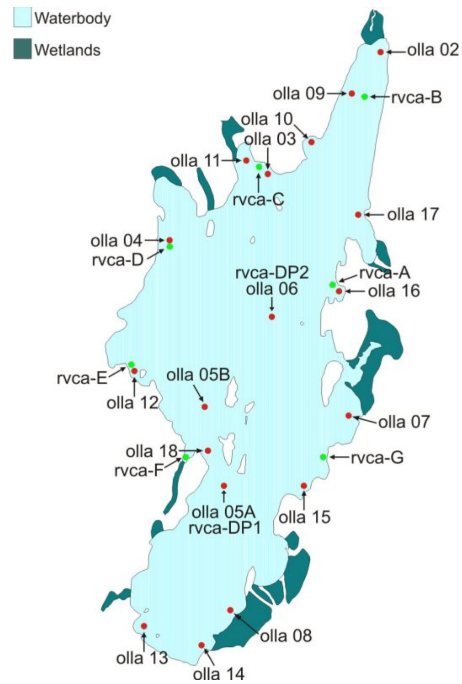
LAKE STEWARD'S REPORT - 2013

Water quality testing is an important diagnostic tool to help residents of Otter Lake determine the health of the lake. We need early warnings to predict important changes in the lake's ecological process. By systematic testing and monitoring over time, it is possible to evaluate if water quality is improving or declining. By selective testing at strategic sites, water quality indicators can help determine the source or cause of contamination. The ecological and trophic status of a lake is generally determined by the levels of nutrients it contains.

As in previous years OLLA was fortunate to have the assistance of the Rideau Valley Conservation Authority (RVCA) in testing the water quality of Otter Lake. Thanks are due to Sarah MacLeod, Kaitlin Brady and their qualified team of technologists. Both RVCA and OLLA test at least 3 times per year but at different sites. The combined results give us a good indication of the overall state of health of the lake. The map on the right indicates the location of all the current OLLA and RVCA test sites. These sites have been chosen to be representative of the whole lake. Sites 05A, O5B and 06 represent the 3 deepest water sites (more than 90ft). Sites 04, 07, 08, 11 and 18 are in areas where there are known inflows from streams and wetlands into the lake. Other sites are in shallow bays where there is an increased tendency for weed and algae growth. OLLA does not test at all of the sites each year, more often we test at different sites between May and October. Some of RVCA's test sites duplicate OLLA's but they also have sites that are distinct from ours.



NUTRIENTS & TROPHIC STATUS

Recreational water quality can be expressed in terms of how clear the water appears. Water clarity is influenced by the amount of soil sediment and phytoplankton, or microscopic algae, present in the water. Clarity is measured by a simple visual test using a Secchi Disk, a 20 centimeter black and white disk attached to a measured line. The disk is then lowered into the lake until it is no longer visible and the depth recorded.

Another perspective is gained through analysis of samples for nutrients, specifically phosphorus and nitrogen, which gives an indication of how much nutrient and energy is available for the growth of algae and aquatic plants. In the late summer, when the algae drops to the bottom of the lake, its decomposition uses oxygen, so to determine how much oxygen is available for fish and other aquatic animals, dissolved oxygen and temperature profiles are performed. The results of all these tests combine to give an indication of the overall health of the lake. An old or eutrophic lake will have profuse plant growth poor water clarity and relatively few fish species.

The two key indicators of nutrient load in a lake are phosphorus and nitrogen. These are both principal ingredients of fertilizers. When these two are present in excessive quantities in surface water, they stimulate algae and aquatic plant growth, just as they would stimulate the growth of grass or flowers in a garden. Dissolved oxygen levels can also be used to determine the trophic status as they provide a measure of the impact of eutrophication (due to biological growth and decay). Bacteria (originating from stormwater runoff and possibly malfunctioning septic systems) can also be introduced into a lake. High concentrations of pathologic bacteria, such as some species of *Escherichia coli* can render a lake unsuitable for recreational activity.

Phosphorous is generally recognized as the limiting nutrient in freshwater ecosystems and the major nutrient contributing to eutrophication in lakes. Since phosphorous is the principal source of energy for all living organisms the amount of phosphorous in the environment will determine how fast an organism grows and proliferates. Phosphorus is therefore the principal limiting factor in the growth of algae, meaning that algae growth will occur in greater amounts as more phosphorus is added to a lake. It should be born in mind that a conventional septic system cannot do much with phosphorous. Any phodphorous that enters a septic system from phosphorous containing detergents will emerge intact, enter the water table and eventually the lake. Phosphorus levels below 5 µg/L are typical of **oligotrophic** lakes that generally are clear and deep with few nutrients. Such lakes are typically found in the northern regions of Ontario. Phosphorous levels above 20 µg/L are typical of **eutrophic** lakes that are laden with nutrients which lead to excessive algae and plant growth. **Mesotrophic** lakes are in between these two extremes and are typical of the lakes found in our region of Ontario.

Nitrogen is also an important and essential nutrient in aquatic ecosystems. In addition to fertilizers, agricultural waste and wastewater contribute nitrogen into lakes. In large amounts, ammonia and nitrates can be toxic to aquatic organisms. Total Kjeldahl Nitrogen (TKN) which is what we measure, determines the concentration of all forms of nitrogen in the lake. While there currently are no guidelines for acceptable levels of TKN, according to RVCA, TKN in water bodies not influenced by excessive organic inputs typically range from 100 to 500 µg/L.

Dissolved oxygen (DO) and temperature profiling is important for lakes because both parameters affect all aquatic organisms and the chemistry of the lake environment. As the life cycle of many fish and other aquatic organisms are dictated by temperature, the relationship between DO and temperature is important. Also, since temperature determines the ability of water to hold DO, temperature and DO are usually measured together. The primary source of oxygen in aquatic systems is the atmosphere with wind action constantly recharging the surface waters with oxygen. Lake water can also gain some oxygen as a byproduct of photosynthesis by algae and macrophytes. However, as these die, they settle to the bottom of the lake where bacteria convert the organic material into carbon dioxide, consuming oxygen in the process. However, cold water can hold more DO than warm water. Therefore as the lake becomes thermally stratified during the warm summer months, oxygen cannot be replenished in the water below this warm layer known as the hypolimnion. As a result, oxygen levels below the hyperlimnion diminish as the summer progresses. Unfortunately this is where deep cold water fish, such as lake trout live and breed.

All the tests described above give an indication of the age of a lake and what can be expected. An old or **eutrophic** lake will have profuse plant growth and relatively few fish species because of the lack of open water and the competition for oxygen. A middle-aged or **mesotrophic** lake will support the greatest diversity of fish species with a variety of habitats if sufficient oxygen is available. Young or **oligotrophic** lakes have very little or no vegetation and are usually well oxygenated but have relatively few fish species.

Bacteria will be present in all lakes, they are naturally present and will be found in the faeces of the wildlife (fish, waterfowl, beavers, etc.) that inhabit the lake. Coliforms are bacteria found in the large intestine of humans and other mammals and are usually present in soil. While some strains of coliforms do produce toxins, most are not harmful to humans.

Some such as *Escherichia coli* (*E. Coli*) do produce pathogenic toxins. Therefore levels of *E. Coli* are often used as indicators of possible contamination by fecal matter, thus high *E. Coli* levels in lakes or rivers can be an indication of septic pollution. The recommended safety level of *E. Coli* in a lake for recreational safety is not more than 100 colony-forming units (cfu) per 100ml of water. *E.coli* at any level is unacceptable for drinking water, therefore some form of treatment and purification is necessary for anyone who draws water from the lake for drinking purposes.

RESULTS FOR 2013

The table on the right indicates the results of all the water quality testing done in 2013 by OLLA and RVCA. *Total Coliforms* were low at all sites tested except at OLLA 07 in June. Site 07 is close to Barker's Creek, the major inflow into the lake and higher than normal *Coliform* levels at this site are not uncommon since Barker's Creek drains an extensive wetland and farming area west of highway 15. *E. coli* was generally low or not detectable at all sites tested. Total Kjeldahl Nitrogen levels were generally in the acceptable range of between 200 - 500 µg/L at all sites tested. Phosphorous levels were somewhat surprising compared to last year. Phosphorous levels were above 15 µg/L at many test sites and were over 20 µg/L at 5 of our test sites. However, since the phosphorous levels remained below 10 µg/L at all our deep water sites it is possible that these high phosphorous readings resulted from groundwater runoff in shallow bays because of the wetter than normal Summer we had in 2013. Secchi depth readings were generally around 5 metres indicating that the lake remains very clear. In fact we obtained Secchi disk readings greater than 12 metres in October, the highest ever recorded. Increased water clarity means that sunlight can penetrate deeper and may often result in algae blooms over the summer months however there were no really significant algae blooms last summer. Therefore with an average phosphorous level of 12.8 µg/L and an average Secchi depth of 7 metres the lake remains on the borderline between oligotrophic and mesotrophic, but a little closer to mesotrophic in 2013. The low *E. coli* values at virtually all sites tested indicates that the overall health of the lake is excellent.

Water Quality Test Results - 2013 (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)			
		May	Jun	Jun	Jul	Aug	May	Jul	Aug	Oct	May	Jul	Aug	Oct	May	Jul	Aug	Oct
	OLLA 02																	
RVL-26C	OLLA 03				0	2		730	350			20	14					
RVL-26D	OLLA 04		3	0	0	2		440	550			9	25					
RVL-26DP1	OLLA 05A						380	390	450	380	6	8	8	7	4.50	5.75	5.75	12.50
	OLLA 05B																	
RVL-26DP2	OLLA 06							370	380	400	9	9	9	8	3.75	5.50		12.50
	OLLA 07		37	2	0	0		430	590			12	17					
	OLLA 08					0			730				25					
RVL-26B	OLLA 09				0	2		330	380			11	12					
	OLLA10		1	0														
	OLLA 11																	
RVL-26E	OLLA 12				0	0		340	440									
	OLLA 13				0	0		310	500			15	14					
	OLLA 14		12	0														
	OLLA 15																	
RVL-26A	OLLA 16				0	0		330	400			7	12					
	OLLA 17		1	0	0	0		420	530			10	21					
RVL-26F	OLLA 18		3	0	0	4		530	520			11	22					
Average		**3.63**		**0.48**			**446.15**				**12.84**				**7.18**			
Std. Error		**5.75**		**0.20**			**42.28**				**2.16**				**1.40**			

For comparison, the table on the left shows the water quality data for 2012 which is not very different from 2013 with the exception of somewhat higher than average phosphorous levels

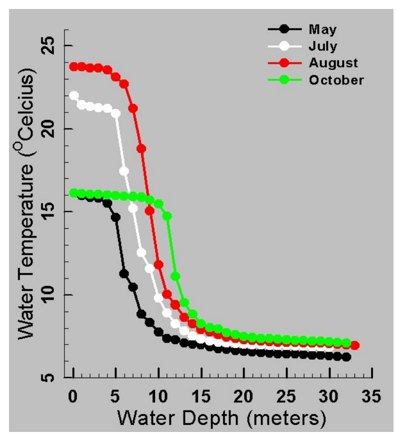
Water Quality Test Results - 2012 (OLLA + RVCA)

RVCA ID	OLLA ID	E. Coli (cfu/100 ml)			Total Kjeldahl nitrogen (µg/l)				Total Phosphorous (µg/l)				Sechi Disk (meters)	
		May	Jun	Aug	May	Jun	Aug	Sep	May	Jun	Aug	Sep	May	Sep
	OLLA 02													
RVL-26C	OLLA 03			2				710				2		
RVL-26D	OLLA 04	0			340			570	3			4	7.5	5.50
RVL-26DP1	OLLA 05A					340	380	380	2	7	11	8		
	OLLA 05B													
RVL-26DP2	OLLA 06						340	510	4	6	11	6	7	6.00
	OLLA 07	6	0	6	500	450	580	640	8	11	12	9		
	OLLA 08													
RVL-26B	OLLA 09			10										
	OLLA10					520	490			7	8			
	OLLA 11	0			340				3					
RVL-26E	OLLA 12	0			460		350		8		5			
	OLLA 13			4		450	550			8	13			
	OLLA 14	0			360			510	3			3		
	OLLA 15					440				9				
RVL-26A	OLLA 16						350				6			
	OLLA 17					370				7				
RVL-26F	OLLA 18		2	2		330	360	400		10	11	2		
Average		**2.67**			**445.19**				**6.90**				**6.50**	
Std. Error		**1.22**			**19.56**				**0.61**				**0.46**	

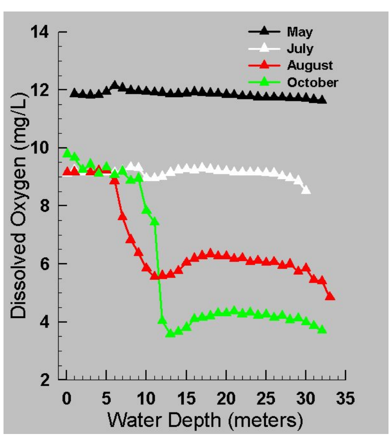
in 2013.

As mentioned earlier sufficient DO in a lake is necessary for all aquatic organisms to survive. Dissolved oxygen concentrations are linked to water temperature and depth and will therefore fluctuate with the seasons. Over the winter, water temperature decreases and becomes relatively constant (below 10^{o}C). As a result, DO is also relatively constant. As the lake warms up during the months of June through August, DO at the surface remains plentiful since it is constantly being recharged from the atmosphere. However, since warm water is less dense than cold water, the DO in the warmer surface water is not able to penetrate the hyperlimnion. As a result, the DO below the hyperlimnion cannot be replenished and DO concentrations at depths greater than 10 - 15 metres will begin to decrease. This stratification of DO usually reaches a peak in early fall. Cold water fish such as lake trout, rainbow trout and splake require a minimum of 5-6 mg/L of DO below the hyperlimnion but will not survive if concentrations fall below 4 mg/L.

MNR often stocks lakes in Eastern Ontario with various fish species. In 1999 NMR stocked Otter Lake with splake. The splake *(Salvelinus namaycush X Salvelinus fontinalis*) is a hybrid of two fish species resulting from the crossing of a male brook trout (*Salvelinus fontinalis*) and a female lake trout (*Salvelinus namaycush*). The name itself is a portmanteau of speckled trout (another name for brook trout) and lake trout, and may have been used to describe such hybrids as early as the 1880s. Spalke is a deep cold water fish and although the hybrid is genetically stable and is, theoretically, capable of reproducing, splake reproduction is extremely rare, for behavioural reasons, outside the hatchery environment. Why MNR stocked Otter Lake with a species of fish that cannot reproduce remains something of a mystery. MNR did their own determination of DO levels in Otter Lake in 2002 and determined the level was too low for survival of deep, cold water fish. As a result Otter Lake was taken off their "stocking list".

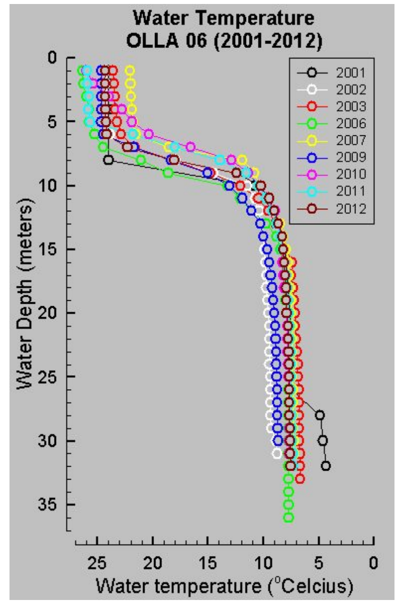


However, beginning in 2007 DO levels began to improve. The graph on the right shows temperature measurements for the months of May to October, 2013 and are for the deepest location in Otter Lake (OLLA 06) which is about 35 metres (120 ft). The graph shows how the water temperature changes during the course of the Summer months which leads to the development by July and August of an established hyperlimnion at between 10 and 15 metrs depth. As can be seen from the graph of DO concentrations on the left, in mid May, before any significant temperature stratification had occurred DO levels were quite high at 12 mg/L at all depths. DO levels dropped to 9 mg/L in July but were still relatively constant irrespective of water depth. However by August, we began to see a loss of DO occurring below the hyperlimnion but DO levels were still around 6 mg/L which is acceptable for cold water fish. By October DO concentrations were still at 9 mg/L above the hyperlimnion but had dropped to 4.5mg/L below it. Depending on how long this level of DO persists it could be stressful for cold water fish since



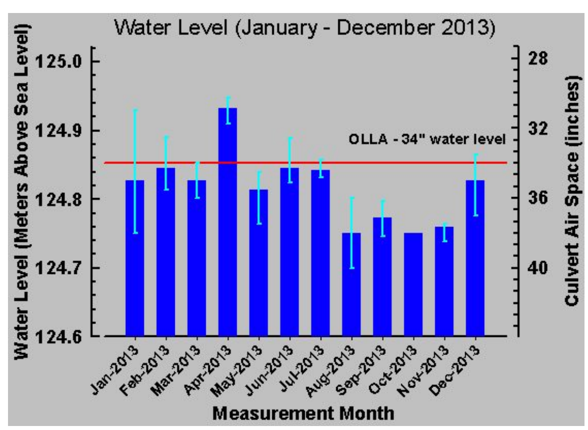
it is below the 5-6 mg/L that these species require. These results are very similar to what was obtained in 2011 and 2012 Despite the low levels of DO reached by early fall, the DO levels do seem to recover well over the winter when the lake de-stratifies. Hopefully this trend will continue, since it will help us to convince MNR that Otter Lake can once again be restocked with cold water fish.

A phenomenon that is of concern to MNR and fish biologists in general is the fact that as a result of global warming the water temperature of lakes during the Summer months is increasing in all regions of Ontario. As a result, lakes that once had an abundant population of cold water fish are now seeing that population decline. This decline is more pronounced in shallow lakes that are not able to maintain a large enough volume of cold water over the Summer months to support these species of fish, especially since they breed only in cold water. Otter Lake is probably characterized as a moderately shallow lake. Even though the lake has some deep areas, the average depth of the lake is probably about 20 - 30 meters. Are we seeing any effects of global warming in Otter Lake? The graph on the right shows all the midsummer water temperature that we have obtained (mostly from RVCA) since 2001. The temperature data clearly shows that over this 10 year period global warming is not having a significant influence on water temperatures in Otter Lake.



WATER LEVELS

As most of you will remember, the Summer of 2013 did not beak any records for temperature or drought. It would have to be described as a “typical” Eastern Ontario Summer. The graph on the right represents the water level in Otter Lake for all of 2013. The vertical bars represent maximum and minimum water levels recorded for each month. The relatively high water levels in Otter Lake in January and February reflected the freezing rain and wet snow we received. RVCA issued the following water conditions statement in early March, "the water content of the snow covering the Rideau watershed is at near-record levels which makes flooding this spring a real possibility. Snow measurements were completed by RVCA water resource technicians on March 4th and have shown that the snow pack presently covering the Rideau River watershed is the second highest, in terms of its water content, for the time of year (equivalent to an average water depth of 126 mm), since the Conservation Authority snow surveys were begun in 1974. There is enough water content in the snow pack to generate flooding conditions in flood vulnerable communities but whether or not flooding will actually occur this spring depends on weather



patterns (temperatures, snowfall and rainfall) over the next few weeks". However most of our snow melted quite slowly throughout March and the ice was off the lake on April 17. Our spring high water level was only 30 inches and was reached in mid April, thus there should not have been any serious flooding of low-lying areas around Otter Lake. As warmer weather approached, and since Otter Creek was flowing well, water levels dropped significantly beginning in May and remained relatively constant throughout June and July. The fact that water levels remained constant from May through July may have contribute to the success our Loons had in producing chicks last Summer. The drop in August resulted from little rainfall and relatively warm temperatures that increased loss due to evaporation. The lack of significant rainfall throughout September, October and November resulted in little change in water levels. The rise in December, resulted from significant snowfall in late November and early December followed by milder temperatures that melted a lot of that snow. The lake was completely frozen over by December 15, much earlier than in previous years.

Doug Franks
Lake Steward