characteristics. Burridge Lake is fairly shallow; the shallow basin and organic rich soils make internal loading of nutrients likely as oxygen becomes depleted from the deep waters. All residents can help reduce their impact on the lake 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 13 summarizes the recorded depths and shows that all readings have exceeded the minimum PWQO of 2 metres indicating good water clarity; the average Secchi depth is 5.4 metres. Figure 32 shows that no individual reading has been below the guideline and measureddepths range from 3.5 metres to 9 metres. It should be noted that Secchi depths in many waterbodies have been influenced by the colonization of zebra mussels resulting in clearer waters than may have been seen prior to the introduction of this species.

Table 13 Summary of Secchi depths recorded at the deep point in Burridge Lake, 2008-2013

Secchi depth 2008-2013			
Site	**Average (m)**	**Above Guideline**	**No. Samples**
RVL-12	5.4	100%	21

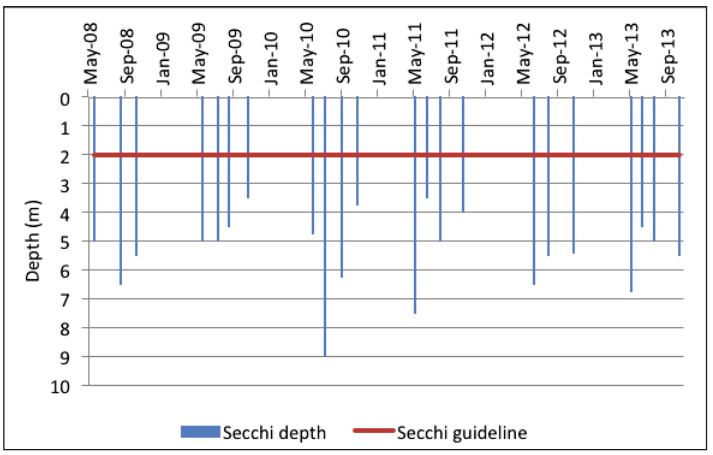


Figure 32 Secchi depths recorded at the deep point in Burridge Lake, 2008-2013

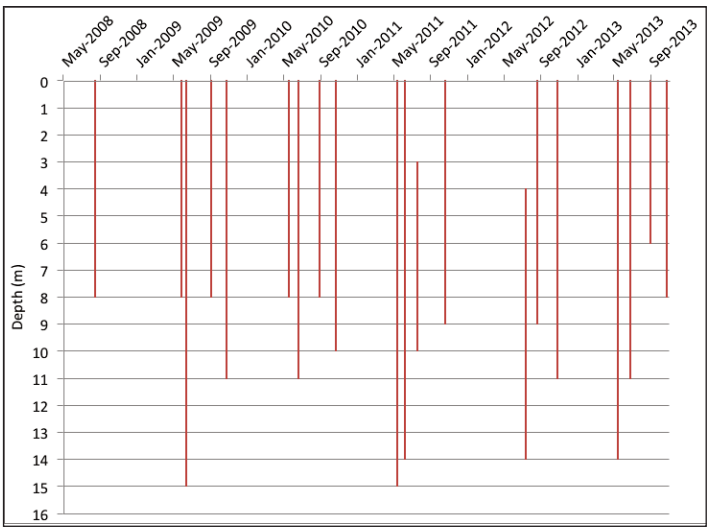


Figure 33 Depths suitable for warm water fish at the deep poiint in Burridge Lake, 2008-2013

Summary

This data indicates that waters are very clear and sufficient sunlight is able to penetrate the water column to support aquatic life and provide sufficient visibility for safe recreational use (i.e. boating, swimming). This information is comparable to the 2002 *Burridge Lake State of the Lake Environment Report*, which reported an average Secchi depth of 4.9 metres.

Fish Habitat

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

Dissolved Oxygen and Temperature

The red bars in Figure 33 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 monitored deep point. 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 8.5 metres.

There are typically good conditions for fish habitat at the deep point. Throughout the summer months the portion of the water column suitable for warm water fish species becomes more limited; this is due to warming of surface waters and oxygen depletion at deeper depths.

pH

pH is a basic water quality parameter used to assess the acidity of water, an important factor for aquatic life. Figure 34 shows pH concentrations in Burridge Lake and Figure 35 summarizes average concentrations by year.

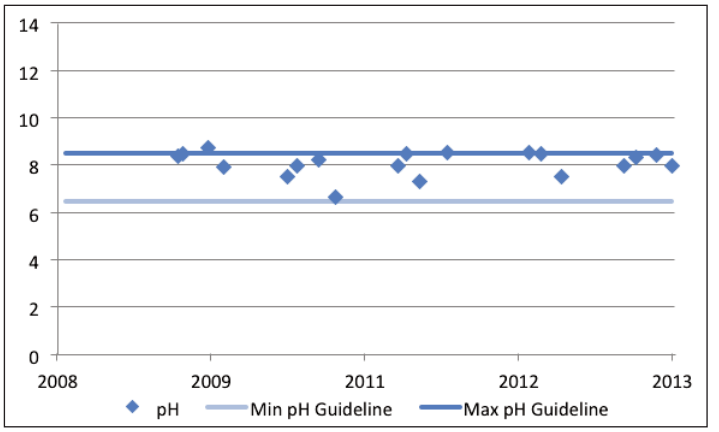


Figure 34 pH concentration at the deep point in Burridge Lake, 2008-2013

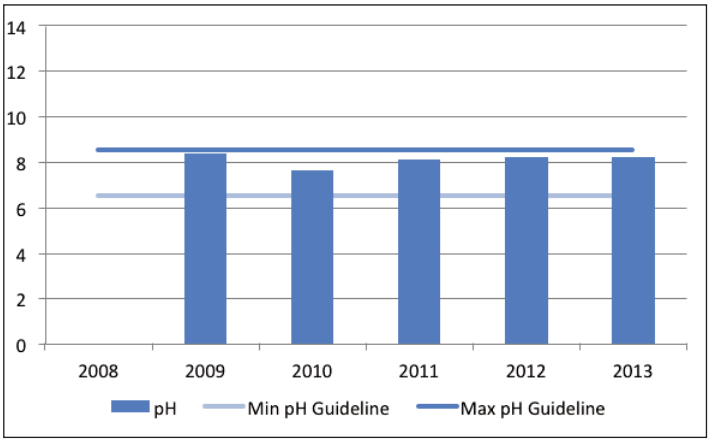


Figure 35 Average pH concentration at the deep point in Burridge Lake, 2008-2013

Seventy-four percent of samples (Table 14) 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. Results tend to border on the upper limit of the guideline indicating that elevated pH is a feature of this lake.

Table 14 Summary of pH results at the deep point in Burridge Lake, 2008-2013

pH 2008-2013			
Site	**Average**	**Within Guideline**	**No. Samples**
RVL-12	8.1	74%	19

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 point describes suitable habitat conditions for warm water fish species. There is some evidence that the warming of the water column in the mid-summer may limit the amount of habitat for some sensitive species. pH conditions are typically on the upper end of the range recommended for the protection of aquatic life. Overall, the data indicates 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 calculations of the WQI rating for the lake due to differences in sampling frequency and site locations. Ninety-seven percent of 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[5] was only 8 CFU/100ml (Table 15).

Table 15 Summary of *E. coli* results for Burridge Lake, 2008-2013

E. coli 2008-2013			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
RVL-11	8	97%	32

Figure 36 shows that samples across all sites were well below the guideline. Site C was previously identified as having higher *E. coli* counts compared to other sites (*2002 Burridge Lake State of the Lake Environment Report)*. Figure 36 also shows that this site is elevated relative to other sites, perhaps warranting further investigation into possible contamination sources at that site.

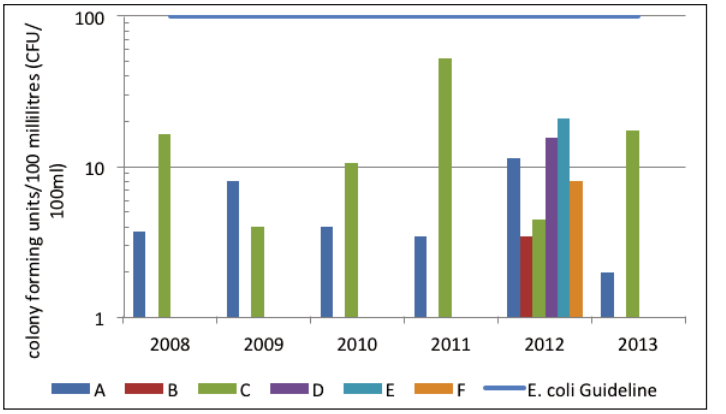


Figure 36 Geometric mean of shoreline sites monitored on Burridge Lake, 2008-2013

Summary

Overall, the results presented above provide evidence that bacterial contamination is not a significant concern in Burridge Lake and the water should be safe for recreational activities such as swimming and boating.

1) e. Green Lake Water Quality

Surface water quality conditions in Green Lake (RVL-44) have been monitored by RVCA's Watershed Watch Program since 2005. Data from the deep point site has been used to calculate the WQI rating for Green Lake, which was determined to be "Fair" (Table 1). Rare instances of nutrient exceedances, good conditions for fish habitat, 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.

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 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[6] within surface waters.

At the Deep Point

One deep point site is monitored within this lake. Average nutrient concentrations are summarized in Table 16 as well as the proportion of results that meet the 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.
[6] 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

Table 16 Summary of nutrient results for Green Lake, 2008-2013

Total Phosphorus 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-44	0.009	95%	22
Total Kjeldahl Nitrogen 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-44	0.253	100%	22

TP and TKN sampling results are presented in Figures 37 and 38. The majority of samples (95 percent) analyzed for TP were less than the TP guideline as was the average concentration at 0.009 mg/l (Table 16). TKN results were all below the TKN guideline with an average concentration at 0.253 mg/l (Table 16). Average year to year concentrations have varied for both TP and TKN; average concentrations of both variables have been well below respective guidelines (Figure 39 and 40). Overall, the data presented indicates that low nutrient concentrations are a feature of Green Lake.

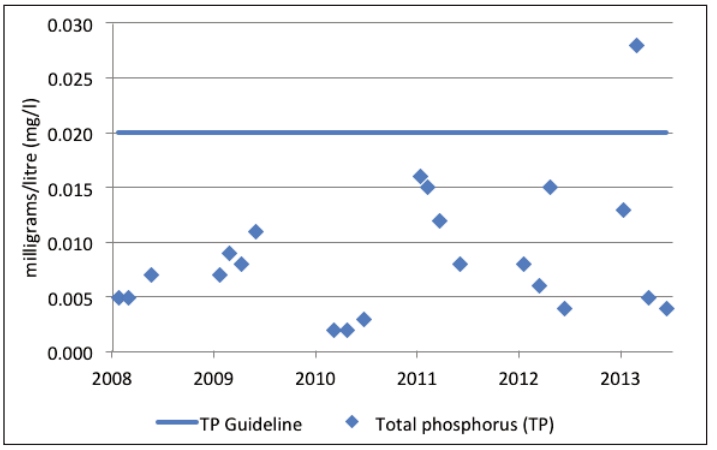


Figure 37 Total phosphorus sampling results at the deep point in Green Lake, 2008-2013

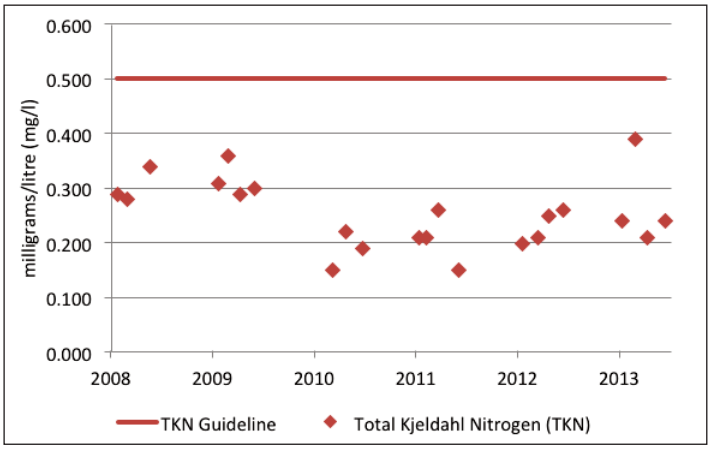


Figure 38 Total Kjeldahl nitrogen sampling results at the deep point in Green Lake, 2008-2013

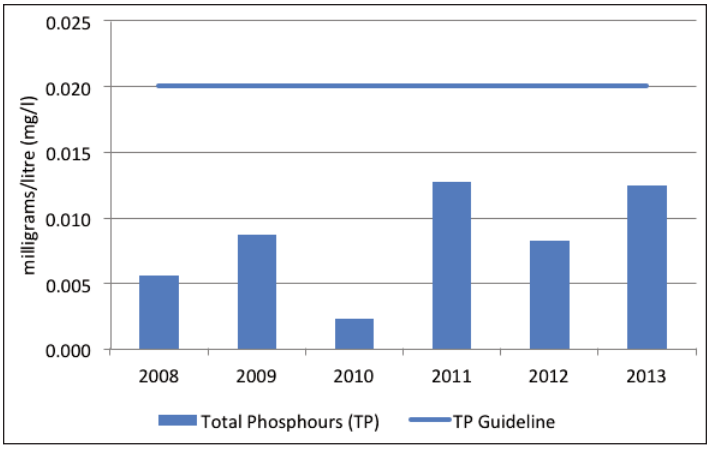


Figure 39 Average total phosphorus at the deep point in Green Lake, 2008-2013

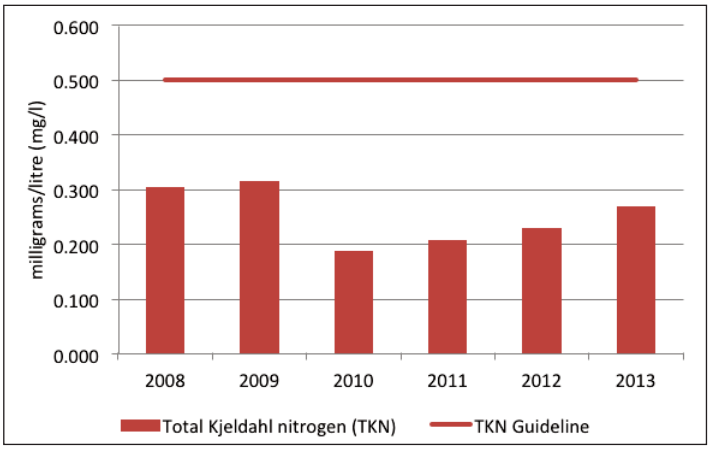


Figure 40 Average total Kjeldahl nitrogen at the deep point in Green Lake, 2008-201

Summary

There is very little development around the lake and what does exist is generally well buffered by natural vegetation. Although there is little evidence of nutrient loading, there are steps that all catchment residents can take to slow the aging of the lake in the future; this includes reducing nutrient inputs through practices such as proper maintenance of septic systems, keeping shorelines natural, minimizing runoff and using phosphate free soaps and detergents.

Water Clarity

Water clarity is measured using a Secchi disk during each deep point sample. Table 17 summarizes the recorded depths and shows that all readings have exceeded the minimum PWQO of 2 metres indicating good water clarity; the average Secchi depth is 6.5 metres. Figure 41 shows that no individual reading has been below the guideline and measured depths range from 5 to 8.25 metres. In many cases around the subwatershed water clarity has been influenced by the colonization of zebra mussels; however, at this time there is no evidence of an established population in Green Lake.

Table 17 Summary of Secchi depths recorded at the deep point in Green Lake, 2008-2013

Secchi depth 2008-2013			
Site	**Average (m)**	**Above Guideline**	**No. Samples**
RVL-44	6.5	100%	20

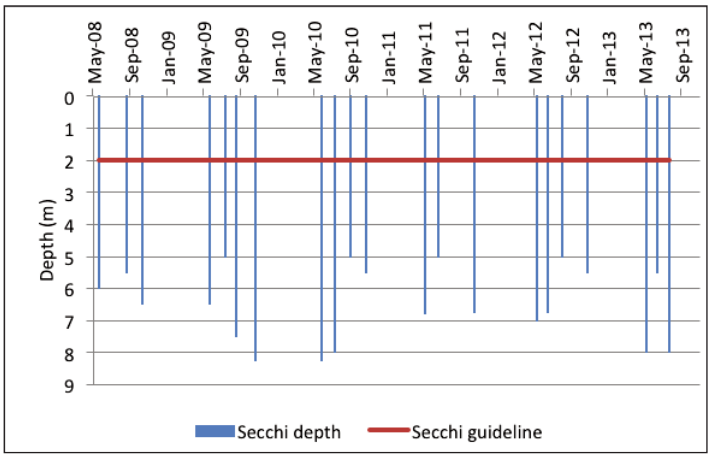


Figure 41 Recorded Secchi depths at the deep point in Green Lake, 2008-2013

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 Green Lake from a fish habitat perspective.

Dissolved Oxygen and Temperature

The red bars in Figure 42 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 monitored point. The vertical axis represents the total lake depth at each site where the profile is taken. Suitable oxygen and temperatures exist over an average depth of approximately 18 metres.

There is some evidence of a reduction of habitat conditions, particularly limited oxygen availability in the deeper waters throughout the summer months which may put stress on some sensitive species.

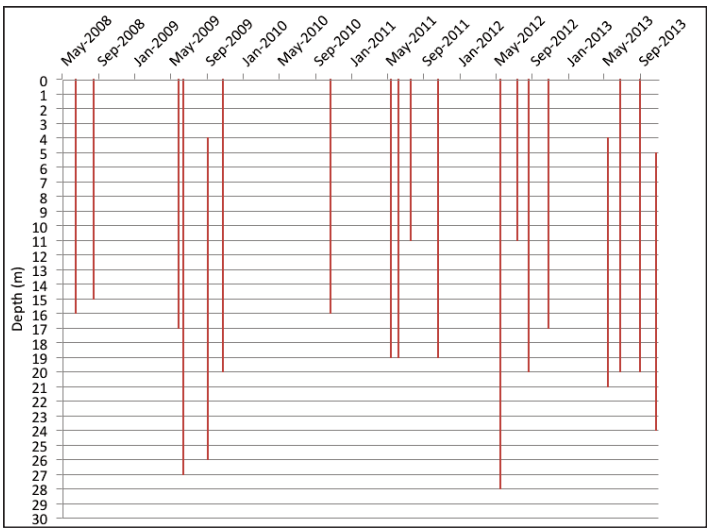


Figure 42 Depths suitable for warm water fish species at the deep point in Green Lake, 2008-2013

pH

pH is a basic water quality parameter used to assess the acidity of water, an important factor for aquatic life. Figure 43 shows pH concentrations in Green Lake and Figure 44 summarizes average concentrations by year.

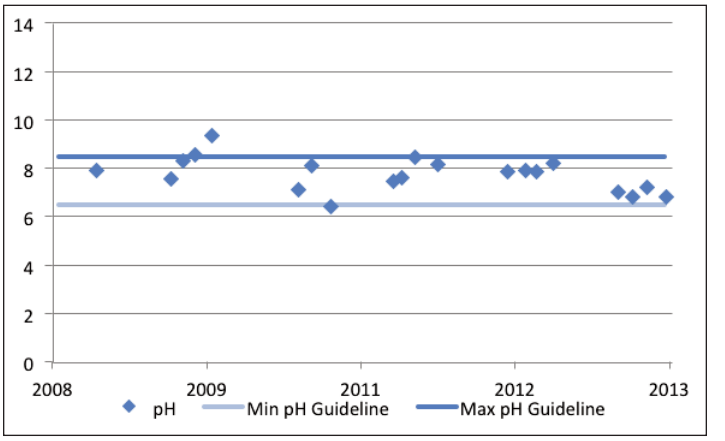


Figure 43 pH concentrations at the deep point in Green Lake, 2008-2013

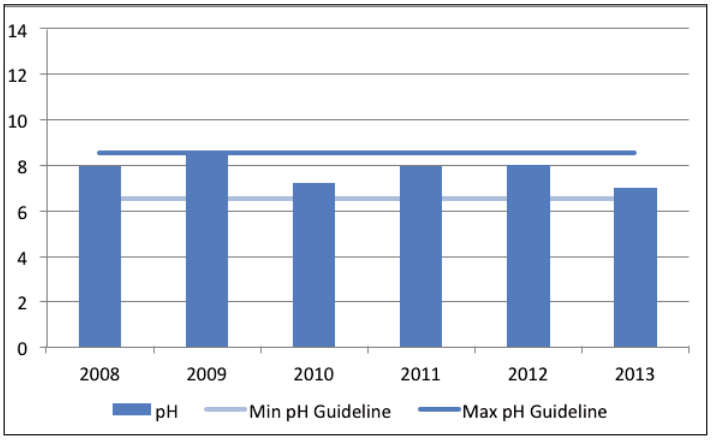


Figure 44 Average pH concentrations at the deep point in Green Lake, 2008-2013

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 point describes suitable habitat conditions for warm water fish species such as pickerel, bass and pike. The limited oxygen availability in the deep waters may limit the amount of habitat available to some aquatic communities. pH conditions are generally within the range recommended for the protection of aquatic life, indicating a healthy environment for aquatic species.

1) f. Spectacle Lake Water Quality

Surface water quality conditions in Spectacle Lake (RVL-40) have been monitored by RVCA's Watershed Watch Program since 2006. Data from the deep point site has been used to calculate the WQI rating for Spectacle Lake, which was determined to be "Fair" (Table 1). Rare instances of nutrient exceedances, good condition for fish habitat, 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.

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 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[7] within surface waters.

At the Deep Point

One deep point site is monitored within this lake. Average nutrient concentrations are summarized in Table 19 as well as the proportion of results that meet the guideline.

Table 19 Summary of nutrient results for Spectacle Lake, 2008-2013

Total Phosphorus 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-40	0.014	87%	23
Total Kjeldahl Nitrogen 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-40	0.413	87%	23

TP and TKN sampling results are presented in Figures 45 and 46. The majority of samples (87 percent) analyzed for TP were less than the TP guideline as was the average concentration at 0.014 mg/l (Table 19). TKN results were all below the TKN guideline with an average concentration at 0.413 mg/l (Table 19). Average year to year concentrations have varied for both TP and TKN; average concentrations of both variables have been consistently below respective guidelines (Figure 47 and 48). Overall, the data presented indicates that low nutrient concentrations are a feature of Spectacle Lake.

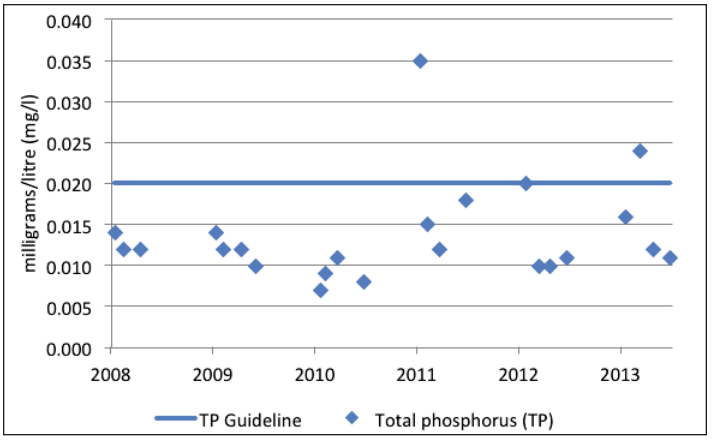


Figure 45 Total phosphorus sampling results at the deep point in Spectacle Lake, 2008-2013

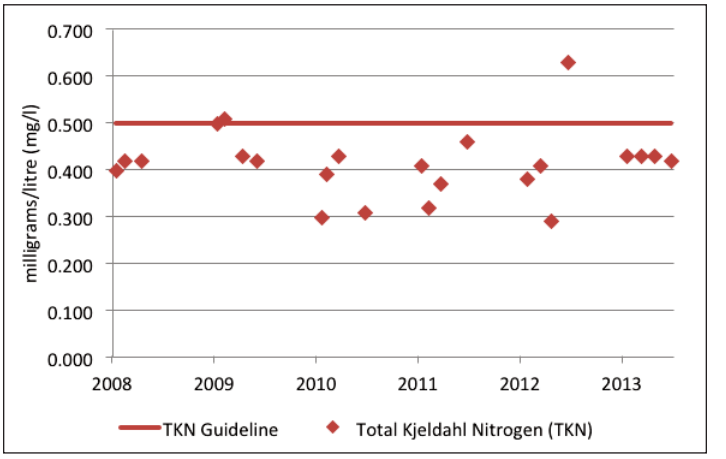


Figure 46 Total Kjeldahl nitrogen sampling results at the deep point in Spectacle Lake, 2008-2013

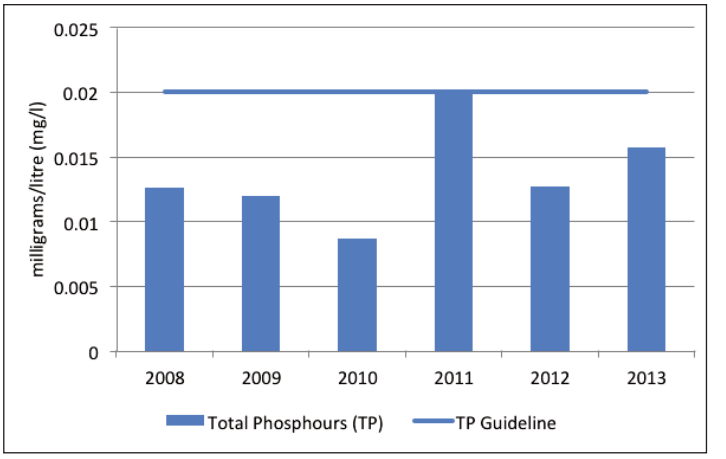


Figure 47 Average total phosphorus at the deep point in Spectacle Lake, 2008-2013

[7] 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

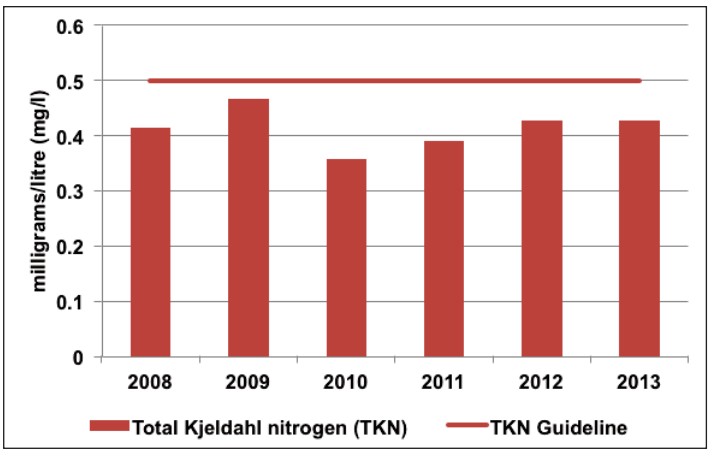


Figure 48 Average total Kjeldahl nitrogen at the deep point in Spectacle Lake, 2008-2013

Summary

There is very little development around the lake. Though there is limited evidence of nutrient loading, there are steps that all catchment residents can take to slow the aging of the lake in the future. This includes reducing nutrient inputs through practices such as proper maintenance of septic systems, keeping shorelines natural, minimizing runoff and using phosphate free soaps and detergents.

Water Clarity

Water clarity is measured using a Secchi disk during each deep point sample. Table 20 summarizes the recorded depths and shows that all readings have exceeded the minimum PWQO of two metres indicating good water clarity, the average Secchi depth is 4.6 metres. Figure 49 shows that no individual reading has been below the guideline and measured depths range from two to 7.25 metres. In many cases around the watershed, water clarity has been influenced by the colonization of zebra mussels; however, at this time there is no evidence of an established population in Spectacle Lake.

Table 20 Summary of Secchi depths recorded at the deep point in Spectacle Lake, 2008-2013

Secchi depth 2008-2013			
Site	**Average (m)**	**Above Guideline**	**No. Samples**
RVL-40	4.6	100%	21

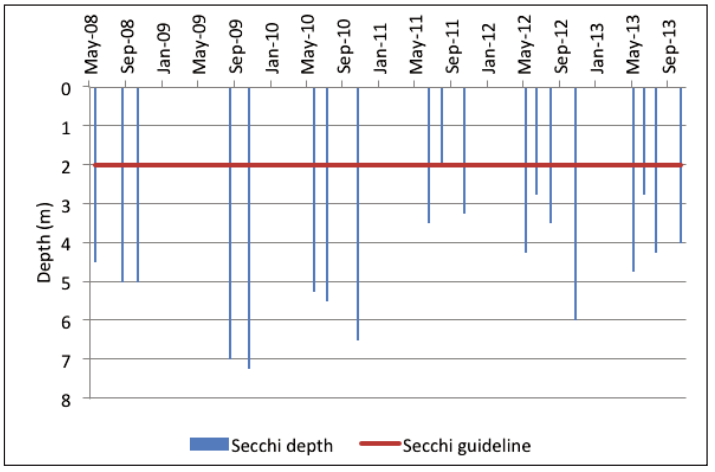


Figure 49 Recorded Secchi depths at the deep point in Spectacle Lake, 2008-2013

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 Spectacle Lake from a fish habitat perspective.

Dissolved Oxygen and Temperature

The red bars in Figure 50 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 monitored point. The vertical axis represents the total lake depth at each site where the profile is taken. Suitable oxygen and temperatures exist over an average depth of approximately 10 metres.

There is some evidence of a reduction of habitat conditions, particularly limited oxygen availability in the deeper waters throughout the summer months which may put stress on some sensitive species.

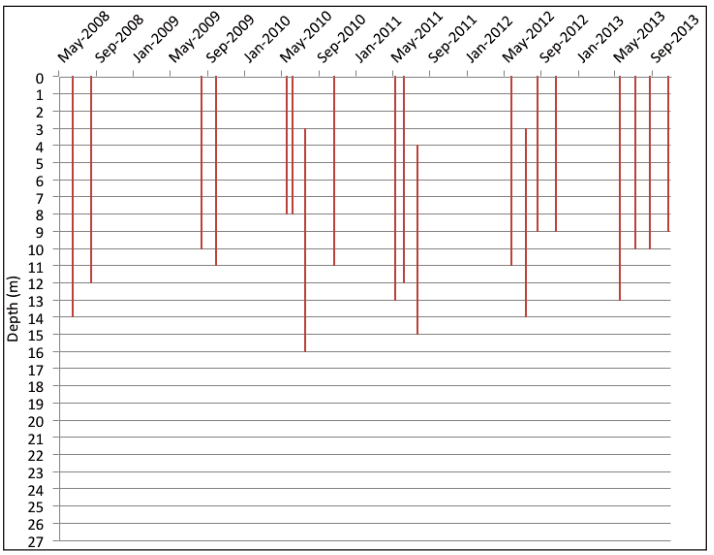


Figure 50 Depths suitable for warm water fish species at the deep point in Spectacle Lake, 2008-2013

pH

pH is a basic water quality parameter used to assess the acidity of water, an important factor for aquatic life. Figure 51 shows pH concentrations in Spectacle Lake and Figure 52 summarizes average concentrations by year.

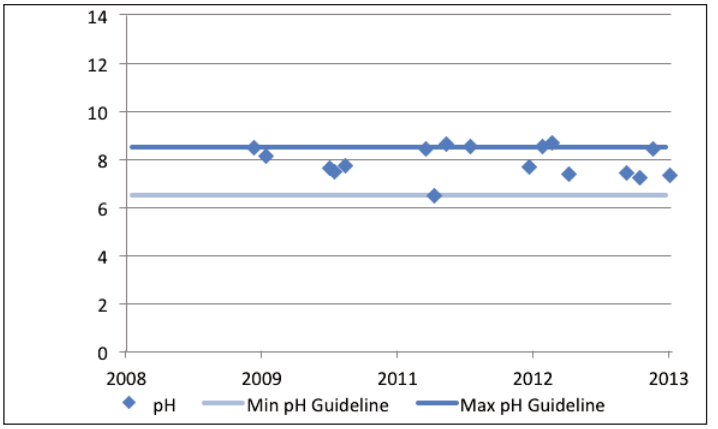


Figure 51 pH concentrations at the deep point in Spectacle Lake, 2008-2013

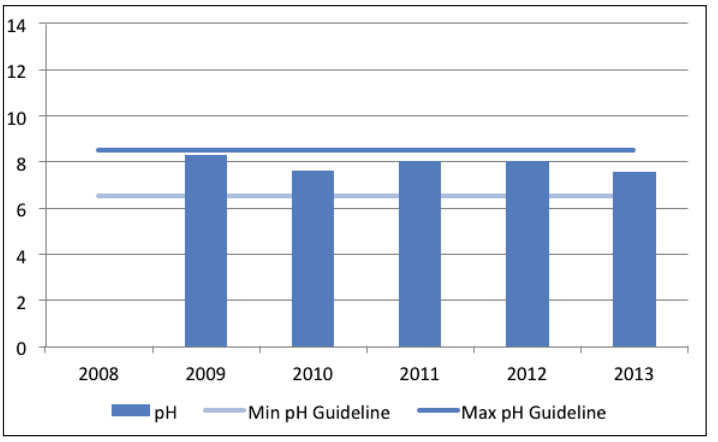


Figure 52 Average pH concentrations at the deep point in Spectacle Lake, 2008-2013

Seventy-six percent of samples (Table 21) 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 21 Summary of pH results for the deep point in Spectacle Lake, 2008-2013

pH 2008-2013			
Site	**Average**	**Within Guideline**	**No. Samples**
RVL-40	7.9	76%	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 point describes suitable habitat conditions for warm water fish species such as pickerel, bass and pike. The limited oxygen availability in the deep waters may limit the amount of habitat available to some aquatic communities. pH conditions are generally within the range recommended for the protection of aquatic life, indicating a healthy environment for aquatic species.

1) g. Wolfe Lake Water Quality

Surface water quality conditions in Wolfe Lake (RVL-27) have been monitored by RVCA's Watershed Watch Program since 2004. Data from the deep point sites has been used to calculate the WQI which was determined to be "Fair" (Table 1). Few nutrient exceedances, generally good fish habitat conditions, clear water and often 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 sites that are 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.

The *2004-2006 Wolfe Lake State of the Lake Environment Report* (Rideau Valley Conservation Authority, 2006) noted that Wolfe Lake had a moderate concentration of nutrients, generally suitable fish habitat conditions and good water clarity. The data presented in this report indicates that this continues to be the case and that a proactive, cautionary program of best management practices is important to ensure the protection of the lake environment.

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 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[8] within surface waters.

At the Deep Point

Two deep point sites are monitored on the lake. Average nutrient concentrations at these sites are summarized in Table 22 as well as the proportion of results that meet the guideline.

Table 22 Summary of nutrient results for Wolfe Lake, 2008-2013

Total Phosphorus 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-27	0.011	95%	22
Total Kjeldahl Nitrogen 2008-2013			
Site	**Average (mg/l)**	**Below Guideline**	**No. Samples**
RVL-27	0.297	100%	22

TP and TKN sampling results are presented in Figures 53 and 54. Almost all (95 percent) samples analyzed for TP were less than the TP guideline. The average concentration was also below the guideline at 0.011 mg/l (Table 22). TKN concentrations were minimal as well; all reported results were below the TKN guideline and the average concentration was 0.297 mg/l (Table 22). Average year to year concentrations have varied for both TP and TKN (Figures 55-56) and all average results are below guidelines. Overall,

[8] 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

the data presented indicates that nutrient concentrations may be considered low to moderate in the mid-lake, deep water sites of Wolfe Lake.

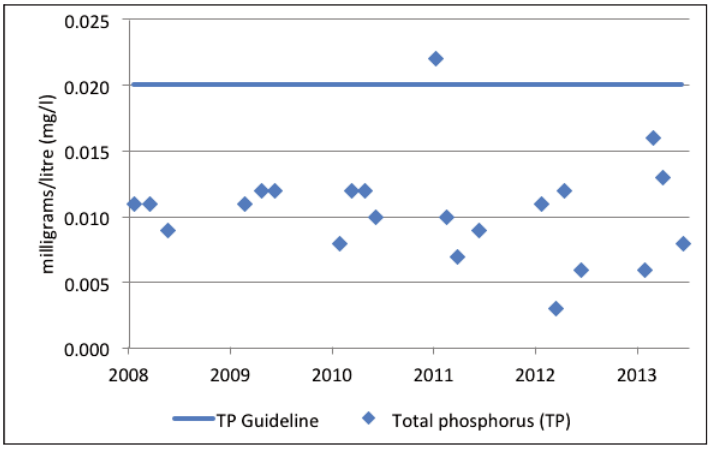


Figure 53 Total phosphorus sampling results at the deep point sites in Wolfe Lake, 2008-2013

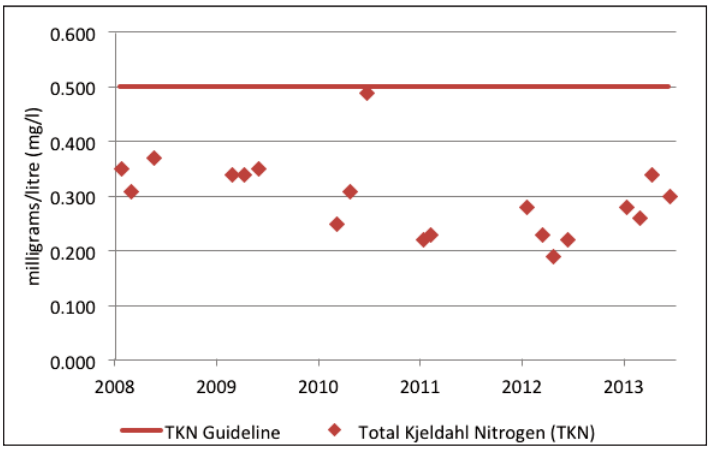


Figure 54 Total Kjeldahl nitrogen sampling results at the deep point sites in Wolfe Lake, 2008-2013

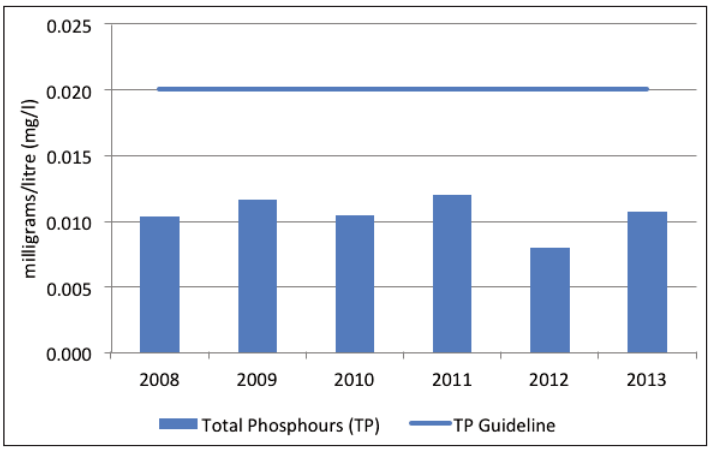


Figure 55 Average total phosphorus at the deep point sites in Wolfe Lake, 2008-2013

Around the Lake

The average nutrient concentrations at monitored sites around the lake vary from year to year (Figures 57 and 58). Please note that sites D, I, J and K are monitored each year while other sites (A, B, C, E, F, G, and H) are monitored every fifth year.

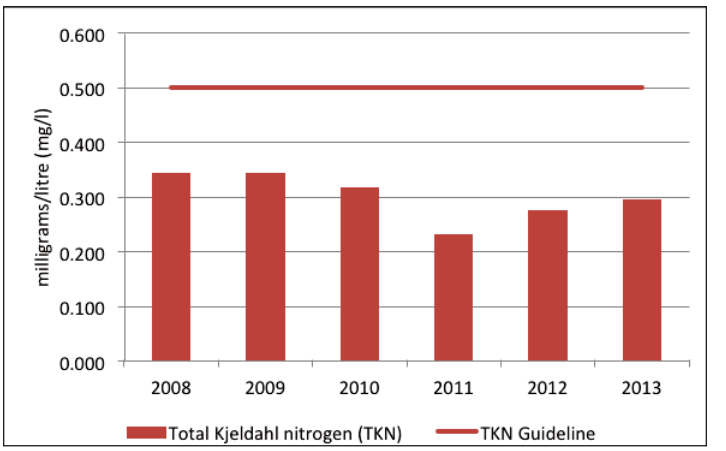


Figure 56 Average total Kjeldahl nitrogen at the deep point sites in Wolfe Lake, 2008-2013

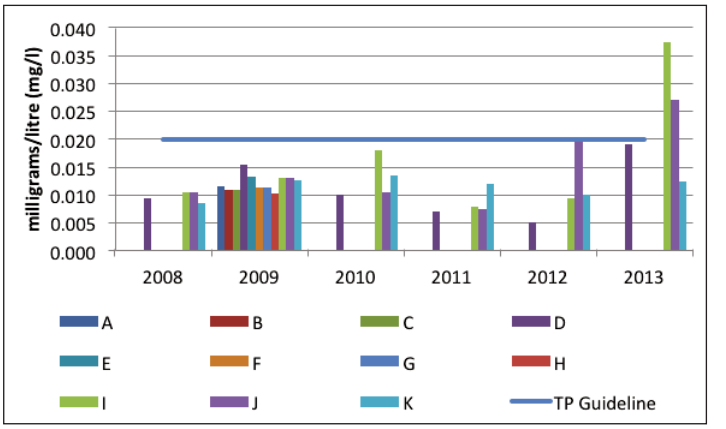


Figure 57 Average total phosphorus concentration at additional monitoring sites on Wolfe Lake, 2008-2013

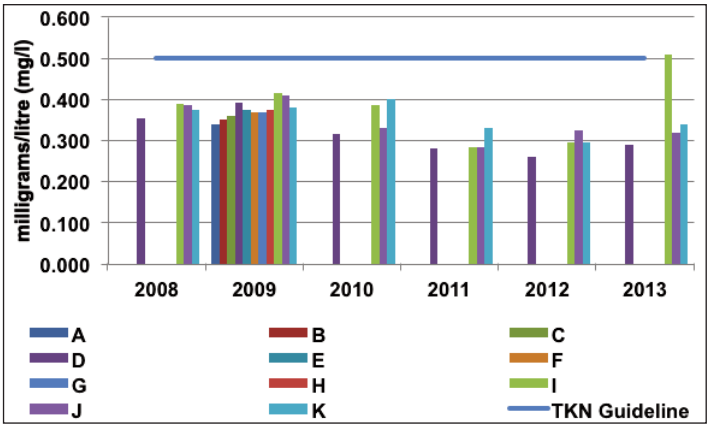


Figure 58 Average total Kjeldahl nitrogen concentrations at shoreline sites on Wolfe Lake, 2008-2013

Average total phosphorous concentrations are below the TP guideline at most sites, indicating nutrient enrichment does not to appear to be a problem in the monitored near shore areas. The exception to this are sites I and K in 2013. Both these sites have been previously identified as having elevated concentrations likely due to the influence of Barrs Creek during periods of high flow (*2004-2006 Wolfe Lake State of the Lake Environment Report).*

TKN concentrations were also at or below the guideline at the majority of sites; however, as with the TP data, site I was the exception in 2013. These results provide further support that nutrient enrichment is generally limited along the shoreline, with the exception of some nutrient loading occasionally occurring at site I.

Summary

Within Wolfe Lake nutrient concentrations generally meet guidelines. Average TP concentrations (Table 22) are slightly less than those reported in the *2004-2006 Wolfe Lake State of the Lake Environment Report* which noted average TP concentrations of 0.012 mg/l.

Efforts such as the diversion of runoff and enhanced shoreline buffers are important to continue to protect and enhance water quality and reduce future nutrient exceedances. Nutrient exceedances may be partially attributed to the natural aging of a lake and basin characteristics. All residents can help reduce their impact on the lake 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 23 summarizes the recorded depths and shows that all readings have exceeded the minimum PWQO of two metres indicating good water clarity, with an average Secchi depth of 6.8 metres. Figure 59 shows that no individual reading has been below the guideline and measured depths range from 4.5 metres to 10.75 metres. It should be noted that Secchi depths in many waterbodies have been influenced by the colonization of zebra mussels resulting in clearer waters than may have been seen prior to the introduction of this species.

Table 23 Summary of Secchi depths recorded at the deep point sites in Wolfe Lake, 2008-2013

Secchi depth 2008-2013			
Site	**Average (m)**	**Above Guideline**	**No. Samples**
RVL-27	6.8	100%	22

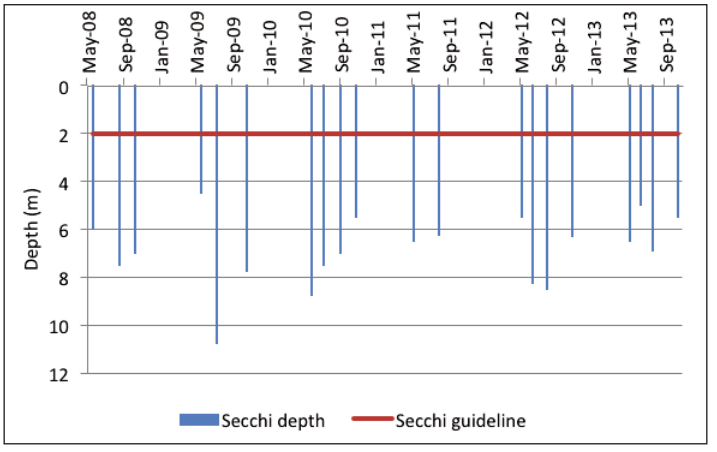


Figure 59 Secchi depths recorded at the deep point sites in Wolfe Lake, 2008-2013

Summary

This data indicates that waters are very clear and sufficient sunlight is able to penetrate the water column to support aquatic life and provide sufficient visibility for safe recreational use (i.e. boating, swimming). This data shows an increase from the Secchi depth of 4.7 metres reported in the *2004-2006 Wolfe Lake State of the Lake Environment Report;* the increase can likely be attributed to the presence of zebra mussels which have now colonized the lake but were not yet observed at the time of that report.

Fish Habitat

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

Dissolved Oxygen and Temperature

The red bars in Figure 60 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 monitored deep point. The vertical axis represents the lake depth. Suitable oxygen temperatures exist over an average depth of 22 metres.

There are generally good conditions for fish habitat at the deep point. However, through the late summer and early fall, the proportion of the water column suitable for warm water fish species becomes more limited. This is largely due to oxygen depletion at deeper depths as vegetation (including algae and phytoplankton) dies off and begins to decay, a process which consumes oxygen.

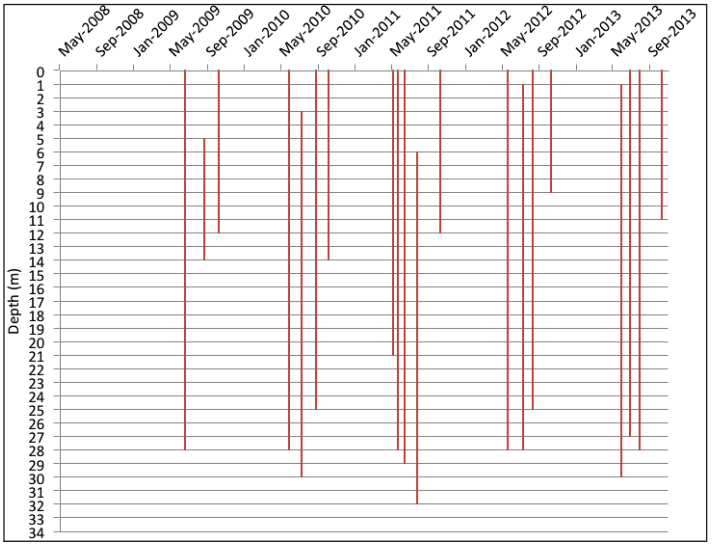


Figure 60 Depths suitable for warm water fish at the deep point sites in Wolfe Lake, 2008-2013

pH

pH is a basic water quality parameter used to assess the acidity of water, an important factor for aquatic life. Figure 61 shows pH concentrations in Wolfe Lake and Figure 62 summarizes average concentrations by year.

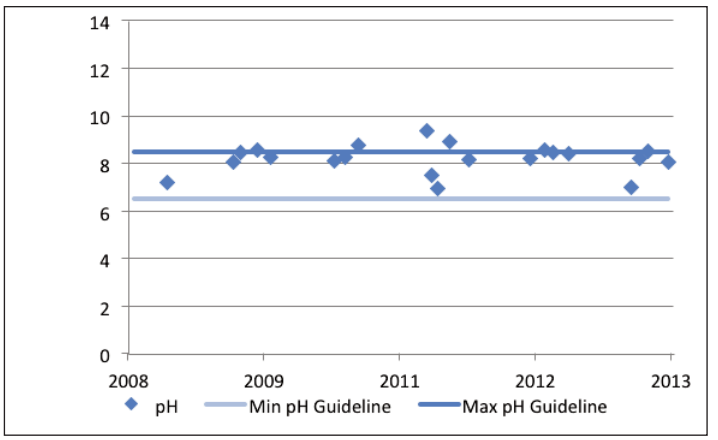


Figure 61 pH concentrations at the deep point sites in Wolfe Lake, 2008-2013

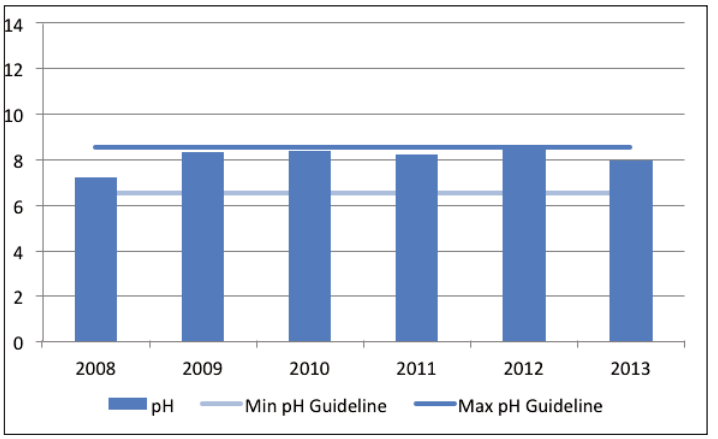


Figure 62 Average pH concentration at the deep point sites in Wolfe Lake, 2008-2013

Sixty-seven percent of samples (Table 24) 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. Results tend to border on the upper limit of the guideline indicating that elevated pH is a feature of this lake.

Table 24 Summary of pH values in Wolfe Lake, 2008-2013

pH 2008-2013			
Site	**Average**	**Within Guideline**	**No. Samples**
RVL-27	8.2	67%	21

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

Summary

Overall, the water chemistry data at the deep point describes suitable habitat conditions for warm water fish species. There is some evidence that the warming of the water column in the late summer/fall may limit the amount of habitat for some sensitive species. pH conditions are typically on the upper end of the range recommended for the protection of aquatic life. Overall, the data indicates 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 calculations of the WQI rating for the lake due to differences in sampling frequency and site locations. All samples (100 percent) 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[9] was only 3 CFU/100ml (Table 25). Figure 63 shows that samples across all sites were well below the guideline.

Table 25 Summary of *E. coli* results for Wolfe Lake, 2008-2013

***E. coli* 2008-2013**			
Site	**Geometric mean (CFU/100ml)**	**Below Guideline**	**No. Samples**
RVL-27	3	100%	66

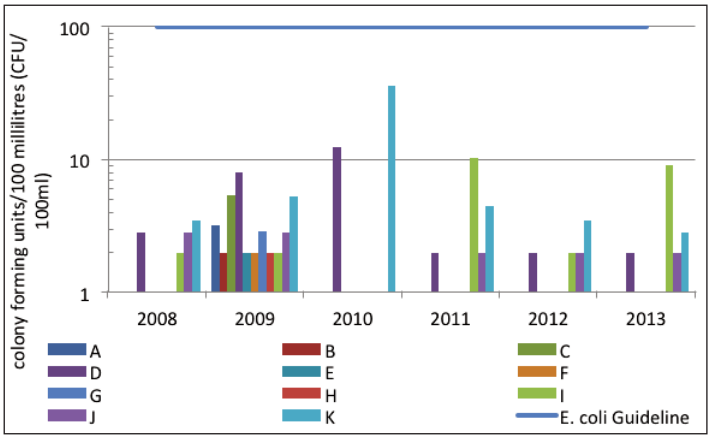


Figure 63 Geometric mean of shoreline sites monitored on Wolfe Lake, 2008-2013

Summary

Overall, the results presented above provide evidence that bacterial contamination is not a significant concern in Wolfe Lake and the water should be safe for recreational activities such as swimming and boating.

[9] 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.

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: 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 64 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 metres wide strip) in the catchment is comprised of woodland (59 percent), wetland (31 percent), crop and pastureland (five percent), settlement areas (three percent) and transportation routes (two percent).

Around **Wolfe Lake** itself, the shoreline buffer is made up of woodland (73 percent), settlement areas (11 percent), wetland (nine percent), transportation routes (six percent) and crop and pastureland (one percent). Around **Spectacle Lake**, the shoreline buffer is made up of woodland (83 percent), crop and pastureland (15 percent), settlement areas (one percent) and wetland (one percent). Around **Long Pond Lake**, the shoreline buffer is made up of woodland (84 percent), wetland (13 percent) and settlement areas (three percent). Around **Green Lake**, the shoreline buffer is made up of woodland (92 percent), wetland (four percent) and settlement areas (four percent). Around **Fermoy Lake,** the shoreline buffer is made up of woodland (87 percent), wetland (six percent), transportation routes (five percent) and settlement areas (two percent). Around **Butterill Lake**, the shoreline buffer is made up of woodland (52 percent), wetland (47 percent) and transportation routes (one percent). Around **Burridge Lake**, the shoreline buffer is made up of woodland (69 percent), settlement areas (17 percent), transportation routes (10 percent), wetland (four percent), and crop and pastureland (one percent).

Along streams in the catchment, the riparian buffer is comprised of woodland (45 percent), wetland (45 percent), crop and pastureland (seven percent), transportation routes (two percent) and settlement areas (one percent).

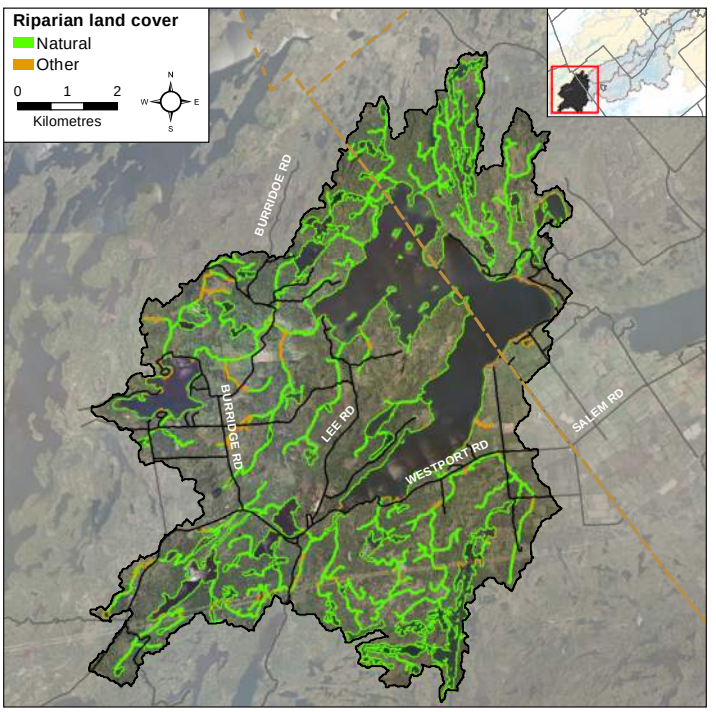


Figure 64 Natural and other riparian land cover in the Wolfe Lake catchment

Barrs Creek Overbank Zone

Riparian Buffer Width Evaluation

Figure 65 shows buffer conditions along the left and right banks of Barrs Creek. Using data from the 2013 Stream Characterization Program, Barrs Creek had a buffer of greater than 30 meters along 99 percent of the right bank and 97 percent along the left bank.

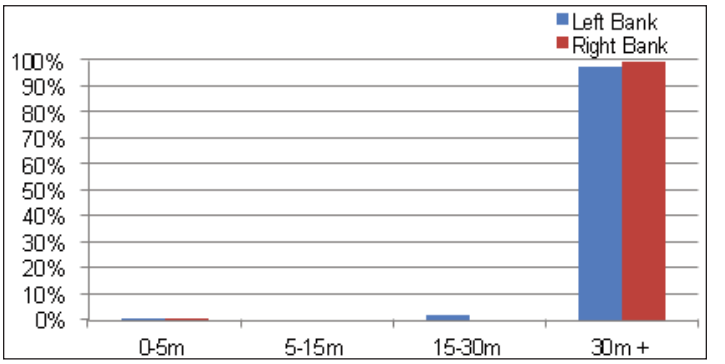


Figure 65 Riparian buffer evaluation along Barrs Creek

Adjacent Land Use

The RVCA's Stream Characterization Program identifies seven different land uses beside Barrs Creek (Figure 66). Surrounding land use is considered from the beginning to end of the survey section (100 metres) 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 96 percent of the stream, characterized by wetlands, forest, scrubland and meadow. The remaining land use consisted of infrastructure in the form of road crossings.

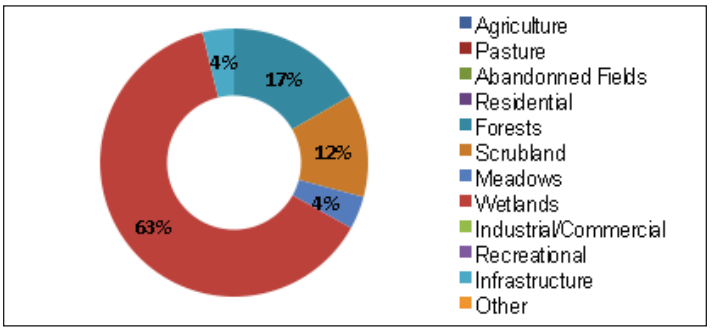


Figure 66 Land use along Barrs Creek

Barrs 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 67 shows low levels of erosion along Barrs Creek.

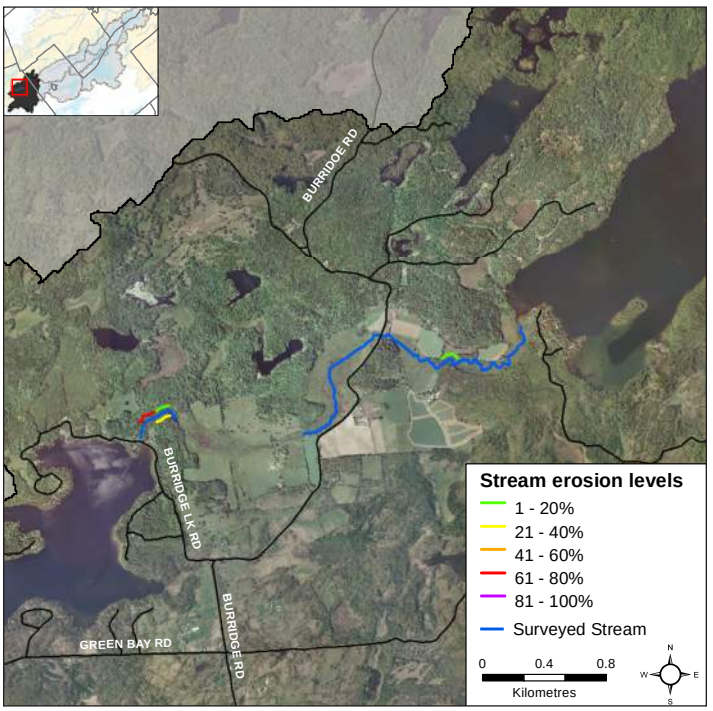


Figure 67 Erosion along Barrs Creek

Undercut Stream Banks

Undercut banks are a normal and natural part of stream function and can provide excellent refuge areas for fish. Figure 68 shows that Barrs Creek had low levels of undercut banks.

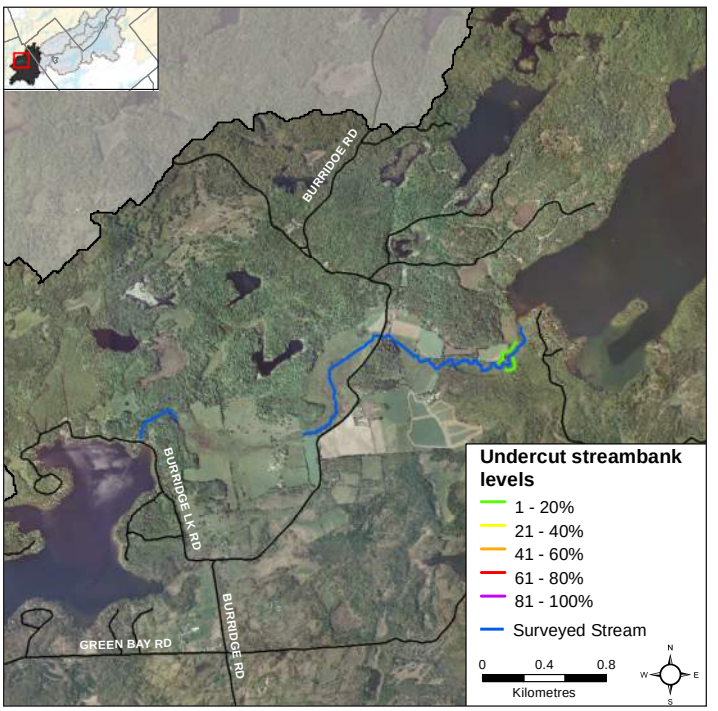


Figure 68 Undercut stream banks along Barrs Creek

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 69 shows highly variable stream shading conditions ranging from low levels in the lower reach and high levels in the upper reach along Barrs Creek.

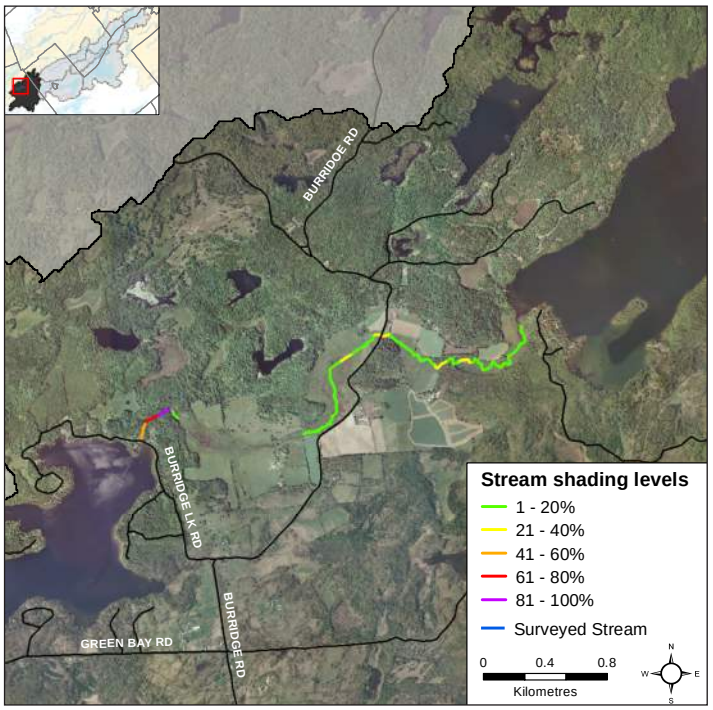


Figure 69 Stream shading along Barrs Creek

Instream Woody Debris

Figure 70 shows that the majority of Barrs Creek had low to moderate 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.

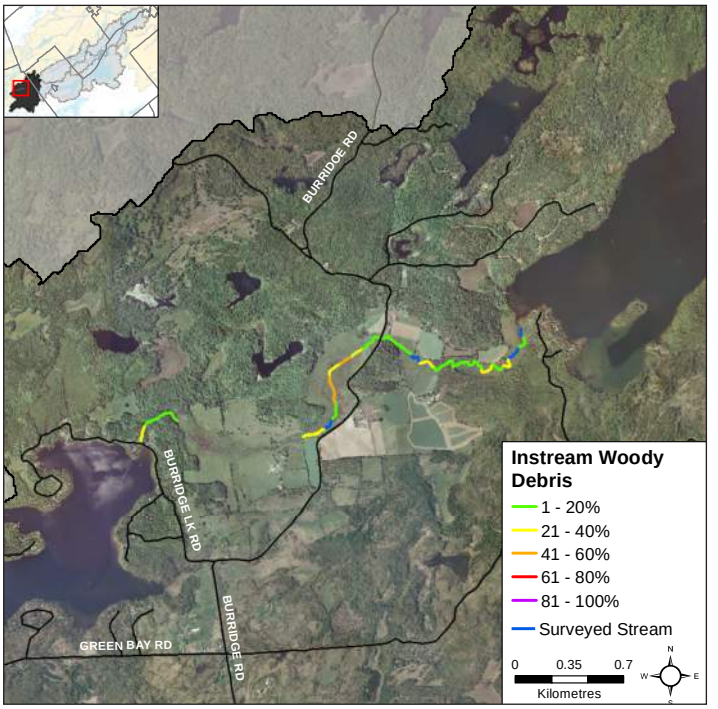


Figure 70 Instream woody debris along Barrs Creek

Overhanging Trees and Branches

Figure 71 shows low levels of overhanging branches and trees along Barrs Creek. Overhanging branches and trees provide a food source, nutrients and shade which helps to moderate instream water temperatures.

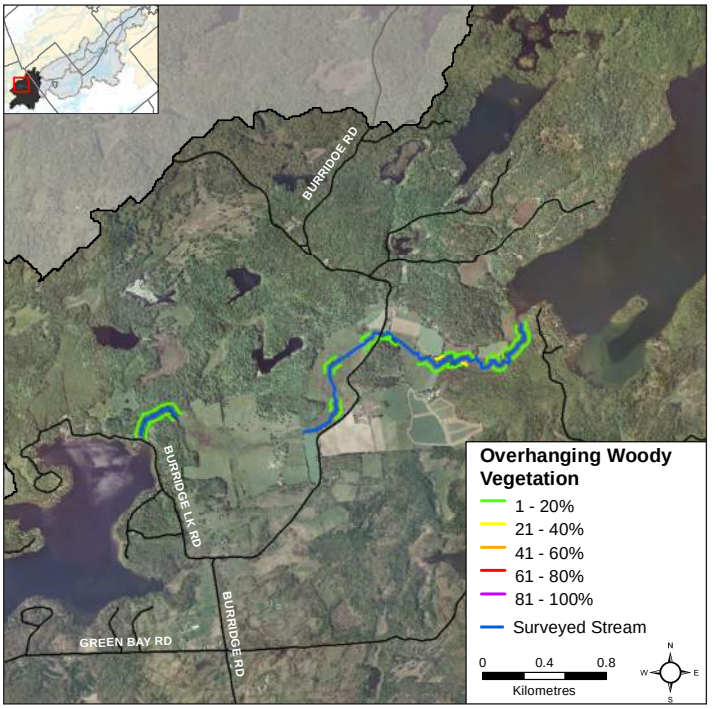


Figure 71 Overhanging trees and branches along Barrs Creek

Anthropogenic Alterations

Figure 72 shows 83 percent of Barrs Creek remains "unaltered" with no anthropogenic alterations. Fourteen percent of Barrs Creek was classified as natural with minor anthropogenic changes and three percent of its length was considered highly altered in the form of road crossings.

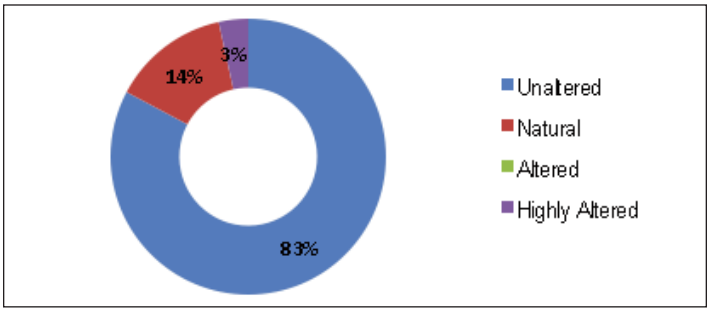


Figure 72 Anthropogenic alterations along Barrs Creek

Barrs 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. Seventy nine percent of Barrs Creek was considered homogeneous, as shown in Figure 73.

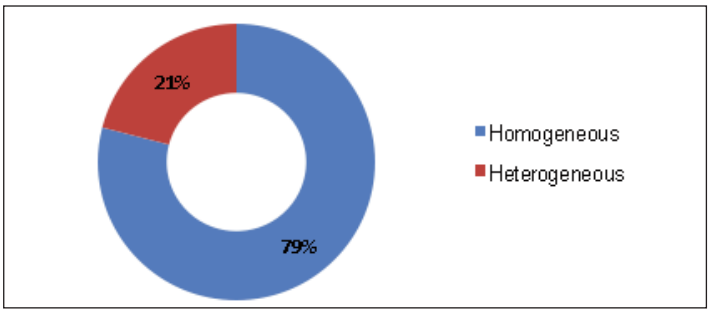


Figure 73 Anthropogenic alterations along Barrs Creek

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 74 shows where cobble and boulder substrate are found in Barrs Creek.

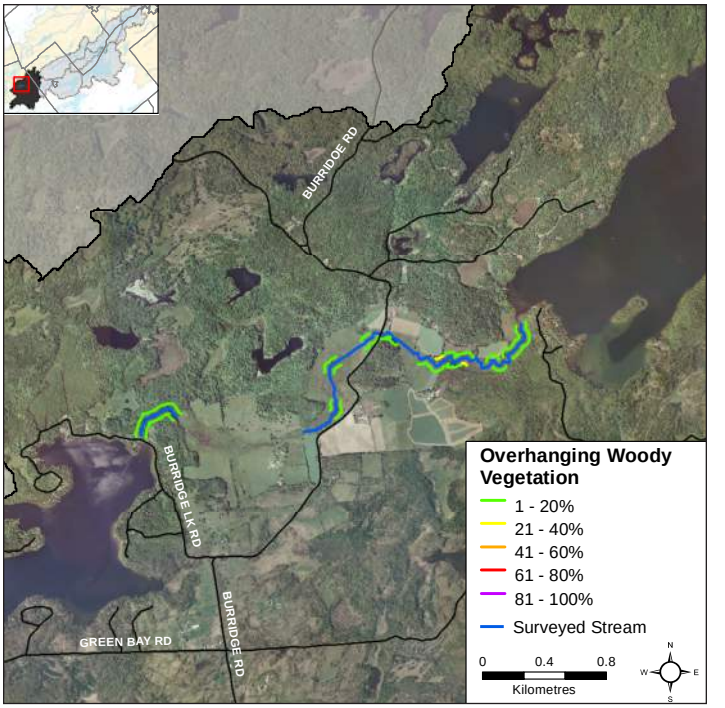


Figure 74 Instream substrate along Barrs Creek

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 75 shows that Barrs Creek is fairly uniform; 93 percent consists of runs and 7 percent riffles.

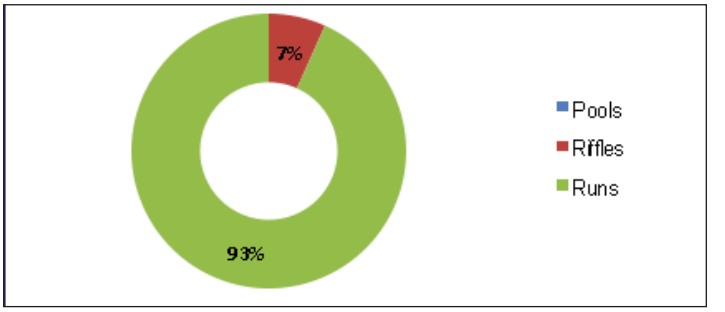


Figure 75 Instream morphology along Barrs Creek

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. Barrs Creek had moderate

levels of diversity of instream vegetation. The dominant vegetation type recorded at forty-nine percent consisted of narrow leafed emergents. Figure 76 depicts the plant community structure for Barrs Creek.

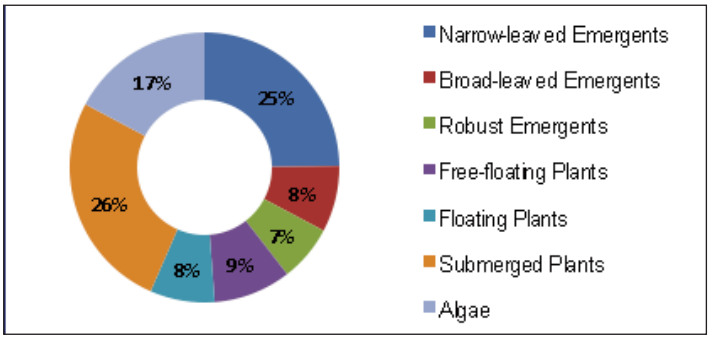


Figure 76 Vegetation type along Barrs Creek

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 77 demonstrates that Barrs Creek had common to normal levels of instream vegetation for most of its length.

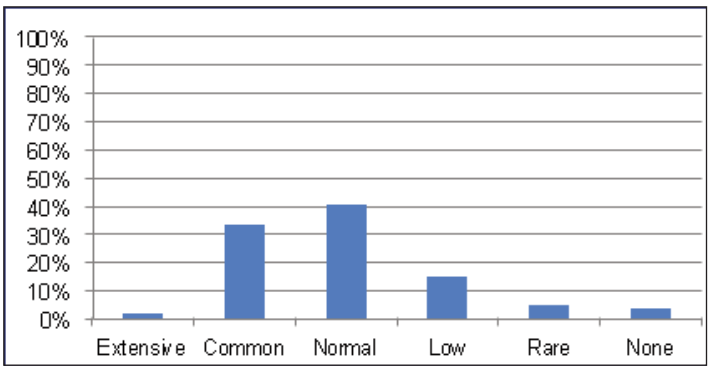


Figure 77 Instream vegetation abundance along Barrs Creek

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 out compete native species, having negative effects on local wildlife, fish and plant populations. Seventy six percent of the sections surveyed along Barrs Creek had invasive species (Figure 78). The invasive species observed in Barrs Creek were European frogbit and purple loosestrife.

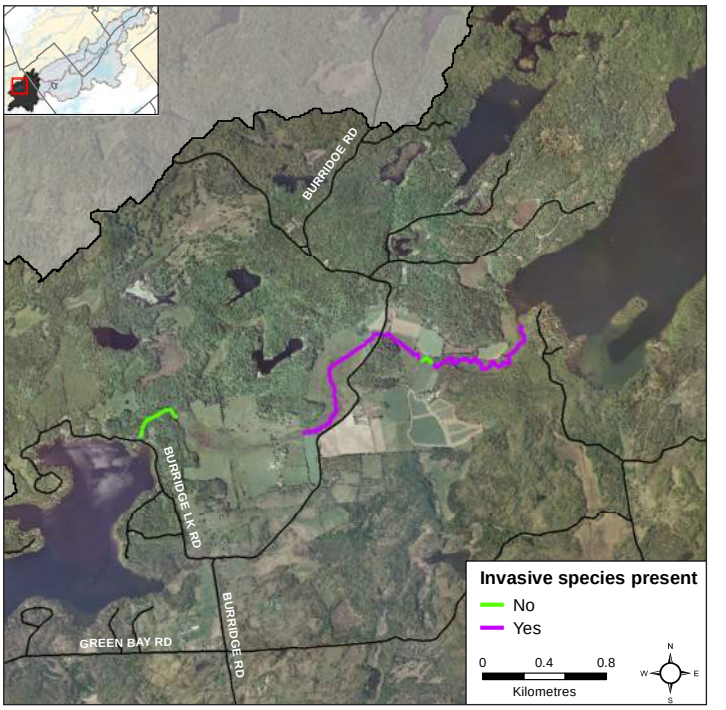


Figure 78 Invasive species along Barrs Creek

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 79 shows the location of temperature loggers at two sampling locations along Barrs Creek. Analysis of the data collected indicates that Barrs Creek is classified as a warm water system (Figure 80).

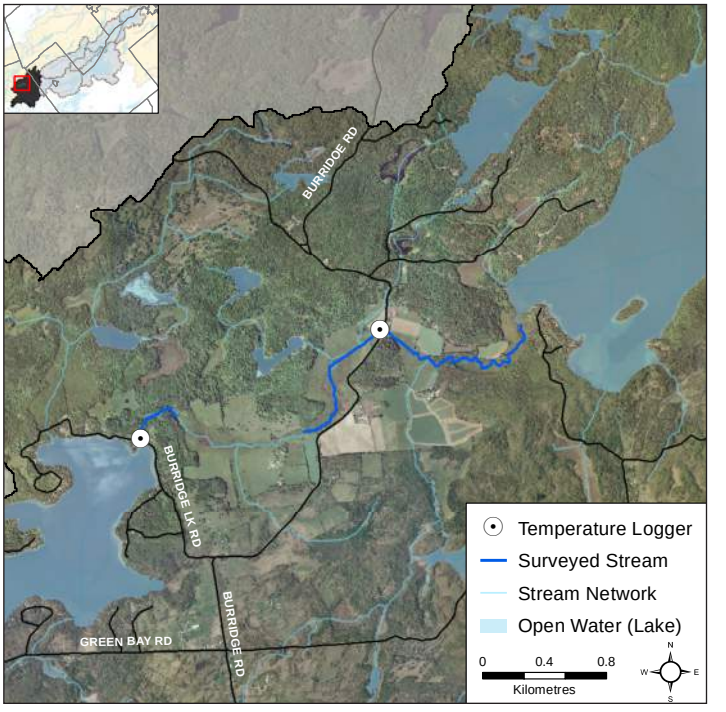


Figure 79 Temperature loggers in Barrs Creek

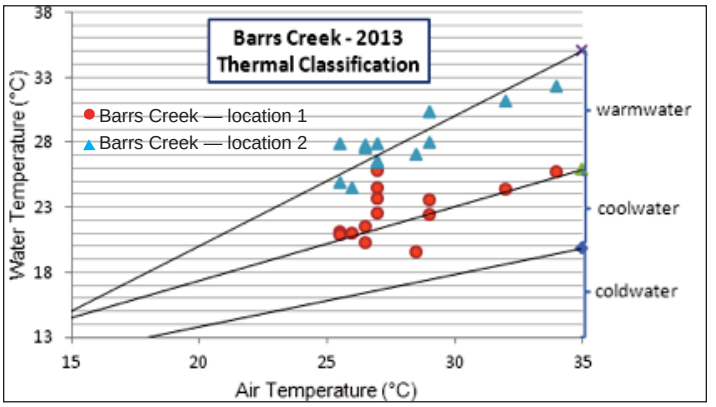


Figure 80 Temperature logger data for two sites on Barrs Creek

Headwaters Sampling Map

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 16 sites in the Wolfe Lake catchment area. Figure 81 shows the headwater drainage features sampling locations in the catchment.

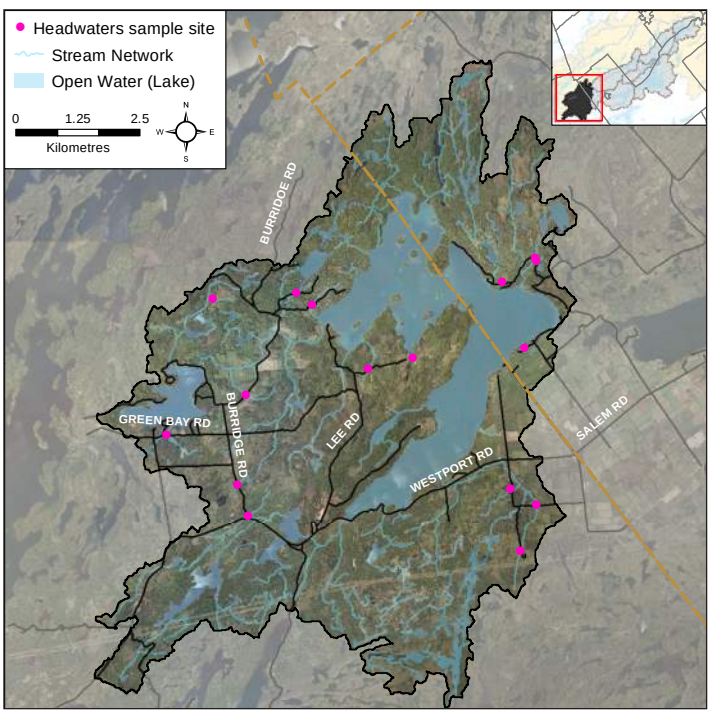


Figure 81 Headwater drainage feature sampling locations in the Wolfe Lake catchment

Two headwater drainage features sampled in the Wolfe Lake catchment

Fisheries

The Wolfe Lake catchment is classified as a mixed community of warm and cool water recreational and baitfish fishery with 24 species observed. The following is a list of species observed in the watershed (Source: MNR/RVCA). Fish sampling sites are shown in Figure 82.

smallmouth bass
finescale dace
brown bullhead
central mudminnow
common shiner
fallfish
rock bass
brook stickleback
northern redbelly dace
pumpkinseed
bluntnose minnow
golden shiner
blacknose shiner
fathead minnow

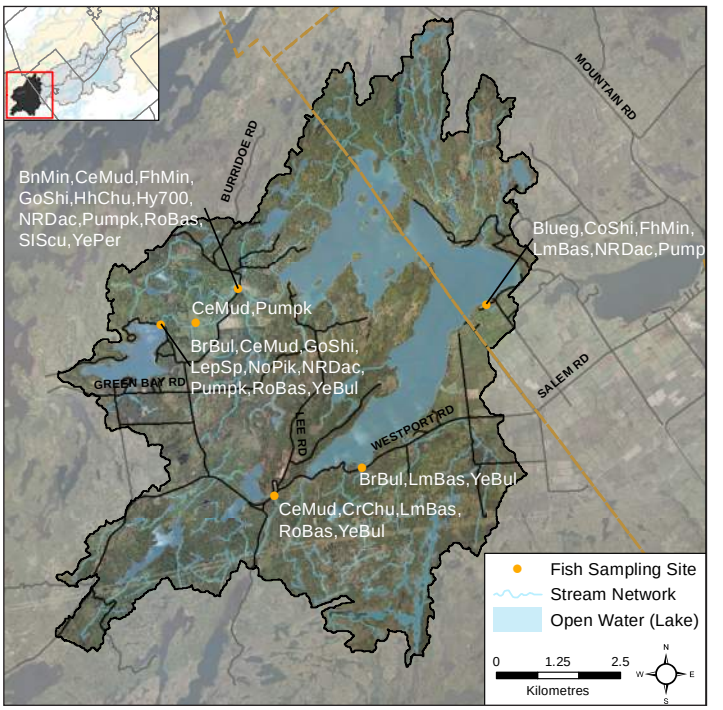


Figure 82 Fish sampling on Wolfe Lake

Young of the year northern pike captured on Barrs Creek

Riparian Restoration

Figure 83 depicts the locations where various riparian restoration activities can be implemented as a result of observations made during the stream survey assessments.

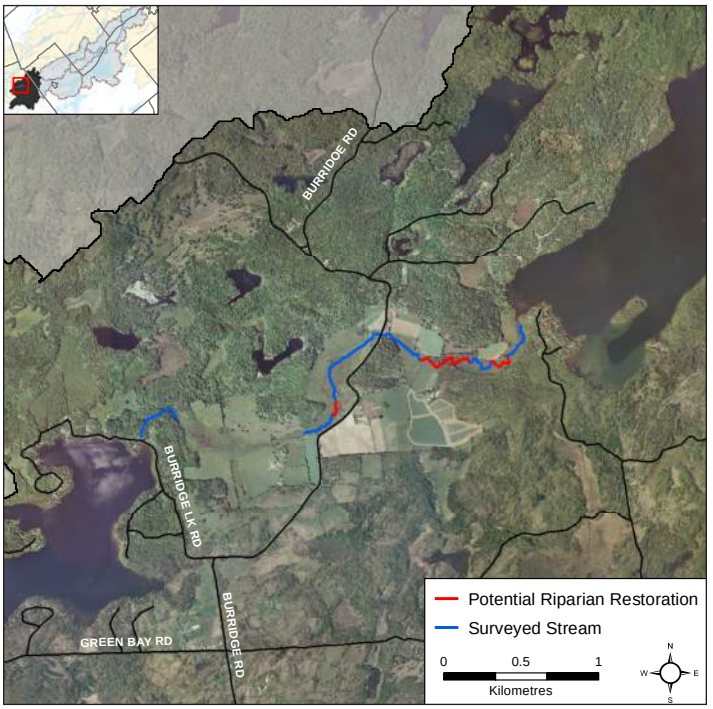


Figure 83 Riparian restoration along Barrs Creek

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.

2011 data for these four parameters is summarized in Table 26.

Table 26 Water chemistry in Barrs Creek

Month	Range	DO (mg/L)	DO(%)	Conductivity (µs/cm)	pH
May 2013	Low	11.4	124.9	491	8.0
	High	14.0	153.4	498	8.6
June 2013	Low	7.5	74.2	463	7.5
	High	14.2	140.8	600	8.6

RVCA staff completing stream surveys on Barrs Creek

3. Land Cover

Woodland is the dominant land cover type in the catchment, as shown in Table 27 and displayed in the map on the front cover of the report.

Table 27 Catchment land cover type

Cover Type	Area (ha)	Area (% of Cover)
Woodland*	3890	53
Water	1386	19
Wetland**	916	13
Crop & Pasture	759	10
Settlement	190	3
Transportation	149	2

* Does not include treed swamps ** Includes treed swamps

Woodland Cover

The Upper Rideau Lake catchment contains 3890 hectares of upland forest and 118 hectares of lowland forest (treed swamps) (Figure 84) that occupies 55 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 seventeen (60 percent) of the 196 woodland patches in the catchment are very small, being less than one hectare in size. Another 57 (29 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 22 (11 percent of) woodland patches range between 21 and 1011 hectares. Thirteen 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, nine (less than five percent) of the 196 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. Six 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 196 woodlands contain 143 forest interior patches (Figure 84) that occupy eight percent (624 hectares) 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 (126) have less than 10 hectares of interior forest, 74 of which have small areas of interior forest habitat less than one hectare in size. Another 13 patches contain between 10 and 30 hectares of interior forest. Conversely, four patches have greater than 30 hectares of interior forest (at 33, 40, 63 and 76 hectares).

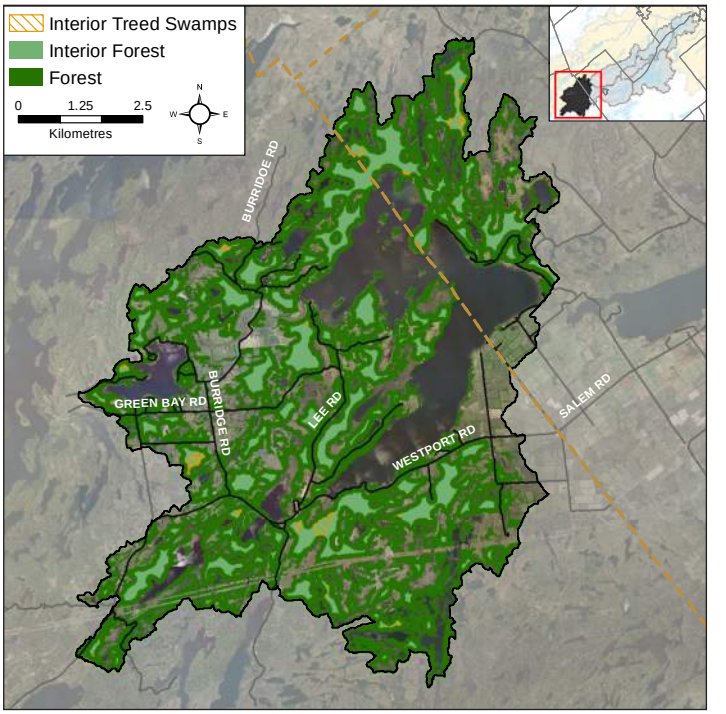
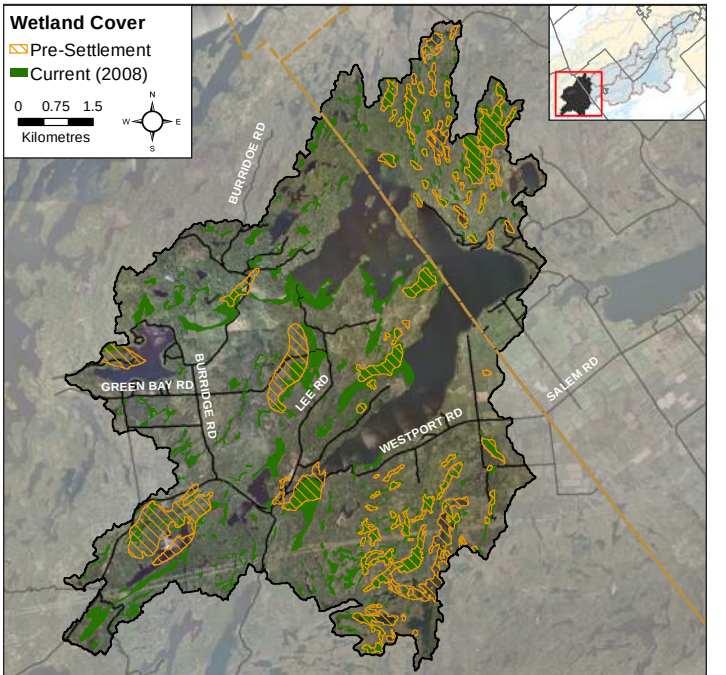


Figure 84 Catchment woodland cover and forest interior

Wetland Cover

Figure 85 shows pre-settlement wetland cover (Ducks Unlimited Canada 2010) versus current wetland cover (DRAPE 2008) in the catchment.



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 85 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.

Tree Planting Projects

The location of tree planting projects is shown in Figure 86. A total of 17,830 trees were planted at two sites through the RVCA Tree Planting Program. Project value is $27,986 with $16,914 of that amount coming from other fundraising sources.

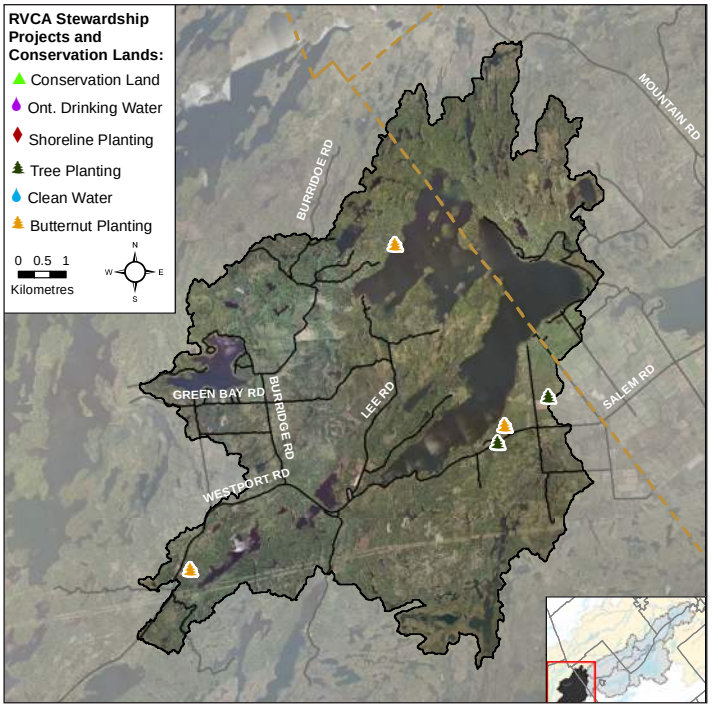


Figure 86 RVCA stewardship program project locations

Septic System Re-Inspections

From 2009 to 2013, the Mississippi Rideau Septic System Office performed 27 septic system re-inspections (22 cottages and five houses) on Wolfe 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 14 (or 52 percent) of those properties that were inspected with more information provided to a further two landowners with identified septic system concerns.

Valley, Stream, Wetland and Hazard Land Regulation

Nine square kilometres or 13 percent of the catchment drainage area is within the regulation limit of Ontario Regulation 174/06 (Figure 87), giving protection to wetland areas and river or stream valleys that are affected by flooding and erosion hazards.

Natural features within the regulation limit include 3.1 square kilometres. of wetlands (representing 34 percent of all wetlands in the catchment) and 20.5 kilometers of streams (representing 13 percent of all streams in the catchment). Some of these regulated watercourses (13.8 km or nine percent of all streams) flow through regulated wetlands.

Regulation limit mapping has been plotted along 6.6 km (or 33 percent) of the streams that are outside of wetlands. Plotting of the regulation limit on the remaining 140 kilometres (or 87 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.

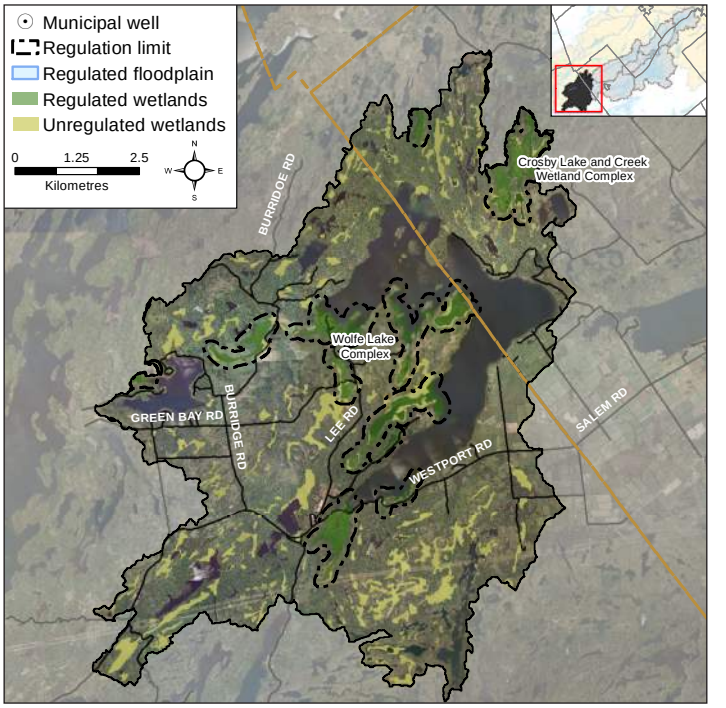


Figure 87 RVCA regulation limits

Vulnerable Drinking Water Areas

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 small portion of the catchment area for Wolfe Lake 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.

Prepared by the Wolfe and Green Lakes communities and their partners, the *Wolfe and Green Lakes Vision and Overview* (June 2013) outlines issues and concerns identified by the lake communities and efforts that are being made to protect the long-term health of the two lakes. The following list includes some of those identified issues taken from that document that have implications for the water and land resources of each lake ecosystem, as well as other lakes in the catchment drainage area. Refer to the Vision and Overview document for a complete list of those concerns, issues and efforts/opportunities for action.

5. Issues

Water Quality

- Recent findings for the RVCA's surface water quality monitoring program indicate that Long Pond Lake and Butterill Lake have a "Poor" surface water quality rating (for the 2008-2013 period); both lakes are characterized by moderate nutrient concentrations. Butterill Lake also exhibits limited conditions for warm water fisheries in the summer, due to warm surface water temperatures and low oxygen availability at deeper depths. Given the limited development around each lake, these characteristics can be largely attributed to natural conditions such as the shallow basin and nutrient rich organic sediment found within the lakes and surrounding wetlands
- Fourteen (of 27) Rideau Lakes Township septic system voluntary re-inspections conducted from 2009 to 2013 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
- *Wolfe and Green Lakes Vision and Overview* notes that, as of the date of the report, no septic system re-inspection program has been implemented by South Frontenac Township. The Lake Association will continue to communicate its concerns to the Township
- Wolfe and Green Lakes property owners Lake Vision Survey (2009) identified the preservation of water quality as a major concern

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

Shorelines

- Wolfe and Green Lakes property owners Lake Vision Survey (2009) identified the preservation of natural shorelines and vegetation (i.e., lawns extending to the lake edge) as a major concern
- 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

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
- *Wolfe and Green Lakes Vision and Overview* notes that Rideau Lakes and South Frontenac Townships face continuous pressure from various sources to grant minor variances. With waterfront properties limited and in high demand, developers may seek to increase density with back-lot, campground and fractional-ownership developments. Back lots with lake access may have fewer bylaw restrictions. At the same time, the threat to the lake in terms of more pollution, shoreline erosion, boat traffic and loss of privacy, peace and quiet may be increased exponentially. Lake residents may proceed with construction projects without permits or replace shoreline vegetation with lawns without considering harmful environmental impacts (from *Wolfe and Green Lakes Vision and Overview)*
- *Wolfe and Green Lakes Vision and Overview* states that significant differences exist between the two (South Frontenac/Rideau Lakes Townships) municipal (official) plans, complicating land use and development on Wolfe Lake
- *Wolfe and Green Lakes Vision and Overview* notes that all cottage owners should be aware of township fire protection guidelines in order to ensure that private lanes meet prescribed municipal requirements so that fire and other emergency vehicles can respond to cottage emergencies without any delays or restrictions in service. Non-compliance with private lane standards is also becoming more of a municipal liability for emergency vehicle access (ambulance, fire and police) as waterfront cottage lots are re-developed with larger, permanent residences

Fisheries

- 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. There is limited information available about the state of the fisheries resource in this catchment with the only scientific study conducted to date being a Fall Walleye Index Netting (FWIN) exercise that was performed with the assistance of the Ministry of Natural Resources on Wolfe Lake in 1997 (from *Wolfe and Green Lakes Vision and Overview)*
- Wolfe and Green Lakes property owners Lake Vision Survey (2009) identified invasive species (on land and in-water) as a major concern

6. Opportunities

Water Quality

- Reduce pollutant loadings to Wolfe Lake and other catchment lakes 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 beneficial 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 water resources of Wolfe and Green Lakes and other catchment lakes through implementation of municipal and agency land use and development policies and practices
- Continue to promote septic system 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
- The Wolfe Lake Association is committed to: continuing water quality monitoring (possibly modified to include additional criteria); working to control invasive plant and aquatic species such as Eurasian Milfoil and Zebra Mussels; initiating action to promote timely septic tank inspections by municipal authorities and educating property owners and users concerning best shoreline practices (from *Wolfe and Green Lakes Vision and Overview)*
- Continue to offer septic repair/replacement project funding provided by the Rideau Valley Rural Clean Water Program to waterfront landowners
- Review monitoring of surface water quality in Wolfe and Green Lakes 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*)
- The Wolfe and Green Lakes property owners Lake Vision Survey (2009) indicated that the Wolfe Lake Association's primary goal and priority should be to protect and preserve the overall lake environment (including water quality, natural trees and vegetation, wildlife and birds, retention of natural shorelines and good swimming)

Development

- *Wolfe and Green Lakes Vision and Overview* lists a number of initiatives for the Wolfe Lake Association to pursue with Rideau Lakes and South Frontenac Townships, to develop policies for land use and sustainable development including:
  - Monitoring township Official Plans on a regular basis and attending meetings and public hearings to ensure that the lakes' requirements are given serious consideration; in particular, the Township of South Frontenac must be encouraged to initiate septic inspections and to control high-density (e.g., back-lot and fractional-ownership) development
  - Liaising with the township planning departments to ensure that the lake association is made aware of all major planned developments on a timely basis, providing opportunity for input and action as appropriate
- Collectively work with approval authorities (Townships of Rideau Lakes and South Frontenac, 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 use the 2014 Site Evaluation Guidelines[10] 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)
- The Wolfe and Green Lakes property owners Lake Vision Survey (2009) indicated that a priority of the Wolfe Lake Association should be to take political action to impact regulations on the development of lake property

Shorelines

- RVCA and its partners (including the municipalities of Rideau Lakes and South Frontenac and the Wolfe 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
- *Wolfe and Green Lakes Vision and Overview* encourages property owners to avoid: removing native plant species such as cattails and bulrushes, establishing manicured lawns and non-native plants in the vicinity of the shoreline and building retaining walls, boathouses and seawalls. It also encourages property owners to consider rehabilitating and re-naturalizing manicured shorelines with native vegetation along the lakefront that can benefit the watershed and lake ecosystem by: discouraging the growth of algae and aquatic plants; preventing erosion and runoff; trapping nutrient-rich precipitation runoff and sediments; enhancing water quality; providing shelter and food for wildlife; supporting spawning beds for fish and shading and cooling surface waters
- Protect the riparian buffer along the shoreline of Wolfe and Green Lakes, other catchment lakes and streams during the development approvals process through adherence to and enforcement of municipal land-use policies and zoning standards
- Consider an assessment of shoreline conditions around Burridge Lake and Wolfe Lake (using the MAPLE protocol) to monitor the effect of future changes to the lake ecosystem
- Target shoreline and instream restoration at sites identified in this report (as shown in Figure 64 as "Other" riparian cover)
- Promote the RVCA's Shoreline Naturalization Program and other similar initiatives to enhance natural vegetation cover around Burridge and Wolfe Lakes and other catchment lakes where it is lacking

[10] 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

- Continue to educate boaters about the effect of excessive speeding and ensuing boat wake on the shoreline and wildlife of Wolfe Lake; also consider enforcement of speeding watercraft in close proximity to the shoreline

Fisheries

- Implement the sustainable fishing initiatives listed in the *Wolfe and Green Lakes Vision and Overview* including:
  - Working with the Ministry of Natural Resources (MNR) and other groups to identify, protect, rehabilitate, monitor and maintain fish spawning grounds (especially for species such as walleye and smallmouth bass)
  - Establishing a local education program to: promote catch-and-release fishing and the use of barbless hooks; discourage the use of lead sinkers and weights; encourage fishermen to complete angler diaries and residents to report poaching; work with the municipalities and planning agencies to ensure that approvals for new development take into consideration the protection of fish habitat, including near-shore nursery and spawning areas and encourage all those fishing in the lakes to be aware of and adhere to fishing regulations
  - Educating shoreline owners about near-shore and in-water activities that damage or destroy fish habitat including the removal of rock rubble substrates, submerged wood materials and aquatic plants along with the creation of sandy swimming areas over spawning sites for bass and other species and
  - Working with MNR to encourage the enforcement of existing fishing regulations

Lake Planning

- Implement the identified actions/efforts described in the *Wolfe and Green Lakes Vision and Overview* as a way of moving the lake community ever closer to the two high-level objectives of the Wolfe Lake Association; those being to foster a strong lake community and monitor and act on issues that threaten the sustainable enjoyment and health of the lakes and surrounding lands