STATE OF THE

LAKE ENVIRONMENT REPORT 2003

RIDEAU VALLEY WATERSHED WATCH PROGRAM

THE ONTARIO TRILLIUM FOUNDATION
LA FONDATION TRILLIUM DE L'ONTARIO

FENDOCK

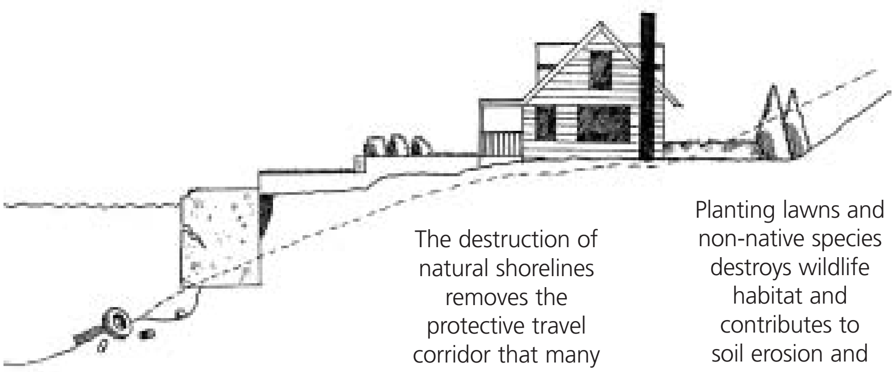
RIDEAU VALLEY
CONSERVATION AUTHORITY

COMMUNITY STEWARDSHIP COUNCIL OF LANARK COUNTY
Lanark

- Alliance of Rideau Lakes Associations
- Big Rideau Lake Association
- Eagle Lake Property Owners Association
- Farren Lake Property Owners Association
- Rideau Valley Conservation Foundation and its many donors
- Township of Bathurst Burgess Sherbrooke

"The Ribbon of Life" Where the Land Meets the Water

Water quality is affected by many things: natural processes of erosion and runoff accelerated by clearing of shorelines, the use of artificial fertilizers and leachate from sewage disposal systems. All result in too many nutrients reaching the lake.



Retaining walls destroy littoral zones. Waves deflected off retaining walls, stir up contaminated sediments and destroy vegetation.

The destruction of natural shorelines removes the protective travel corridor that many species rely on in their journeys between land and water.

Planting lawns and non-native species destroys wildlife habitat and contributes to soil erosion and a reduction in water quality.

Too many nutrients causes profuse weed and algae growth which affects the aquatic animal species makeup by altering habitat and food sources and by reducing oxygen and light penetration.

The shallow waters and first ten metres of shoreland area form a "Ribbon of Life" around lakes. This ribbon — where the land meets the water — is where much of the lake life is born, raised and fed. Many landowners, unaware of the importance of this area, have cleared the shorelines of native vegetation and replaced it with lawns, non-native ornamental vegetation, retaining walls and boathouses. This has a negative effect on fish and wildlife habitat and water quality. Natural vegetation retained or restored along the shoreline helps prevent erosion and improves water quality by binding nutrients before they can enter the lake.

The Rideau Valley Conservation Authority has long recognized the recreational and aesthetic value of lakes within the watershed and is committed to maintaining and protecting water quality and fish habitat. The Conservation Authority has joined together with volunteer Lake Stewards throughout the watershed to take steps to protect and restore water quality by launching the **Watershed Watch** program. **Watershed Watch** is an environmental monitoring and awareness program. The objectives of the program are to collect reliable environmental data to document current water quality conditions and use the data as an essential educational tool to encourage shoreline residents, both seasonal and permanent, to become personal stewards of their lake and to adopt sound stewardship practices aimed at preserving and protecting water quality. By taking an active role in restoring and enhancing their shoreline, they can help to maintain water quality and a healthy lake environment.

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 centimetre black and white disk attached to a measured line that is lowered into the lake until it is no longer visible. Analysis of water samples for **chlorophyll a**, which provides the green pigment in phytoplankton, gives a more specific measure of the abundance of small creatures in the water. Another perspective is gained through analysis of samples for nutrients, particularly **phosphorus** but also **nitrogen**, which tells how much food is available for the algae and aquatic plants. In the late summer when the algae drops to the bottom of the lake, its decomposition uses oxygen so, to find out how much oxygen is available for fish and other aquatic animals, **dissolved oxygen and temperature** profiles are done.

These tests combine to 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 and sufficient oxygen available. Young or **oligotrophic** lakes have very little or no vegetation and are usually well oxygenated but have relatively few fish species.

While lake users are interested in how weedy a lake is and what kind of fishing stories they can experience, they also want to know if the water is safe for drinking and swimming. Eschericia coli (**E.coli.**) are in a family of fecal coliform bacteria common to warm-blooded mammals. A few members of the family are harmful themselves but E.coli. are also a good indicator of the presence of pathogenic or other hazardous bacteria because where there is E.coli., the others will usually be present. Analysis of water samples for E.coli., which is relatively more abundant and easier to count than the other organisms, gives an indication of problems with leaking septic systems or other sources of contamination.

Through **Watershed Watch**, lakes in the watershed will be monitored for these key water quality indicators. Knowing what is in the water will assist the lake stewards when devising a strategy to protect the Ribbon of Life which will reduce the human impact on the aging process and ensure that our lakes will endure for future generations to enjoy.

FIVE EASY STEPS TO IMPROVE WATER QUALITY

1. Build at least 30 metres away from the shoreline.
2. Keep your lot well treed and preserve or replant native vegetation along the shoreline.
3. Pump out your septic tank every three to five years and have the tank and tile field inspected periodically.
4. Reduce water use and use phosphate free soaps and detergents.
5. Keep the size of your lawn to a minimum and do not use fertilizers, herbicides or pesticides.

Low Phosphorus Lifestyle

Human Waste	535 g
No Dishwasher	0 g
No fertilizer	0 g
Uses phosphate-free products	20 g

High Phosphorus Lifestyle

Human Waste	535 g
Dishwasher using powdered detergent once per day	650 g
Lawn fertilized once/year	1,960 g
Uses products with phosphates	180 g

In a Bit More Detail:

The basic characteristics of a lake depend on the physical properties (dimensions and geology) and climate. Six processes or actions further define an individual lake:

- Precipitation directly onto the lake surface deposits phosphorus and other chemicals and runoff from the lake watershed carry bacteria and pathogens, plant debris and soil particles which bear phosphorus and other chemical elements, into the water ;

- Use by aquatic plants of the nutrients (phosphorus, etc.) has two impacts:
  - plant communities develop in the lake, becoming profuse over time, which limits the development and diversity of other plants and aquatic animals, and
  - along with plant debris and sediment from the shoreline, dead phytoplankton and other plants settle to the lake bottom where it decomposes using up oxygen and releasing nutrients;

- Each spring and fall temperature changes in the lake cause a mixing or turnover of the waters which can bring phosphorus from bottom waters to the surface to be available for aquatic plant and microorganism growth;

- A "sink" of phosphorus is created by settling of phosphorus-bearing sediment and the decay process at the bottom of all lakes with the phosphorus either held adsorbed to the lake bed soil particles when dissolved oxygen levels are high or in solution when the dissolved oxygen levels decline.

- After the spring turnover, the lake warms and stratification occurs creating a warmer surface layer (epilimnion), a transition zone (metalimnion) and colder deep waters (hypolimnion). As water warms, the ability to hold dissolved oxygen decreases. While the warm waters of the epilimnion can hold less the air/water contact and wave action ensures that there is a constant supply. As the deep waters of the hypolimnion warm, there is no mechanism to get new oxygen. The demand for oxygen for the decay process can cause the hypolimnion to become anoxic (no dissolved oxygen);

- Lakeshore development affects the shoreline runoff/erosion characteristics which usually leads to increased sediment, bacterial and nutrient loading of lake waters by changes to the vegetation composition, hardening the surface (buildings, roads, retaining walls, etc.) and installation and operation of septic facilities;

There are several methods of measuring the impacts of these processes or actions. The common ones are:

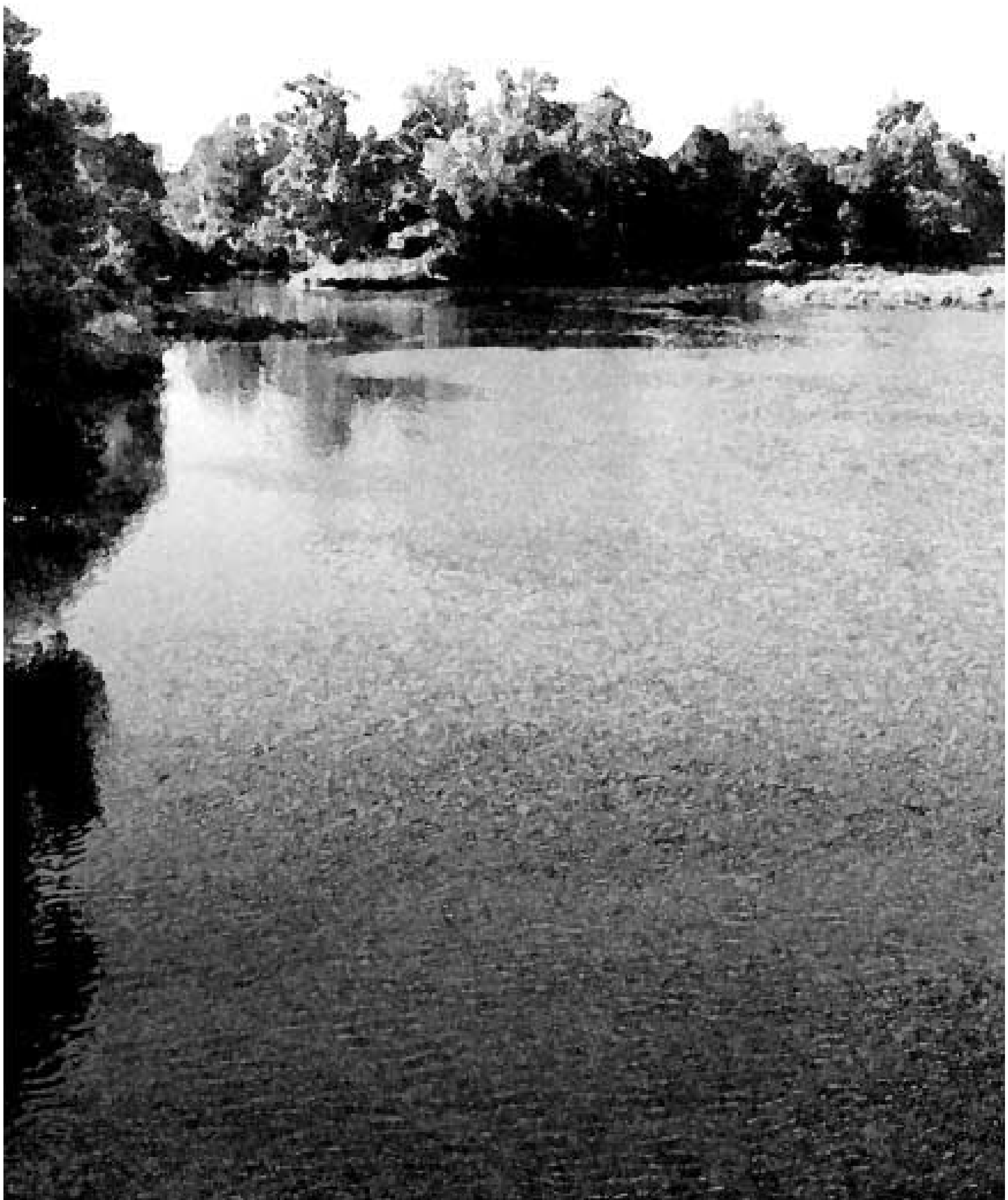
- measurement of **water clarity** or the presence of suspended material using a **Secchi disk**,
- dissolved oxygen (DO)/Temperature profiles to show what the extents of the habitable waters are (most fish species inhabit the warmer, oxygenated surface waters),
- analysis of samples for nutrients: **Total Phosphorus (TP) -** the limiting nutrient for plant and microorganism growth, and/or
- presence or concentration of phytoplankton indicated by the amount of **chlorophyll a**, a pigment in phytoplankton (aquatic plants) – Chlorophyll a was used as the primary indicator of lake trophic state (age or nutrient level) until 1994 when it was replaced by total phosphorus because sampling and analysis for TP was shown to be more reliable and more economical. The relationship between the two is that chlorophyll a is one of the pigments found in phytoplankton giving it a green colour and phosphorus is the primary nutrient for the phytoplankton. In other words, the higher the concentration of TP, the greater the potential for growth of phytoplankton would be which, in turn, would mean that there would be a correspondingly high concentration of chlorophyll present. In such a case, the water clarity could be poor from the abundance of suspended plant material.

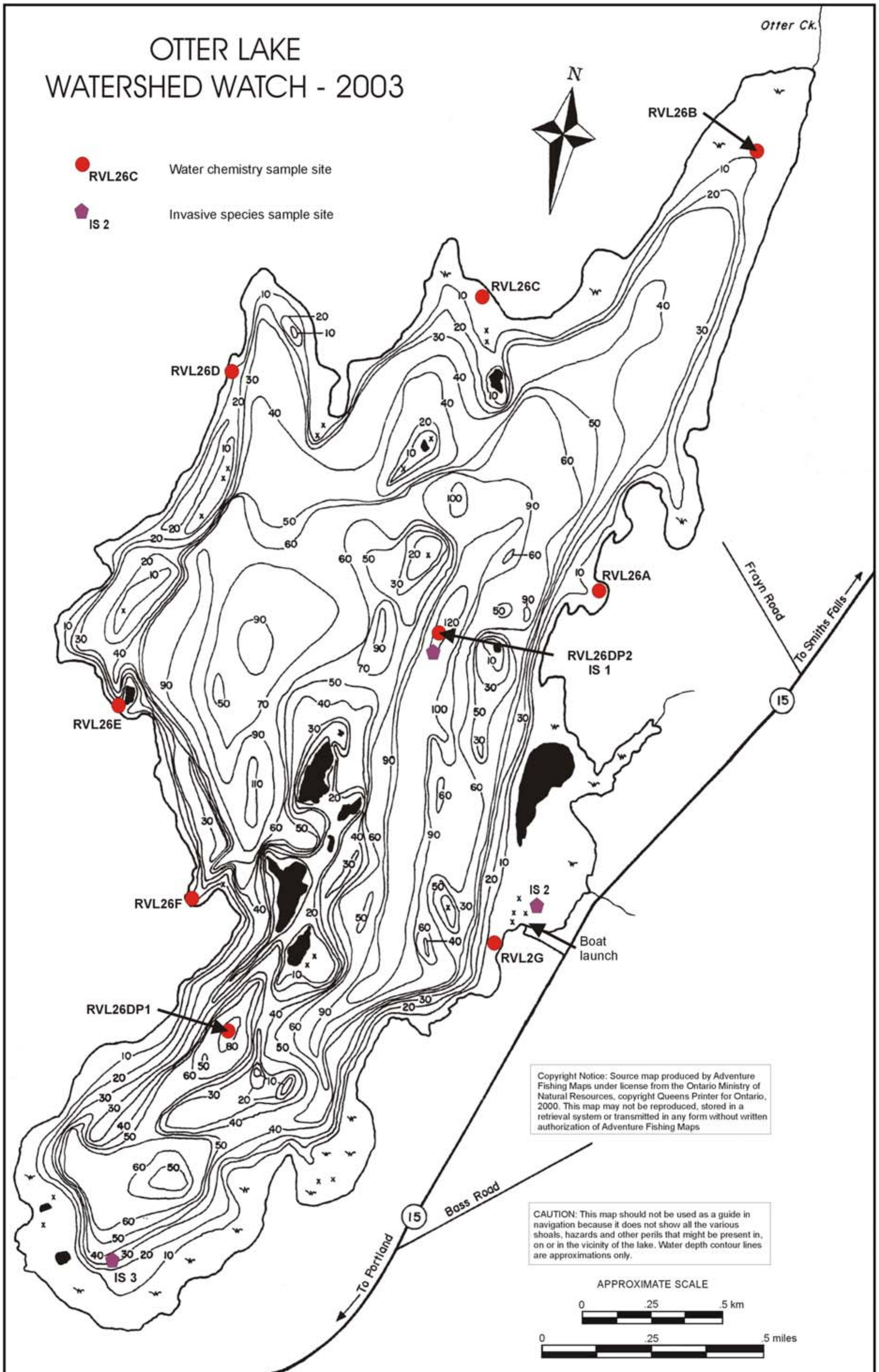
Added for the Watershed Watch program were:

- Total Kjeldahl Nitrogen (TKN), a secondary nutrient, to see what is available to work with the phosphorus and to see if the high counts found elsewhere in the watershed occur in the lakes;
- Eschericia Coliform (E.Coli) sampling around the lake nearshore to check for bacterial pollution problems, and
- Dissolved Organic Carbon (DOC) that comes typically from wetlands and can have a limiting effect on the nutrient uptake process.

Otter lake 2003

published July, 2005




OTTER LAKE
WATERSHED WATCH - 2003
RVL26C
Water chemistry sample site
IS 2
Invasive species sample site
N
Otter Ck.
RVL26B
RVL26C
RVL26D
RVL26A
RVL26DP2
IS 1
RVL26E
RVL26F
IS 2
Boat
launch
RVL2G
RVL26DP1
IS 3
Frayn Road
To Smiths Falls
15
Bass Road
15
To Portland
Copyright Notice: Source map produced by Adventure Fishing Maps under license from the Ontario Ministry of Natural Resources, copyright Queens Printer for Ontario, 2000. This map may not be reproduced, stored in a retrieval system or transmitted in any form without written authorization of Adventure Fishing Maps
CAUTION: This map should not be used as a guide in navigation because it does not show all the various shoals, hazards and other perils that might be present in, on or in the vicinity of the lake. Water depth contour lines are approximations only.
APPROXIMATE SCALE
0 .25 .5 km
0 .25 .5 miles

OTTER LAKE – 2003

LOCATION:	Township of Rideau Lakes. Spring fed, inflow from adjacent wetlands. Outflow through Otter Creek
ELEVATION:	lake surface approximately 124 metres above mean sea level
DIMENSIONS:	perimeter: 20.1 kilometres; maximum depth: 36.6 metres.; area: 600 hectares; volume: 60,460,000 m^3
LAKE WATERSHED:	drainage area: 4655 hectares
FISHERY:	cool water fishery - splake, rainbow trout (stocked 1999) - northern pike, largemouth and smallmouth bass.
DEVELOPMENT LEVEL:	328 properties (2003)
BACKGROUND DATA:	Ministry of Environment Self-Help and Lake Partner Programs (1975-1982); Ministry of Environment Recreational Lakes Program (1975, 1981,1982); Otter Lake Water Quality Monitoring Report 2002 (Centre for Sustainable Watersheds)

The sampling component of the Watershed Watch program consisted of the following:

SITES:	one site at two deepest points of lake, seven around shoreline adjacent to cottage groupings (see map)
TOTAL PHOSPHORUS (TP):	a composite sample taken in the euphotic zone (layer which light penetrates – twice the secchi disk depth) at the deepest points (where there is least point source input) and one metre above the bottom; at seven shoreline sites at approximately half metre depth in one metre of water
TOTAL KJELDAHL NITROGEN (TKN):	samples from deepest points at the surface and one metre above the bottom; at seven shoreline sites at half metre depth in one metre of water
SECCHI DISK (SD):	at deepest points – measurement is depth where disk can no longer be seen
DISSOLVED OXYGEN/TEMPERATURE (DO):	at deepest points readings taken at intervals from surface to bottom and back to the surface
CHLOROPHYLL a (Chl):	a composite sample taken in the euphotic zone (layer which light penetrates – twice the secchi disk depth) at deepest points **not done in 2003 Watershed Watch**
ESCHERICHIA COLI (E. Coli):	at seven shoreline sites at approximately half metre depth in one metre of water
INVASIVE SPECIES (IS):	**not done in 2003 Watershed Watch,** done as part of Ontario Federation of Anglers and Hunters/RVCA project in 2004.
BENTHIC MACRO INVERTEBRATES:	three shoreline sites with three replicates at each site.

Looking a little deeper:

An obstacle to assessing the condition of lakes is the length of the historical data record. There is a relatively moderate length historical dataset for Otter Lake. It should be noted, however, that field collection and lab analytical methods have changed over the years and the data comes from various programs each with different sampling periods (one, two or more months from spring to fall) and frequencies (one or several times in a sampling period). This can mean that an assessment of a historical dataset is a comparison of similar but not identical elements. Nevertheless, the data does provide an indication of the condition of the lake and is sufficient for setting goals for future lake stewardship.

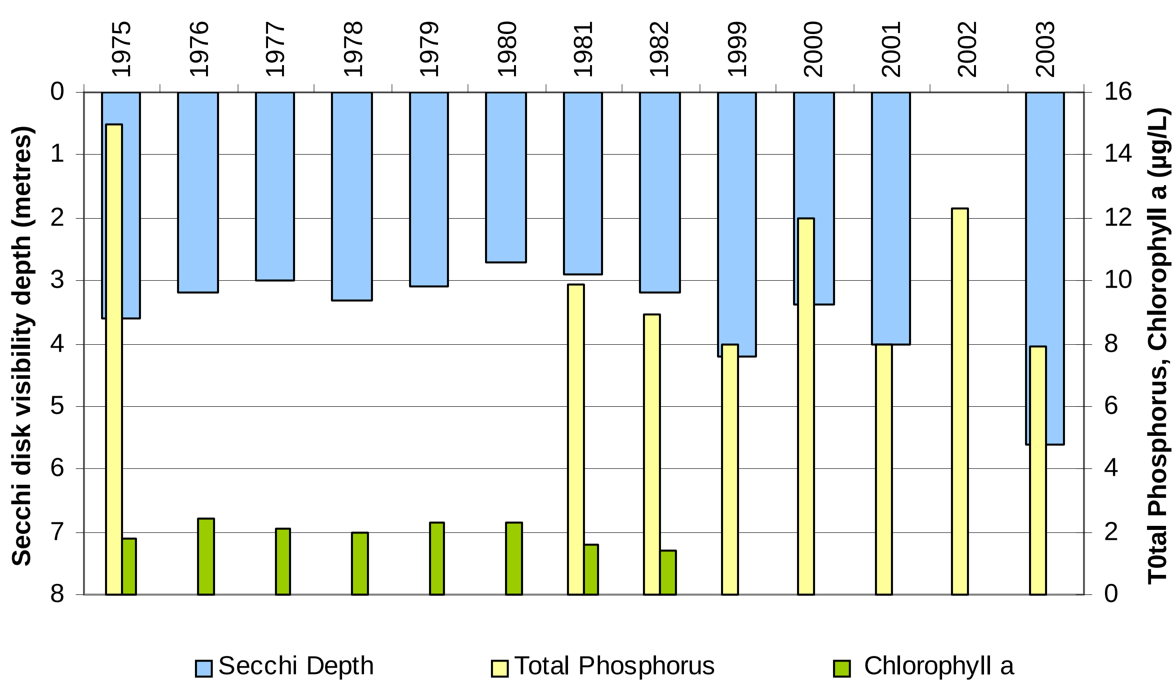
Note: This report was completed in July, 2005. To augment the data from the Watershed Watch sampling done in 2003 and provide as current a picture of conditions in Otter Lake as possible, data from 2004 benthic invertebrate monitoring have been included.

Table 1: Otter Lake, Historical Data - 1975-2003

Sample Year	Secchi Disk (metres)	Total Phosphorus - surface (µg/L)	Total Phosphorus - bottom (µg/L)	Total Kjeldahl Nitrogen (µg/L)	Chlorophyll a
1975	3.6	15	16	443	1.8
1976	3.2				2.4
1977	3.0				2.1
1978	3.3				2.0
1979	3.1				2.3
1980	2.7				2.3
1981	2.9	10	21	434	1.6
1982	3.2	9	12	394	1.4
1999	4.2	8			
2000	3.4	12			
2001	4.0	8			
2002	3.3	12			
2003	5.6	8	10	424	
Number	13	8	4	4	8
Maximum	5.6	12	21	443	2.4
Minimum	2.7	1	10	394	1.4
Mean	**3.5**	**10**	**15**	**424**	**2.0**

Single sample

Figure 1: Otter Lake, Historical Water Clarity and Nutrient Load



In the early seventies, phosphates, the form of airborne and runoff loading of **Total Phosphorus (TP)** to lakes, were being phased out of industrial and residential use. Several other lakes in the Rideau watershed had routinely high concentrations of TP at that time that produced correspondingly high growth of aquatic flora and fauna, as measured by concentrations of **chlorophyll a**. The data (Table 1, above) indicate that that was not the case for Otter Lake where the average concentration of TP for 1975, higher than what has been found in recent years, was not, however, high by comparison to other area lakes and was below the present **Provincial Water Quality Objective (PWQO)** (20 micrograms per litre (μg/L) of sample, above which excessive plant growth can be expected). The chlorophyll a concentration and the average of **Secchi disk** measurements (measure of water clarity) for that year were in keeping with the TP results. Through 1982, concentrations of chlorophyll a remained low with a downward trend in 1981 and '82, and water clarity was reasonably good. From 1999, when water quality monitoring was resumed, to 2003, average concentrations of TP, which replaced chlorophyll a as the indicator of lake productivity in 1994, have fluctuated in a relatively narrow range well below the PWQO. The Secchi disk measurements have increased but, unfortunately, this improvement is likely to be more of a measure of the impact of the arrival of Zebra mussels than lower TP loading.

Low TP concentrations continued to be the normal condition through 2003 as shown by sample results from the two deep points in Otter Lake (Table 2, column 2, below). It is interesting that the results vary markedly at the two sites over the sample period, yet the average concentrations of surface and bottom samples are about the same.

Much of the phosphorus in water bodies eventually reaches the bottom and becomes bound in the sediments. As oxygen concentrations are depleted in the bottom water, some phosphorus is released from the sediments into solution and can be recycled to upper levels. That does not appear to be a problem for Otter Lake where concentrations of TP at the bottom have reflected the relatively low concentrations at the surface (Table 1, column 4, above and Table 2, column 3, below).

Nitrogen is usually the secondary nutrient in lakes. In the Watershed Watch program, it has been measured by the concentration of **Total Kjeldahl Nitrogen (TKN)**. The limited historical TKN sample results and the 2003 data are fairly consistent (Table 1 and Table 2). The indication is that Otter Lake appears to suffer from the problem common to many lakes in the watershed of elevated background nitrogen concentrations. This actually only becomes a problem if the balance of the forms of nitrogen change, which could cause toxic conditions for fish, and/or, if TP concentrations increase, there would be excessive amounts of nitrogen available to work in concert with the phosphorus.

Table 2: Otter Lake, 2003 - Deep Points

sample date	TP DP1, surface (μg/L)	TP, DP2, bottom (μg/L)	TKN DP1, surface (μg/L)	TKN, DP2, bottom (μg/L)	Secchi disk (metres)
June 11	7	10	420	440	3.8
June 25	5	10	420	500	4.0
July 9	9	9	450	450	6.5
July 23	9	9	510	430	5.0
Aug. 6	13	13	460	420	5.3
Aug. 20	8	7	430	380	6.5
Sept.16	10	12	410	390	7.0
Oct. 22	9	12	440	450	7.3
2003 AVERAGE:	**9**	**10**	**443**	**433**	**5.7**

sample date	TP DP3, surface (μg/L)	TP, DP4, bottom (μg/L)	TKN DP3, surface (μg/L)	TKN, DP4, bottom (μg/L)	Secchi disk (metres)
June 11	10	7	440	420	6.0
June 25	8	9	400	420	5.8
July 9	10	10	460	460	4.8
July 23	8	10	470	450	5.5
Aug. 6	15	13	460	400	5.8
Aug. 20	9	8	460	400	7.5
Sept.16	9	9	410	380	4.5
Oct. 22	9	10	440	390	5.3
2003 AVERAGE:	**10**	**10**	**443**	**415**	**5.6**

Figure 2: Otter Lake DP1 - 2003 - Water Clarity and Nutrient Load

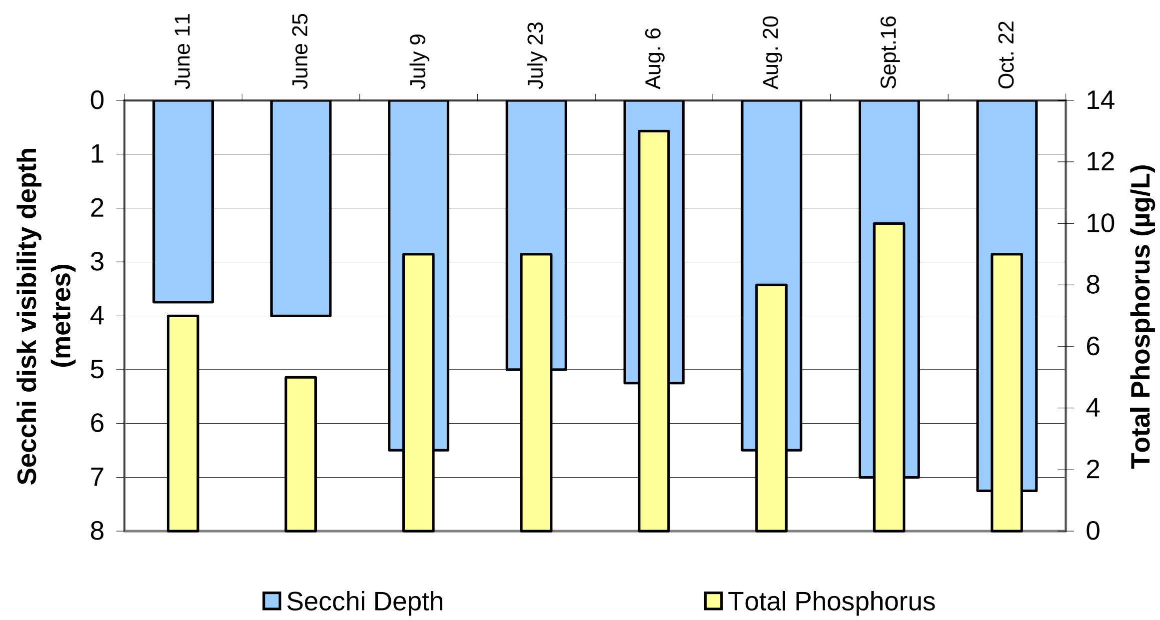
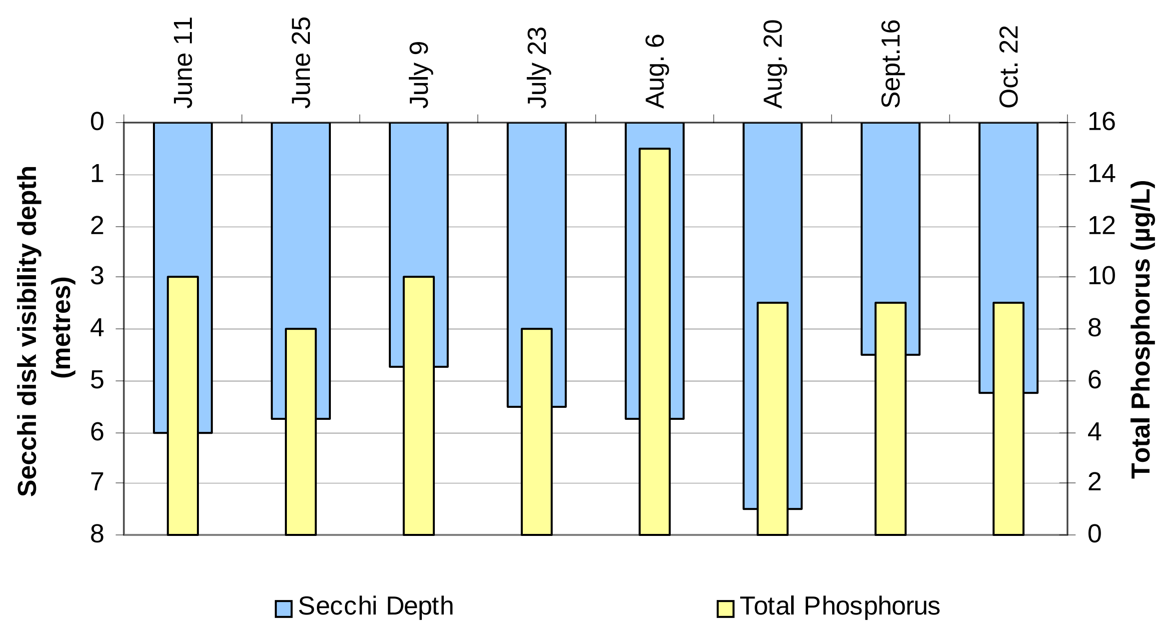


Figure 3: Otter Lake DP3 - 2003 - Water Clarity and Nutrient Load



Dissolved oxygen and temperature profiling is important for lakes because both parameters affect all aquatic organisms and the chemistry of the lake environment. The primary source of oxygen in aquatic systems is the atmosphere with wind action constantly recharging the surface waters with oxygen. Lake waters also gain 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. Because the lake becomes thermally stratified early in the summer, oxygen cannot be replenished in the water in the hypolimnion, the lower part of the lake, so that, as oxygen levels are lowered, phosphorus in the bottom sediments becomes more readily soluble adding to the loading available for plant growth.

Dissolved oxygen and temperature profiles were taken at both deep-point sites (DP1 and DP3) on a monthly basis (results shown as an Appendix). In terms of fish habitability, conditions were at the worst in September in 2003 when temperatures were adequate for the salmonid species (trout) in only seven metres of the total depth at site DP1. Fortunately, the deeper waters at site DP3 provided a greater depth of seventeen metres. Warmer water fish species (pike and bass) had ample habitable depths throughout the year. Near anoxia (no oxygen) occurred at both sites but much less so at DP3. Similar results were found by Centre for Sustainable Watersheds staff in profiles done throughout 2002 with worst case conditions achieved by September. Data from two profiles done in August, 2001, a drought year, by Ministry of Environment staff indicated that Otter Lake can be susceptible to prolonged dry and hot conditions. It appears that the lake was acutely inhospitable for trout and splake with temperatures reaching 24 degrees Celsius at eight metres and less than 4 milligrams per litre oxygen concentrations below that.

Near the shore:

In addition to sampling at the deep point in the lake, the Watershed Watch program included sampling at a number of sites near the shore. The objectives were:

a) To look at the phosphorus and nitrogen distribution around the lake.

b) To do general sampling for bacterial pollution (E.Coli) in proximity to the developed areas to see if there was a problem with septic and grey water entering the lake.

Total Phosphorus was fairly evenly distributed around the lake during the sampling period (Table 5, below). Four out of the 72 surface samples (5.5%) exceeded the PWQO. Two of these high concentrations were at the outflow to Otter Creek (site "B") where some accumulation is to be expected. The high concentration at site "C" on July 9 was not repeated and it is not useful to speculate about the source particularly because there was no corresponding high concentration of TKN or counts of E.Coli that would indicate a septic source or animal congregation. Concentrations were highest on July 9th and August 6th, which coincided with large green algae blooms.

<u>Table 5: TP (µg/L) – Otter Lake (RVL-26)</u>

SITE	A	B	C	D	E	F	G	DP1	DP2	DP3	DP4
11-Jun	8	10	10	8	8	11	10	7	10	10	7
25-Jun	7	8	8	7	6	6	7	5	10	8	9
09-Jul	8	10	51	20	8	15	9	9	9	10	10
23-Jul	8	21	7	15	8	11	8	9	9	8	10
06-Aug	11	21	11	11	12	13	10	13	13	15	13
20-Aug	7	8	7	8	6	6	7	8	7	9	8
16-Sep	7	8	8	7	7	8	8	10	12	9	9
22-Oct	10	7	7	11	9	11	8	9	12	9	10
average	8.3	11.6	13.6	10.9	8.0	10.1	8.4	8.8	10.3	9.8	9.5

2003 AVERAGE, SITES A TO G, DP1 AND DP3: 9.9

The upper end of the range of the RVCA guideline for **Total Kjeldahl Nitrogen (TKN)** is 500µg/L. Seven out of the 72 samples (8%) had results above this concentration (Table 6, below). Three of those were at the mouth of Otter Creek, where TP was also high. These TKN concentrations are similar to other lakes in the area and the Tay River where a prevalence of high TKN values suggests that there may be a naturally occurring background level. The TKN concentrations measured by the Centre for Sustainable Watersheds in 2002 were higher likely because of a wetter season causing more run-in from streams and the lake shore.

Table 6: TKN (µg/L) - Otter Lake (RVL-26)

SITE	A	B	C	D	E	F	G	DP1	DP2	DP3	DP4
11-Jun	440	450	450	450	440	460	470	420	440	440	420
25-Jun	430	440	430	440	420	410	450	420	500	400	420
09-Jul	460	530	530	470	450	500	470	450	450	460	460
23-Jul	450	520	440	470	460	460	510	510	430	470	450
06-Aug	440	500	460	470	480	480	440	460	420	460	400
20-Aug	430	470	450	460	470	430	44	430	380	460	400
16-Sep	400	440	430	410	430	430	410	410	390	410	380
22-Oct	440	460	420	460	430	460	460	440	450	440	390
average	435.7	478.6	455.7	452.9	450.0	452.9	399.1	442.9	430.0	442.9	418.6

2003 AVERAGE, SITES A TO G, AND DP1 AND DP3: 445.6

Escherichia coliform (E.Coli) is used as an indicator of the potential presence of other harmful bacteria and pathogens in water. The main sources of bacteria are animal (decay of dead animals, defecation near and in the water) and human waste (septic systems, grey water). Levels above the Provincial Water Quality Objective (PWQO) of 100 counts/100mL can mean that the water is unsafe for swimming. As a general precaution, lakes should not be used untreated as the primary drinking water source and use for washing and cooking should be limited.

Table 7: E.Coli. (counts/100 mL) - Otter Lake (RVL-26)

SITE	A	B	C	D	E	F	G
11-Jun	2	2	2	2	2	2	2
25-Jun	0	1	20	10	0	2	0
09-Jul	2	4	2	2	2	2	2
23-Jul	2	2	2	2	2	2	2
06-Aug	2	2	2	2	2	2	2
20-Aug	2	6	2	2	2	2	2
16-Sep	2	2	2	2	2	2	2
22-Oct	2	2	N/A	N/A	1	4	3
average	1.8	2.6	4.6	3.1	1.6	2.3	1.9

2003 AVERAGE: 2.5

In the 2003 sampling there were no occurrences of E.Coli counts exceeding the PWQO. Persistent occurrences of high counts over two or more sample dates would indicate the possibility of a bacteria pollution source that should be further investigated. The June 25th sampling noted two slightly elevated counts, but remainder of the samples showed only background counts. The results for Otter Lake indicate that there are generally very low levels of E.Coli bacteria in the water. While all parts of the lake were not sampled, the E.Coli results indicate that the waters of Otter Lake did not pose a health concern for cottagers and residents for swimming and other water contact recreational use.

(Note: Not all bacteria are harmful. Some can be a food source for macroscopic aquatic invertebrates. Also, what is commonly referred to as blue-green algae, are bacteria which share many characteristics with algae and can be toxic to aquatic species as well as cause reactions in humans).

Dissolved Organic Carbon (DOC) has been receiving greater research attention in recent years. It appears that it can interfere with the nutrient uptake process by aquatic plants in Canadian Shield lakes if it is in sufficient concentration and from the "right" source (incoming rather than "resident" in the lake). Elevated DOC can impede the decay process so that, for example, branches falling in the water will accumulate on the bottom in much the same condition as when they fell. Lakes with such conditions are being referred to as dystrophic, rather than eutrophic. Because research is ongoing into the effects of DOC, our main purpose in measuring DOC concentrations at this time is to build a dataset that can be compared to research results. No firm conclusion can be drawn at this time except that it appears that DOC concentrations in Otter Lake are moderate and are resident. This data is available for those who are interested by contacting the RVCA.

Benthic Invertebrates:

In addition to chemical testing, the Watershed Watch program included sampling for benthic macro-invertebrates which, in simple terms, are the bugs that live in the water. The analysis of what actually lives in the lake is an excellent complement to chemical analysis of the shore waters because it gives a longer term look at what creatures the lake can support. The more varied and numerous the macro invertebrates, the better the water quality. A total of 3 sites were sampled in 2003 on Otter Lake.

Taxa Richness

Taxa Richness indicates the health of the community. The greater the number of taxa found within the community, the healthier the community. Generally, a taxa count above 10 can be considered to have excellent family diversity and communities are very stable. Anything below 5 indicates that families have low diversity and communities are unstable. Samples collected from Buck Bay show healthy and stable communities.

Table 6: Taxa Richness- Otter Lake (RVL-26)

SITE	REPLICATE 1	REPLICATE 2	REPLICATE 3
OL-1	7	10	9
OL-2*	8	8	8
OL-3	9	12	13

*Site OL-2 was sampled in a location minimally impacted by development

Tolerance Index

The chart below categorizes the taxa into various pollution tolerances those being sensitive, somewhat sensitive, and tolerant.

SENSITIVE	SOMEWHAT SENSITIVE	TOLERANT
Pollution sensitive organisms found in good water quality	Somewhat pollution tolerant organisms that can be found in good or fair water quality	Pollution tolerant organisms can be found in any quality of water
Caddisfly larvae Hellgrammite Mayfly nymphs Gilled snails Riffle beetle adult Stonefly nymphs Water penny larvae	Beetle larvae Clams Crane fly larvae Crayfish Damselfly/dragonfly nymphs Scuds Sowbugs Fishfly/alderfly larvae	Aquatic worms Blackfly larvae (simuliidae) Leeches (hirudinae) Midge larvae Pouch (and other) snails

As with the chemical testing, the tolerance index indicated good water quality for Otter Lake with the sensitive organisms dominating. Further information on benthic macro invertebrate testing, including complete data sets, graphs and site photos are available at **http://www.rideauvalley.on.ca**, within the surface water quality section or by contacting Jennifer Lamoureux at the RVCA.

Invasive Species:

Zebra mussels have been in Otter Lake for a few years. Signs have already been posted at public boat launches to inform users of the lake. Residents and property owners need to ensure that precautions are taken to prevent the spread of these invasive species into other lakes in the region. Sampling for another invasive species, the Spiny Water Flea, was done in 2004. None were detected.

The Ontario Federation of Anglers and Hunters, in co-operation with the ministry of Natural Resources have published "ZEBRA MUSSELS: A Guide for Boaters and Cottagers". This free publication is available along with other invasive species information including programs, fact sheets, brochures, watchcards, signs and stickers. OFAH also have videos and slide presentations available for purchase or loan, suitable for lake association meetings and information sessions. Visit **http://www.invadingspecies.com** or call the Invading Species Hotline (1-800-563-7711) for more information.

In conclusion:

Unfortunately, Otter Lake does not have lengthy historical data available, therefore, determining the long term trend is difficult. From the historical data available and the Watershed Watch sampling through the summer of 2003, Otter Lake appears to be in reasonably good health despite occasionally elevated concentrations of total phosphorus and total Kjeldahl nitrogen. No high counts of E.Coli were encountered. Water clarity measurements indicated a slightly better condition but some of that can be attributed to the work of zebra mussels. Benthic populations show a good diversity including species sensitive to pollution, indicating good habitat conditions and longer term water quality. The diversity of the benthic populations may be affected in the future depending on how the mussel population develops. Dissolved oxygen and temperature profiles indicate that there is generally sufficient habitat throughout the summer to support cool and warm water species. It appears that the two deep parts of the lake act independently of each other with different stratification and oxygen depletion rates that may be influenced by the location of the springs that supply some of the inflow to the lake. There appears to be a “low stock” of phosphorus in the bottom waters which means that little is available to be cycled to the surface in fall and spring turnover. TKN levels are fairly high but are consistent with many lakes in the area as well as the Tay River.

Of the six things in the list of processes and actions at the beginning of this section that affect the character of a lake, the first point has to be addressed by society as a whole. The amount of phosphorus reaching lakes by airborne deposition can be reduced by controlling the amount that gets into the air from industrial and other emissions. It is the last point in that list regarding lakeshore development that is largely the responsibility of those who own property around the lake to act on. It is not possible to restore any lake to a “youthful”, nutrient free condition nor should that be the objective because it would mean that the present degree of biodiversity would be lost. However, the process of lake aging can be slowed by all users taking a stewardship approach and making sure that they minimize their impact on the lake environment. Now would be a good time to start.

Finally, thanks go to Wendy Mayhew for organizing on-water transportation for RVCA monitoring staff in 2003 as well as those volunteers who spent some time out on the lake helping make the sampling work.

For more information regarding *Watershed Watch* or for free advice on how you can help protect or enhance your lake environment, contact the LandOwner Resource Centre at (613) 692-2390 or info@lrconline.com.

Appendix: Otter Lake, Dissolved Oxygen/Temperature Profiles

(grey shading)	Cool Water Fisheries Habitat (e.g. splake, trout) defined as Dissolved Oxygen concentrations greater than 4 mg/L at temperatures less than 15 degrees Celsius.

Deep Point 1:

June 25th

Depth (metres)	Average Temperature (deg. C)	Average D.O. (mg/L)	Percent Saturation	Lake Stratification
0.1	22.6	7.3	84.8	Epilimnion
1	22.5	7.3	84.5	
2	22.2	7.4	84.8	
3	21.2	7.5	84.4	
4	20.5	7.7	85.5	
5	20.0	7.7	84.6	
6	18.5	7.7	82.2	
7	15.4	8.5	85.2	Metalimnion
8	13.6	8.4	80.9	
9	12.4	9.0	85.0	
10	10.7	9.3	84.6	
11	9.5	9.2	81.5	
12	8.7	9.2	79.5	
13	8.0	9.0	76.5	
14	7.7	8.8	74.6	Hypolimnion
15	7.5	8.7	72.9	
16	7.2	8.6	71.7	
17	7.2	8.5	70.7	
18	7.0	8.4	69.6	
19	6.8	8.3	68.4	
20	6.7	8.2	67.4	
21	6.7	8.0	66.2	
22	6.7	7.6	62.8	
23	6.6	3.2	26.4	
24	6.7	0.4	2.9	

July 23rd

Depth (metres)	Average Temperature (deg. C)	Average D.O. (mg/L)	Percent Saturation	Lake Stratification
0.1	22.3	6.3	72.8	Epilimnion
1	22.3	6.3	72.7	
2	22.3	6.3	72.7	
3	22.3	6.3	72.7	
4	22.2	6.3	72.7	
5	22.2	6.4	73.2	
6	22.0	6.3	71.8	
7	21.7	6.2	70.9	Metalimnion
8	17.9	6.8	72.1	
9	13.3	7.6	73.2	
10	12.2	7.7	72.5	
11	10.8	7.8	70.6	
12	9.4	7.4	64.9	
13	8.8	7.2	62.7	
14	8.4	7.0	60.3	Hypolimnion
15	8.1	6.8	57.8	
16	7.6	6.5	54.9	
17	7.3	5.9	49.6	
18	7.7	4.1	34.8	
19	7.9	4.7	40.0	
20	7.9	4.8	40.9	

August 20th

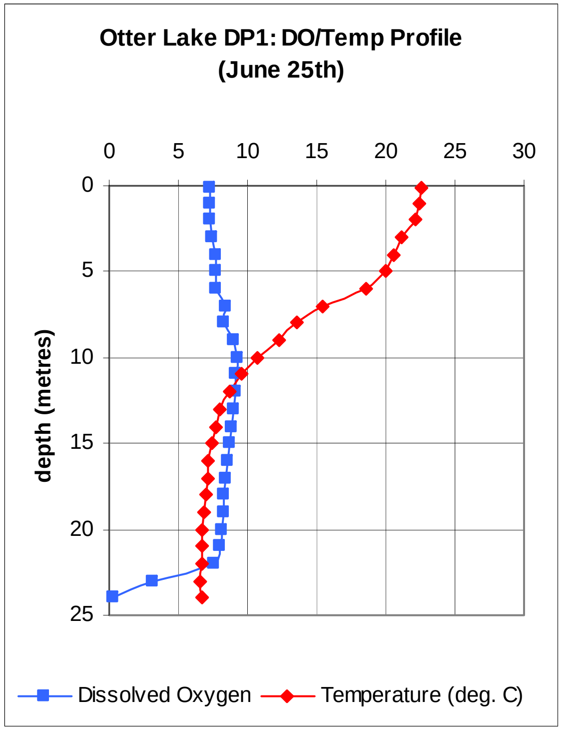
Depth (metres)	Average Temperature (deg. C)	Average D.O. (mg/L)	Percent Saturation	Lake Stratification
0.1	24.5	7.5	89.3	Epilimnion
1	24.4	7.4	88.7	
2	24.4	7.5	89.2	
3	24.3	7.5	89.7	
4	24.3	7.6	90.2	
5	24.2	7.5	89.0	
6	23.5	7.3	86.1	
7	22.5	7.1	81.7	
8	20.2	7.3	80.6	Metalimnion
9	15.7	9.0	91.2	
10	12.6	9.5	89.6	
11	10.7	8.6	77.7	
12	9.5	7.5	65.9	
13	8.6	7.1	61.6	Hypolimnion
14	8.0	6.7	56.8	
15	8.0	6.4	54.2	
16	7.4	6.2	52.2	
17	7.3	6.1	50.8	
18	7.1	6.0	49.7	
19	7.0	5.8	48.4	
20	6.9	5.8	47.8	
21	6.9	5.8	48.2	
22	6.8	5.9	48.5	
23	6.8	5.7	46.8	
24	6.8	0.3	2.5	

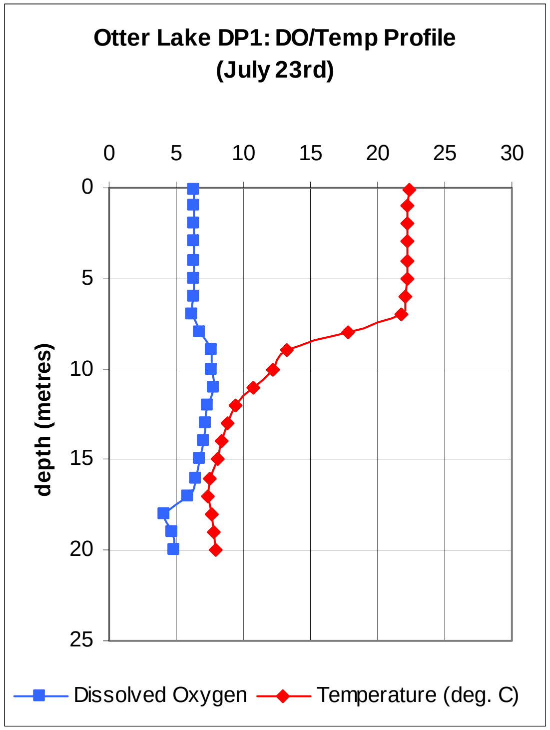
September 17th

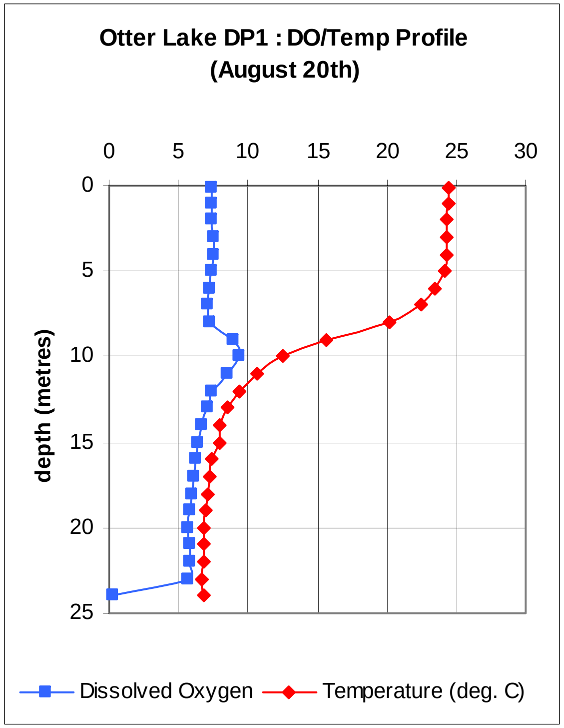
Depth (metres)	Average Temperature (deg. C)	Average D.O. (mg/L)	Percent Saturation	Lake Stratification
0.1	20.9	7.6	86.6	Epilimnion
1	20.8	7.6	86.6	
2	20.6	7.7	87.3	
3	20.5	7.6	86.0	
4	20.5	7.6	86.0	
5	20.3	7.7	86.3	
6	20.2	7.7	86.1	
7	20.0	7.4	83.0	
8	19.6	7.3	80.6	
9	18.6	7.2	78.0	
10	14.5	7.0	69.6	Metalimnion
11	11.6	6.3	58.8	
12	10.0	5.8	52.1	
13	9.0	5.1	45.2	
14	8.2	4.6	40.0	Hypolimnion
15	7.9	4.2	35.8	
16	7.6	4.0	33.9	
17	7.5	3.9	32.9	
18	7.3	3.7	31.4	
19	7.2	3.5	29.7	
20	7.1	3.4	28.4	
21	7.2	3.1	26.3	
22	7.2	1.6	13.6	
23	7.2	1.3	10.6	
24	7.2	0.4	3.4	
25	7.2	0.3	2.5	

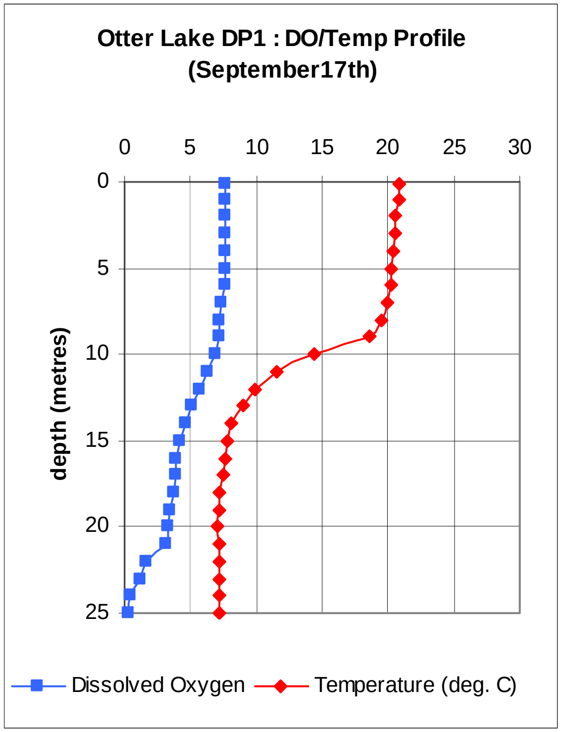
October 22nd

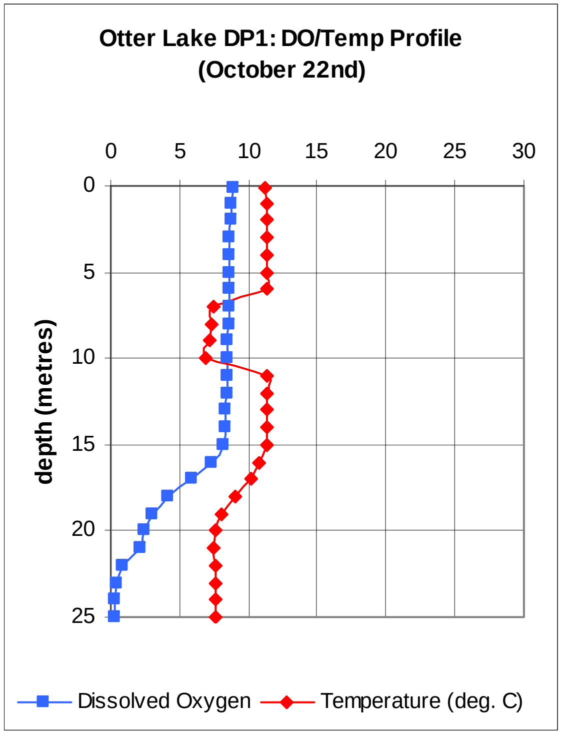
Depth (metres)	Average Temperature (deg. C)	Average D.O. (mg/L)	Percent Saturation	Lake Stratification
0.1	11.3	8.9	83.0	Epilimnion
1	11.3	8.8	82.2	
2	11.3	8.8	81.7	
3	11.3	8.6	79.9	
4	11.4	8.7	80.9	
5	11.4	8.6	80.4	
6	11.4	8.6	80.0	
7	7.4	8.6	72.9	
8	7.3	8.6	72.7	
9	7.2	8.5	71.6	
10	7.0	8.5	71.3	
11	11.4	8.4	78.6	
12	11.4	8.4	78.6	
13	11.4	8.4	78.2	
14	11.4	8.3	77.6	
15	11.3	8.2	76.1	
16	10.8	7.3	67.3	Metalimnion
17	10.2	5.9	53.3	
18	9.1	4.1	36.4	
19	8.0	3.1	26.4	
20	7.7	2.5	21.5	Hypolimnion
21	7.5	2.2	18.4	
22	7.6	0.8	6.9	
23	7.7	0.5	4.3	
24	7.7	0.3	2.6	
25	7.7	0.3	2.1	


Otter Lake DP1: DO/Temp Profile
(June 25th)
depth (metres)
Dissolved Oxygen
Temperature (deg. C)


Otter Lake DP1: DO/Temp Profile
(July 23rd)
depth (metres)
Dissolved Oxygen
Temperature (deg. C)


Otter Lake DP1 : DO/Temp Profile
(August 20th)
depth (metres)
Dissolved Oxygen
Temperature (deg. C)


Otter Lake DP1 : DO/Temp Profile
(September17th)
depth (metres)
Dissolved Oxygen
Temperature (deg. C)


Otter Lake DP1: DO/Temp Profile
(October 22nd)
depth (metres)
Dissolved Oxygen
Temperature (deg. C)

Deep Point 3:

June 25th

Depth (metres)	Average Temperature (deg. C)	Average D.O. (mg/L)	Percent Saturation	Lake Stratification
0.1	23.6	7.1	84.3	Epilimnion
1	23.5	7.1	84.7	
2	23.3	7.1	84.5	
3	23.0	7.2	84.7	
4	22.2	7.3	84.7	
5	19.9	7.5	83.9	Metalimnion
6	18.2	7.7	82.8	
7	17.1	8.0	84.0	
8	15.1	7.4	74.6	
9	12.4	8.8	83.8	
10	11.9	8.9	84.2	
11	9.6	9.3	83.1	
12	9.0	9.3	82.0	
13	8.1	9.2	79.3	
14	7.6	9.0	76.6	Hypolimnion
15	7.3	9.0	76.2	
16	7.2	8.9	75.0	
17	7.1	8.9	74.9	
18	7.0	8.8	73.9	
19	7.0	8.8	73.8	
20	7.0	8.7	73.4	
21	6.8	8.7	72.6	
22	6.7	8.6	72.0	
23	6.7	8.6	71.6	
24	6.6	8.5	70.6	
25	6.6	8.4	69.7	
26	6.5	8.4	69.6	
27	6.5	8.4	69.6	
28	6.5	8.3	69.2	
29	6.5	8.3	68.7	
30	6.5	8.1	67.5	
31	6.4	8.0	66.1	
32	6.4	7.9	65.3	
33	6.4	7.8	64.9	
34	6.4	7.9	65.7	
35	6.4	1.1	9.2	
36	6.4	0.8	6.7	
37	6.4	1.0	7.9	
38	6.4	0.9	7.5	

July 23rd

Depth (metres)	Average Temperature (deg. C)	Average D.O. (mg/L)	Percent Saturation	Lake Stratification
0.1	22.5	6.5	76.3	Epilimnion
1	22.5	6.4	75.1	
2	22.4	6.4	74.4	
3	22.3	6.4	74.8	
4	22.2	6.4	74.7	
5	22.0	6.4	74.5	
6	21.9	6.4	73.7	
7	21.0	6.4	72.6	
8	17.1	6.9	73.0	Metalimnion
9	13.7	7.6	74.3	
10	12.1	7.8	74.2	
11	10.5	8.0	72.9	
12	9.6	7.9	71.0	
13	8.9	7.6	66.8	
14	8.4	7.2	62.9	
15	8.0	6.9	59.7	
16	7.2	7.3	61.9	Hypolimnion
17	7.5	6.6	56.4	
18	7.4	6.6	55.8	
19	7.2	6.5	54.8	
20	7.2	6.5	54.7	
21	7.1	6.5	54.6	
22	7.0	6.5	54.4	
23	6.9	6.4	53.9	
24	6.9	6.4	53.9	
25	6.9	6.3	52.6	
26	6.8	6.3	52.5	
27	6.8	6.2	52.0	
28	6.8	6.2	51.6	
29	6.7	6.1	51.1	
30	6.7	6.0	50.3	
31	6.7	3.2	26.4	
32	6.7	0.5	3.8	
33	6.7	0.4	2.9	

August 20th

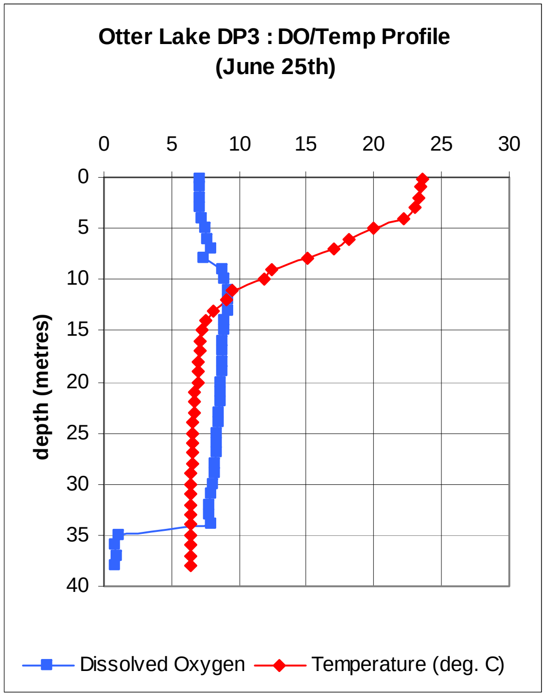
Depth (metres)	Average Temperature (deg. C)	Average D.O. (mg/L)	Percent Saturation	Lake Stratification
0.1	24.6	7.6	92.0	Epilimnion
1	24.6	7.6	92.0	
2	24.6	7.6	92.0	
3	24.6	7.5	91.3	
4	24.6	7.6	92.5	
5	24.5	7.6	91.7	
6	23.9	7.5	89.5	
7	22.3	7.4	86.0	
8	19.3	7.7	85.1	Metalimnion
9	15.9	9.2	94.9	
10	12.1	9.5	90.3	
11	10.3	8.9	80.8	
12	9.4	8.0	71.1	
13	8.9	7.6	67.2	
14	8.2	7.2	62.1	
15	7.9	6.8	58.7	Hypolimnion
16	7.6	7.0	60.0	
17	7.4	7.1	60.6	
18	7.3	7.0	59.5	
19	7.2	7.0	59.3	
20	7.1	7.0	59.3	
21	7.1	6.9	57.9	
22	7.0	6.8	57.4	
23	7.0	6.8	57.4	
24	6.9	6.8	57.2	
25	6.8	6.7	55.9	
26	6.8	6.6	55.5	
27	6.8	6.6	55.0	
28	6.8	6.6	55.0	
29	6.8	6.5	54.1	
30	6.8	6.4	53.7	
31	6.7	6.2	51.6	
32	6.6	0.2	1.3	
33	6.6	0.2	1.3	

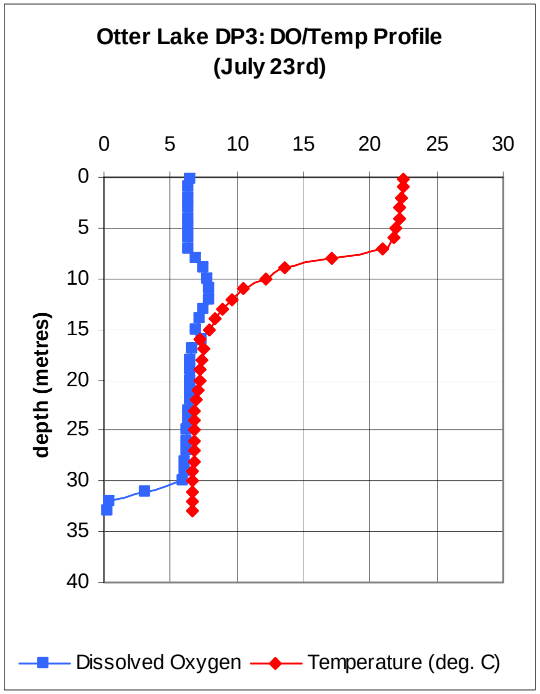
September 17th

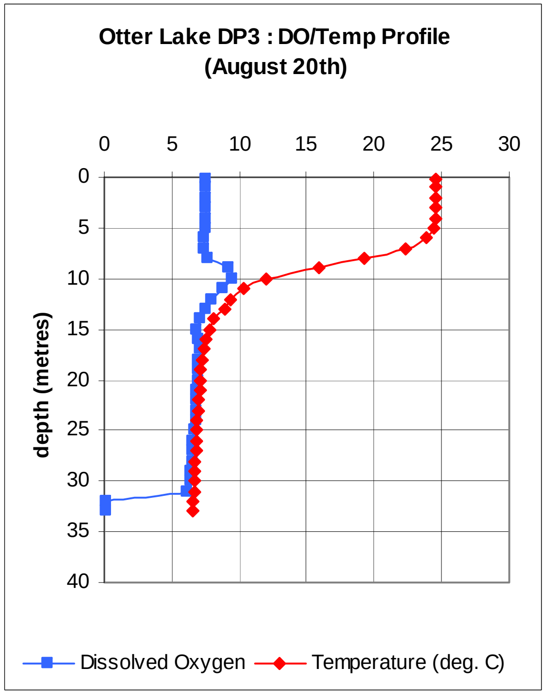
Depth (metres)	Average Temperature (deg. C)	Average D.O. (mg/L)	Percent Saturation	Lake Stratification
0.1	21.2	7.7	87.7	Epilimnion
1	21.2	7.7	88.3	
2	21.1	7.7	88.1	
3	21.0	7.7	88.0	
4	21.0	7.7	88.0	
5	20.9	7.6	86.7	
6	20.7	7.6	86.4	
7	20.0	7.4	82.9	
8	19.4	7.3	80.3	Metalimnion
9	18.4	7.1	77.1	
10	15.7	7.1	72.4	
11	12.8	6.7	64.7	
12	10.5	6.1	56.0	
13	9.6	5.5	49.4	
14	8.7	5.1	44.4	Hypolimnion
15	8.4	5.2	45.4	
16	8.1	5.2	44.7	
17	7.9	5.1	44.1	
18	7.6	5.1	43.7	
19	7.4	5.0	42.6	
20	7.4	5.0	42.6	
21	7.3	4.9	41.6	
22	7.2	4.9	41.1	
23	7.0	4.9	41.0	
24	7.0	4.8	40.5	
25	7.0	4.8	40.1	
26	6.9	4.8	40.0	
27	6.9	4.7	39.2	

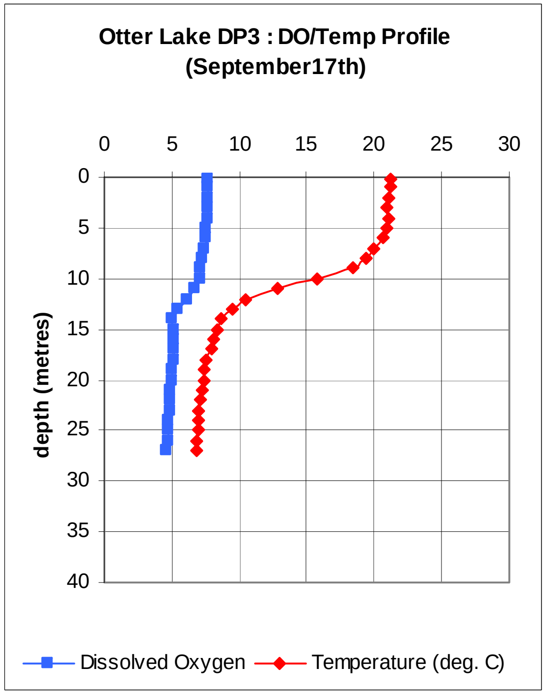
October 22nd

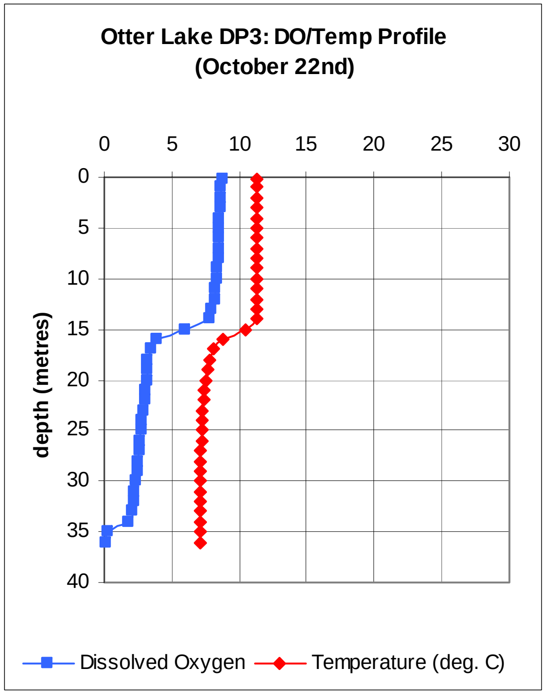
Depth (metres)	Average Temperature (deg. C)	Average D.O. (mg/L)	Percent Saturation	Lake Stratification
0.1	11.3	8.8	82.2	Epilimnion
1	11.3	8.7	81.3	
2	11.4	8.7	80.9	
3	11.4	8.6	80.4	
4	11.4	8.6	80.0	
5	11.4	8.6	80.0	
6	11.4	8.5	79.5	
7	11.4	8.5	79.0	
8	11.4	8.5	79.0	
9	11.4	8.4	78.1	
10	11.3	8.4	78.0	
11	11.3	8.3	77.5	
12	11.3	8.2	76.6	
13	11.3	8.0	74.7	
14	11.3	7.9	73.2	
15	10.5	6.0	55.0	Metalimnion
16	8.8	3.9	34.0	
17	8.1	3.5	29.9	Hypolimnion
18	7.9	3.3	28.0	
19	7.7	3.2	27.5	
20	7.6	3.2	27.0	
21	7.4	3.1	26.0	
22	7.4	3.0	25.6	
23	7.3	2.9	24.7	
24	7.3	2.9	24.3	
25	7.3	2.8	23.8	
26	7.3	2.7	22.9	
27	7.2	2.6	22.0	
28	7.2	2.6	21.6	
29	7.2	2.5	21.2	
30	7.1	2.4	20.3	
31	7.1	2.3	19.5	
32	7.1	2.3	19.1	
33	7.1	2.1	17.4	
34	7.1	1.8	15.2	
35	7.1	0.3	2.1	
36	7.1	0.2	1.7	


Otter Lake DP3 : DO/Temp Profile
(June 25th)
depth (metres)
Dissolved Oxygen
Temperature (deg. C)


Otter Lake DP3: DO/Temp Profile
(July 23rd)
depth (metres)
Dissolved Oxygen
Temperature (deg. C)

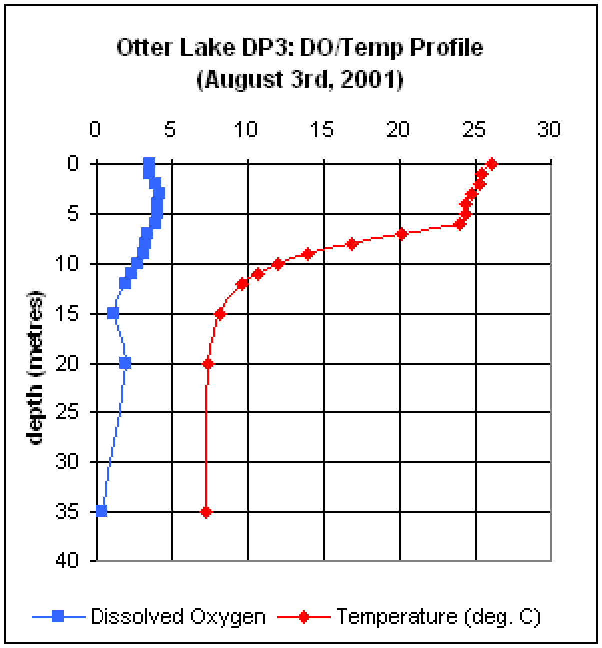

Otter Lake DP3 : DO/Temp Profile
(August 20th)
depth (metres)
Dissolved Oxygen
Temperature (deg. C)


Otter Lake DP3 : DO/Temp Profile
(September17th)
depth (metres)
Dissolved Oxygen
Temperature (deg. C)


Otter Lake DP3: DO/Temp Profile
(October 22nd)
depth (metres)
Dissolved Oxygen
Temperature (deg. C)

Augusr 3rd, 2001 MOE data

Depth (metres)	Average Temperature (deg. C)	Average D.O. (mg/L)	Percent Saturation	Lake Stratification
0	26.0	3.6	42.6	Epilimnion
1	25.4	3.6	42.6	
2	25.3	3.9	46.2	
3	24.8	4.2	49.7	
4	24.4	4.1	48.6	
5	24.3	4.1	48.6	
6	23.9	4.0	47.4	
7	20.1	3.4	36.6	
8	16.9	3.3	33.4	Metalimnion
9	14.0	3.1	30.7	
10	12.0	2.8	26.6	
11	10.6	2.4	22.1	
12	9.6	2.0	18.0	
15	8.1	1.2	10.4	Hypolimnion
20	7.4	2.0	17.1	
35	7.3	0.4	3.4	



August 17th, 2001 MOE data

0	24.0	8.6	101.9	Epilimnion
1	24.0	8.6	101.9	
2	24.0	8.7	103.0	
4	24.0	8.7	103.0	
6	24.0	8.6	101.9	
8	24.0	6.8	80.5	
10	10.8	4.2	37.3	Metalimnion
12	9.2	2.7	23.9	
14	8.2	3.2	27.0	
16	7.9	3.4	28.7	Hypolimnion
18	7.8	3.5	29.6	
20	7.6	3.7	31.3	
22	7.6	4.0	33.8	
24	7.6	4.0	33.8	
26	7.5	5.1	43.1	
28	4.9	4.9	39.3	
30	4.6	4.6	36.6	
32	4.3	4.3	33.9