OTTER LAKE LANDOWNERS ASSOCIATION

WATER QUALITY REPORT 2005

Prepared by:

Otter Lake Landowners Association through the support of the annual fees of the membership

INTRODUCTION:
This report presents the findings of the water quality testing and monitoring performed from April to November 2005.
The previous report in 2004 was completed by the Centre for Sustainable Watersheds in Portland. The Centre was unable to offer their services to OLLA in 2005 and after a search for an alternate provider of testing services, the OLLA board decided to purchase the required equipment and perform the tests internally.
In most cases the key tests and sample locations were consistent with the 2003 and 2004 report so direct comparisons could be made with previous results.
On one occasion, the equipment necessary for deep water temperature profiling was rented from Sustainable Watersheds.

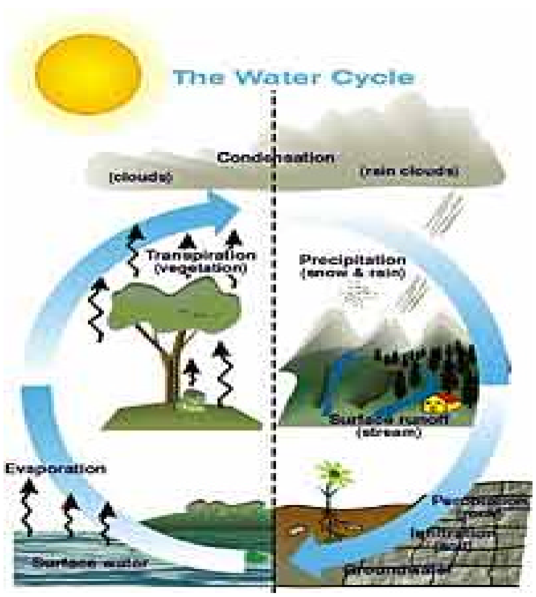
ABSTRACT:
The results from the 2005 testing regime indicate that Otter Lake demonstrates most of the characteristics of a mesotrophic lake. Phosphorus, Coliform bacteria, and surface oxygen levels are within the acceptable range for most Ontario lakes. The increasing levels of Phosphorus since 1996 are noted and seem to counter the decreasing trend in other area lakes including the Rideau Lakes. Oxygen in the hypolimnion was less than 6 mg/liter which is generally accepted as the level required for maintenance of cold-water fish. This is a significant difference compared to readings in 1975 when oxygen levels were adequate throughout the summer. Coliform bacteria levels indicate some low level pollution at three locations. E.coli is present at most sample sites and indicates that all water requires adequate treatment before drinking.

BACKGROUND:
Water quality testing is an important diagnostic tool to help residents of Otter Lake determine the health of the lake. 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.
Otter Lake is located on a limestone plain which lies on the Canadian Shield. So there are features around the lake which show the hard igneous rocks typical of the shield and also the soft light brown limestone typical of the area. Plant and animal life are quite sensitive to changes in acid levels and limestone tends to buffer the effects of acid rain which drifts in from the industrial areas of the US and Canada to the southwest.
Otter Lake is about 1700 acres in size and is central in an elongated drainage basin of about 10,000 acres. The shoreline length is about 20 km. The lake is 124 meters above mean sea level and is part of the Rideau River drainage basin. There are several parent streams flowing into Otter Lake and one primary outlet, which is Otter Creek, which flows about 33 km into the Rideau River.
The chemistry and health of a lake is influenced heavily by the nature of the drainage basin through which the parent streams flow. Otter Lake is also fed by springs although little is known about the volume or source of these springs. Springs usually are charged by wetland areas at higher elevations from the discharge area. So healthy wetlands in the basin are important for keeping Otter Lake healthy and free of contamination.

Otter Creek is a second order stream which means that there are two branches which feed into the stream, one from Otter Lake and one which has headwaters near Tower Road west of Lombardy. These two branches merge about 1000 meters upstream from the village of Lombardy before flowing north through the Lombard Glen Golf Course and then northeast of Smiths Falls where it broadens out considerably before joining the Rideau River.

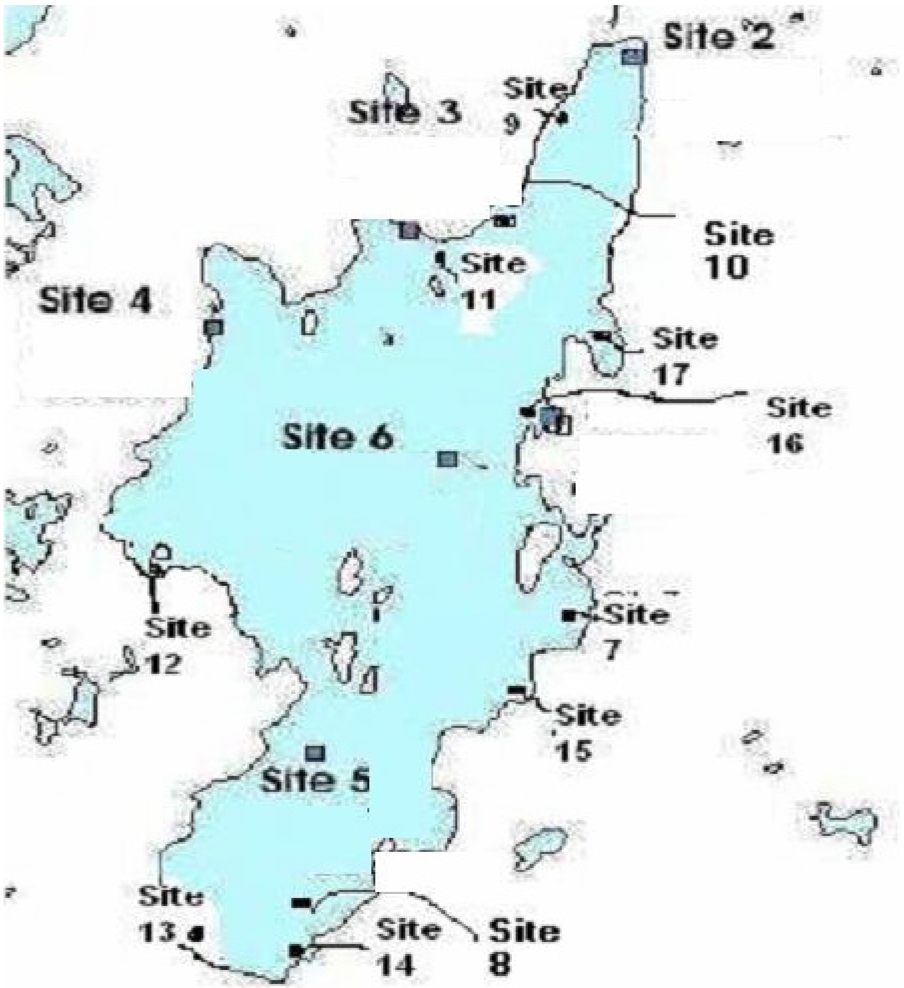
The trophic status of a lake is an assessment of the enrichment levels contained in the water. Oligotrophic lakes are clear and deep with few nutrients. Eutrophic lakes are laden with nutrients which stimulate algae and plant growth. Mesotrophic lakes are in between these two extremes. Otter Lake generally exhibits the characteristics of a mesotrophic lake although the deep bathymetry of the central and southern areas of the lake is more typical of an oligotrophic lake.

The development pressure is relatively high on Otter Lake with approximately 330 cottages, homes and commercial properties. As it relates to shoreline length, this is a much higher rate than the Rideau Lakes area and indicates that factors such as septic system leaching, fertilizer application and shoreline erosion can have a greater collective impact.



Water in Otter Lake replenishes about every two years through surface runoff, precipitation, and from groundwater springs.
Water leaves the system through Otter Creek, evaporation, and seepage.

North



OTTER LAKE TESTING SITES and GPS LOCATIONS

South

REGULAR TESTING SITES: OLLA 2,4,5,6,7,8
INTERMITTANT TEST SITES: OLLA 10,11,12,13,14,16,17

METHODS AND EQUIPMENT:

Testing was completed by the Rideau Valley Conservation Authority in 2003 and The Center for Sustainable Watersheds in 2004. Unfortunately neither organization were in a position to perform the 2005 testing regime for OLLA which prompted the board to authorize the purchase of certain equipment to enable testing to be completed. The Lake Steward, Karl Fiander, was responsible for the sampling and testing and subsequent reporting.

The procedures were similar to the previous professional organizations so that testing would be consistent with previous years and some degree of comparison could be drawn.

Sampling sites were consistent with previous years and were selected to include two deep water sites and several near-shore sites. The deep water sites provide information about water in the hypolimnion (where the cold water fish live) and the shoreline sites are useful for tracking changes in the epilimnion (where most of the plant and animal life live) due to pollution which may include high nutrient levels, excessive algae growth, and organic loading due to erosion.

Dissolved oxygen and temperature were recorded on a HACH HQ 10 portable testing instrument which was purchased by OLLA in 2005. This unit is a professional grade meter which accurately records dissolved oxygen which is a valuable water health indicator. The HACH 10 also records temperature down to 15 m depths.

Samples were drawn periodically in sterile lab bottles for nutrient testing by the Water Quality Laboratory at Trent University. Nutrient testing is complex and not easily performed on site.

Bacteria testing was done by Caduceon Labs in Ottawa. Samples were drawn from the one meter levels and stored in sterile bottles, and tested within 24 hours. All regular sites were tested once and follow up tests as needed. OLLA 10 was added in 2005 because there was a high reading in 2004.

Water levels and flow are recorded at least once per month from April to November. Water levels are measured as height above the bottom of the culvert on Otter Lake Road. The water flow through the culvert is calculated by timing the flow according to the procedures in Applied Aquatic Ecosystem Concepts. Thanks to Dr Jim Henninger (Trent math prof retired) who helped with the water flow equation for Otter Creek.

Secchi disk depths were recorded primarily at OLLA 6 where there was little influence from shoreline silt and algae growth. A standard black and white disk was used and depth measured according to standard procedures.

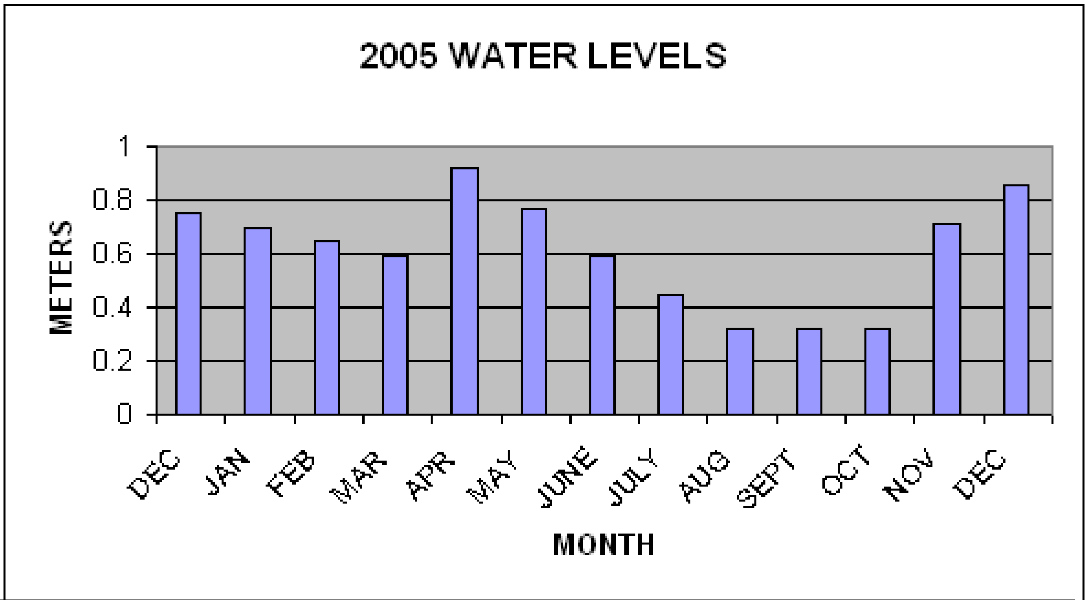
Water samples were taken with a specialized weighted bottle at the 1 meter depth and with a Wildco 2.2 liter Kemmerer sampler for the 20-30 meter depth.

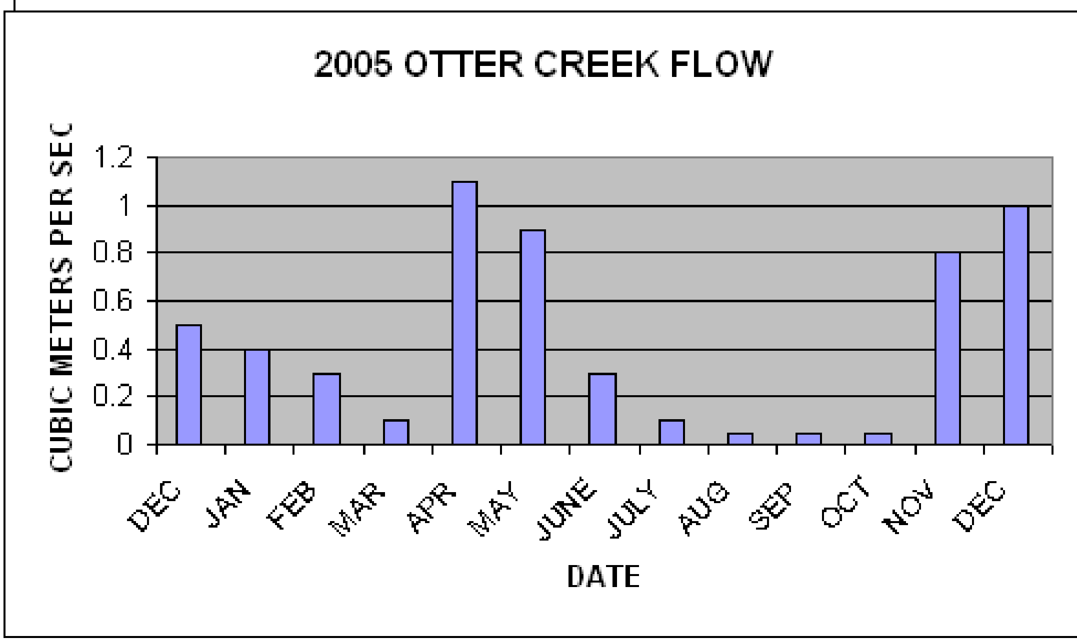
Acid readings were taken with HACH standard litmus paper for pH range of 4.5 to 9.0.

RESULTS

The results are presented according to the format established in previous years by the RVCA and Sustainable Watersheds. It is noted that changes in equipment and labs were made in 2005.

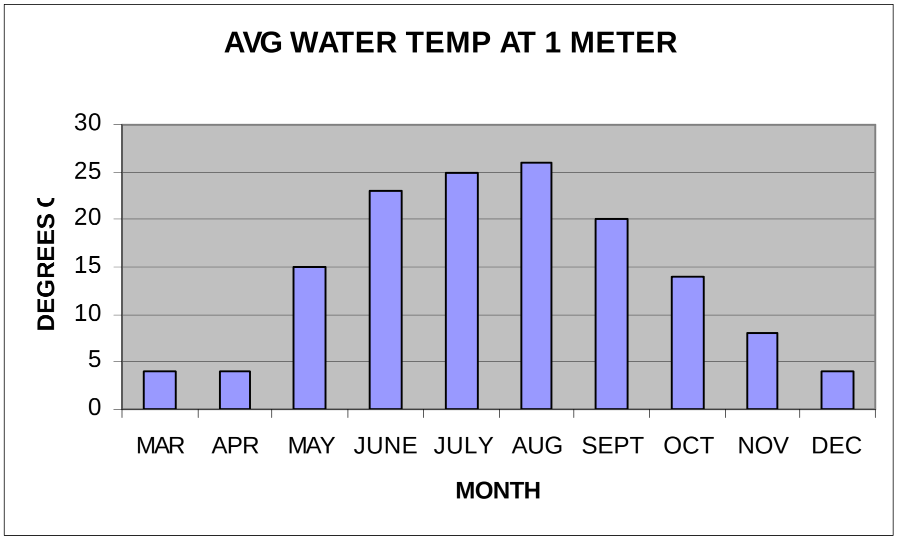
Water Level and Otter Creek Flow

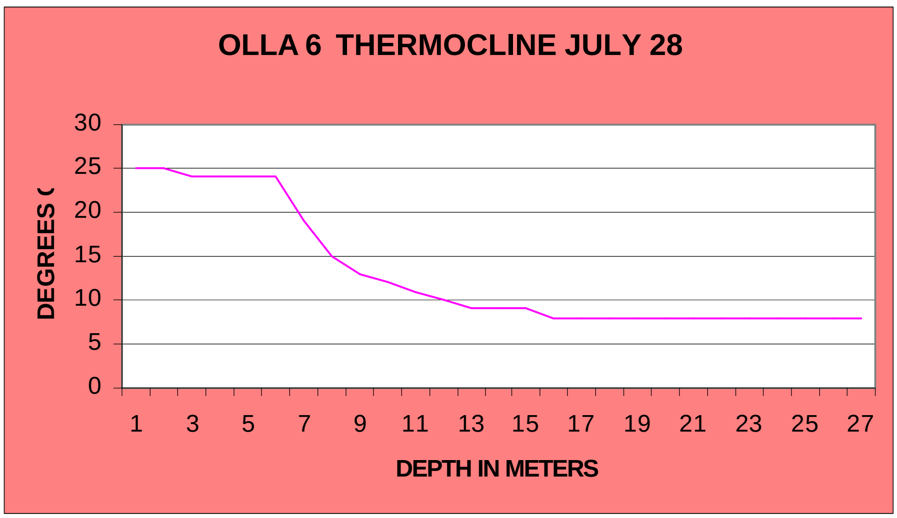




Water levels were quite normal early in the year and began to decline during the early summer and reached a low level in August and September that had not been seen since the mid sixties. By the end of July the drop in water levels brought water flow at Otter Creek to a standstill. The flow is limited by the topographical height at the culvert bottom on Otter Lake Road and any beaver dams that may exist within the first 1000 meters from the lake.

Water Temperature and Thermocline





Water temperature reached a higher level than the previous two years and surpassed 20 C at an earlier date. Compared to data supplied by the Ontario Ministry of the Environment which tested Otter Lake in 1975, the water warmed to 20 C about 25 days earlier in 2005 compared to 1975. The thermocline was lower as a measure of height above sea level. This means that the total volume of the hypolimnion, the cold lower layer of water, is less in 2005 than in the last few years. The hypolimnion is the cold-water area that supports fish such as Lake Trout. When the volume of the hypolimnion is reduced, the effective habitat of cold-water organisms is reduced. The thermocline is defined as the region of the lake where water temperature declines by more than 2 C per meter.

Secchi Depth at OLLA 6

Secchi depths are indirect measurements of the amount of microscopic life that exists in the water column. Most of these species are beneficial and serve as food for fish and insects. Chlorophyll readings are also indicators of microscopic algae in the water. Secchi readings can be affected by turbidity caused by rain or runoff and are not generally taken until good light conditions and still waters are available.

2005 Secchi depth and Chlorophyll Levels	**OLLA 6**		
	Secchi (m)	**Chlorophyll**	**Trophic Status**
25-Apr	3.9		Mesotrophic
28-May	7.4		Oligotrophic
15-Jul	7.1	1.7	Oligotrophic
9-Oct	6.8	2.6	Oligotrophic
15-Nov	7.7		Oligotrophic
Average	6.6	2.2	
2004 Avg	5.1	3.3	

Notes

Chlorophyll is a measurement of phytoplankton in the water column
Secchi depth measures zooplankton and phytoplankton in the water column
2005 results indicate an increase in water clarity and a decrease in plankton in the water column compared to 2004

Macrophytic algae (large species) and aquatic plants would not influence water clarity directly but may survive at a greater depth

The depth recorded this year was greater on average compared to 2004. A greater Secchi depth means that sunlight penetrates deeper in the lake and effectively means there is a greater habitat area for algae and aquatic plants which must photosynthesize. The depth recorded is consistent with an Oligotrophic lake however increased lake clarity is largely attributed to the presence of Zebra Mussels which filter plankton.

MOE data from 1975 indicated that the average Secchi depth for that year was 3.8 m compared to 6.6 m in 2005. This change is consistent with other lakes in the area that have been affected by Zebra Mussels. The same data in 1975 estimated the littoral zone at 25% of the lake. (The littoral zone is defined as the surface area that supports submerged and emergent plant life.) With the additional sunlight penetration into the water due to greater water clarity in 2005, the littoral zone would be larger compared to 1975. Zebra Mussels were not present in the lake in 1975.

The thermocline in 1975 was at the 7 m level and the temperature dropped to about 5 C in the hypolimnion. The thermocline location at 7 m is consistent with 2005 however the water was about 3 degrees cooler in the deep water in 1975.

The oxygen levels did not drop in the hypolimnion during the late summer in 1975 as we have seen in 2004 and 2005. In 1975 the oxygen levels in August remained at the 8 ug level which is about double the 2005 level. Oxygen depletion is often caused by bacterial blooms caused by organic loading due to soil erosion or decay of excessive algae growth.

pH Levels (acidity)

The acidity in lake water usually changes from slightly acidic in the spring to slightly basic (alkaline) in the summer. Rain is often acidic especially in the areas downwind from the industrial northeast, and heavy precipitation can have the effect of changing the pH level. Lower pH levels are more strongly acidic. The pH scale is a measurement of free hydrogen ions in solution which causes acidity.
Microscopic algae and zooplankton live in a very narrow pH range. Small and largely imperceptible changes to pH levels in the lake water may create large changes in microscopic life in Otter Lake.

pH LEVELS OTTER LAKE 2005 AVG OF OLLA 2 AND 6

Date	pH	
25-Apr	6.1	slightly acidic
28-May	6.6	slightly acidic
28-Jul	7.9	alkaline
18-Sep	7.5	alkaline
23-Sep	7.9	alkaline
13-Nov	6.5	slightly acidic

Notes

a pH of 7 is considered neutral
pH of 2 is strongly acidic, pH 6 is slightly acidic
Early spring runoff from snowmelt is acidic
pH variances influence phytoplankton populations
Readings between 6.5 and 8.5 are considered normal

Water acidity followed a predictable pattern with slight acidity in the spring and then became alkaline in the summer. All readings were in the expected range for a fresh water lake in Ontario. The abundance of limestone in the area has a buffering effect on the lake which would make strong shifts to acidic conditions unlikely.

Dissolved Oxygen

Oxygen is required for all life in the water. Aqueous oxygen is generated by algae when it is photosynthesizing and it is supplied from the atmosphere at the water-air interface. Once the thermocline is in place in the spring, the cold, deep hypolimnion water is cut off from the surface and since very little algae lives there, there is no source of fresh oxygen until the late fall turnover. There is however organic matter that falls down from above in the form of dead algae, eroded soil, leaves etc, and bacteria which consume oxygen decompose this material. The greater the organic loading, the faster the depletion of oxygen in the hypolimnion. The importance of this phenomenon is that cold water fish that live in the deep water can become oxygen-stressed in the late summer if the levels drop below 6 mg per liter.

DISSOLVED OXYGEN mg/Liter 2005 OTTER LAKE

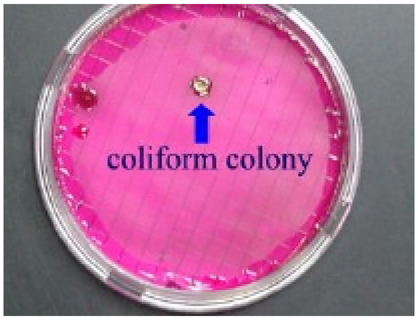
DATE	OLLA 2	OLLA 4	OLLA 5 (1m)	OLLA 5(20m)	OLLA 6(1m)	OLLA 6(20m)	OLLA 7	OLLA 8	OLLA 10	OLLA 12	OLLA 15	OLLA 17
28-May	10.4		10.3	11.1								
12-Jun	8.6	9.4		8.9		8.8	11.1	9.9				
28-Jul	8.1	9.2		5.4		6.2	9.1	9.2				
18-Sep	7.9	8.7		4.1		3.7	8.2	8.8				
23-Sep	10.1	9.1	8.8	3.6	9.1	3.9		9.7	9.8	9.2	9.4	9
13-Nov	10.1	9.6					10.2	10.4	10.1			

Notes DO levels were slightly reduced compared to 2004 but adequate for warm-water fish
DO in the highlighted 20 meter basins declines to levels that will cause stress for cold-water fish such as trout
Deep basins are not replenished with oxygen until the fall turnover when temperature approaches 4 C
There is little mixing of the epilimnion and hypolimnion during the summer so oxygen gradually depletes

The MOE data from 1975 indicate that the oxygen levels are not significantly different in the upper or lower levels in the early summer compared to 2005. The deep water oxygen levels did not show the same rate of depletion in the late summer as the readings indicate in 2005. In 1975 the oxygen level did not degrade to less than 6 mg at any time during the late summer. This would indicate that the cold water fish population was not under any oxygen-related stress in 1975.

Coliform Bacteria Testing

Lab culture of coliform bacteria



Water samples are drawn and tested within 24 hours. The sample is diluted and applied to a specific nutrient medium and grown on Petri plates. After a certain time the colonies are counted and reported as a function of the number of bacteria per 100 ml of lake water.

BACTERIAL TESTING		**2005 OTTER LAKE**			**bacteria colonies per 100 ml of water**							
	OLLA 2	**OLLA 4**	**OLLA 5**	**OLLA 7**	**OLLA 10**	**OLLA 11**	**OLLA 12**	**OLLA 13**	**OLLA 14**	**OLLA 15**	**OLLA 16**	**OLLA 17**
JULY 28 SAMPLES												
TOTAL COLIFORM	2	8	2	8	22	2	6	10	26	14	2	2
E.coli	2	2	2	2	2	2	2	2	6	2	2	2
FECAL COLIFORM	2	2	2	2	2	2	2	2	8	2	2	2
AUG 15 FOLLOW-UP												
E.coli					1				1	1		
FECAL COLIFORM					1				1	1		
SEP 24 FOLLOW-UP												
TOTAL COLIFORM					25				21			
E.coli					1				1			
FECAL COLIFORM					1				1			

Notes

Provincial guidelines limit total coliform levels to 100 per 100 ml for general use such as washing and swimming

Coliform bacteria are found in the gut of animals and are considered reliable indicators of fecal pollution

The ratio of fecal coliform to total coliform levels can determine whether the source is human or natural

E.coli is found in mammals only and is indicative of pollution from human or livestock sources (not found in birds or fish)

No level of E.coli contamination is considered safe for drinking water

Nutrient Testing – Phosphorus and Nitrogen

Nutrient testing is one of the most important evaluations of water quality. Phosphorus is the most important nutrient element in most lakes because it is usually a nutrient in limited supply. This means that excess amounts of other nutrients will have no effect on the growth of plant life but incremental amounts of Phosphorus will have corresponding effects on the growth of plants and algae. In theory, for every extra gram of Phosphorus in the water, about 400 grams of plant material are produced.

Nitrogen is an important plant nutrient also but given that it is not a limiting factor in algae growth, there is only one test per summer conducted.

TOTAL PHOSPHORUS (ug/L) OTTER LAKE 2005

DATE	**OLLA 2**	**OLLA 4**	**OLLA 5**	**OLLA 6**	**OLLA 7**	**OLLA 8**	**OLLA 10**	**OLLA 12**	**OLLA 15**	**OLLA 17**	**Barkers**
25-Apr	7.35			17.85							
28-May	8.35	7.75	9.2	13.25	22.9	8.25	9.65	8.95		9.25	
12-Jun	26.9	18.5			26.4	14.4					
7-Aug	deleted	29.2	26.4	10.8	11.4	12.1	deleted		13.4		12.9
18-Sep	6.3	7.5			6.9	7					
13-Nov	8.5	8.1			8.8	6.5	16.8				
Average	11.48	14.2	17.8	13.97	15.28	9.65	13.23	8.95	13.4	9.25	12.9

2004 Avg	8	9	10	10	12	10

Notes
Two August readings were unusually high in two sites and were omitted from the results
The 2005 averages were higher than the 2003 and 2004 averages
The deep basin readings at OLLA 5 and 6 were unusually high and not reported
P is deposited by septic leaching, aerial dust, and fertilizer runoff
Readings indicate P is limiting factor and more P results in increased algae growth

TOTAL NITROGEN (ug/L) OTTER LAKE 2005

DATE	**OLLA 2**	**OLLA 4**	**OLLA 5**	**OLLA 6**	**OLLA 7**	**OLLA 8**
12-Jun	285	371	317	241	282	267

Notes
Levels consistently over 300 indicate a Mesotrophic status
These readings indicate that N is in surplus and P is the limiting growth factor
ie: more N will not necessarily cause more algae growth if P remains low
N is deposited by fertilizer runoff, septic leaching, and organic degradation

REGIONAL NUTRIENT LEVELS 1996-2005				
	1996		2005	
LAKE	SECCHI	PHOS	SECCHI	PHOS
OTTER	3.5	8.1	6.6	13.9
BIG RIDEAU	4.3	19.2	8.1	9.8
UPPER RIDEAU	1.8	25.2	4.4	25.7
OTTY	4.1	20.3	4.9	14.5
SAND	4.1	17.4	6.3	13.5

Notes: Data from Lake Partners Program, MOE

Phosphorus levels in 2005 were consistent with the long term averages although there is a rising trend indicated from the 1975 and 1996 data available. This trend is based on very limited data and should be interpreted with caution. Phosphorus levels can vary temporarily with inputs such as contamination from upstream sediments, deposition of certain types of sand or soil in the lake and from excessive dust conditions in the atmosphere. It can also be released from lake bottom sediments when dissolved oxygen levels are very low. Therefore trends should be assumed only when readings can be repeated.

The Nitrogen levels are within the normal standards for an Ontario lake and are less than the 1975 data available.

Nitrogen in water is often traced to runoff from lawns and farmland and the readings from 2005 indicate a general decline since 1975.

The test site called “Barkers” is situated upstream from Otter Lake in the creek that drains a significant agricultural area that is equipped with tile drains and a large wetland area. Both could be the source of nutrients. The results of the one test in August did not indicate that nutrient levels were any higher than the lake average.

OLLA 2 and OLLA 10 sites had readings that were above 100 ug of Phosphorus on August 7. These readings were not averaged into the others because they seemed unusually high. The other locations on August 7 showed Phosphorus readings elevated about 20%. September and November readings returned to lower levels.

CONCLUSIONS

Water level was a big topic of conversation in 2005. The level that was observed in August was likely the lowest since the mid sixties. The water flow out of Otter Lake essentially stopped in mid July when the lake level dropped to a point where the topography of Otter Creek does not allow a significant amount of water to escape the lake. Water levels are a function of a number of environmental factors including precipitation, evaporation, outflow/inflow, and groundwater springs and/or seepage. Buttle, Ensom, and Sibley estimated that about 2/3 of the precipitation falling on an Ontario lake evaporated during the season. We know that precipitation was minimal in 2005 between April and September. The Rideau Valley Conservation Authority classified the Otter Lake area as a class 2 drought area for most of August and September. Temperature of the water and air were higher than usual which enhances evaporation even further. Water levels were down on other uncontrolled lakes in southern Ontario but the drought was not as severe outside of the Lanark-Leeds area. It is concluded that the drought conditions were the most important factor that caused low water levels.

Water temperature reached its peak in August but had advanced to above 20 C early in the summer. This may have had a biological affect since the growth rates of algae and aquatic plant life is influenced by temperature. The thermocline was found at the 7 m level which was about average. The temperature in the hypolimnion was warmer than indicated from 1975 data.

Lake acidity was normal for the area and followed the expected pattern from spring acidity to summer alkalinity.

Dissolved oxygen is possibly the most important indicator of lake health and the good news is that near-surface levels were normal and within an acceptable range for a mesotrophic lake. The bad news is that late summer levels in the hypolimnion were below the levels required to support cold-water fish. Oxygen is depleted in the depths by bacterial action which is stimulated by supplies of organic material. Organic material can come from inflow creeks, decaying algae and plants, and soil erosion or soil/sand deposits.

The bacterial tests showed levels of fecal coliform bacteria and E.coli at all sites tested on July 28. Tests are usually taken after a significant rainfall so the test was delayed due to the continuing drought. There was a modest rainfall on July 27 and the samples were collected the following day. There were two sites which showed higher levels and these were retested twice during the season. Considering the tests last year, there are three sites which warrant greater inspection: OLLA 8, OLLA 10, and OLLA 14. The count profile indicates that pollution from a human source is likely (but not conclusive) in these areas. Although the bacteria counts are within provincial guidelines for recreational use, note that no level of E.coli is considered safe for drinking, so appropriate water treatment is necessary at all sites if lake water is used for drinking. E.coli is an indicator species of fecal contamination from mammals. The presence of E.coli indicates contamination from either humans or cattle. Since E.coli only survive at higher temperatures they live only a short time in the lake water. The repeated findings of E.coli indicate that the sources of contamination are continuous. Since there are no pastures or feedlots in direct contact with the lake it is probable that the source is from some human activity.

Nutrient levels were slightly higher than 2004 readings and two readings were exceptionally high and were deleted from the averages. High Phosphorus readings in conjunction with high bacteria readings can point to septic pollution. OLLA 10 showed high readings of both in 2005. The August Phosphorus readings were the highest in three years and may be a result of a July 28 rainfall which had the effect of flushing nutrients that had been held in the soil due to the drought. The levels were reduced in September. Nitrogen levels were normal. The comparison of other lakes in the area between 1996 and 2005 does indicate that Otter Lake has higher Phosphorus levels whereas other lakes remained similar or were reduced significantly. The data is based on Lake Partner data collected by the Ministry of Natural Resources. As expected, the water clarity as measured by Secchi depth is greater across all lakes. OLLA will be looking at Phosphorus levels closely to try to determine why Otter Lake has increasing levels while other lakes are decreasing.

In summary, there are a few issues that warrant close investigation: Bacterial levels at some locations, oxygen levels in the hypolimnion, and phosphorus levels. The development pressure is likely past the point where the lake can cope adequately with pollution due to the size and volume of the lake in relation to the number of residents and commercial establishments on the lake. But we can minimize the effects by vigilance and good management of septic systems, shorelines, and nutrient use.

Otter Lake residents have often compared the health of our lake with that of the Rideau system. Twenty years ago it compared favourably. Today, the Rideau is better than it used to be and Otter Lake has deteriorated in some respects so the gap has certainly narrowed. Despite the higher population density on Otter Lake compared to the Rideau it is possible to avoid the decline or even make improvements. Suitable planning and actions will be necessary to facilitate the changes though.

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