Wolfe Lake (Westport) Association

Water Quality Report 2017

Daniel Spitzer, April 2018

Introduction to Water Quality

Reference: https://www.ec.gc.ca/eau-water/default.asp?lang=En&n=2C3144F5-1

We tend to think of water in terms of a particular purpose: is the quality of the water good enough for the use we want to make of it? Water fit for one use may be unfit for another. We may, for instance, trust the quality of lake water enough to swim in it, but not enough to drink it. Along the same lines, drinking water can be used for irrigation, but water used for irrigation may not meet drinking water standards. It is the quality of the water which determines its uses.

Scientists, on the other hand, are interested in other aspects of water quality. To them quality is determined by the kinds and amounts of substances dissolved and suspended in the water and what those substances do to inhabitants of the ecosystem. It is the concentrations of these substances that determine the water quality and its suitability for particular purposes.

The water of even the healthiest rivers and lakes is not absolutely pure. All water (even if it is distilled) contains many naturally occurring substances -- mainly bicarbonates, sulphates, sodium, chlorides, calcium, magnesium, and potassium.

Many factors affect water quality. Substances present in the air affect rainfall. Dust, volcanic gases, and natural gases in the air, such as carbon dioxide, oxygen, and nitrogen, are all dissolved or entrapped in rain. When other substances such as sulphur dioxide, toxic chemicals, or lead are in the air, they are also collected in the rain as it falls to the ground.

Rain reaches the earth's surface and, as runoff, flows over and through the soil and rocks, dissolving and picking up other substances. For instance, if the soils contain high amounts of soluble substances, such as limestone, the runoff will have high concentrations of calcium carbonate. Where the water flows over rocks high in metals, such as ore bodies, it will dissolve those metals. In the Canadian Shield, there are large areas with little soil and few soluble minerals. Consequently, the rivers and lakes in these areas have very low concentrations of dissolved substances.

Another factor influencing water quality is the runoff from urban areas. It will collect debris littering the streets and take it to the receiving stream or water body. Urban runoff worsens the water quality in rivers and lakes by increasing the concentrations of such substances as nutrients (phosphorus and nitrogen), sediments, animal wastes (fecal coliform and pathogens), petroleum products, and road salts.

Industrial, farming, mining, and forestry activities also significantly affect the quality of Canadian rivers, lakes, and groundwater. For example, farming can increase the concentration of nutrients, pesticides, and suspended sediments. Industrial activities can increase concentrations of metals and toxic chemicals, add suspended sediment, increase temperature, and lower dissolved oxygen in the water. Each of these effects can have a negative impact on the aquatic ecosystem and/or make water unsuitable for established or potential uses.

Water Quality Sampling in Wolfe Lake

The water quality was tested by the Water Quality Director on 5 occasions in 2017. The water clarity (Secchi Disk depth) was measured and deep-water samples were taken at sites DP1 and DP3 on May 25, June 11, July 10, August 13 and September 02. The samples were analyzed for total phosphorus (TP) concentration through the Lake Partner Program (Ontario Ministry of the Environment). Deep and shallow-water samples were also taken at several sites by the Rideau Valley Conservation Authority (RVCA). These were analyzed for a number of variables including TP, calcium, total nitrogen, E. coli and dissolved oxygen concentration. The laboratory results from the Lake Partner Program are summarized in Tables 1,2 and 3. Figure 1 shows the map of the Wolfe Lake with sampling sites and depth contours indicated. In Figure 2, multi-year trends of annual averages of the sampled water quality parameters are presented.

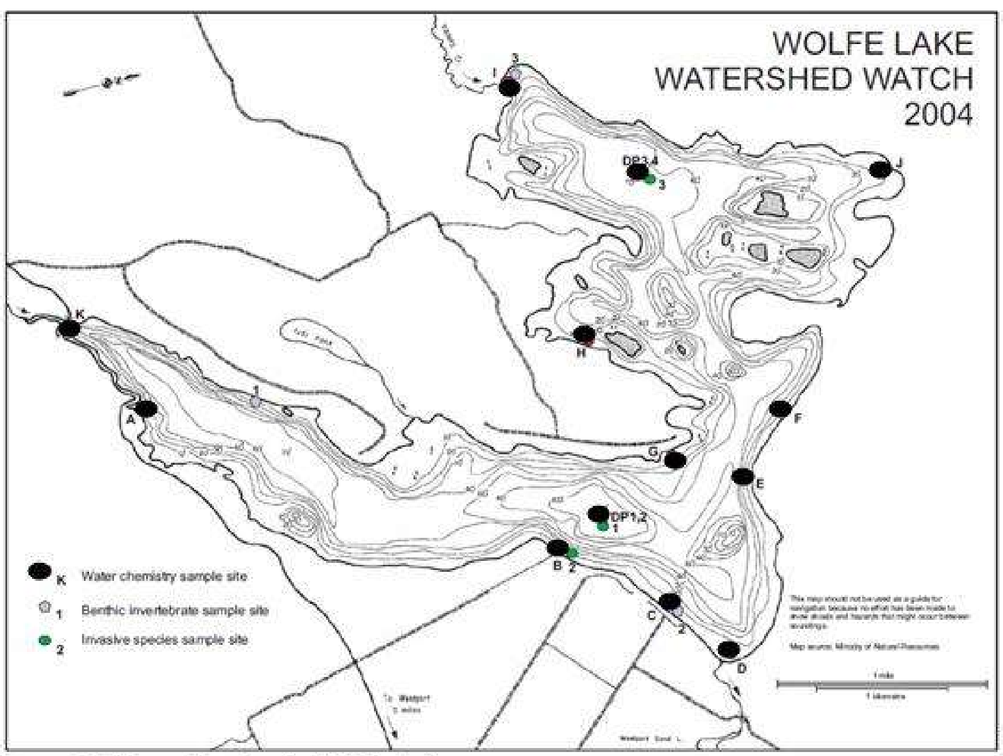


Figure 1. Water Testing in Wolfe Lake

Results

Total Phosphorus (TP) and Total Nitrogen (TKN) are two of the main indicators of water pollution due to runoff from lake surrounding areas. The concentration of the E. Coli bacteria is another important indicator of water contamination released by the fecal material of human or animal origin. The measured Secchi depth refers to the turbidity of the water caused by algae, pollen and sediments.
Tables 1, 2 and 3 below display the results of the water sampling and analyses.

LAKE	LAKE CODE	PARAMETER	TOTAL # OF SAMPLES	MAXIMUM	MINIMUM	AVERAGE	MEDIAN	# SAMPLES > STANDARD	% SAMPLES > STANDARD	STANDARD
Wolfe Lake	RVL-27	E.COLI (cfu/100 mL)	177	280	0	10	2	3	2%	100
sample period: 2004 - present		TKN (µg/L)	295	880	190	372	360	18	6%	500
		TP (µg/L)	295	63	2	12	10	17	6%	20
		Ca (mg/L)	46	31	23	27	26	46	100%	20
		Secchi depth (m)	92	11.5	3.1	6.3	6.1	0	0%	2
2017		E.COLI (cfu/100 mL)	8	20	2	9	6	0	0%	100
		TKN (µg/L)	16	500	220	338	315	0	0%	500
		TP (µg/L)	16	34	7	13	11	1	6%	20
		Ca (mg/L)	2	26.2	26.1	26	26	2	100%	20
		Secchi depth (m)	6	6.0	4.5	5.3	5.4	0	0%	2
2016		E.COLI (cfu/100 mL)	8	4	2	2	2	0	0%	100
		TKN (µg/L)	15	650	200	369	340	3	20%	500
		TP (µg/L)	15	22	6	10	9	1	7%	20
		Ca (mg/L)	2	26.5	25.5	26	26	2	100%	20
		Secchi depth (m)	6	7.0	4.4	5.8	5.9	0	0%	2
2015		E.COLI (cfu/100 mL)	8	62	2	10.5	2	0	0%	100
		TKN (µg/L)	16	540	280	363.125	350	1	6%	500
		TP (µg/L)	16	25	4	8	7	1	6%	20
		Ca (mg/L)	2	27.3	25.4	26.35	26.35	2	100%	20
		Secchi depth (m)	8	9.3	3.1	5.42	4.78	0	0%	2
2014		E.COLI (cfu/100 mL)	22	38	2	6	2	0	0%	100
		TKN (µg/L)	30	880	260	457	415	7	23%	500
		TP (µg/L)	30	17	2	12	12	0	0%	20
		Ca (mg/L)	2	29.7	28	29	28.85	2	100%	20
		Secchi depth (m)	8	6.75	5	6	6.1	0	0%	2
2013		E.COLI (cfu/100 mL)	8	42	2	7	2	0	0%	100
		TKN (µg/L)	16	690	260	333	315	1	6%	500
		TP (µg/L)	16	63	6	19	12	4	25%	20
		Ca (mg/L)	0							20
		Secchi depth (m)	10	9.5	5.3	6.8	6.5	0	0%	2

Table 1: Averaged Water Quality data recorded by Rideau Valley Conservation Authority and the Water Quality Director

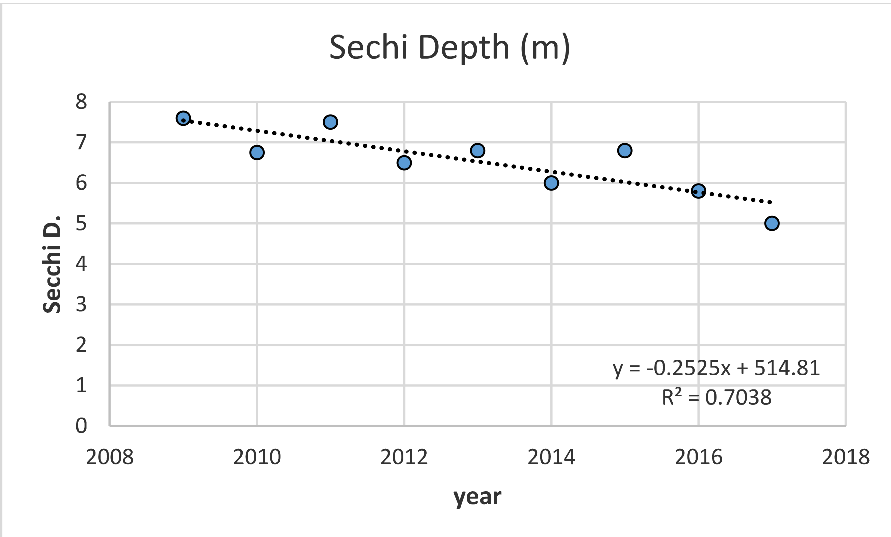
Wolfe Lake				Dissolved	Total			
2017				Organic	Kjeldahl	Total	Calcium	Secchi Disk
			E.Coli	Carbon	Nitrogen	Phosphorus		Depth
			(cfu/100 mL	(mg/L)	(µg/L)	(µg/L)	(mg/L)	(m)
		total # samples	8	2	16	16	2	
		maximum	20	5	500	34	26.2	
		minimum	2	5	220	7	26.1	
		average	9	5	338	13	26.2	
		median	6	5	315	11	26.2	
		# samples > standard	0	0	0	1	2	
		% samples > standard	0%	0%	0%	6%	100%	
		standard	100	5	500	20	20	
DATE	**CLIENT ID**	**STATION**	**EC**	**DOC**	**TKN**	**TP**	**Ca**	**Secchi**
25-May-17	RVL-27	DP1			330	11		4.5
25-May-17	RVL-27	DP3			340	10		4.3
25-Jun-17		DP1				10		5.2
25-Jun-17		DP3				12		4.3
14-Jul-17	RVL-27	D	18		370	13		
14-Jul-17	RVL-27	DP1		4.9	280	9		6.0
14-Jul-17	RVL-27	DP3		4.9	310	14		4.9
14-Jul-17	RVL-27	I	2		300	14		
14-Jul-17	RVL-27	J	2		480	34		
14-Jul-17	RVL-27	K	20		500	14		
13-Aug-17		DP1				12		6.3
13-Aug-17		DP3				12.9		5.3
28-Aug-17	RVL-27	D	12		340	10		
28-Aug-17	RVL-27	DP1			310	10	26.1	
28-Aug-17	RVL-27	DP3			290	7	26.2	
28-Aug-17	RVL-27	I	2		310	11		
28-Aug-17	RVL-27	J	2		460	15		
28-Aug-17	RVL-27	K	10		220	11		
02-Sep-17		DP1				10.5		4.1
02-Sep-17		DP3				11.8		4.0
18-Oct-17	RVL-27	DP1			320	12		5.3
18-Oct-17	RVL-27	DP3			250	10		5.5
Highlighted values are <2 CFU/100ml								
AVERAGE			**8.5**	**4.9**	**338.7**	**12.5**	**26.2**	**5.0**

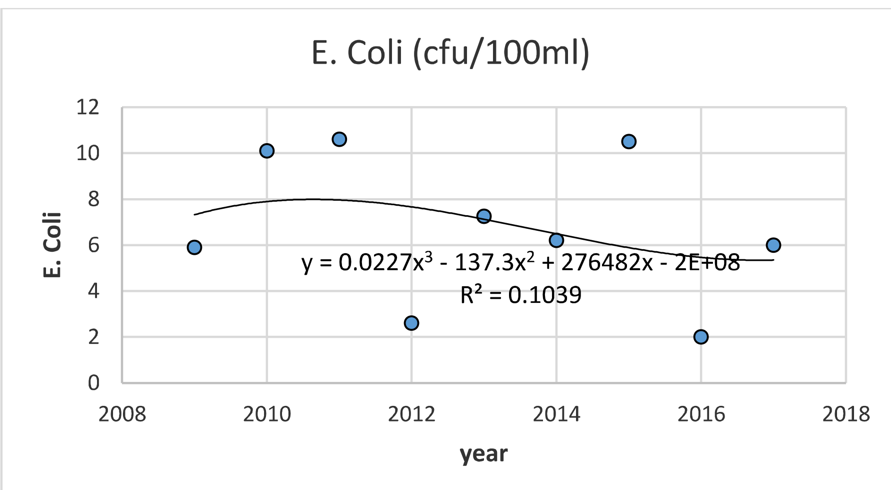
Table 2: Sampling data recorded by Rideau Valley Conservation Authority, LPP and WQ Director

Compared to the average values over the period of last 13 years, in 2017, compliance with the Water Quality standards improved with exception of the Total Phosphorus concentration, that exceed in 6% of the total number of samples the standard level, just like the average of the past 14 years.

Trends

The graphs in Figure 2 show the variability of the water quality parameters as monitored over a longer period of time. No spectacular changes were recorded in 2017. The Water Quality is still far above the standards, but the water clarity continues to decrease.





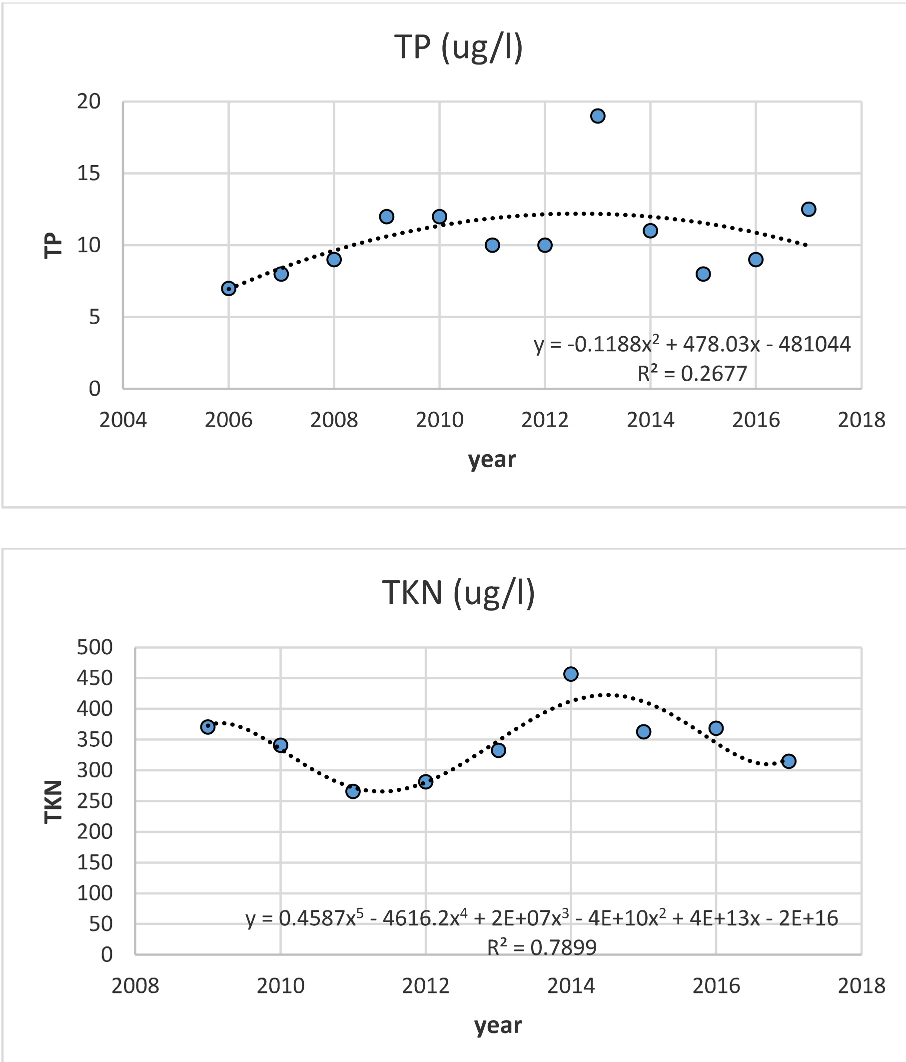


Figure 2. Secchi depth and water pollutant concentrations over the period 2006 – 2017.

<u>Milfoil</u>

It appears that the milfoil infestation remains the key environmental issue for Wolfe Lake. In 2017, we continued our efforts to identify the best monitoring and eradication methodologies.
Technical and scientific articles dealing with various lake vegetation elimination techniques were reviewed. A large number of relevant publications were collected and downloaded by Paul Thompson during the past years.
The experimental procedures were supported by underwater photography, using the Olympus TG5 camera with GPS. The camera acquisition was kindly funded by the FOCA.
Series of underwater images were taken in the bay close to the dam, and around the laminar flow aeration system placed in 2016 at a site at the south-western corner of the Lake. These pictures will be compared with observations at the same sites to be performed in 2018 and in the upcoming years, in order to monitor the progress of the underwater vegetation growth.

Examples of the milfoil infestation at both monitored sites, as recorded by the underwater camera, are shown in the figures below.

Figure 1. Abundant Milfoil growth at 1.5 m depth, at approximately 3 m distance from an aerator.

Figure 2. Pictures of two aerators in operation at approximately 1.8 m depths.

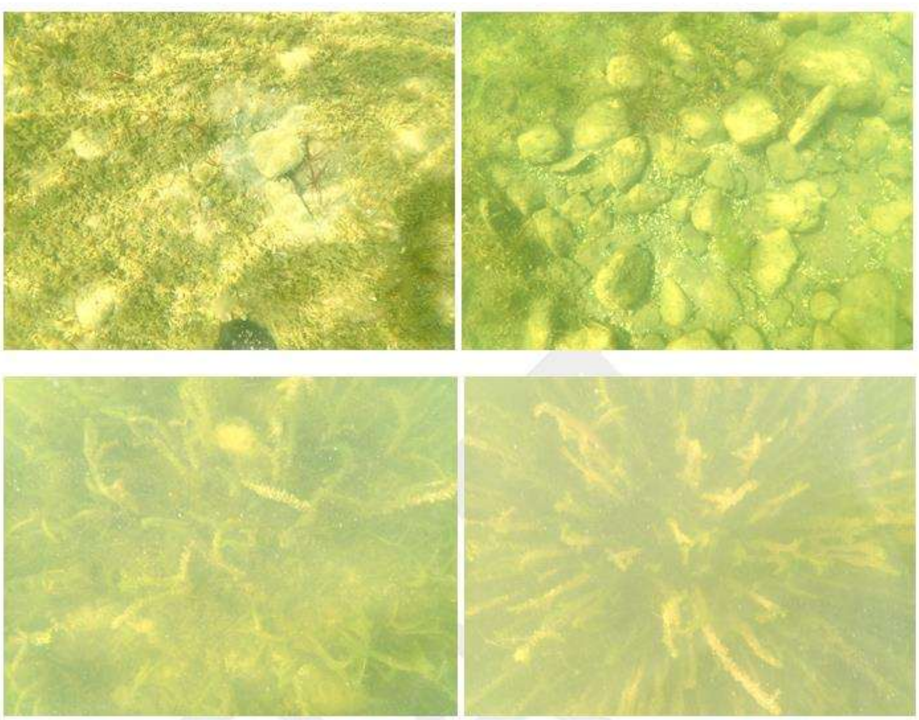


Figure 3. Images of the bottom vegetation in the eastern bay of the Lake with gradually increasing depth from about 0.5 m to 3 m. Milfoil presence was observed only after the depth exceeded approximately 1.5 m.

In cooperation with the Rideau Valley Conservation Authority and the Carleton University, a project proposal, dealing with 'New Methodologies for Protecting Native Bottom Vegetation in Ontario Lakes', was summitted for funding to the Ontario Ministry of the Environment and Climate Change.
The goal of the project is to evaluate and to quantify various methodologies leading to effective control of invasive lake bottom vegetation. Results of the project activities will lead to recommendations with respect to lake vegetation management and to remedial actions. In-situ measurements, high resolution spectral satellite observations and digital underwater photography will be employed. This includes historical data records as well as results of observations performed in 2018. Standard water sampling techniques and equipment will be applied. The in-situ measurements of the water clarity, nutrient concentrations and bottom vegetation density will be performed during a joint measuring campaign participated by volunteers from the Wolfe Lake Association and Carleton University. Data on water quality and bottom vegetation density will be statistically analyzed in order to specify factors affecting the Eurasian Milfoil proliferation. Effectivity of currently applied bottom vegetation reduction methods, bottom mats and Laminar Flow Aeration, will be evaluated at localized small areas. Findings, conclusions and recommendations resulting from the project execution will be summarized in the Final Report and presented to organizations representing lake communities.

Satellite Observations

Multispectral satellite imagery covering the full body of Wolfe Lake has been acquired and processed over the period April 2013 – November 2017. The analyses of the satellite data were supported by local observations.

The imagery was analyzed with respect to:

- Estimates of macrophyte biomass (mostly milfoils) across the entire lake as well as across its delimitated areas of interest.
- Monitoring the lake weed growing process in weed infested areas of the lake.
- Mapping algae and suspended particulates in the water body of the lake.
- Surface temperature mapping of the water as well as of the frozen surfaces.
- Snow and ice patterns across the frozen lake.
- Monitoring the thawing process of the frozen lake.

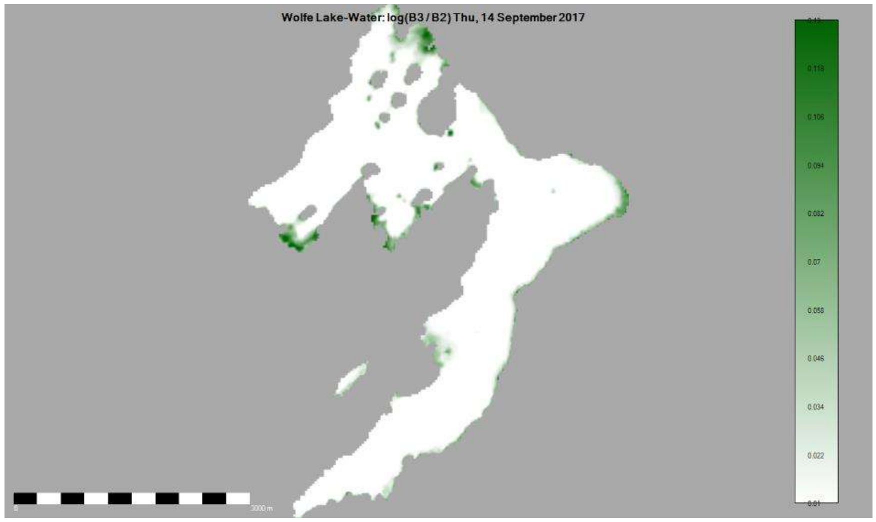


Figure 3. Lake vegetation spread (in dark green) along the shores of Wolfe Lake, as recorded by the satellite sensor on 14 September 2107.

Conclusions

Overall results were very comparable to the period on record. In general, the Water Quality in Wolfe Lake remains excellent, only in one case the Phosphorus concentration in a northern bay of the Lake significantly exceeded the standard. Since there are no buildings and no agricultural objects in the nearby shore area, this single elevated value could be assigned to a measurement error. The E. Coli concentrations were far below the required provincial maximum values.

Water clarity, as expressed by the annual average Secchi Disk depth, seems to have decreased in the past few years. This trend continued also in 2017. A probable cause for the decrease in water clarity over the past few years may be the rapid decline in zebra mussel numbers which has occurred over that time. Remarkably low zebra mussel infestation was observed in 2017.

The average concentrations of nutrients (TP and TKN) seem to fluctuate over the last years. Since the recorded values are far below the standards, there is no reason to worry.

Finally, regarding the current general scientific knowledge on aquatic lake environment, there is an excellent publication by Marten Scheffer: https://archive.org/details/springer_10.1007-978-1-4020-3154-0. Highly recommendable reading.

Acknowledgements

Water sampling in August – September 2017 was kindly assisted by Les Kom. The RVCA water quality data were provided by Sarah MacLeod. The LPP data were provided by Anna DeSellas, Ontario Ministry of the Environment and Climate Change https://www.ontario.ca/data/ontario-lake-partner. The Level 1 satellite imagery was downloaded from the US Geological Survey website.
Federation of Ontario Cottager's Association, FOCA has kindly provided funding for the acquisition of the Olympus TG5 underwater camera with GPS.