MARCH 1, 2021

STATE OF THE LAKE REPORT (2nd Edition)
OTTER LAKE
Township of Rideau Lakes

Otter Lake Landowners Association

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1.0 INTRODUCTION

The State of the Lake Report is a snapshot of the existing conditions that characterize the lake environment and provides a platform from which to launch the goals of the Sustainable Lake Plan. This document was updated in March 2021 to facilitate the updating of the Otter Lake Sustainable Lake Plan. The original Lake Plan was published July 25, 2015. The updated Lake Plan will continue to identify the significant social, natural and physical features that make the lake and its surrounding area a desirable place for people to live and visit. The updated plan will recommend a series of actions that will ensure the long-term sustainability and healthy existence of the lake for future generations. The actions will encompass the lake's health, beauty, wildlife habitat, recreational opportunities as well as opportunities for residential and commercial development.

This summary document was prepared to promote discussion with government agencies, commercial operators and residents about the possible actions to be included in the Sustainable Lake Plan. The following observations and recommendations are taken from various background documents including Rideau Valley Conservation Authority (RVCA) reports, scientific papers, and OLLA records.

The observations are based on the information that has been collected to date and the framework for the report is drawn from best practices of Lake Plan templates from the Rideau Valley Conservation Authority and the Federation of Ontario Cottagers' Associations.

2.0 CHARACTERISTICS OF OTTER LAKE and the CATCHMENT AREA

2.1 History

Otter Lake was carved from the retreat of the last ice age about 10,000 years ago. The location of the lake is positioned where a limestone plain intersects with the pre-Cambrian Shield causing a combination of features from both geological formations.

Native fish species populated Otter Lake at that time and largely evolved separately from other lakes until stocking began about 1920.

By 1830 some commercial and agricultural activity began in the area and some clearing began of the catchment basin draining into Otter Lake. It is suggested by Smol et al[1] that some degradation of water quality could have occurred as a result of large scale clearing of land in the catchment area during this period. Michalski and Usher[2] suggested in 1992 that Chlorophyll levels in the water column increased from half to three times in the last 200 years as a result of development on and near the lakes in the Rideau Basin. Chlorophyll is a measure of biological life in the water column as a result of nutrient enrichment.

There is some evidence that indigenous people spent time in and around Otter Lake using it for fishing and hunting. Settlers began fishing the lake in earnest in the early 1900's. Winter harvesting of Lake Trout occurred regularly and some sport fishing began as roads and trains opened up the area for visitors. By 1930 some shoreline development began and by 1940, there were several cottages and a few permanent residents and farms around the lake.

[1] Water Quality Impact from the Construction of the Rideau Canal. Smol et al
[2] Rideau Lakes Basin Carrying Capacity and proposed Shoreland Development Policies, Michalski and Usher for RVCA 1992

Cottage development continued through the 1960's and 1970's with the number increasing from about 200 in 1970 to about 290 in 1980[3],[4] Most of the new lots were created as farmland was abandoned and subdivided. Ministry of Natural Resources and Forests (MNRF), formerly Ministry of Natural Resources, surveys in 1975[5] expressed concern over development pressure and the effect on fish habitat.

Commercial operations contributed to the recreational appeal of the lake. Some have been in business since 1940 and expansion has continued to the present. Commercial operations include trailer sites and rental cabins. Camp Otterdale was established in 1954 and became a world-class destination for summer camps initially for girls and later as a co-ed camp.

Wickware[6] documented the location of development as it existed in 1959, 1965, and 1970. Higher ground and proximity to roads appeared to be the driving factors for early development. As the private road network expanded, access to other building lots became possible.

[3] Survey Data for Otter Lake MNRF 1970
[4] Report on Field Investigations of Dissolved Oxygen and Temperature Conditions for Otter Lake, MNRF 1975
[5] Survey Data for Otter Lake MNRF 1975
[6] Land Use Development Otter Lake. Master's Thesis Carleton University Wickware, 1971

2.2 Watershed Characteristics as documented by RVCA and MNRF

- Lake Surface Area 572 ha
- Catchment basin draining into the lake: 36.38 km ^{2}
- Shoreline: 20.1 km
- Lake Volume: 60.5 x 10 ^{6} cubic meters
- Estimated Inflow: 15.2 x 10 ^{6} cubic meters
- Exchange Rate or Flushing Rate: 0.25 times per year (This means that ¼ of the total lake volume is lost and gained each year.)
- Max Depth: 36m
- Drainage through Otter Creek for about 30 km to the Rideau River
- Several inlet creeks exist around the lake
- No upstream lakes over 25 ha

RVCA hydrology reports characterize the lake as a high volume lake with a relatively low flushing rate, meaning that inflow and outflow measured annually is approximately a quarter of the total volume of the lake. The surface of the lake represents a relatively large percentage of the total catchment area which results in a quick response to precipitation compared to lakes with a large catchment area relative to the size of the lake. This factor will be particularly important in considerations in terms of flooding, building or road precaution.

Soils surrounding the lake are relatively shallow on the igneous granite and sedimentary limestone underlays. Depths of soil range from less than 1 meter to about 3 meters. Pockets of well drained loam support mixed hardwood and coniferous forest.

Wetlands are abundant on and near Otter Lake and include provincially and locally significant areas. In ***Figure 1*** (next page), the wetlands are apparent as outlined in different colours which represent relative environmental significance.

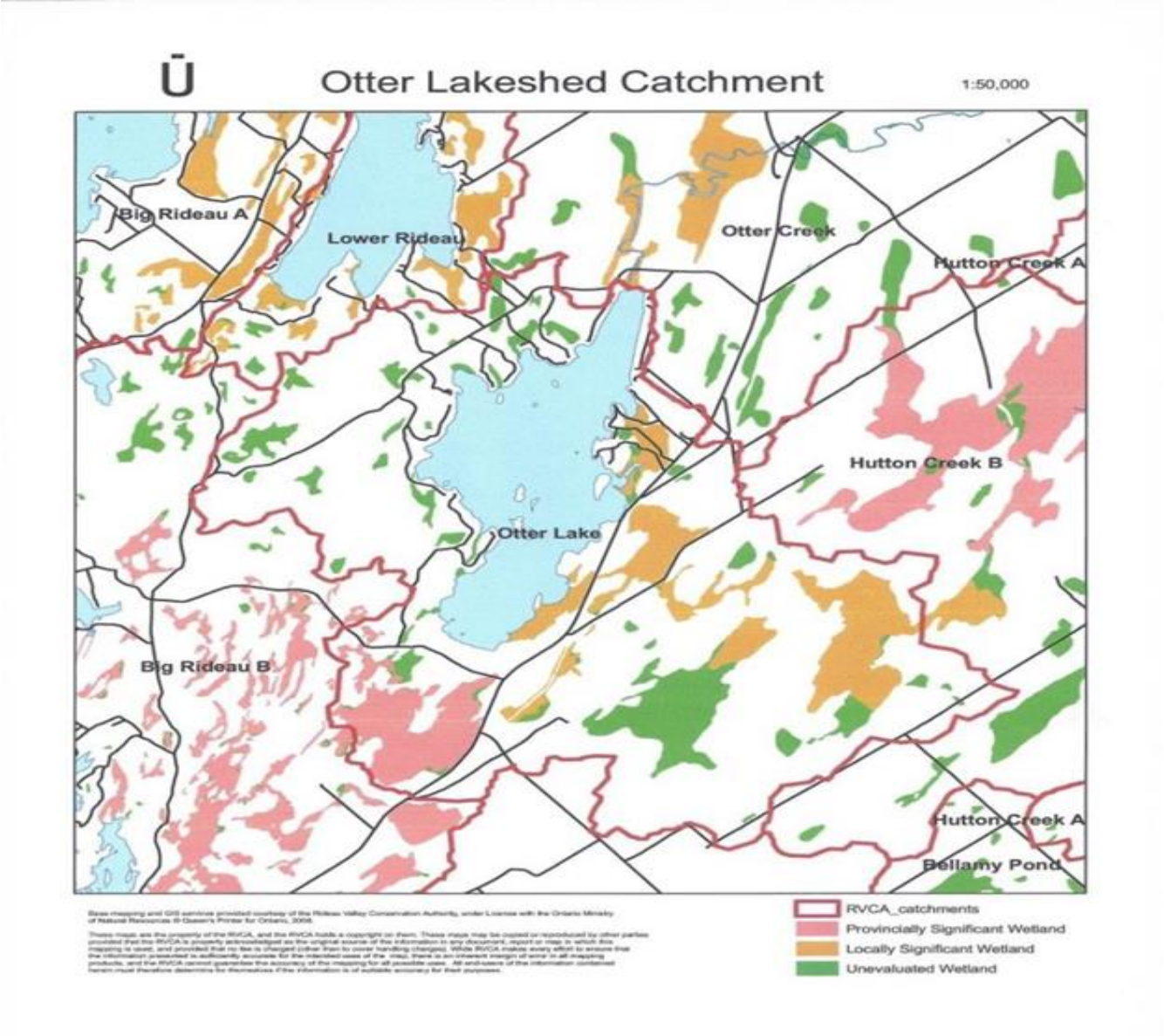

Figure 1: Rideau Lakes Watershed Plan. RVCA. 2009

Farming and logging operations established in the area in the early 1800's were significant contributors to the local economies until the 1900's. Gradually farmland was abandoned with some being sold for waterfront lots and the remaining being returned to a natural state. Some local farming continues and periodic forestry operations occur in the RU (rural) areas nearby.

Statistics Canada reports that the population of the Township **declined** 1.4% between 2006 and 2011. The 2016 Statistics Canada survey indicates that the population increased by 1%. The Township of Rideau Lakes has issued approximately 50 residential building permits per year on average over the last 4 years as the trend to more permanent residential status continues.

3.0 WATER

The RVCA 2009 document entitled: Rideau Lakes Watershed Plan – Priorities and Recommendations describes the preservation of water quality as its number one goal.[7] Surveys of Otter Lake residents have determined that water quality is by far the most import issue.[8]

Most of the lakes in the Rideau Watershed are described by RVCA as either "Eutrophic" or "Mesotrophic". These classifications are based on the degree of nutrient loading and plant and algae growth within the lake.

Otter Lake is relatively deep compared to its area and Phosphorus levels appear to be less than neighbouring lakes such as Bass Lake and Upper Rideau Lake. Where the latter lakes are categorized as "Mesotrophic", which means they have more nutrients and plant life, Otter Lake trends toward "Oligotrophic" which is characteristic of deep, clear lakes. This may mean that nutrient contamination here will have a more profound affect compared to the same amount deposited in another lake. Some municipalities classify lakes according to their sensitivity to Phosphorus or other characteristics however no such system is in place in Rideau Lakes Township or under the RVCA jurisdiction. There is however a comprehensive system of site assessment administered by the RVCA which is discussed under the Development section.

[7] Rideau Lakes Watershed Plan. RVCA 2009
[8] Resident Surveys by OLLA 2006 and 2015

3.1 Water Quality

Surveys conducted by OLLA in 2006 and 2015[9] indicate water quality is a top priority with responding residents. A 1994 Shoreline and Resident survey performed by the Township of South Elmsley indicated that 90% of the residents use water recreationally, 70% use it as a source of wash water and 20% use it as a source of drinking water.

Water sampling and a range of testing has been performed for about 15 years by OLLA and intermittently for many years prior. In addition, samples have been drawn by RVCA technicians and the combined information from OLLA and the RVCA provides a detailed data set for nutrients, bacteria, and dissolved oxygen. There are periodic water chemistry test reports conducted by MNRF and the Ministry of the Environment, Conservation and Parks (MECP), formerly the Ministry of the Environment, that are decades old and provide some historical reference points.

Much of the work was performed to support fish stocking activities that took place between 1920 and 2002. These historical tests suggest that Otter Lake supported a healthy native Lake Trout population and was classified as a "Trout Lake" under provincial policy. Overfishing on the Rideau Lakes led to efforts to stock Otter Lake as an alternative fishing location. Over time, water quality changed and/or environmental conditions changed and both the native Lake Trout and introduced salmonid species declined or failed to survive.[10]

Sampling points are identified on the map in ***Figure 2*** (next page).

[10] Fish Survey of Otter Lake MNRF 1953, 1958, 1970, 1983, 2000

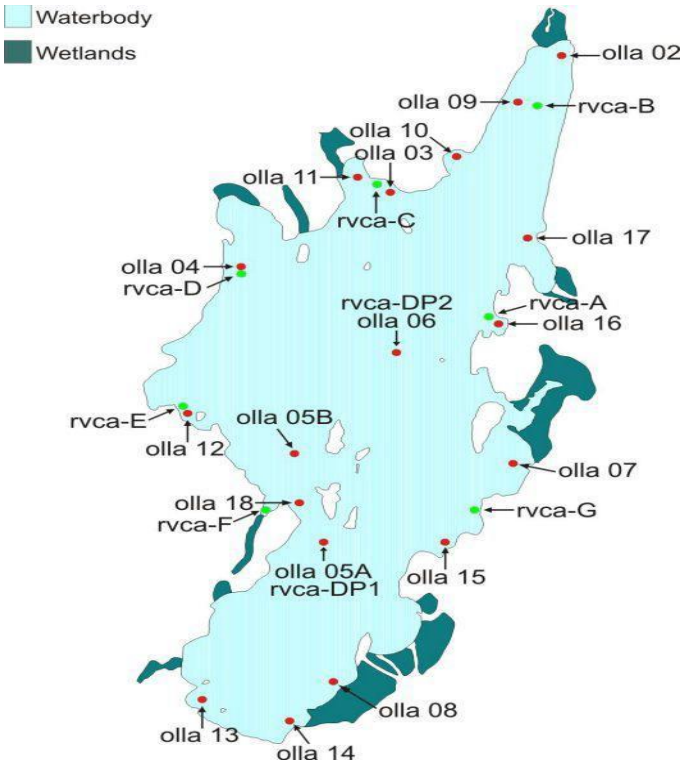

Figure 2: 2020 Sampling Sites

Oxygen and Temperature:

Temperature readings taken at various depths during the summer indicate that there is a normal thermocline however oxygen levels in the deep levels (hypolimnion) are often less than the 7 ug/L (micrograms/litre), 7 units being the standard required in late summer for trout species to thrive and that specified by provincial policy to qualify as a "Trout Lake". Although historical oxygen reports are not available, field notes and observations made by field technicians for MNRF in the 1950's through to the 1970's suggest that there was a gradual decline in cold-water fish in response to declining cold water characteristics and/or loss of habitat and spawning grounds. In 2004, the last MNRF oxygen test completed, indicated that the deep water oxygen levels were sub-standard for lake trout and this was largely responsible for a curtailment of fish stocking operations.

Since then, RVCA oxygen tests between 2014 and 2020 indicate a gradual improvement, especially for the late summer readings, and this may be a consideration for a re-start of fish stocking and an improvement in Lake Trout habitat at depth.

Climate change data however suggests that average lake temperatures have increased in Ontario which could lead to a decrease in the total habitat for cold-water fish species.

Nutrients:

Nutrients, especially Phosphorus, are indicators of lake health. Sampling has been done over many years and recorded over a background of changes such as development pressures, septic technologies, changes to consumer products, invasive species and climate change.

Dr. John Smol of Queen's University suggests that water nutrient levels in Otter Lake prior to 1900 were probably higher than they are now. Total Phosphorus may have been as high as 30 ug/L compared to an average of about 12.8 in 2013 and 10.5 in 2018. This probably would have resulted in a more turbid water profile with much more algae than what we see today. It is suggested that as fields were cleared for agriculture and lumber, massive amounts of nutrients were released into the water from decomposing root and vegetative matter in a relatively short period of time. Today it is possible that open fields being reclaimed by nature are acting as a nutrient sink thereby keeping them from entering the lake. Buffer strips of tall grass, shrubs and trees in the 30 meter zone around the lake are considered to be critical in keeping nutrients out of surface water. Shoreline buffers around Otter Lake are discussed further in Section 4.2.

Phosphorus is the "limiting factor" in algae and aquatic plant growth in a sensitive lake meaning that there is a direct response in growth when additional Phosphorus is available. Other nutrients and trace elements are important as well however Phosphorus is the chief indicator for water quality. Phosphorus contributions arise in large part from human activities so long term monitoring is desirable. The table below illustrates the most recent data as collected by OLLA and the RVCA.

Water Qualiy Data - OLLA + RVCA																		
RVCA ID	OLLA ID	Total Coliform (cfu/100 ml)			E. Coli (cfu/100 ml)			Total Kjeldahl nitrogen (µg/l)				Total Phosphorous (µg/l)				Sechi Disk (meters)		
		Jun	Jul	Aug	May	Jul	Aug	May	Jul	Aug	Oct	May	Jul	Aug	Oct	May	Aug	Oct
	OLLA 02																	
RVL-26C	OLLA 03		2	2					440	690			12	21				
RVL-26D	OLLA 04		90	10		2	0		360									
RVL-26DP1	OLLA 05A							300	380	710	570	3	9	15	9		5.45	7.0
	OLLA 05B																	
RVL-26DP3	OLLA 06							340	290	660	500	3	5	12	7		5.50	7.0
	OLLA 07		30			0			350				8					
	OLLA 08																	
RVL-26B	OLLA 09		2	2					390	1290			8	23				
	OLLA10								320	300			7	8				
	OLLA 11																	
RVL-26E	OLLA 12									890				19				
	OLLA 13																	
	OLLA 14																	
	OLLA 15									280				5				
RVL-26A	OLLA 16									540				12				
	OLLA 17								540				8					
RVL-26F	OLLA 18					2	2		380	690			9	10				
Average		31.00			1.20			509.55				10.14				6.24		
Std. Error		29.34			0.41			50.69				1.11				0.33		
	RVCA																	
	OLLA																	

Figure 3 - Typical results of Water Quality Testing (2018)

Water Clarity:

Water clarity is a measure of the population of plankton in the water column and this is usually accepted as an indicator of eutrophication resulting from nutrient loads.[11] This measurement has been confused by the introduction of Zebra Mussels, an invasive species, about 20 years ago which are aggressive feeders of plankton. The Secchi Disk readings, as tabulated above, indicates an improvement in water clarity since early readings taken from 1950 to 1995. The average for the Rideau watershed is 5 m. The average for Otter Lake at 7.18 m in 2013 is 43% better than the watershed average. There has been an approximate 40% increase in water clarity in Otter Lake over recent years but this does not necessarily indicate an improvement in water quality since Phosphorus levels have remained fairly consistent. In the absence of Zebra Mussels, nutrients are utilized by plankton and would grow in response to increased Phosphorus in the water. These small species of algae would increase quickly in the water column and this would lead to a decrease in water clarity. Although this relationship still exists, the introduction of Zebra Mussels has increased clarity so measurements of chlorophyll and water clarity are not reliable indicators of Phosphorus loading as they once were.

While water clarity is usually considered desirable, this change has created a different lake environment. As the sun penetrates to greater depths, the available habitat for algae and aquatic plants increases and the nutrients formerly utilized by plankton become available to others. Anecdotal evidence from surveys in 2006 and 2018 indicates that there has been an increase in aquatic plants and larger species of algae since water clarity has increased. Other factors such as a warming climate and changing oxygen levels may be influencing the increase in certain aqueous plants and filamentous algae or "slime". There is a possible link between water clarity, nutrient loading, and oxygen however scientists haven't yet documented which of these factors has the greatest influence. A survey in 1994 reported that 80% of lake residents felt

[11] Middle Rideau sub watershed report RCA 2009

that algae and plant growth had increased in previous years. Records for adjacent lakes at that time show a gradual increase in Phosphorus so it is possible that Otter Lake was subject to that trend as well. The 1994 survey was prior to the introduction of Zebra Mussels so concerns about algae have been with us for some time.

Since 2015 anecdotal evidence indicates that the Zebra Mussel population is no longer increasing and may have declined slightly. There are reports of fish and waterfowl species adapting to them as a food source which may be happening in Otter Lake and consequently the population is remaining stable or possibly in decline.

Coliform Bacteria:

Routine sampling indicates bacteria levels fall within recommended provincial guidelines for recreational use. Coliform bacteria originates in the gut of mammals, and although high levels can be caused by non-human sources, it is generally accepted that high levels are a result of human activity and could be due to inadequate septic treatment before waste water reaches the lake. Over 15 years there have been a few high readings but none on a regular basis.

Heavy Metals:

Water samples were tested by OLLA for lead and mercury in 2007 and found to be at very low levels.

3.2 Septic Systems and Impact on Water Quality

Phosphorus and other nutrients arise from several sources, one of them being the nutrient loading from septic systems. At this time scientists assume some of the Phosphorus produced in septic systems with leaching beds eventually makes its way to the water body.[12] How much reaches the lake is dependent on soil types, drainage, and vegetation buffering the leaching bed. For seasonal residents studies have shown that on average .66 kg of Phosphorus is produced per person per year. For permanent residents it is approximately 2.39 kg. Evidence suggests that buffer strips of vegetation between the septic leaching bed and the lake prevents or delays the introduction of nutrients and bacteria to the lake. Peterjohn and Correll 1984[13] suggested that a 30m buffer strip will capture a very high percentage of the nutrients. Dillaha et al 1988[14] declared that "Buffers from 9-30m provide more effective attenuation of nutrients and 30m buffers provide effective water quality protective functions".

In a 1992 report by Michalski and Usher, development was attributed to 59.1% of the Phosphorus on Bass Lake but only 41% on Otty Lake. It was noted that at that time Bass Lake had on average, more residents per km of shoreline and less shoreline vegetation. Otter Lake was not part of the study. Zhang et al 2010[15] reported that buffers filter sediment and other pollutants and absorb nutrients from run-off water making them critical components of sound development conditions as more residential construction occurs.

The nutrient levels recorded in ***Figure 3*** (p. 10) indicate levels well within the range of the Ontario Water Quality Standards. Nothing is known about the pre-development levels (notwithstanding the Smol estimate) but Michalski and Penner suggested that the nutrient load has doubled or tripled in the last 200 years in the Rideau Lakes Basin. It is unknown what the background levels were prior to development activity around the lake.

[12] Lake Capacity Handbook MECP 2010
[13] Nutrient Dynmics in Agricultural Watershed Ecology. Peeterjohn and Currell Ecology 1984
[14] Evaluation of Vegetative Filter Strips. Dillaha et al. Water Environment Federation. July 1988
[15] A review of Vegetative Buffers in Reducing Non-Point Source Pollution. Zhang et al. Journal of Environmental Quality (39) 2010.

3.3 Otter Creek Water Quality

Otter Creek water quality is of importance as 1) Otter Lake residents (as well as others) are recreational users of the creek; and 2) any impact on fish spawning in the creek determines the success of fish in Otter Lake.

Field studies on Otter Creek by RVCA [16] rate the condition as "fair" based on high nutrient and bacteria levels. Based on samples of benthic organisms (bugs in the mud) it is rated as "poor". Over a period of 6 years 76% of E.coli counts and 67% of Phosphorus levels exceeded provincial guidelines. It is unclear what has contributed to the less-than-ideal rating for Otter Creek. RVCA recommends further study and actions to improve the quality characteristics.

Creek netting studies by RVCA indicate that Otter Creek is a primary spawning area for certain species of fish and contains a diverse population of wetland flora and fauna species. Preserving spawning habitat and water quality is important to the fish populations in the lake. [17] [18]

Otter Creek has two main tributaries which arise from: 1) A field north of County Road #1, and 2) The area south-east of Tower Road. Since these drainage areas are active agricultural zones, some of Otter Creek would be subject to periodic agricultural runoff and associated pollutants.

[16] Otter Creek catchment Data sheet RCA 2009
[17] Otter Creek Hoopnet survey RVCA 2009
[18] Otter Creek Wetland Species List RVCA 1991

3.4 Water Levels

Water levels have fluctuated within a range of 0.8m or 2 feet 7 inches since water level records have been routinely recorded by OLLA beginning in 2003. These records are provided to RVCA for use in conjunction with their own readings. Most of the fluctuation happens during the spring freshet however hot dry summers have occasionally produced low late summer levels.

There are about 9 in-flow creeks that bring surface water from neighbouring land areas into Otter Lake. The largest, Barker's Creek, on the east side near the public boat launch brings a large amount of water throughout the year, from a small lake upstream and the largest land area which includes agricultural land. Many of the other inlet creeks are intermittent.

Otter Creek is the only outflow creek, which winds its way to the Rideau River through about 30 km of wetland, forest and agricultural land. Two tributaries meet Otter Creek within the first two kilometers which drain lands towards County Rd #1 west of Lombardy. Depending on conditions, these tributaries have contributed temporarily to the occasional 'reverse flow' of the creek back into Otter Lake.

Water levels are influenced by several factors, including precipitation (including type of precipitation), ambient temperatures, wind, culvert head-loss, downstream creek features and potentially the impact of beaver dams in key locations affecting inflow and outflow creeks. Parks Canada plays a significant role in water level management on Rideau Canal lakes but has no jurisdiction on Otter Lake.

Recent investigations into climate change effects have demonstrated that precipitation has increased in Eastern Ontario by about 15% in the last 100 years. Most of this increase is during the late winter and early spring which elevates the risk of flooding during the spring freshet. Data also suggests that the summer period is becoming hotter and dryer which can increase the evaporation rate leading to an increased risk of lower water levels in the mid-summer to fall periods.

The RVCA chief hydrologist determined that the 1:100 year flood level for Otter Lake is 125.5 Meters Above Sea Level (MASL) which in familiar terms is about 9 cm below the top of the culvert situated under Otter Lake Road. The top of the culvert is 30 cm higher than the highest water levels experienced in the last 15 years on Otter Lake. In recent times we have experienced water levels that are 21 cm less than a 1:100 year flood and are roughly equivalent to a 1:50 year flood.

The significance of the 1:100 year level of 125.5 MASL is that this in turn defines the extent of the flood plain on land adjacent to the lake and is used by the municipality to restrict development of flood plain areas or on properties served by the roads that are on the flood plain.

The 1:100 year flood level is addressed in Section 28 of the RVCA policy document on development standards. This section suggests what is considered a "Safe Road Access" for the purpose of residents, first responders, and municipal vehicles travelling on private and public roads. Although there may be other factors that contribute to a safe and serviceable road, generally a road or driveway can have no more than 30 cm of water over any part of it in order to ensure safe passage. Currently there are 4 known private roads that would have, in some sections, greater than 30 cm of water during a 1:100 year flood. Emergency responders usually use best efforts to traverse flooded roads and driveways regardless of the level of flooding.

Although the natural fluctuation of water levels on Otter Lake is much less than some neighbouring lakes, it has been a 'hot topic' historically and represents the confluence of opinions based on environmental issues, recreational use, beaver management, and riparian law. For specific detail on specific water level concerns, investigations, community and legal opinion, refer to *Appendix A: History of Concerns, Activities & Reports Regarding Water Levels at Otter Lake*.

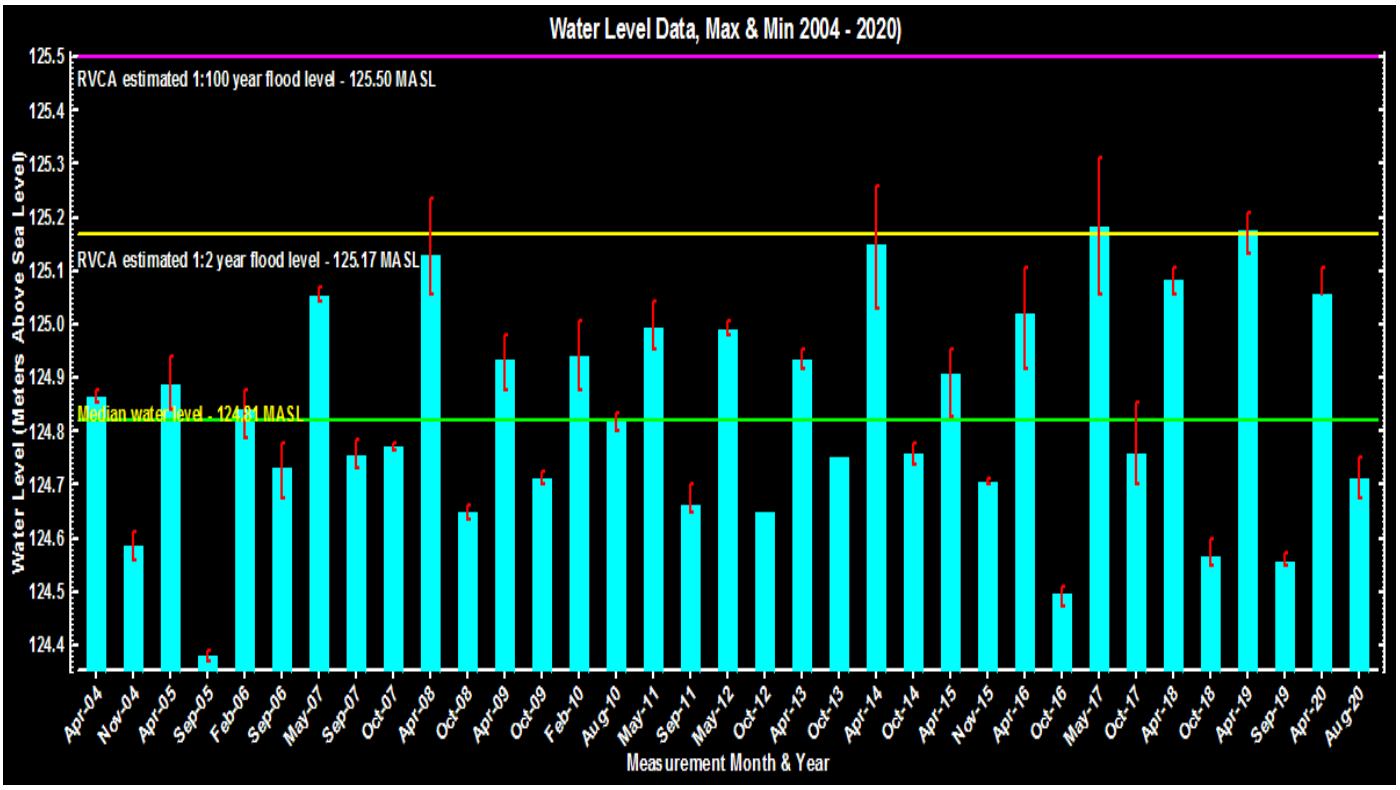

Figure 4: OLLA water level data, 2004 to 2020

Note: Pursuant to para.9.3.4 of the OLLA Constitution, the Lake Steward's duties include monitoring water levels. The sites where these readings are taken (Toohey's Bay and the Otter Lake Road culvert) have been calibrated by the RVCA. Over recent years, data fluctuated significantly, in part due to various interventions (residents, Township and friendly neighbourhood beavers). Given many conflicting views on managing and reporting water levels, OLLA took the decision in 2019 to remain impartial, leaving it to RVCA to officially report, assess and provide commentary. Per constitutional commitment, OLLA continues to observe changes in water levels and provide them to RVCA. All official reporting thereafter is issued by the RVCA. A link to the appropriate page will be provided on the OLLA website. All data collected by OLLA is available and should be viewed as unofficial and not supported for purposes of flood study or land use planning. OLLA will refrain from providing any commentary regarding water levels.

4.0 NATURAL ENVIRONMENT

4.1 Aquatic Plants and Algae

Aquatic indigenous vegetation is an important aspect of a healthy lake ecosystem and therefore must be understood and respected. Aquatic plants are categorized as either submersed or floating, but some can be both. Residents on Otter Lake have reported an increase in aquatic plants which is likely, in part, due to the introduction of Zebra Mussels but may also be influenced by climate and changing water chemistry. An overgrowth of indigenous aquatic plants can have a negative effect both on the health of a lake and from a recreational perspective. Aquatic plants and algae contribute to fish habitat therefore indiscriminate destruction is unlawful. Removal of any aquatic plants is allowed under certain conditions and guidelines and with the appropriate permissions received from MNRF.

Field surveys of flora and fauna of the natural environment, conducted by RVCA, MECP, and MNRF since 1930 have revealed a lengthy list of species. Reports from MNRF list a diversity of aquatic plants and algae in Otter Lake.[19] [20]

4.1.1 Aquatic Plant Survey

In 2005, the OLLA Lake Steward surveyed Otter Lake to determine how many species of aquatic plants existed. The following were found:

Water Milfoil, *Myriophyllum sp.*
Coontail, *Ceratophyllum sp.*
Canada Waterweed, *Elodea sp.*
Pondweed, *Potomogeton sp.*
Water Lily, *Nymphaea sp.*

[19] Otter Lake Species List MNRF 1984
[20] Otter Lake Wetland Species List MNRF 1984

Duckweed, *Spirodela sp.*
Pickerelweed, *Pontedaria sp.*
Bladderwort, *Utricularia sp.*
Cabomba sp. (no common name)

Three of these species were found in a 1930 MNRF survey: Milfoil, Canada Waterweed, and Pondweed.

4.1.2 Invasive Aquatic Plants

Plants considered to be "invasive" are introduced from other geographical areas or other parts of the world and threaten the natural environment of existing aquatic vegetation. Invasive species do not typically have natural predators, are easily adaptable and thrive in disturbed systems thus reproduce quickly and out-compete common vegetation. Indigenous species can also be considered a problem if moved from one lake to another. The most common pathway for spreading aquatic invasive plants is recreational boating but they can also be introduced by ATVs, bikes, wind, water currents, gardening and aquariums. Many invasive plants are readily available for purchase at gardening centres and pet stores. Education is paramount to prevent the introduction and spread of invasive species. Early detection and rapid response is the only way to manage, and possibly eradicate, an invasive plant. OLLA and RVCA participate in the Aquatic Invasive Species (AIS) Program which is offered through an MNRF and Ontario Federation of Anglers and Hunters (OFAH) partnership and facilitates early detection, mapping and trending.

The following list of aquatic invasive plants is on the Watch List:

- European Frog-bit
- European Water Chestnut
- Fanwort
- Flowering Rush
- Hydrillia

- Parrotfeather
- Yellow Floating Heart
- Yellow Iris
- Water Soldier

Note: European Milfoil and Purple Loosestrife are considered to be too firmly entrenched to be on the Watch List.

In 2016, at the request of OLLA, RVCA conducted a survey of both indigenous and invasive aquatic plants. That survey found the presence of European Frogbit and a small amount was removed. In 2017, 2018 and 2019, OLLA conducted a Frog-bit removal operation in conjunction with RVCA. OLLA members co-funded this program in 2018 and 2019 and it was also partly funded through a grant from the Federation of Ontario Cottagers Association. The majority of this invasive plant has been eradicated but conditions will be monitored and maintained in the future.

See *Figures A & B* on the following two pages for maps of the 2016 RVCA survey results.

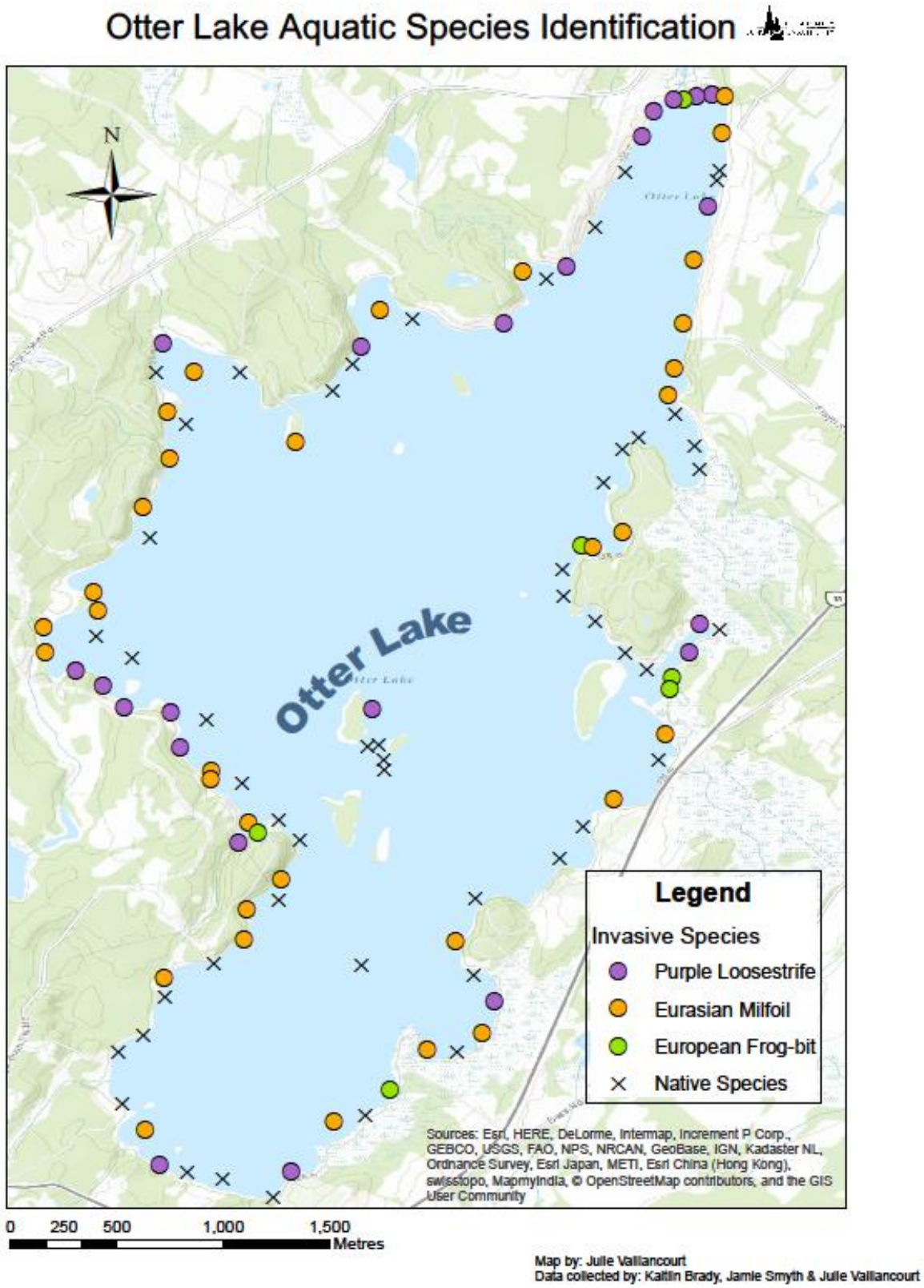

Figure A: Year 2016

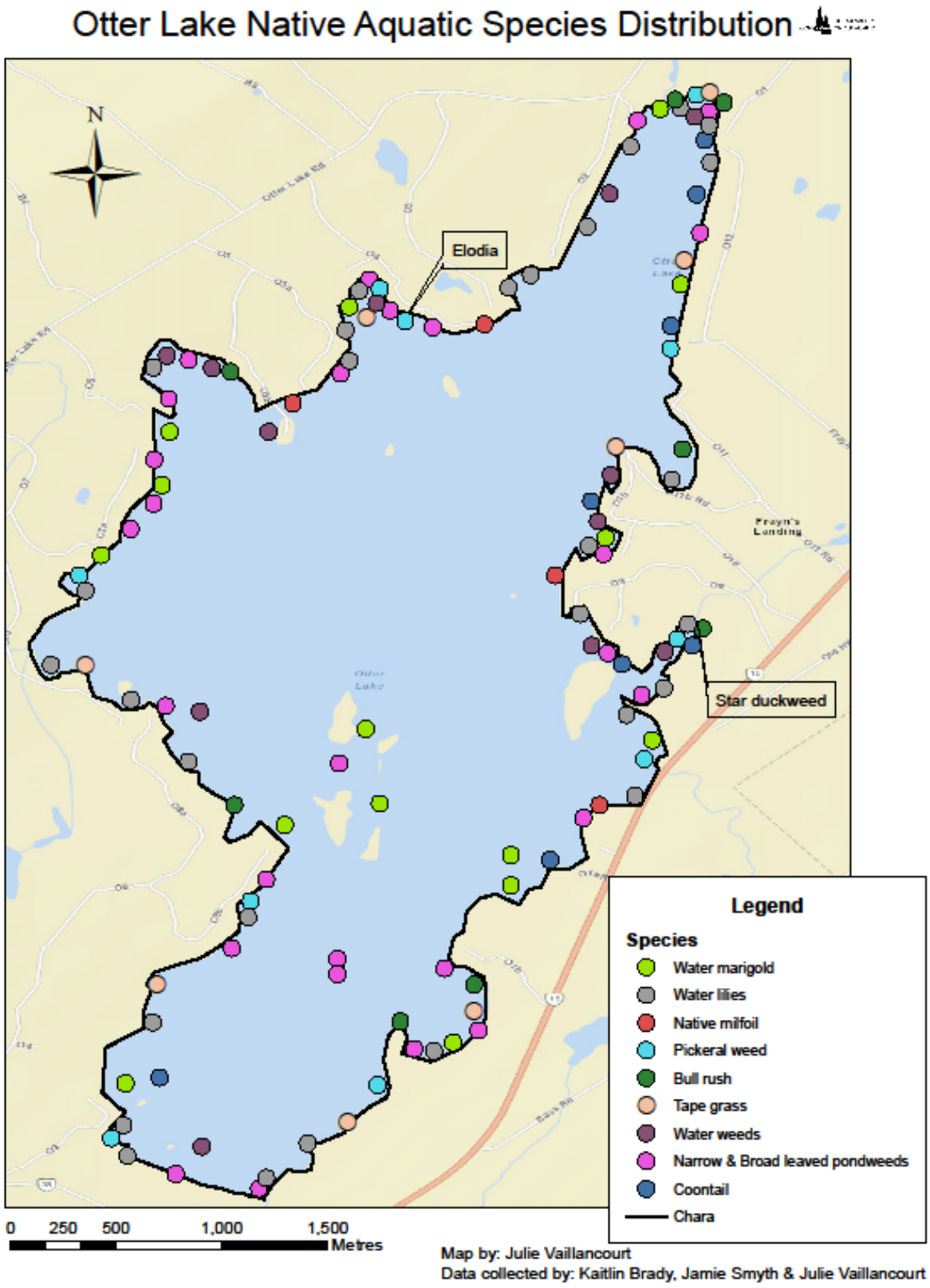

Figure B: Year 2016

4.1.3 Algae Blooms

Algae blooms can be attributed to a favourable set of conditions such as ideal water temperature, excessive nutrient levels, and adequate sunlight penetration of the water column. In some cases, lack of wind is favourable especially for certain species of blue-green algae. Usually there are many species of algae found in Otter Lake at any given time but their appearance isn't noticed until growth is more visible or excessive.

Of particular concern are blue-green algae blooms. Some species are harmless, such as *Anabaena sp.* which is noticeable in Otter Lake as a black scum on dock and boat lift legs at the water surface. Some species can produce toxins that cannot be removed by filtration or boiling. There are no reports of blue-green algae on Otter Lake in recent years. There was a blue-green bloom on the Upper Rideau Lake in 2014 and on Lower Rideau Lake in 2019. With increasing water temperatures due to climate change, the conditions for blue-green algae are increasing.

4.1.4 Algae Survey

In 2005 the OLLA Lake Steward found the following larger species of algae in Otter Lake:

- Stonewort, *Chara sp.* Found in higher calcium lakes, in shallow water.
- Muskgrass, *Nitella sp.*
- *Spyrogyra sp.* This is the filamentous algae that can form slime, sometimes called "Elephant Snot".

There are numerous species of microscopic species of algae, including the class called Diatoms that inhabit the lake. Most are beneficial and can be good indicators of lake health. Diatomaceous algae are very sensitive to their environment and live in very narrow environmental conditions. When they die, Diatom's crystalline shells are

deposited in lake sediments where they can be identified according to deposition rates. Smol's[1] study of the environmental effects of the construction of the Rideau Canal used Otter Lake as a control. One of the interesting parallels is demonstrated in the relationship between Phosphorus levels and the Diatom Aurlcoseira sp. This species population is closely tied to Phosphorus levels and therefore Smol estimated Phosphorus levels in Otter Lake from the levels of Aurlcoseira in the sediments.

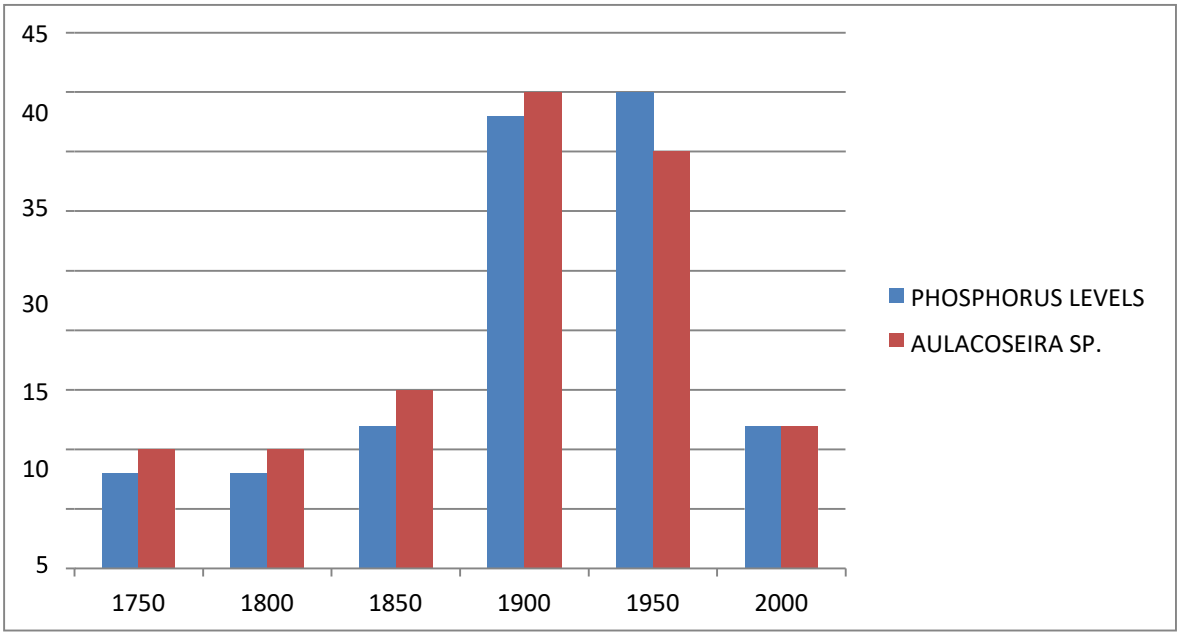

Figure 6: 2002, Smol's study

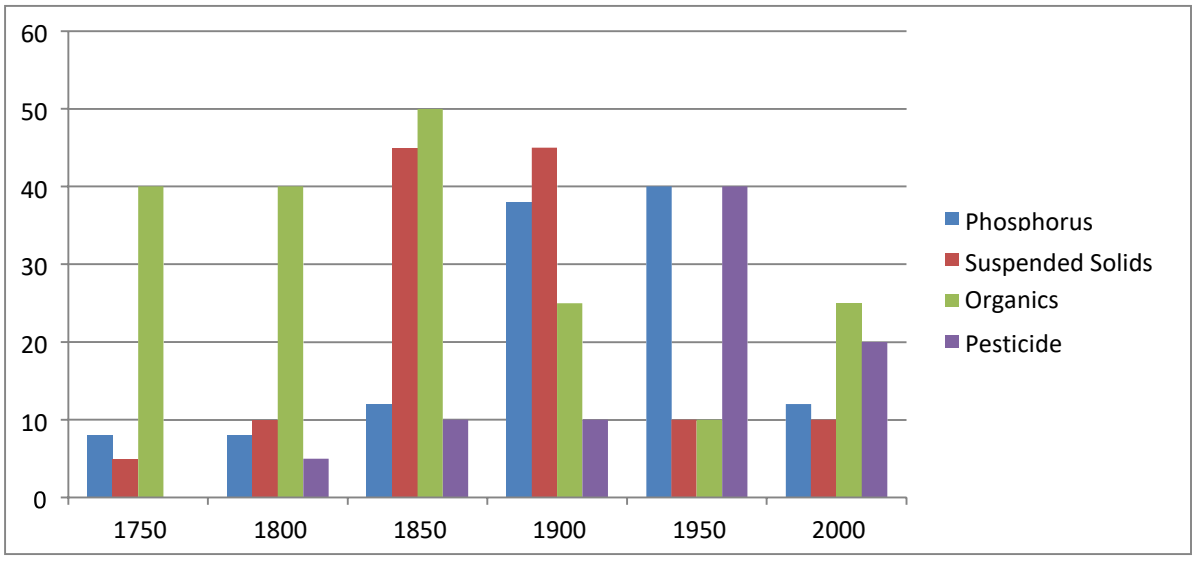

Figure 7: 2002, Smol's study

The results suggest that water levels were higher in 1750 but conditions were stable as no outside forces such as deforestation, beaver trapping and development had influenced the lake environment. As development occurred, organic levels and phosphorus rose.

4.2 Shoreline Conditions

Various field surveys by MNRF from 1930 to 1999 have recorded some details about shoreline conditions. A 1986 survey which included scuba inspections, revealed conditions of sub-surface materials (i.e. gravel, silt, muck) in an effort to determine fish spawning habitat. [21] [22]

In 1994 a summer survey of 100 properties on Otter Lake was completed by the Township of South Elmsley. It was determined that approximately 42% of the shoreline was "natural" and approximately 45% was "manicured lawn". It was further estimated that the lake had 34% of all lots in an "untouched" state.

In 2017, at the request of OLLA, Watersheds Canada conducted a shoreline survey on each lake property and found that 90 lots required urgent attention because of eroded banks or excessive shoreline development. In general, Otter Lake properties had a deficiency of natural shoreline and too much manicured or hard-surface shoreline. From a development perspective, the lake falls well below the recommended naturalized shoreline of 75%.

There is a relationship between water quality and shoreline conditions. Knutson and Naaf (1997)[23] reported that 90% of surface drainage sediment is removed in a 30 m buffer strip over a 2% grade. Most environmental scientists suggest that 75% of the

[21] Technical Memorandum RVCA2011
[22] Otter Lake Survey Station Map MNRF 1986
[23] Knutson and Naaf Report on sedimentation 1997

shoreline around a lake should be left in a natural state. Best Management Practices (BMP) for shoreline preservation include maximizing buffer strips to 30 m from the high-water mark, increasing building and septic setbacks, and encouraging tertiary septic treatment systems. Based on the 1994 and 2017 surveys mentioned above, Otter Lake is deficient in natural shorelines.

Currently the Township of Rideau Lakes does not enforce qualitative conditions on building and development permits which would encourage more property owners to establish and protect the vegetative buffers that are critical to continued water quality protection. Conversely, larger cottage and recreational communities, surrounding municipalities and those in the Muskoka area, have stronger site plan controls.

In 2019 the Rideau Lakes Lake Association Committee proposed and encouraged the Township to adopt a stronger enforcement of waterfront site planning conditions. In response to this, the Township has committed to register site plans on title for all developments over 30 square meters and better enforce conditions for the protection or establishment of vegetative buffers. It is anticipated that this will be entrenched in an amended site plan bylaw in the near future.

As water quality is closely tied to diverse and natural shorelines, further studies would be beneficial.

4.3 Fish

Numerous hoop, angling and net surveys have been performed by MNRF and RVCA to determine the natural and stocked populations in Otter Lake. [24] Most of this has been to assess the success of fish stocking which has been done since 1930 and include many salmonid species and Smallmouth Bass.

The species recorded in fish surveys over the years include:

SPECIES	1930	1959	1970	1975	1990	1994	1997	2000	2003
S.M Bass	x	x	x	x				x	x
L.M Bass			x	x				x	
Ling Cod	x	x							
Northern Pike		x	x	x			x	x	x
Bullhead		x	x			x		x	
Golden Shiner	x		x			x			
Lake Trout			x	x					
Sunfish		x	x			x	x	x	
Splake					x	x			x
Whitefish	x								
Lake Herring	x		x						x
Sucker	x	x	x					x	x
Perch	x	x	x		x	x		x	x
Rock Bass	x	x	x			x		x	x
Common Carp								x	

Figure 8

[24] Historic Stocking Levels for Otter Lake MNRF 2003

Fish surveys are not an exact science so the presence or absence of a species does not necessarily mean it is gone from the lake. In early years there was a specific effort to rid the lake of Ling Cod as it was perceived that they were threatening Trout populations. In the case of stocked fish, there were follow-up studies done to determine the success of stocking and there is little evidence of success for any of the stocked Trout species.

Between 1957 and 2003, the following fish numbers were stocked by MNRF:

Small Mouth Bass	Lake Trout	Splake	Brook Trout	Rainbow Trout
33,250	66,500	27,000*	2,000	50,500

*In 2020 an additional 7,000 Splake were released in Otter Lake.

Figure 9

Stocking apparently took place as early as 1920 but there are no details available. In 1996, Lake Steward Jim Reeves worked with MNRF to determine the extent of the Trout habitat in Otter Lake. Through an extensive testing of oxygen and temperature across the entire depth of the lake it was determined that only 4% of the lake volume would support Lake Trout.[25] Further field notes labelled the lake as "poor" for Lake Trout from 1983 to 2003. These studies indicated that the warmer epilimnion layer was increasing in depth thus reducing the available habitat for cold-water fish such as Trout which reside in the hypolimnion. Rainbow Trout were stocked aggressively from 1999 to 2002 in an effort to support some form of Trout fishery but as no evidence of Rainbow Trout was found in the 2003 survey, all stocking was stopped.

Current provincial policy dictates that 7 ug of oxygen is required in the hypolimnion in September in order to classify the lake as a "Trout Lake" and therefore Otter Lake does not qualify according to MNRF data from 2004. Since then, RVCA tests have indicated an improvement in deep water oxygen levels in the late summer.

[25] Temperature and Oxygen levels at Various depths of Otter Lake. Reeves and MNRF 1996

In 2017 and 2018, OLLA participated in a fish habitat enhancement program in partnership with the RVCA. Many OLLA residents contributed time and financial resources to this project.

Brush bundles, composed of old Christmas trees, were placed by OLLA volunteers in strategic locations around the lake where smaller fish can find protection in the brush bundles. This is intended to replace the habitat found when trees fall into the lake in natural conditions but are usually removed by residents in developed areas. This type of fish habitat is important to the many species of fish found in Otter Lake. It is hoped that this project will increase the overall success of reproduction for all fish species and increase populations. OLLA is prepared to revisit this project as needed in the future.

4.4 Wetlands

Wetlands are key areas for lake health. They support fish spawning, food for waterfowl and other birds and act as a filter for contaminants. Much of the loon population will nest or seek refuge in wetlands.

When wetlands are linked, they support a greater and more diverse population of wildlife therefore carving wetlands into smaller parcels through drainage and development is not recommended.

Wetlands are categorized by level of significance. "Provincially Significant" (shown as pink in the map in figure 1) is the highest category. "Locally Significant" is in yellow and wetlands not yet assessed are in green.

RVCA and Township policies are in place to protect wetlands.

5.0 CLIMATE CHANGE

In 2011 two reports conducted for the provincial government predicted that Eastern Ontario will experience some changing weather patterns in the next 40 years. It is reported that precipitation has already increased by 15% since 1985 in Eastern Ontario and may increase another 10% by 2030. Most of the increase will occur in the winter and spring with the summers becoming hotter and with less precipitation. Lake water temperatures have increased 1.20C since 1921 and are predicted to increase another 3C in the decades ahead. These changing weather patterns will promote changes in the Otter Lake environment and much of it may be unpredictable. Some of the possible changes are:

- More precipitation on an annual basis with most of the increase occurring in the winter and early spring. Snowpack may be less if precipitation falls as rain instead of snow.
- More extreme precipitation patterns with wetter, warmer winters and drier, hotter summers.
- Summer surface temperature of the lake may increase 4-6^{0}C by 2080. This will lead to a host of changes to fish, bugs, and aquatic plants due to decrease in dissolved oxygen.
- Reduction of ice cover duration leading to changes in stratification and wildlife patterns.
- Greater loss of water due to summer evaporation unless offset by increased precipitation and/or timing of precipitation.

Local initiatives to reduce the effect of these changes can be accomplished and include protection of shoreline vegetation, control of development within the watershed, and efforts to reduce run-off and recharging ground water.

6.0 DEVELOPMENT

In early years, development progressed without significant environmental considerations. Guidelines for sewage systems, setbacks, and building size were lax or non-existent. This led to a rather uncoordinated system of approvals with little consideration of long-term sustainability. Municipalities considered cottage development as a seasonal activity with little drain on municipal resources, so they were taxed at a "seasonal" rate which was much less than permanent residential units.

In 1965, the Ontario Government acted to form conservation authorities which would manage water resources on a watershed basis. This allowed for consistent guidelines across municipal boundaries. Gradually, regulations were created and enhanced and development around Otter Lake moved from a largely unregulated activity to one that is controlled to a greater extent.

Development on or near the waterfront is governed by several provincial and federal policies acts and regulations. Guidelines are enforced by the Township of Rideau Lakes. The Ontario Provincial Policy Statement (OPPS) sets broad policy that municipalities must meet. Water quality, shoreline protection and protection of the natural environment are all mentioned in the OPPS. Usually a municipality determines priorities in the Official Plan and uses the Zoning Bylaw as the enforcement arm of these priorities. In the Township of Rideau Lakes, the Rideau Valley Conservation Authority is delegated certain responsibilities to render opinions and decisions on development matters.

In Ontario, shoreline development is handled in two general ways:

1) Management by Capacity…..in other words setting limits on development, or
2) Management by Mitigation….using best management practices to minimize the effect of development.

The RVCA has a well-developed site assessment program which is used by the Township to consider development proposals within 300 m of a waterfront. This falls into the second of the above two management options. It includes a detailed site-scoring system which is used to identify the suitability of the development for the site and recommendation for mitigation methods depending on the classification of the lot. The Township however, has not entrenched the RVCA site-assessment program into planning policies or the Official Plan. Therefore they are free to deviate from the RVCA recommendations. The RVCA site assessment goal is "*NO NET DECLINE IN WATER QUALITY ASSOCIATED WITH DEVELOPMENT".*

Among the RVCA site criteria:

- Determination of the 1:100 year flood level on a building lot or serviced by a private road
- Set-back, frontage, and lot area
- Slope, depth of soil and type
- Degree of existing vegetation in the 30 m buffer zone
- Proximity to wetlands

For large scale development, a "Lake Impact Study" would be required to be produced by the developer in conjunction with the RVCA.

Locally there is no system in place that recognizes lake sensitivity as a factor in the planning and approval process. Furthermore there is no entrenched method of assessing lake or recreational capacity which could be used to determine maximum development loads.

In Ontario the Planning Act requires that Official Plans for municipalities must take into account the cumulative impacts of planning decisions. In other words, the site by site approval process is important but the cumulative effects of these approvals must be considered as well.

6.1 Residential Development

Wickware[6] documented development on Otter Lake from 1950 to 1970. Prior to that, records are incomplete but it is generally assumed that shoreline cottages and residences were constructed beginning in the 1930's and reached a peak rate in the 1960's. As the supply of subdivided lots decreased, the rate of construction slowed and is now close to zero with about 295 cottages and homes. Conversion of existing cottages to homes continues. The density on the lake is 15 residential units per km of shoreline which is one the highest in the Rideau Basin and 3 times higher than Big Rideau Lake.

Seasonal cottages make up 72% of the total based on a 2007 RVCA survey. There are no large-scale backlot developments on or near the lake.

Development on and near the shoreline contributes to eutrophication which essentially is a conversion of a clear cold-water lake with few nutrients to a warm turbid lake with high levels of nutrients. This happens to all lakes over time however the effects can be mitigated with good stewardship techniques and development controls. Models exist which may be useful to determine if Otter Lake is approaching the point where further development will result in a degradation of water quality. These models are not extremely accurate but may prove to be one factor in the decision-making process A 2014 report by Hutchinson Environment Services to the MECP[26] recommends that municipalities use three tools to mitigate degradation to water quality:

1) Classify lakes according to sensitivity to Phosphorus or other factors
2) Use lake capacity and recreational models to add to the available data
3) Encourage BMP's to increase shoreline health and stability

[26] Review and Analysis of Existing Approaches for Managing Shoreline Development on Inland Lakes. Hutchinson Environmental Science Report for MECP 2014

There has been no development or lake capacity modeling performed on Otter Lake however Michalski and Usher[2] modeled Bass Lake in 1992 and predicted a 30% rise in Chlorophyll content (due to nutrient loading) with a 5% increase in development and a 56% increase with 25% more development.

6.2 Commercial Development

There are four resort operations on the lake. Four trailer parks contain approximately 300 permanently fixed trailer units with accompanying stores, pools etc. (Google Earth Survey Feb 2021). There were 25 motel rental units in the 1970's but these have been discontinued. There are 28 rental cabins currently in use. Camp Otterdale has a complement of an estimated 150 campers from July 1-August 15.

There is increased interest in campground development in the Township across all areas. Trailer campgrounds are zoned 'Tourist Commercial' in the Township of Rideau Lakes and unlike residential zoning, there are few policies in place for the controlled development of the trailer parks, including the individual trailer sizes, densities, accessory buildings, and impact on water resources.

6.3 Recreational Levels

There is public use of the lake through the public launch area with unlimited and undocumented access. The launch property is owned by MNRF and leased to Township of Rideau Lakes.

There is a large land area owned by the RVCA on the southwest side of the lake however no immediate plans exist for development of the site into a recreational or natural area.

Of those residents who responded in the 2006 survey,70% had power boats. Based on the estimate of property owners, this equals 206 power boats. Of those, 66% are greater than 25 HP. On August 2, 2017, OLLA volunteers performed an informational shoreline count of water craft and found 646 boats of all kinds. Of this total, 274 were power boats and 22 were in operation at 2 p.m. Sailboats numbered 29 but many were no doubt on shore or in storage. The balance were canoes, kayaks and paddle boards. The informational 2017 count, while providing an approximate assessment, included boats at commercial establishments so this represents an addition number not included in the 2006 resident survey.

There are few studies which identify the effect on water quality by boat traffic but Michalski and Usher[2] concluded that the pollution from boat traffic was minimal compared to other sources.

Robina Duermeyer, in a 1998 Carleton University thesis on Otter Lake recreational power boat use,[27] reported that Volatile Organic Compounds (arising from boat fuel use) did not persist for long in the water and that they were dissipating faster than they accumulate over time. She noted that there were approximately 30 power boats operating on the lake during a typical long weekend.

In some municipalities in Ontario a calculation of "Recreational Capacity" is used to assess development capacity for a lake. Similar to the calculation planners use to determine how much park space is required for cities, municipalities can estimate how much lake area is suitable for the number of lake users. This serves as a "social density filter" which accounts for environmental as well as social pressures. Seguin Township has used such a system for several years and applies a factor of 1.62 ha per residential user. Using such a formula would allow for 359 residence units on Otter Lake. Including cottages, permanent homes and trailer park residents there are 490 residential units, exceeding the maximum by 36% using this form of calculation. While this type of

[27] Contamination by Marine Engines in Otter Lake, Duermeyer Honours Thesis, Carleton University 1998

assessment is quite subjective, it is easy to calculate and accounts for a range of factors including social pressures. Hutchinson[26] suggests it is one tool that planners can use in a holistic approach to lake planning.

6.4 Septic Systems

Private on-site sewage systems are considered "buildings" under provincial regulations and therefore are regulated under part 8 of the Ontario Building Code which is administered by the Ministry of Municipal Affairs and Housing. These regulations cover systems up to 10,000 L per day. Larger systems, such as those found in trailer parks, are regulated by the MECP but usually operate on the same principles as small private systems.

Section 8.9.2.3(2) of the Ontario Building Code dictates that the homeowner is responsible for the effective operation of a septic system.

Septic systems are important considerations in the lake environment since nutrients released from them can and do reach the water and can contribute to poor water quality.

Systems are composed of two or three units depending on the design:

Tanks: The septic tank is the primary treatment unit and its purpose is to liquefy solids and allow wastewater to pass on to the secondary treatment system. The discharge from the tank includes water, organic material usually measured as BOD (Biological Oxygen Demand), bacteria, and nutrients. Inorganic sludge remains at the bottom of the tank and must be pumped out periodically to maintain the effectiveness of the tank. Tanks are designed to receive twice the estimated daily capacity of the house. This allows more time for biological action before effluent is discharged from the tank to the secondary treatment system.

Secondary Treatment System: A traditional system uses a leaching bed to distribute wastewater to the soil where it is processed by organisms in the presence of oxygen. Essentially the soil bacteria fulfill the role of processing the effluent and discharging it to the groundwater. In a properly functioning leaching bed, there should be minimal contamination of groundwater and the lake however the design and construction of the system must be adequate for the volume it receives. Seasonally used systems can be less efficient since it takes time for the biological action to initiate the degradation process in the tank. A leaching bed is also limited by the thickness and consistency of the soil in which the effluent is treated. Thin sandy soil is less able to process effluent and has a greater risk of passing nutrients and bacteria to the lake.

There are units available that intensively treat effluent and discharge it to the soil with reduced levels of bacteria, nutrients and BOD. Eco-Flow and Waterloo Biofilter are examples of advanced secondary treatment units that offer better effluent discharge characteristics compared to a leaching bed.

Tertiary Treatment: In highly sensitive areas, technology exists to remove virtually all the harmful bacteria and nutrients prior to discharge to the environment. These would be located in or after the secondary unit but before effluent is discharged to the soil.

Inspection:

Septic systems around Otter Lake include traditional leaching beds, some holding tanks, and some advanced secondary treatment units. Holding tanks are not allowed for new construction but existing systems are grandfathered. All systems need to be inspected and maintained periodically.

A voluntary inspection program was undertaken in 2007 of 100 systems in Rideau Lakes with some on Otter Lake. There was a 56% failure rate on this program although most were minor. 5% of units were found to be completely inoperable and taken out of use until repaired. Otter Lake was among four lakes surveyed in 2007 and the type of systems found were overwhelmingly the traditional tank and leaching bed systems. Holding tanks were found in 5% of those surveyed.

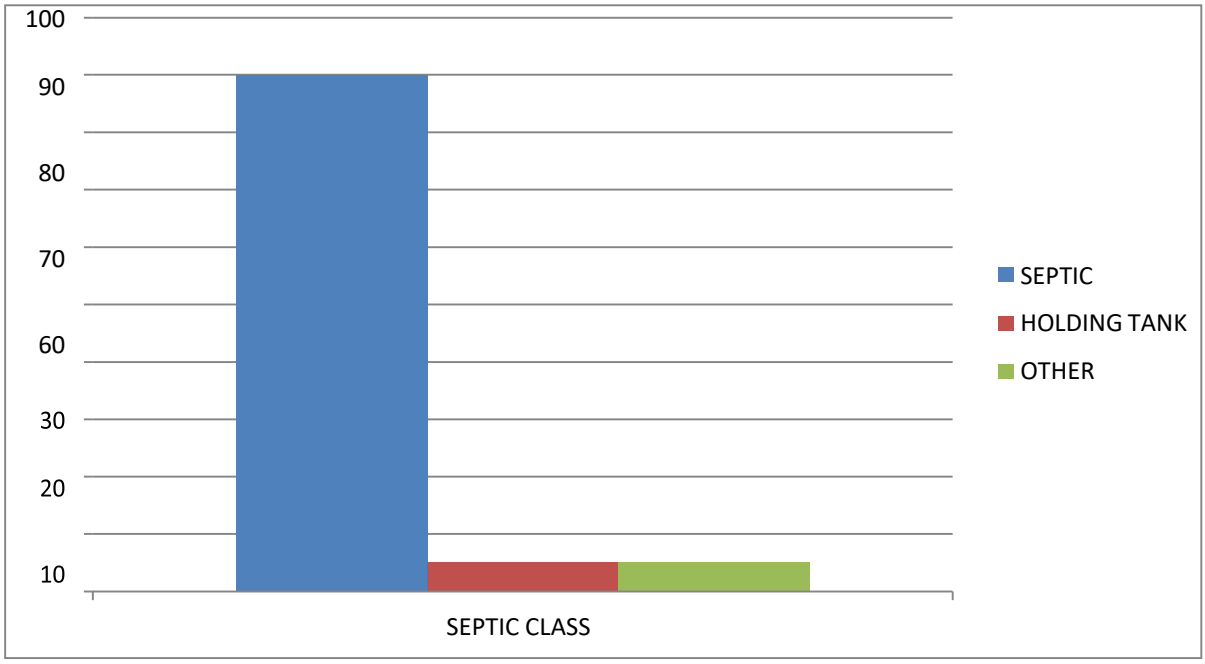

Figure 10: Types of Septic Systems identified by TRL during Voluntary Inspection Program 2007

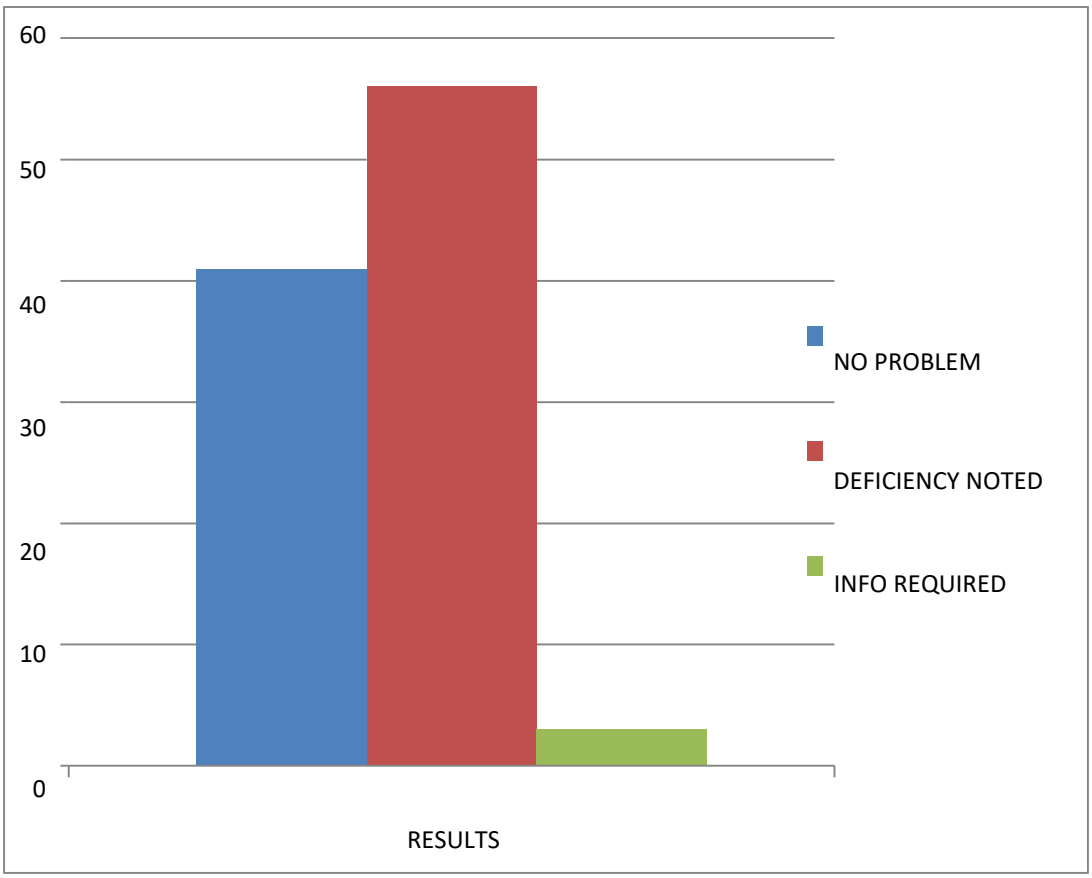

Figure 11: Deficiency Levels identified by TRL during Voluntary Inspection Program 2007

The deficiencies required solutions that ranged from total replacement (5%) to needing a tank pump-out(37%).

It was observed during the inspections that some residents had pumped out their tank just prior to the inspector arriving which means that the number of pump-outs required is likely under-reported.

Some municipalities are adopting mandatory inspections usually on a 5 or 10 year cycle and/or upon sale of the property. Regardless of the inspection system in place, a municipality is obliged to react to a complaint by a resident regarding a possible malfunctioning septic system.

In 2017 OLLA delivered an information package called "Septic Smarts" to each residence on Otter Lake. During this project, a survey was conducted and it was found that 86% of systems were the standard class 4 tank and leaching bed type. Holding tanks represented 8% and 5% had tertiary (or advanced) equipment for improved nutrient removal. Composting toilets and/or outhouses represented 1%. This indicates a slight rise in advanced treatment units since the 1990 survey.

Mandatory Re-Inspection:

In the 2006 survey 89% of those Otter Lake resident responding agreed that septic inspection was important. In the 2015 survey 77% are in favour of mandatory re-inspection. (Participation rate in surveys conducted involves OLLA members in the community, not all the community. On average, membership represents 100 properties or 1/3 of the community.)

Ontario Regulation 315/10 was established in 2011 to govern mandatory and discretionary sewage system re-inspection programs. It forms part of the Ontario Building Code and serves to further the goals of the Clean Water Act.

The Township of Rideau Lakes has followed a discretionary program since 2007 which invites approximately 100 volunteers annually to have their systems inspected by an accredited person. The reports are available at:

https://www.rideaulakes.ca/live/home-and-property/developing-your-property/septic-re-inspection-program

A voluntary program may not capture a true cross-section of systems and their operational condition.

In 2018 the Township of Rideau Lakes introduced a mandatory septic inspection program. Initially 100 properties were selected per annum but the program will be increased to 300 eventually. Areas of higher risk in the Township are initially targeted which included the Upper and Lower Rideau Lakes and Bass Lake. It is anticipated that Otter Lake will receive mandatory inspection notices for 2021.

7.0 SUMMARY

Otter Lake has been well-studied over several decades and residents are fortunate to have a significant amount of data available for use in Sustainable Plan. Significant gaps do exist for some issues namely extensive hydrology reports, mapping of fish habitat and spawning beds, cumulative development impacts, and shoreline assessment. Where possible, additional study and data collection will continue to expand what is known about Otter Lake, working with local and regional agencies, scientists, and local residents, to further the aims of the Sustainable Lake Plan.

IF you would like to get involved in any activities to monitor, research or report on a specific area of interest impacting Otter Lake, please contact OLLA@otterlake.org.

The State of the Lake Report is supported and compiled by members of the Board of Directors for OLLA for the benefit of community residents, planners and in tracking elements which impact the health of the Lake.

8.0 REFERENCES / FOOTNOTES

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Photo Credit: Philip Craig, Artist, Otter Lake Resident

APPENDIX A: History of Concerns, Activities & Reports Regarding Water Levels at Otter Lake (March 2021)

A 2011 Technical Memorandum by the RVCA (hydrology report) conducted by chief hydrologist Ferdous Ahmed, concluded that the culvert under Otter Lake Road would function adequately in a 1:100 year flood or at least within expected parameters. It further describes the condition called 'head-loss' which is typical of all culverts, and acts to partially restrict water flow especially at higher levels typically found in the spring. This can best be described as surface "friction" of water in the culvert leading to a higher level on the inlet side compared the outlet.

The 2011 RVCA report (outlined below) provided an estimate of 24 cm of head-loss in a 1:100 year flood but also called for more investigation of downstream conditions to determine if there are other factors which lead to water level fluctuation.

There is a rock ridge in Otter Creek 200 m downstream from the culvert which has an elevation of 124.4 MASL. The ridge elevation is about 50 cm above the bottom of the culvert and even without beaver activity in the area, water flow is greatly reduced when the water level drops to that elevation.

In 2007, OLLA created a water level policy after concluding that OLLA has no legal status to interfere in any way with inlet or outlet creeks. In essence, OLLA withdrew any policy reference to water level interference. This left the matter of flooding to be considered by landowners along the banks of the creek who hold the legal right to decide whether beavers are culled, dams removed or other such action taken to relieve flooding impact on their land. The Township also administers public land along Otter Creek in two locations and has the same riparian rights as private landowners.

Riparian law considers the potential impact for upstream and downstream landowners. Briefly, this element of Common Law indicates that while riparian landowners have a right to the natural flow of water from upstream, they are also obliged to allow natural flow to their downstream neighbours. Any interference in water flow cannot adversely affect upstream or downstream riparian landowners. The physical characteristics of the creek bed and any beaver activity are considered part of the natural environment, but a man-made dam or restriction for example, would not.

In 2007, RVCA began a program of removing beaver dams in the upper reaches of Otter Creek on behalf of the municipality and an Otter Creek riparian land owner. In 2011, RVCA planned to convert to a user-pay formula if the program were to continue. At this point in time, costs were allocated between the municipality and the private landowner on Otter Creek according to activity in their respective areas.

OLLA passed a motion at the 2011 AGM to support, in principle, the continued activities of the RVCA program. A group was formed, which was independent of

OLLA, and was comprised of local lake and creek residents, some of whom were also OLLA Board members. This group referred to themselves as the Otter Creek Beaver Management Group. This group would liaise with RVCA (as the agent for the Ontario Wildlife Conservation Act), who would then receive landowner permission to access and cull the beavers and remove any dams suspected of contributing to flood conditions. All costs would be borne by the Township and members of the Group.

In 2014, the OLLA board communicated with the Mayor and RVCA in a letter dated July 4, 2014. Citing concern for extreme high water levels in the spring, the letter asked Council to consider the RVCA suggestion of the dual-culvert option to reduce the effects of spring flooding.

The Ontario Wildlife Conservation Act allows riparian landowners to remove beavers only on their property. The Ontario Municipal Act allows a municipality to remove dams on public land but also on private property in order to protect public lands. Neither Acts allow Otter Lake residents to take any independent action in Otter Creek or any of the other inlet creeks. The implication of beaver dams on flooding and water levels remains contentious with many residents, with pressure sometimes brought to bear on Township authorities from both sides.

In 2017 the OLLA board decided to eliminate any reference to a water level policy and would not lobby or inform the municipality or Conservation Authority about water levels except in the context of publishing water level readings on the OLLA website.

In 2017 the subject of water levels on Otter Lake was a topic at the Township Municipal Services Committee. It was initiated by a lake resident who had complained about flooding for many years. At the direction of Council, CAO Mike Dwyer presented a report to the MSC on Sept 25, 2017, outlining the various regulatory pathways available to address the issue. He outlined four possibilities: 1) Do nothing; 2) Raise private roads subject to flooding; 3) Enlarge the existing culvert or add a second one; and 4) Construct a weir to control water flow. His final recommendation was to raise private roads (at the sole cost of homeowners) and take no action with the existing culvert (aside from routine maintenance). He stated: "A change to the outlet would benefit a small number of individuals and private interests. There is not compelling broad public interest. Accordingly the expenditure of public funds for private benefit in this circumstance would seem counter to the principles of good governance."

Following this report, the MSC deferred action until a legal opinion was rendered and also that RVCA be asked to advise on the matter. Solely in reaction to the discussion at the MSC and the possibility of an engineering study, OLLA conducted

a survey of OLLA members and past members to determine their views. These views were documented in a January 3, 2018 letter to the MSC with the recommendation that the MSC consider a larger or second culvert to reduce the risk of spring flooding, which was consistent with the survey results.

At the January 24, 2018 MSC meeting, a legal opinion was considered from Cunningham-Swan (outlined below) as well as a January 17, 2018 letter from the RVCA answering Council questions. The MSC deferred action and recommended that staff obtain a cost for an engineering report.

Subsequent to this discussion, the Township staff were preparing to engage a professional engineer to study the Otter Creek and Bass Lake drainage areas and collect resident views. For the Otter Lake watershed, the study would focus on the degree that the flow of water in Otter Creek was influenced by the culvert under Otter Lake Rd. The study was partly in response to suggestions by RVCA that the culvert was restricting flow, especially during the spring freshet. Several residents, some members of OLLA, independently called on the Township to enlarge the culvert to relieve the risk of spring flooding. Some supported the idea floated by the RVCA in 2007 and in 2014 that two culverts could be installed at different elevations, to increase flow capacity during the spring freshet. Others suggested that the natural ebb and flow of water levels was a natural occurrence and should not be tampered with even if it resulted in higher water levels during the spring freshet.

Meanwhile a group of lakeshore and campground residents opposed to any interference or action established themselves as Friends of Otter Lake. A petition of >500 signatures of seasonal and permanent residents, spouses and renters was collected and submitted to Council.

The key public and private reports that contribute to our understanding of lake water levels are briefly described below:

The 2011 RVCA Technical Memorandum (Hydrology Report)

Ferdous Ahmed PhD, Chief Hydrologist for the RVCA, was tasked with identifying the 1:100 year flood levels around Otter Lake, primarily to determine what shoreline areas should be considered as flood plain for the purpose of rendering development decisions. In determining the 125.5 MASL flood plain, he identified that the outlet culvert was primarily responsible for restricted flow from the lake at medium to high water levels. At the 1:100 year flood level it creates a restriction representing about 24cm of water. In other words, the lake level would be 24 cm higher than if the culvert was not present. At very low water levels the rock ridge becomes the stronger influence in holding back water, essentially stopping flow when there is less than 50cm of water in the culvert.

The Bailey Opinion 2019
A scientific opinion paper (authored by a local limnologist, Dr. Robert Bailey) on seasonal water flows, was prepared and presented to Council and to a public meeting dealing with the subject. The main points of Dr. Bailey's paper are:
All lakes undergo periods of higher and lower water levels, both seasonally and from year-to-year, and these are normal and healthy for a lake environment.
The creek drains through Provincially Significant Wetlands which should be protected.

In the 60 years since the installation of the culvert, the lake and creek have found an ecological balance and any alteration, such as making it larger or smaller, could trigger negative effects.
Dr. Bailey was not addressing whether the culvert is the cause of flooding, only that fluctuations in water levels are normal and man-made alterations may have unknown and undesirable effects.

The Jp2g Consulting Engineers Report 2019
The Township contracted with Jp2g Consulting Ltd. to study the hydrology of Otter Creek and estimate the performance of the Otter Lake Road culvert across various water level conditions. Also, the investigation was to collect lake and creek resident information and views. The hydrology models contained in the report considerably extended the understanding of water flow as it existed in the 2011 RVCA study and included for the first time, some consideration for the role of the rock ridge 200m downstream from the culvert outlet.

Some key points of the study:

The report concluded that the rock ridge was the most significant factor impacting water levels at the tail end of the culvert and having more influence than previously thought as expressed in the 2011 RVCA Hydrology Report. The 2019 Jp2g Report suggests through hydraulic modelling that the rock ridge, not the culvert, is mainly responsible for water level fluctuations.

With this assumption in mind, any increase to the size and configuration of the culvert would have minimal effect on water flow and therefore on lake levels.
The study included a community liaison component prior to the release of any data and the feedback gathered was significantly in favour of a 'do nothing' approach.
The resident survey included the following information:

a) About 300 surveys were distributed in hard-copy format and 250 were received back in hard-copy, email, and on-line. The survey was distributed to lake and downstream residents alike.
b) Of the 250 replies, about 170 were non-OLLA members and 80 were OLLA members.
c) Of the 250 replies, 205 identified as lake residents and 45 identified as 'other'.

d) A significant majority of 72% indicated a desire to maintain the existing average water levels.
e) About 69% of the respondents were content with the seasonally high water levels during the spring freshet.

In light of the results of the hydraulic modelling performed in the study and the feedback from the community, the report's primary recommendation to the Township was to 'do nothing' and leave the existing culvert alone until such time as it requires replacement.

After reviewing the data, OLLA subsequently communicated to the Township that the association endorses the position that the culvert should remain at its current size and configuration and no public funds should be used to subsidize any beaver removal activity on private land except as required to protect public property according the Municipal Act.

The Cunningham-Swan Report 2018 and the Ross Report 2020
Following the Dwyer Report to the MSC in 2017, the legal firm of Cunningham-Swan, offered the Township a legal opinion on the matter. Mr. Fleming stated in his discussion about riparian rights: ***"If the municipality is a riparian right holder, it has an obligation to both upstream and downstream riparian rights holders to "It is our recommendation that the Township retain the assistance of experts to determine the adequacy of the Otter Lake culvert, if there is uncertainty maintain the water levels and not interfere with their rights…."*** and ***"There is potential liability associated with altering the flow through the culvert…"*** He concluded the riparian law section by saying: ***"The Township should maintain the historical flows within the culvert in order to avoid interfering with the riparian rights of upstream and downstream owners."***

He described the case law on similar issues which has been mixed. He stated: ***"It is our recommendation that the Township retain the assistance of experts to determine the adequacy of the Otter Lake culvert, if there is uncertainty on this issue."***

His final recommendation in the report was: "***At this point, as there is no indication that the culvert is inadequate or deficient, we recommend that the Township take no action with respect to changing the culvert."***

After the release of the Jp2g Report, Township Council asked for and received a legal review by a lawyer with more experience in riparian law. It was intended to assess the liability to the Township under different scenarios proposed in the engineering report. Kristi Ross performed the review and her report; Application of Riparian Rights and Applicable Case Law, was shared with Council on August 4, 2020.

Some of the key points of the Ross report:

About 1960, the Township (the pre-amalgamation South Elmsley Twp.) altered the original flow of the creek and installed a culvert that ***"restricted flow to some extent"*** and some potential liability is associated with this if plaintiffs can prove damage arising from the effect of the culvert on flooding.

The 2011 RVCA Hydrology Report and the 2019 Jp2g Reports did not establish a causal link between flooding and the culvert. It acknowledges that the downstream rock ridge is a key factor but Ross points out that the engineering report did not elaborate on the exact influence the culvert has as a secondary restriction on water flow***. "It is unknown if flooding is a result of the rock ridge, the culvert, or a combination of the two."***

In the event that water flow is altered by selecting one of the engineering report options, such as enlarging the culvert, there is a liability risk (potentially more than what exists in point #1) from downstream riparian land owners that may be subject to a higher risk of flooding.

The report identifies that the Township has an obligation under the Planning Act, to create policy that shields the municipality from liability. This may result in actions that produce the least risk of liability for the Township from altering, or not altering water flow.

The report recommends that a further engineering study be completed to determine in more detail, the relationship between the rock ridge and the culvert. The implication is that the Jp2g hydraulic models were estimates only and not real-time observations at different water levels. She further suggests that the Township has a legal duty to ensure that ***"the culvert is sufficient to deal with the changes in the water flow caused by spring runoff and other events."*** In the context of the report, she is referring to climate change increases as 'other events'.

RVCA 2011 Hydrology Report Follow-Up: Letters to Rideau Lakes Township, 2020.

In September of 2020, Municipal Council requested clarification and commentary on the findings of the Jp2g Report which identified the rock ridge as the main flow restriction across all water levels. This was contrary to the 2011 RVCA Report which identified the culvert as the main restrictive feature except at very low water levels. Two letters were subsequently sent by General Manager Sommer Casgrain-Roberts to the Township on December 10, 2020 which is summarized here:

The first letter reinforces the conclusions of the original RVCA Hydrology Report and suggests the conclusions found by Jp2g are in error: She reinforced that "***The culvert under Otter Lake Road acts as the outlet control of the lake while the rock ridge plays no significant role"*** under medium to high flow conditions.

Furthermore: "***The outlet culvert determines the lake water levels during flood events."*** The letter also reinforces the estimation of 24cm of head loss during a 1:100 year event.

The second letter recognizes that the resident survey within the Jp2g Report shows that 73% if respondents believe that: ***"The Beaver Management Program should be discontinued with beaver activity allowed to occur unfettered potentially resulting in higher water levels."*** Acknowledging that no beaver management activity has taken place since 2017, RVCA is declaring to the Township (and Otter Lake residents) that no further RVCA participation will take place in the future.

With respect to letter #1, the contrary opinion to the previous Jp2g Report, leaves a significant difference of opinion for the municipality and interested lake residents to consider.

With respect to letter #2, it notifies all parties that RVCA will not participate in any beaver management activities on behalf of riparian landowners, the Township, and/or lake residents. This does not mean however that the Township and Otter Creek residents will cease any activity, but only that RVCA will not be an active partner.

The existing culvert will eventually be scheduled for routine replacement given that it is already more than 60 years old. In light of the engineering report and resident consensus on the matter, OLLA has communicated to the Township that when a replacement is due, it should be replaced with a similar type and dimension and at the same elevation as the existing unit. If further studies shine more light on the matter, it will be reviewed at that time.

Water levels remain a complex subject being influenced by changing weather, beaver activity in outflow and inflow creeks, the culvert, and the rock ridge. The 2019 study by Jp2g suggests that the rock ridge is the main feature of Otter Creek that influences water levels while the RVCA has a contrary view and suggests the culvert is the main influence except at very low water levels. With further analysis, we may learn how these two features interact.

What we do know is that the main contributing factors to spring flooding are precipitation and melting snow pack. Following this, the main contributor to summer time low water levels is hot dry weather. Dr. Bailey has maintained that water level fluctuations are normal and part of the ecological reality of water courses. Water level fluctuations can and should be expected by all residents depending on how all of these elements are expressed in any given year.