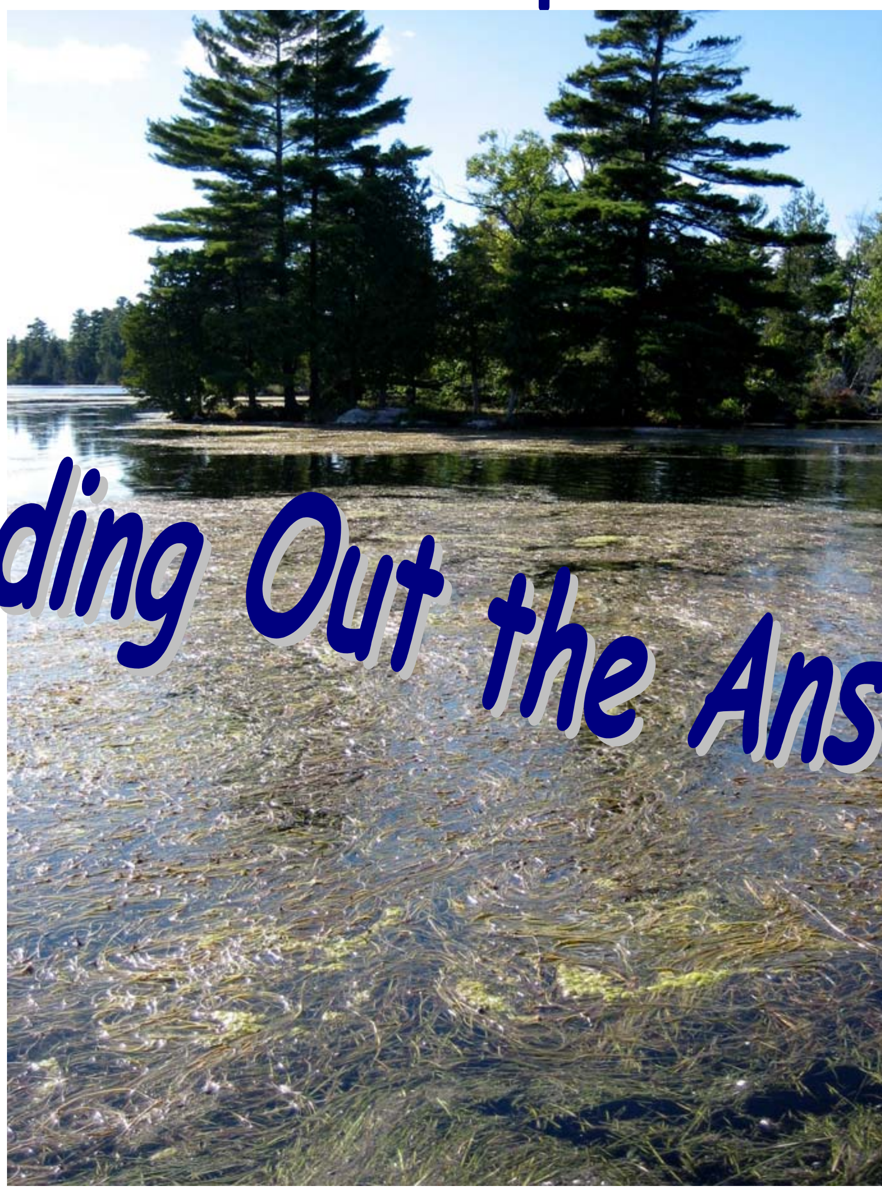
Kawartha Lake Stewards Association
Winner of FOCA'S 2002 Jerry Strickland Award

Lake Water Quality
2005 Report

Weeding Out the Answers!



April 2006

kawarthalakestewards@yahoo.ca

Special Thanks to the following Major Sponsors of KLSA

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You can view Adobe pdf versions of KLSA reports on the web at the Trent University Oliver Ecological Centre www.trentu.ca/olivercentre and the Stony Lake Cottagers Environment page www.stonylake.on.ca/environment.html

This year's cover photo shows the beauty of the Kawarthas and floating tape grass, helping to convey the title theme of the report, **"Weeding Out the Answers".**
Many thanks to Ann Ambler, Linda Lloyd, Sheila Gordon-Dillane and Jeff Chalmers for contributing the photographs used in the report.

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Presentation at the September 2005 Meeting to past chair Jim Keyser by Board members Kathleen Mackenzie, Mark Potter, Ann Ambler, Pat Moffat and Kevin Walters.

Message from the Chair

Where we've been

KLSA began in the summer of 2000, when a nucleus of concerned cottagers got together to discuss whether we might do lake water testing for phosphorus and *E.coli* bacteria on many of the interconnected Kawartha Lakes on the Trent-Severn Waterway. We were concerned about swimming safety and we were concerned about tracking the ecological health of our lakes. We realized right from the start that in a river system, with the same water flowing from lake to lake, it made little sense to do water quality monitoring in just one lake. In October of 2000, representatives from Lower Buckhorn, Lovesick, Stony, Buckhorn, Pigeon, Clear and Big Bald Lakes formally met. We called ourselves the Kawartha Lake Stewards Association (KLSA), and mapped out a coordinated water testing program for 2001, ensuring that we would be doing exactly the same method of sampling on the same days. We received valuable guidance in this early stage from the Ministry of Environment (MOE), the Peterborough County-City Health Unit, and what was then Lakefield Research. By the time we began water sampling in 2001, Upper Stoney, Sandy and Katchewanooka Lakes as well as the Kawartha Fisheries Association and Curve Lake First Nation had joined KLSA. We all sampled for phosphorus through MOE's Lake Partner Program, and had our lake water samples analyzed for *E.coli* at Lakefield Research. A major selling point of KLSA then – and even now – is that it is much cheaper per sample bottle to be part of a large group rather than a small one from just one cottagers' association.

While our member associations contributed funds for their own bacteria testing, we also had external funding partners from the beginning. The Trent-Severn Waterway (TSW) was one of our first partners, and their continued participation today creates a secure financial basis for our programs and activities, including the publication of these annual reports. Mattamy Homes has been with us since the beginning and has supported us generously. Most of the municipalities in the region have become our partners in gathering water quality data and keeping watch over the ecological health of these lakes. Not all yet, but most.

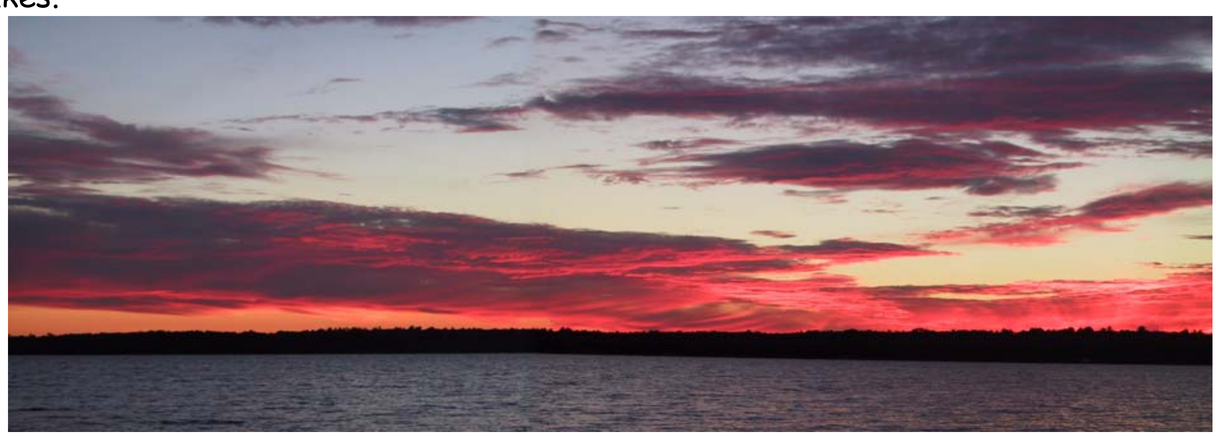
Where we're headed

Every year the results of our water testing programs teach us something new about our lakes. When we analyzed our data and volunteer logs after that first year, we were surprised that the sampling sites that had the highest bacteria counts often had the highest concentrations of Canada geese too, and so we titled that first report "Don't Feed the Geese." This year, as you will see in Kathleen Mackenzie's report on the 2005 *E.coli* and phosphorus testing programs, we learned more about the effects of dry vs. wet years on water chemistry, and built on the knowledge gained in 2003 and 2004 about the behaviour of phosphorus in our lakes.

Our learning curve has been accelerating year by year. As we have tried to piece together the meaning of the data we were gathering, and as we observed our lakes closely, we found we were asking what amounted to research questions:

- Why are there so many water weeds lately?
- Is this part of a natural cycle or is something else stimulating them?
- Could it be too much phosphorus?
- What is causing the fairly high levels of phosphorus in our lakes?
- Is this a natural phenomenon or are human inputs tipping the balance?
- What effects are the zebra mussels having on the ecology of the lakes?

Now, at the beginning of our sixth year, KLSA has reached a turning point. While our data gathering for phosphorus and *E.coli* continues, we are also putting a new emphasis on research studies that will help answer our persistent questions. In this report you will read about the exciting new research projects KLSA is undertaking in partnership with Trent University and Sir Sandford Fleming College. We believe that whatever answers will eventually come out of these projects, they will provide direction on how we all can better protect and preserve these beautiful Kawartha Lakes.



Summer sunset on Clear Lake

KLSA volunteers and board

KLSA is an entirely volunteer-run organization. In 2005, KLSA represented 15 lakes, and a great many volunteers. Our current Board of Directors, elected at our AGM in October 2005, are:

Pat Moffat (Lovesick Lake) – Chair and co-editor of annual report
Jeff Chalmers (Clear Lake) – Treasurer and report production
Ann Ambler (Lovesick) – Secretary
Kathleen Mackenzie (Stony) – Vice-chair: bacteria and phosphorus testing programs
Sheila Gordon-Dillane (Pigeon) – Director: co-editor of annual report
Mark Potter (Lower Buckhorn) – Director: expansion program
Kevin Walters (Big Bald, Lovesick) – Director: coordinator of phosphorus studies
Mike Stedman (White Lake) – Director: fundraising and insurance
Norma Walker (White) – Director at large

Appendix A lists addresses, emails, and phone numbers for KLSA board members.

Finances

We begin our 2006 season with a cash surplus of $2,794 of which approximately $2,200 will be used to cover this report's production and distribution. Most of our yearly budget, $6,747, goes to SGS Lakefield Research for *E.coli* lab analysis, while $1,661 covers insurance and $850 goes to administrative costs such as bank fees, memberships and office expenses. See Appendix C for our detailed financial statements.

Thanks

On behalf of all KLSA members and partners, I would like to extend our heartfelt thanks to Jim Keyser, who steered this organization so ably for its first five years. We will miss Jim and wish him well in his "retirement." Many thanks to our financial partners, without whom KLSA could not operate: the Trent-Severn Waterway (Parks Canada), Mattamy Homes, Ltd., the Township of Galway-Cavendish-Harvey, the Township of Douro-Dummer, the Township of Smith-Ennismore-Lakefield, Eganridge Inn & Country Club and Carol McCanse. Many thanks to Eric Sager, Kristy Hodgsen, Maggie Xenopoulos and Michael White of Trent University and Sara Kelly and her students at Sir Sandford Fleming College for helping to answer important research questions that will allow the bigger picture of our lakes to emerge. We are very grateful to George Gillespie of McColl Turner Chartered Accountants for reviewing our financial records each year. SGS Lakefield Research staff, MOE's Lake Partner Program staff, the Peterborough County-City Health Unit (PCCHU), the Buckhorn Community Centre, Sir Sandford Fleming College Cartography Department, the City of Peterborough Land Information Services Division, Trent University's Geography Department, the Oliver Ecological Centre, and the Otonabee Region and Kawartha Conservation Authorities all contribute in various and valuable ways to our programs. Finally, thanks to everyone who helped create this fifth annual report. In addition to our hardworking report committee (Jeff Chalmers, Kathleen Mackenzie, Sheila Gordon-Dillane and myself), Eric Sager, Kristy Hodgsen, Kevin Walters and Michael White contributed fascinating articles on our research programs. Special thanks to Bev Clark at the MOE and Tom Cathcart from the PCCHU for reviewing sections of this report.

We look forward to another year of monitoring and gaining knowledge about the Kawartha Lakes. Please feel free to contact us, come to our meetings, and get involved. **KLSA's spring meeting will be held at 2:00 p.m. on Saturday, May 13, 2006 at the Buckhorn Community Centre.**

Pat Moffat, Chair

Pat Moffat, Jeff Chalmers and Sheila Gordon-Dillane editing the report

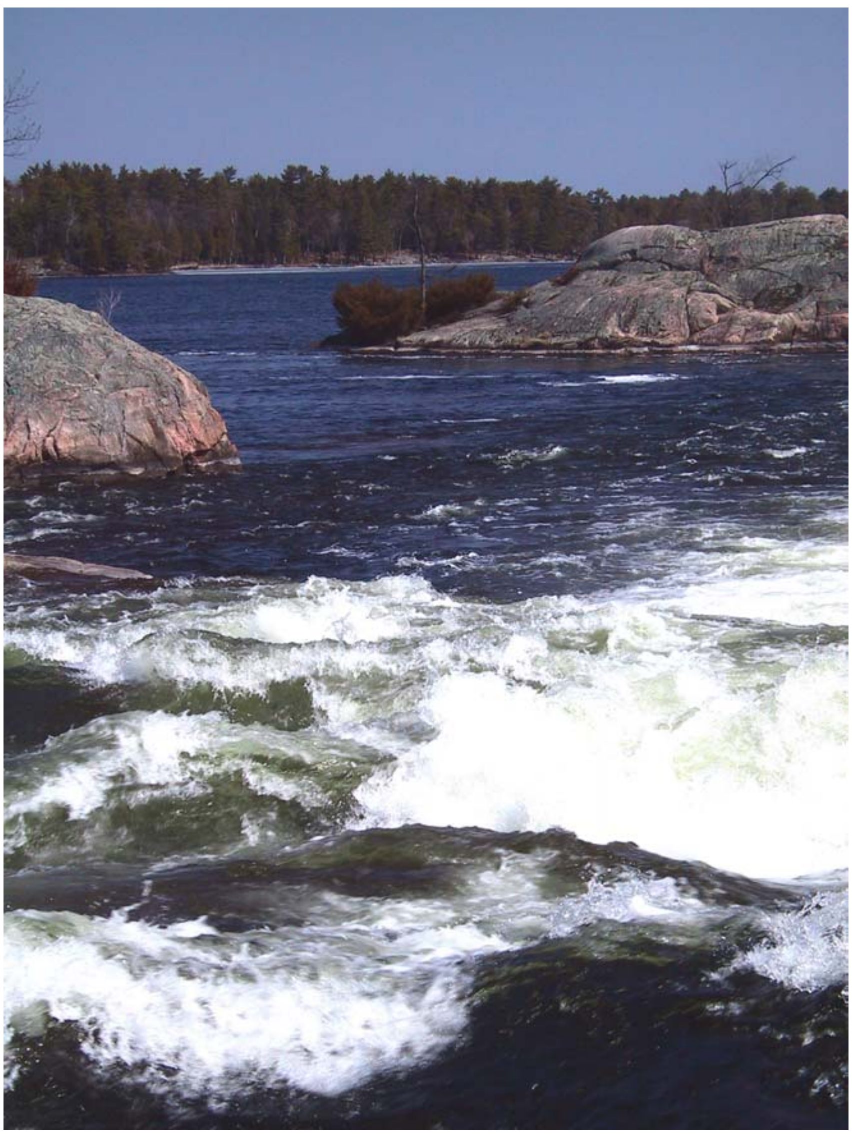
Introduction

The shining waters of the interconnected Kawartha Lakes arise at the foot of the Gull River where the waters of the Haliburton Highlands tumble into the valley of the Trent, and enter the first of the Kawartha Lakes, Shadow Lake. Deflected by the height of land at Balsam Lake, the waters continue east and south through the Trent-Severn Waterway (TSW) and the Otonabee and Indian Rivers to Rice Lake, where they form southern Ontario's largest river – the Trent River – and eventually reach Lake Ontario. Historically the area was both farmland and home to a forestry industry; the TSW canals and locks were built around the turn of the last century to aid the harvesting and transport of logs for lumber. At the same time, for more than a century now, the Kawartha Lakes have been a magnet for tourism. The shorelines and islands in these beautiful lakes are home to thousands of seasonal cottagers and year-round residents, and a great many fishermen, boaters, hunters and campers visit the lakes every year. Because the Kawarthas are situated on the interface of two different geological formations – the largely granitic Precambrian Shield and a younger limestone formation from ancient seas – they support a great diversity of flora and fauna, making them very attractive to visitors.

The two geological formations influence the chemical composition of the water in the Kawartha Lakes. Water entering the system from lakes, streams and springs originating in the Shield is clear, and low in phosphorus, which is the major nutrient influencing plant and algal growth. To the south it is different. The limestone formation formerly extended much further north over the Shield. Glaciation has pushed it south to where it stands today, and has created other formations – moraines and drumlins - out of the ground-up material removed. These have been deposited on top of the limestone to the south. Rivers and streams flowing into the Kawarthas from these areas carry with them higher levels of phosphorus more freely dissolved from the ground-up limestone. As well, as the water flows downstream through the system, it is increasingly fed by water flowing over or through the limestone formations, which become increasingly higher in natural phosphorus as one moves from west to east.

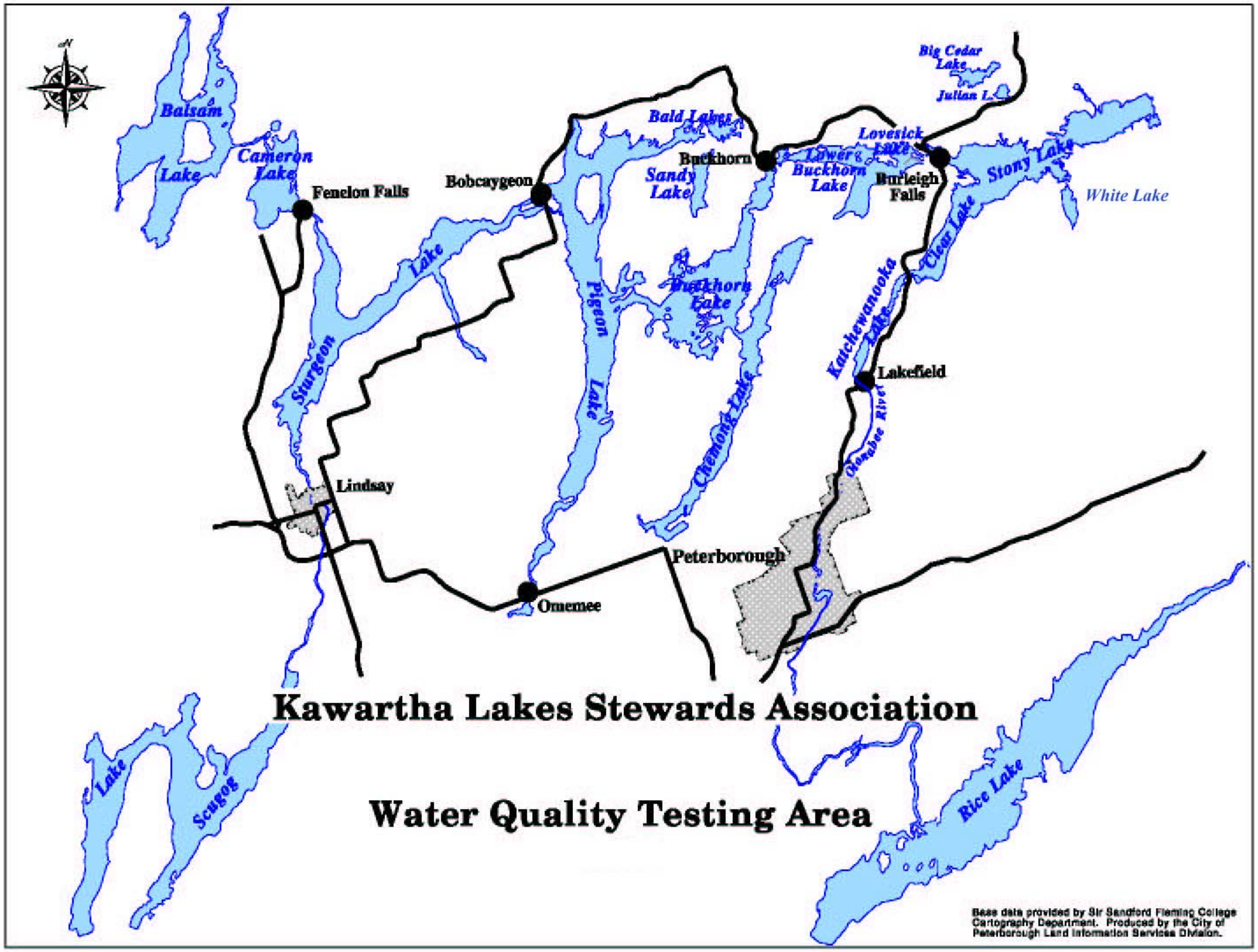
In contrast to lakes that are situated entirely in the Canadian Shield, such as the Muskokas, our Kawartha Lakes have historically been higher in phosphorus and therefore more productive in terms of aquatic plants. They are shallower too, which favours plant growth. Over periods of years and decades, the amount of water "weeds" in the Kawarthas comes and goes. During the past several years, since KLSA began lake water testing in 2001, we have noticed an increase in aquatic plants in many of our lakes. We have also seen many phosphorus readings over 20 ppb, a level at which nuisance algae can become a significant problem in recreational lakes.

Human beings have probably been part of the ecology of the Kawarthas for as long as the lakes have existed, since the retreat of the last glaciers. Since European settlement, human influences on the lakes have intensified until today there are a great many more of us here than ever before, enjoying the lakes and impacting them. KLSA's new research studies, carried out in partnership with Trent University and Sir Sandford Fleming College, aim to find out what the causes of such vigorous aquatic plant growth are, and where all the phosphorus in our lakes is coming from. The answers to those questions may provide direction for the next steps we all can take to preserve the health and beauty of the Kawartha Lakes.



Spring flows from Lovesick Lake into Stony Lake at Burleigh Falls

Map of the Kawartha Lakes 2005 Testing Area



Executive Summary

The Kawartha Lake Stewards Association (KLSA) is a volunteer-driven, non-profit organization representing cottage associations and year-round residents in the Kawartha Lakes. Established to provide a coordinated approach to lake water monitoring, the Association has now completed five years of testing for phosphorus, water clarity and *E.coli* bacteria. In 2004, KLSA began surveys of aquatic vegetation. This work was expanded in 2005, with additional plant studies and the initiation of two studies of phosphorus in the lakes.

Phosphorus and water clarity monitoring results

As part of the Ministry of the Environment's Lake Partner Program, volunteers collect water samples at deep points in their lakes six times per year (May to October) for phosphorus testing. At the same time, using a Secchi disk, they take measurements of water clarity. In 2005, KLSA volunteers sampled 38 locations in 15 lakes. The Ministry's Provincial Water Quality Objectives consider average phosphorus levels exceeding 20 parts per billion (ppb) to be of concern since at that point algae growth accelerates, potentially creating unpleasant algal blooms, adversely affecting enjoyment of the lakes.

The Kawartha Lakes include low-phosphorus lakes (levels stay between 7 and 10 ppb throughout the summer), high-phosphorus lakes (low levels in May rise to between 15 and 30 ppb during the summer) and one marl lake (Sandy Lake where levels are consistently below 5 ppb). The majority of the Kawartha Lakes are high-phosphorus lakes.

Phosphorus levels in our lakes vary widely, from lake to lake and from month to month. The main reasons seem to be:

- Lakes with inflows predominantly from the north have much lower phosphorus levels than those with inflows from the south.
- During the spring when spring runoff provides large flows from the north, all lakes are "flushed out" and spring phosphorus levels are low on all KLSA-tested lakes.
- In lakes with very high calcium carbonate levels, phosphorus may be precipitated out with the calcium carbonate. This is probably the cause of very low phosphorus levels in Sandy Lake, but may be happening to a lesser extent on some of the other lakes.
- As plants and animals (including zebra mussels) grow in our lakes, they absorb phosphorus from the water. (Did last year's warm water cause more growth, removing phosphorus from the water?)

The ongoing monitoring of phosphorus produced some unexpected results this year. In 2004, we speculated that low mid-summer phosphorus levels resulted from very heavy rainfall in July. The weather in the summer of 2005 was very hot and dry. Surprisingly, in all but one lake, phosphorus levels were lower than those found in 2004.

Normally, higher phosphorus levels result in reduced water clarity due to algae growth. The 2005 data showed that this correlation existed where phosphorus levels were below 10 ppb but disappeared between 10 and 25 ppb, the levels seen in most of the Kawartha Lakes. In these lakes, there was about a 50% chance that the Secchi reading would be lower than 4 meters, which is less than ideal for recreation and enjoyment of the lakes. Lakes with readings higher than 4 meters are considered clear.

Our data this year confirmed some theories from previous years, and contradicted some others. This reinforces the value of collecting data each year.

Studies of sources of phosphorus

In 2005, KLSA began two studies of phosphorus sources in the lakes, coordinated by Board member Kevin Walters. Michael White, a PhD student at Trent University, is documenting current phosphorus concentrations in the lakes and studying historical data, lake characteristics and land use patterns that contribute to phosphorus loading. Human uses such as agriculture, sewage treatment plants and shoreline development result in increased soluble phosphorus entering the lakes, encouraging plant and algae growth. The final phase of this study will be recommendations of actions to prevent and reduce phosphorus loading in the Kawartha Lakes. Prevention is far more effective than restoration.

A second study, undertaken by students at Sir Sandford Fleming College, under the direction of faculty member Sara Kelly, is examining the impact of six Kawartha area sewage treatment plants, determining the allowable discharge level for each one and analyzing their current discharge levels. Total phosphorus loading will be calculated for the six plants. Results are expected in the spring of 2006.

Macrophyte (weed) monitoring

The abundance of aquatic plants or macrophytes has been a concern of shoreline residents in the Kawarthas for several years. A monitoring program begun in 2004 was expanded in 2005 to assess the quantity and variety of plants (including non-native and potentially invasive species) and to identify factors that contribute to their growth. Although aquatic plants benefit wildlife and fish, excessive plant growth alters the dynamics of the lakes, eventually leading to an increase in algae.

Dr. Eric Sager of Trent University and colleagues at the Oliver Ecological Centre undertook a study in Lovesick Lake to measure the amount and mix of aquatic plants and monitor phosphorus and free-floating algae at 10 designated nearshore sites. Volunteers from four other lakes surveyed macrophytes at single sites on their own lakes. On Lovesick Lake, 24 species, all but two of which were native, were recorded. The volume or biomass of weeds varied significantly from site to site. Most sites produced 3-5 species of plants and non-native species represented a small proportion of the total, except in Pigeon Lake, where Eurasian milfoil was prevalent. Concentrations of chlorophyll *a*, indicating algae, were consistently low in Lovesick Lake during the summer, likely due to the heavy concentrations of aquatic plants.

Future plans include continued monitoring of the sites sampled in 2005, expanded studies of historical data and sites located on Curve Lake First Nation shorelines and assessment of the impact of zebra mussels on macrophyte growth.

E.coli bacteria test results

KLSA volunteers tested 132 sites six times during the summer for *E.coli* bacteria. Samples were analyzed by SGS Lakefield Research. Public beaches are posted as unsafe for swimming when levels reach 100 *E.coli*/100 mL of water. KLSA believes that counts in the Kawartha Lakes should not exceed 50 *E.coli*/100 mL and requests volunteers to retest any site with a count higher than this level. In 2005, *E.coli* levels continued to be low with 115 of the sites considered "very clean" or "clean". Of the remainder, 8 sites had 3 or more counts over 20, 5 were designated as "needing observation" due to 4-6 high counts. Only 4 sites had more than 2 counts over 100, requiring further investigation. Most of the latter sites were not used for swimming.

Generally, heavy rainfall increases *E.coli* counts due to shoreline runoff. In 2005, there was very little rain but *E.coli* levels were similar to those found in 2004 and in previous years. Possible explanations include more abundant wildlife (mainly Canada geese and ducks), increased human use of the lakes due to hot, dry weather and lower water flows to wash away bacteria. Measures to reduce *E.coli* in the lakes include not feeding the birds and taking measures to keep them off the land (they prefer mowed lawns they can see from the water), maintaining a natural shoreline buffer zone, maintaining septic systems and keeping pet droppings away from the shoreline.

KLSA is grateful to the many volunteers who participate in our monitoring programs, the scientists who are assisting us with our studies and our financial partners.

Phosphorus and Water Clarity Testing

Why test for phosphorus and clarity?

High phosphorus levels result in a loss of water *clarity*, in the same way that an untended aquarium becomes green and murky. Phosphorus enters lakes from fertilizers, erosion, septic systems, sewage treatment plants, etc. The immediate effect is an increase in algal growth, turning the lake murky. Algae absorb phosphorus, then die and sink to the bottom of the lake. These bottom sediments provide a rich soil for aquatic plant growth and can continue to release phosphorus back into the lake. Once it enters a lake, phosphorus tends to stay there.

The Ministry of the Environment's Provincial Water Quality Objectives (www.ene.gov.on.ca/envision/gp/#groundwater , Report #3303) state:

- Phosphorus concentrations should not exceed an average of 20 ppb (parts per billion, or micrograms per litre) during the ice-free period. At levels higher than 20 ppb, algal growth accelerates, potentially creating unsightly and often foul-smelling algal blooms.
- Ice-free averages of less than 10 ppb give "a high level of protection against aesthetic deterioration".

Phosphorus levels and water clarity, then, are tracked because they give an indication of the recreational quality of our lakes. It hardly need be said that "recreational quality" is closely related to property values.

How did we measure phosphorus?

KLSA took water samples for phosphorus analysis at 38 locations in 15 lakes, an increase from 34 sites in 2004. Sampling was taken around the first of each month, from May to October. In contrast to sampling for bacteria, which is done at elbow depth, phosphorus samples are taken from deeper parts of the lakes, with a collection bottle lowered down to the required depth by a heavy object.

All testing was done through the Ontario Ministry of the Environment's Lake Partner Program. The Lake Partner Program supplies bottles and mailing containers. Samples are tested for phosphorus at an MOE laboratory at no cost to cottagers other than volunteer time. Ontario cottagers are fortunate to have this excellent program. **Anyone interested in tracking their lake's water quality should join the Lake Partner Program. We encourage you to email them at lakepartner@ene.gov.on.ca or phone them at 1-800-470-8322.**

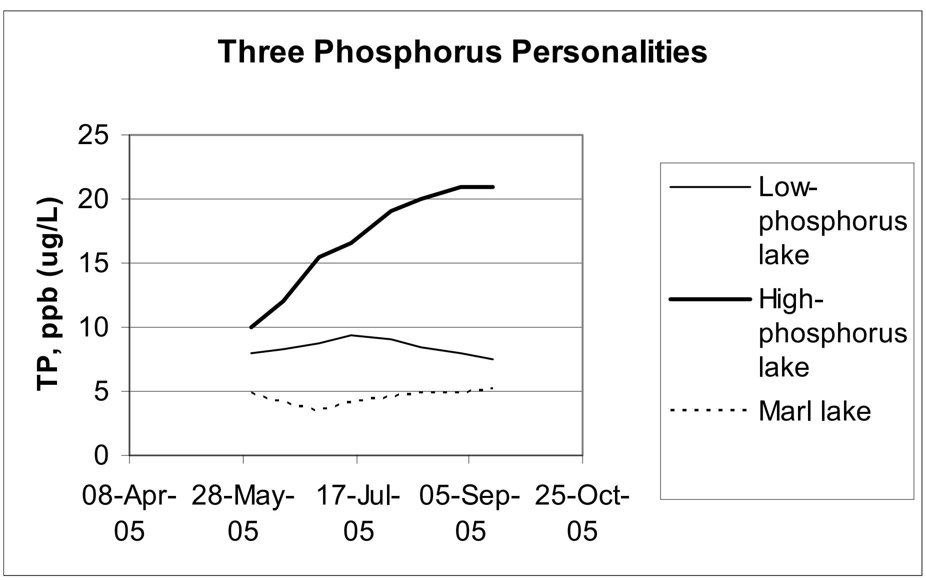
Because the Lake Partner Program refined their laboratory technique in 2002, our phosphorus measurements are almost *ten times more precise* than they were before 2002! Starting in 2002, a measurement of 6.0 ppb means that the measurement has a 95% probability of being between 5.4 and 6.6 ppb. This greater precision means that we will be able to detect much smaller changes in phosphorus levels month-to-month and year-to-year. This change in precision is why 2001 results were reported as 8, l2, 14, 22 ppb, etc., while results in 2002 and after are reported as 8.6, 11.5, 23.7 ppb, etc.

For complete phosphorus and Secchi depth data, see Appendix F.

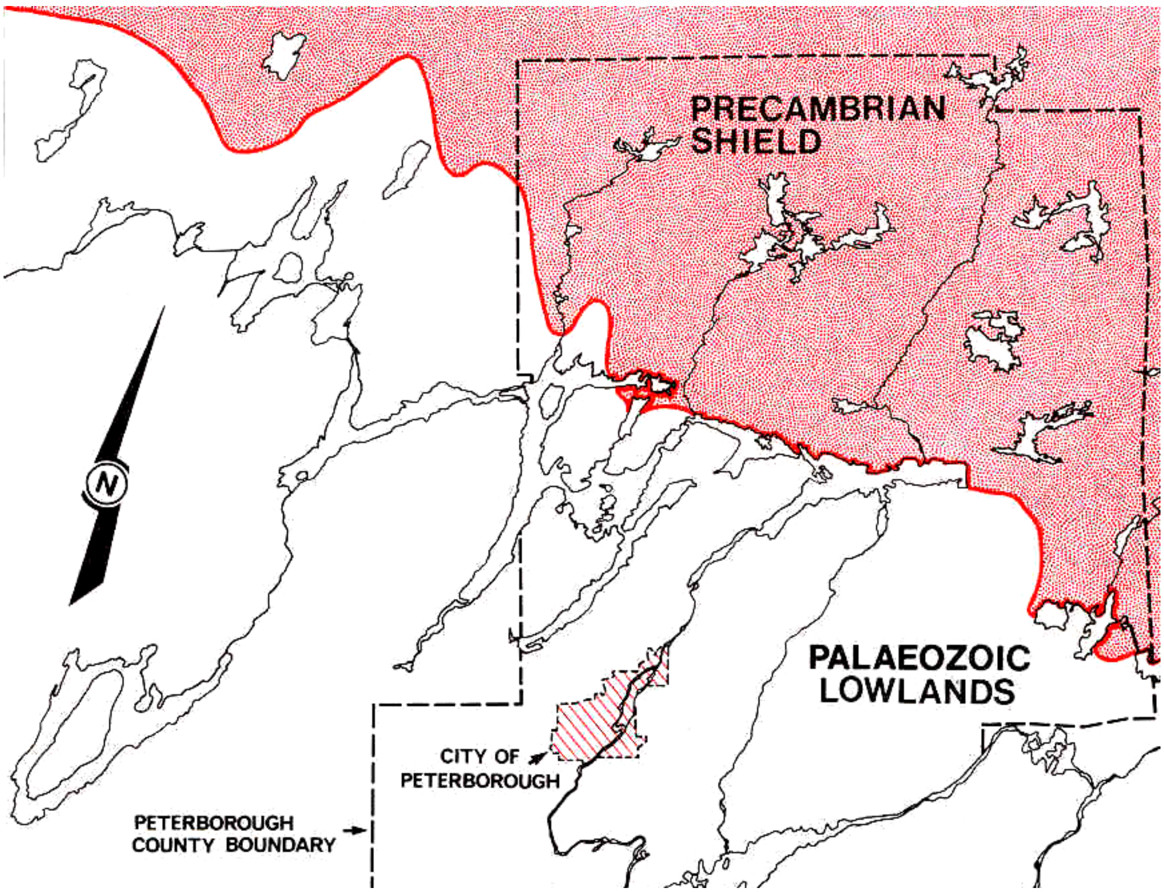
Three different "phosphorus personalities"

Over the years, the lakes we have tested have fallen into three categories: low-phosphorus lakes, high-phosphorus lakes, and one marl lake. That is, the Kawartha Lakes exhibit three distinct "phosphorus personalities" (see graph below):

- The majority of KLSA lakes can be classed as *high-phosphorus lakes*. On these lakes, phosphorus levels in early May are between 5 and 10 ppb. During the summer phosphorus levels rise to between 15 and 30 ppb.
- On *low-phosphorus lakes*, phosphorus levels are low throughout the season, remaining between 7 and 10 ppb.
- One of our lakes, Sandy Lake, has lower phosphorus levels than any other lake, generally below 5 ppb. Due to its very hard water, it is classified as a *marl lake*.



What causes these three phosphorus personalities? The answer lies in the soil and underlying rock of the area. The Kawarthas lie along the border between high-phosphorus limestone-based soils (Paleozoic lowlands) and low-phosphorus frequently granite-based soils (Precambrian Shield) (see map below).



High-phosphorus lakes receive a significant amount of drainage from the south. Water from the south drains off phosphorus-rich and alkaline soil which readily releases phosphorus, and there are also fertilized farmlands and yards as well as sewage treatment plants (potentially rich sources of phosphorus) in this more densely populated region.

Low-phosphorus lakes receive most of their drainage from the north. To the north, agriculture is replaced by pine and mixed forests, and population is less dense. Water draining from these lands with their more acidic, lower phosphorus soils, which also tend to hold on to phosphorus, will generally be much lower in phosphorus.

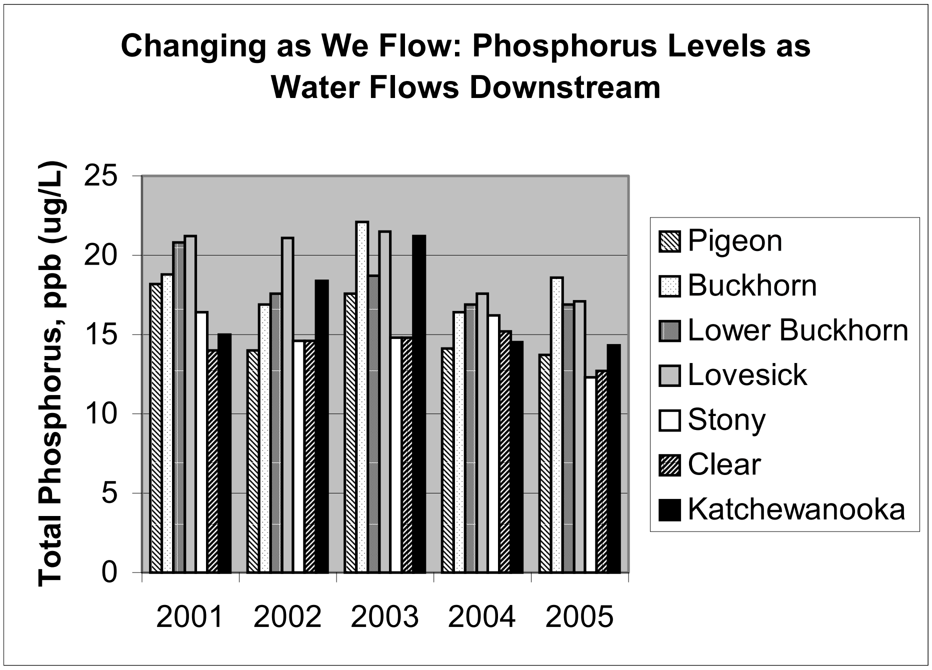
Sandy Lake is a special case; it appears to be a marl lake. In a marl lake, water draining into the lake contains high levels of dissolved limestone, i.e., dissolved calcium and carbonate. When this water drains into the lake, its chemistry changes and the dissolved minerals precipitate out as calcium carbonate, often giving the lake a milky look. These minerals then sink into the sediments. When this precipitation occurs, phosphorus sticks, or adsorbs, onto the crystals of calcium carbonate, resulting in low phosphorus levels. Sandy Lake's limestone watershed, its milky appearance in mid-summer and its unusually low phosphorus levels strongly suggest that it is a marl lake.

It seems to be a contradiction, but it is true that the presence of limestone rocks and limestone-rich soil in a watershed generally raises phosphorus levels in local lakes. However, if drainage water is very concentrated with dissolved limestone (i.e., very hard water), and if the limestone precipitates out during warm summer weather, it is a marl lake, and can have very low phosphorus levels.

Some of the other Kawartha Lakes that have localized drainage may experience a marl lake type of chemistry for part of the year. Lake Scugog, Chemong Lake and possibly Big Bald Lake may experience calcium carbonate precipitation during the summer. This precipitation of calcium carbonate and co-precipitation of phosphorus may be an important factor controlling phosphorus levels on the Kawartha Lakes.

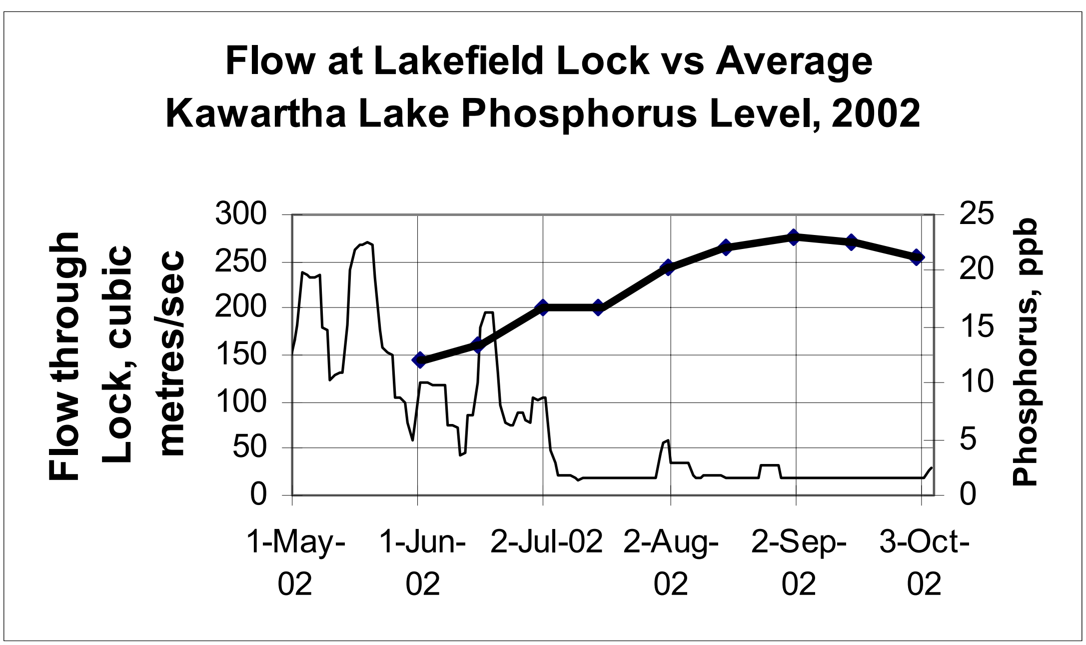
Changing as we flow: Phosphorus levels increase as water flows down the Trent-Severn Waterway

Among the high-phosphorus lakes, phosphorus levels increase as water flows downstream from Pigeon Lake to Stony Lake (see "Changing As We Flow" chart below). This trend is reversed, however, at Stony Lake. Stony Lake and Clear Lake have somewhat lower phosphorus levels than their neighbours upstream, probably due to an input of low-phosphorus water from Upper Stoney Lake. Katchewanooka Lake is somewhat higher in phosphorus than Clear. This pattern of rising phosphorus as water flows downstream, then lower phosphorus in Stony and Clear and slightly rising phosphorus in Katchewanooka, has been consistent for five years.



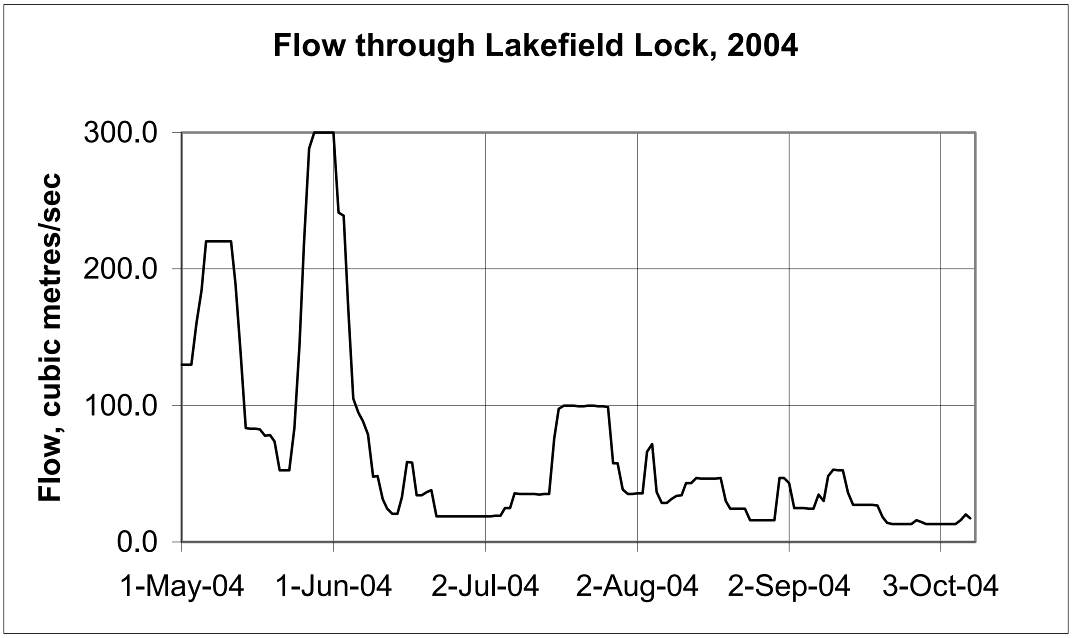
The flush syndrome: Does increased flow lower phosphorus levels?

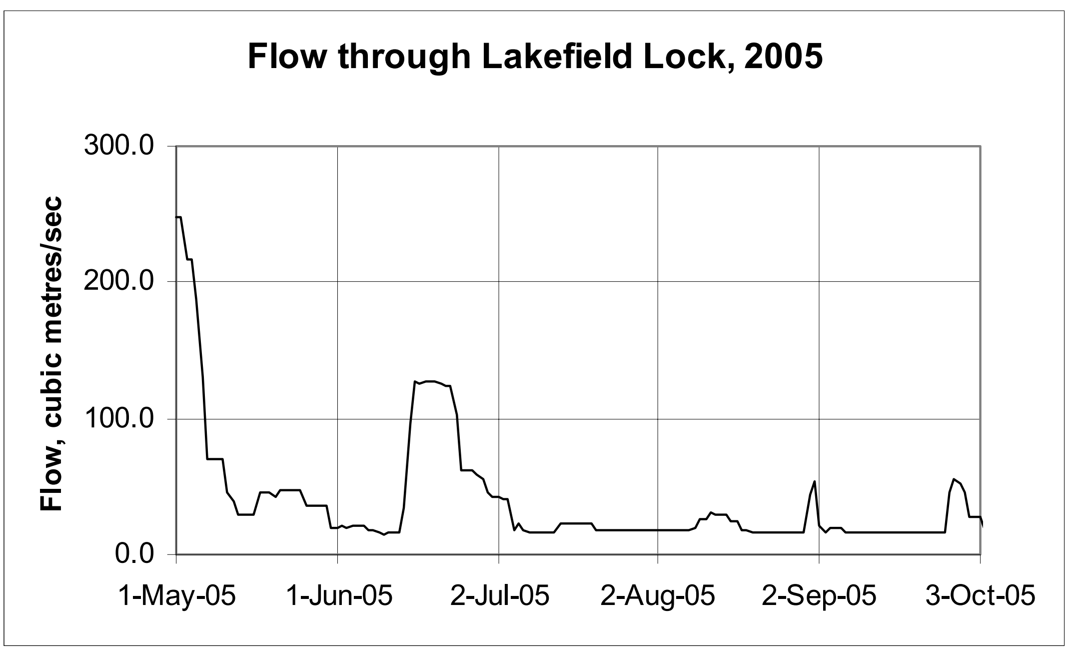
Consistently over five years, high flows through the Trent-Severn Waterway have correlated with lower phosphorus levels; that is, high flows seem to "flush" out the system with lower-phosphorus water. This relationship is easy to see in the flow vs. phosphorus level graph for 2002, below.



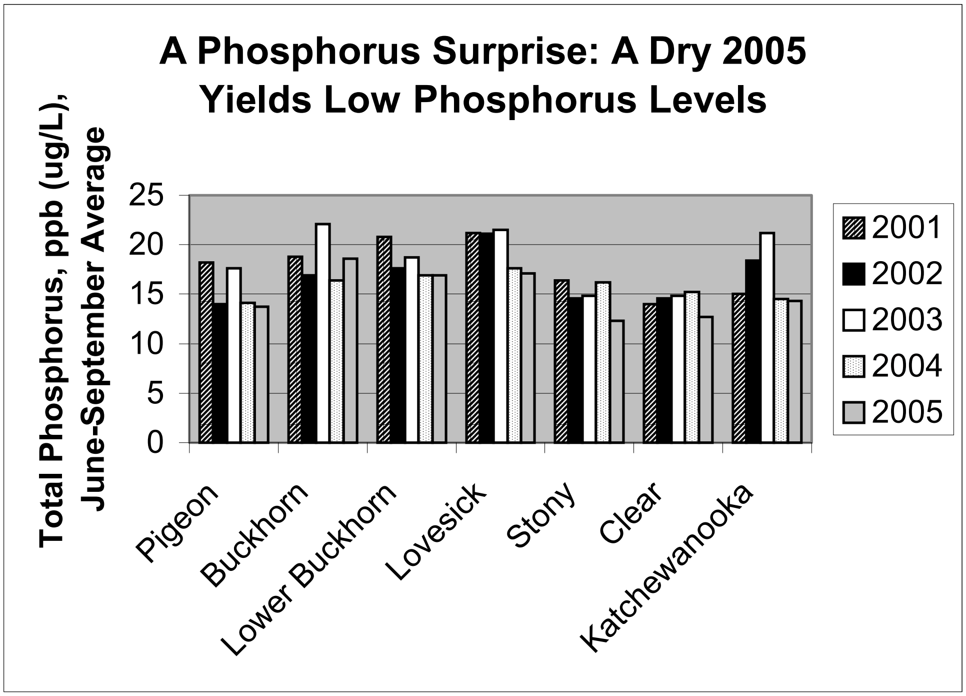
In 2004, this high flow/low phosphorus correlation was noticed in mid-summer as well. The very heavy rains in July (triple the average rainfall) were accompanied by phosphorus levels about 5 ppb lower than in July and August of 2002 and 2003.

2005 was a very dry year and flow rates were low from May through September, (compare flow charts for 2004 and 2005, below).





Because flows were so low in 2005, we were expecting very high phosphorus levels in the Kawartha Lakes. However, this was not the case! In fact, 2005 phosphorus levels were the lowest they have been since 2001 in almost all of our lakes (Buckhorn excepted), as seen in the graph, "A Phosphorus Surprise".



Why were phosphorus levels low in 2005? Here are some suggestions from some limnologists (lake scientists) familiar with these lakes:

- Warmer temperatures may have increased plant growth, which absorbed phosphorus.
- Warmer temperatures may have increased zebra mussel growth, which absorbed phosphorus.
- A lack of runoff probably reduced the amount of phosphorus flowing into the lakes.

The Flush Syndrome seems to exist on the Kawartha Lakes in the spring, i.e.,

high spring flows = low spring phosphorus

However, this year we realized that during the summer the opposite is not necessarily true, i.e.,

low summer flow ≠ high summer phosphorus

What determines phosphorus levels in the Kawartha Lakes?

Phosphorus levels in our lakes vary widely, from lake to lake and from month to month. The main reasons seem to be:

- Lakes with drainage predominantly from the north have much lower phosphorus levels than those with drainage from the south.
- During the spring when spring runoff provides large flows from the north, all lakes are "flushed out" and spring phosphorus levels are low on all KLSA-tested lakes.
- In lakes with very high calcium carbonate levels, phosphorus may be precipitated out with the calcium carbonate. This is probably the cause of very low phosphorus levels in Sandy Lake, but may be happening to a lesser extent on some of the other lakes.
- As plants and animals grow in our lakes, they absorb phosphorus from the water. Did last year's warm water cause more growth, removing phosphorus from the water?

Our data this year confirmed some theories from previous years, and contradicted some others. And that's what makes KLSA's year-over-year data gathering so interesting!

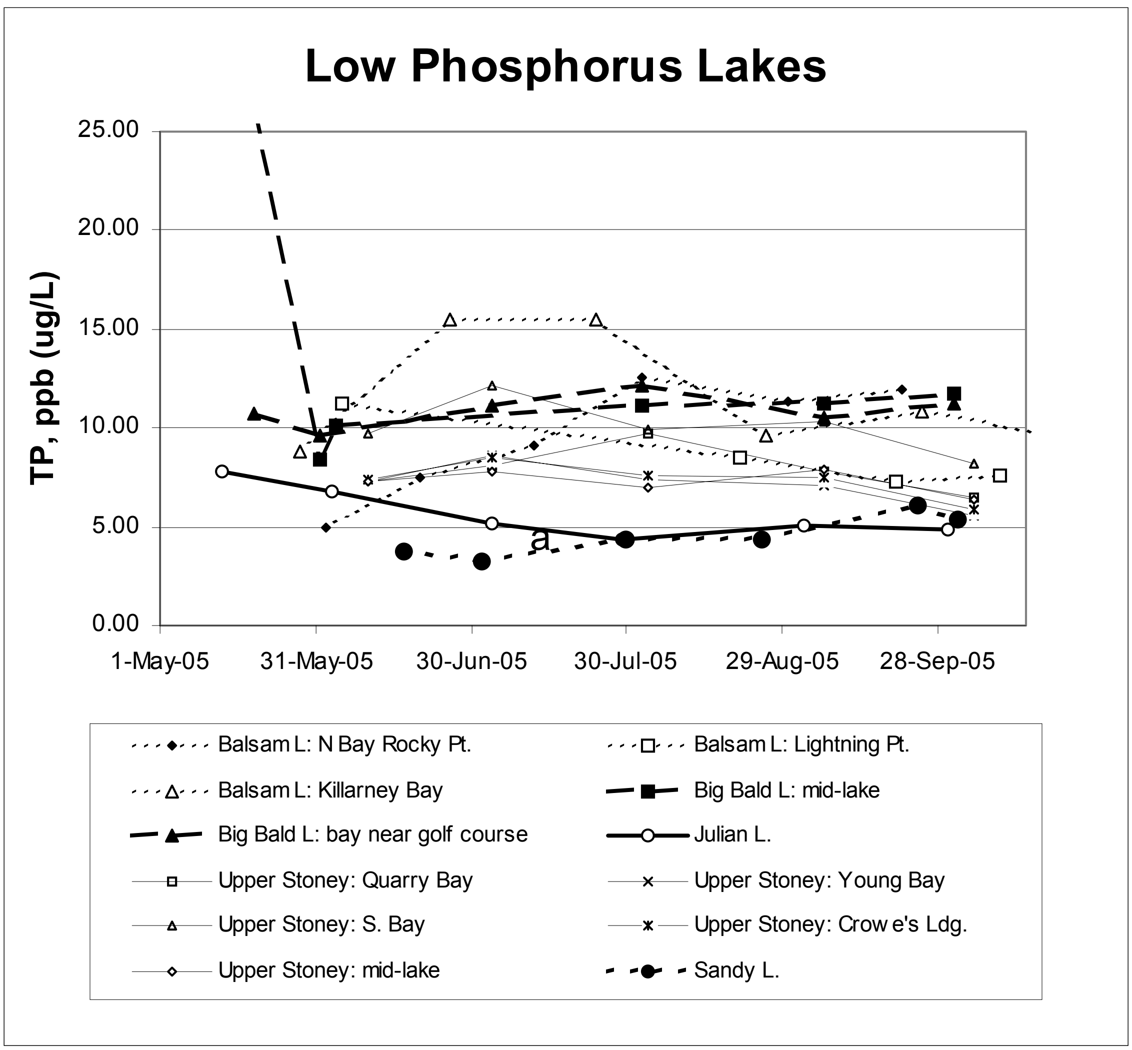
We're not the only ones who think so. Bev Clark, Coordinator of MOE's Lake Partner Program, and an experienced limnologist, says, "We are at a point now where we can show neat things even if we can't explain them. I'm really happy to have this excellent data."

How do phosphorus levels and clarity differ from lake to lake?

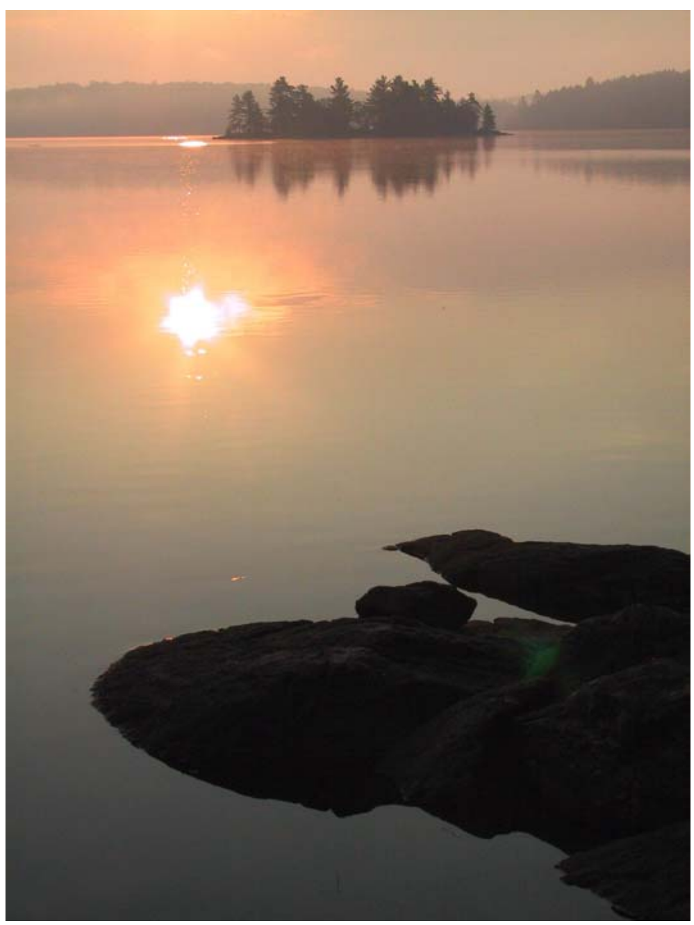
As seen in the following graphs, phosphorus levels can differ quite widely from lake to lake, and from site to site within the same lake. It is good to keep in mind that a difference of 1 or 2 ppb may not mean very much, but a difference of 4 or more ppb probably does.

Low-phosphorus lakes plus a marl lake

- These lakes have very stable phosphorus levels throughout the summer, remaining below 12 ppb. Levels are low because water drains into them from the north, and their water flows *into* the rest of the system. They don't receive high-phosphorus drainage from the south.

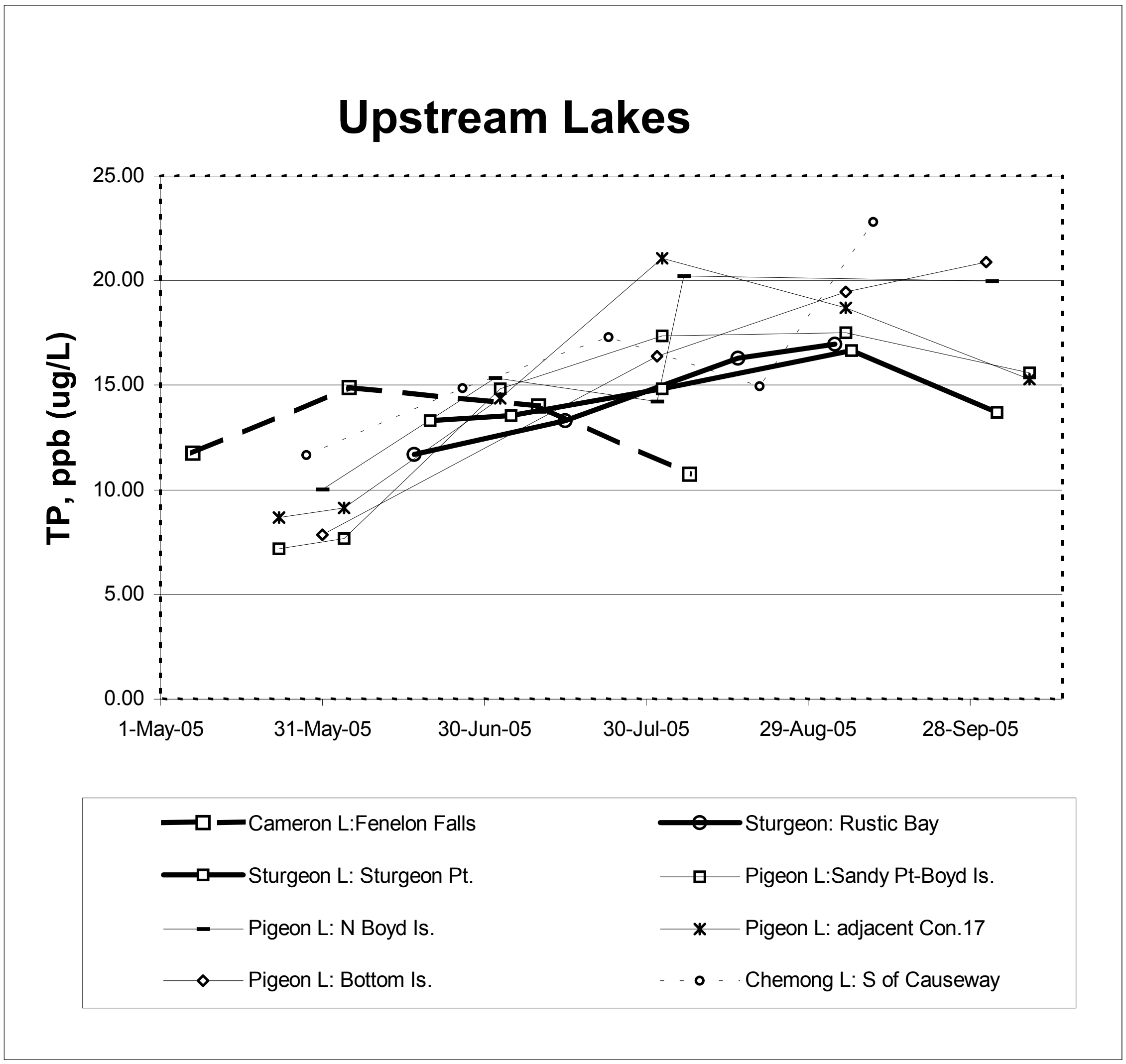


- Looking at the three Balsam Lake sites, we see that Lightning Point and Rocky Point were low-phosphorus areas, but Killarney Bay had two high measurements. Killarney Bay is at the south end of Balsam Lake, and would receive some southern drainage, although there is no large inflow from the south. There is a small stream near this site which comes from an agricultural area, and which occasionally dries up. It looks as if there was more southern drainage during the end of June and the month of July, but more northern waters predominated after that, lowering phosphorus.
- The Upper Stoney Lake sites were extremely close; South Bay, which is shallower and an eastern cul-de-sac, had somewhat higher levels.
- Julian Lake is not on the Trent-Severn Waterway, and exhibited the typical low phosphorus levels of northern Canadian Shield lakes.
- Sandy Lake is a special case; it appears to be a marl lake. Its drainage is from a very local watershed, which is predominantly limestone. Calcium carbonate precipitates out of this drainage water, and phosphorus is removed with the calcium carbonate, resulting in unusually low phosphorus levels. (See section "Three Different Phosphorus Personalities".)



Upstream Lakes

- All four Upstream Lakes show the S-shaped curve of high-phosphorus lakes, starting near 10 ppb in the spring and rising to over 15 ppb in mid-summer.
- This is the first year we have included Cameron Lake. Its phosphorus curve is very different from the other lakes on this graph; the only site it resembles is Killarney Bay (see Low-Phosphorus Lakes graph), We hope that information from our phosphorus source studies will help us understand these two anomalous sites.

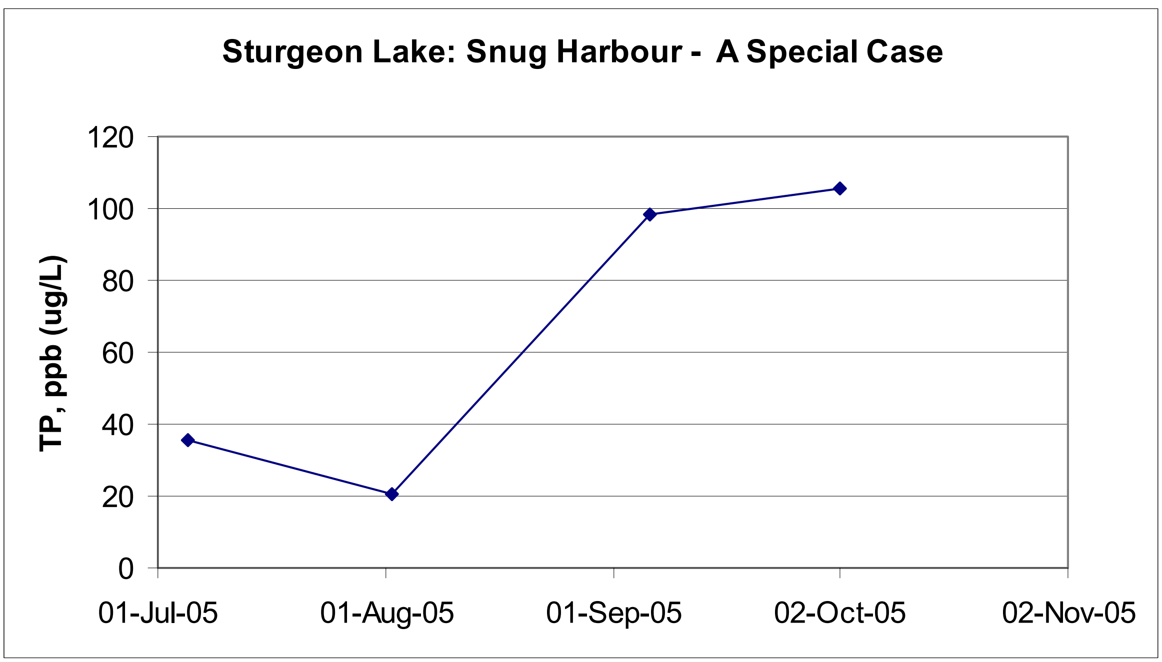


- As we would expect, Pigeon Lake, which is shallow (thus less water for dilution) and receives a fair bit of drainage from the south through the Pigeon River, is higher in phosphorus than Sturgeon Lake.

- Chemong Lake had somewhat higher phosphorus levels, as would be expected, as it is a “dead end” on the Trent-Severn Waterway, with only a very narrow channel into and out of it. Being a long, narrow lake with an extensive and fairly developed shoreline and a fair amount of agriculture nearby, it is perhaps surprising that phosphorus levels are not higher.
- The two Sturgeon Lake points shown here are very close to each other, in the middle of the lake. Next year we intend to have monthly readings for locations at the NW and NE tips of the lake.

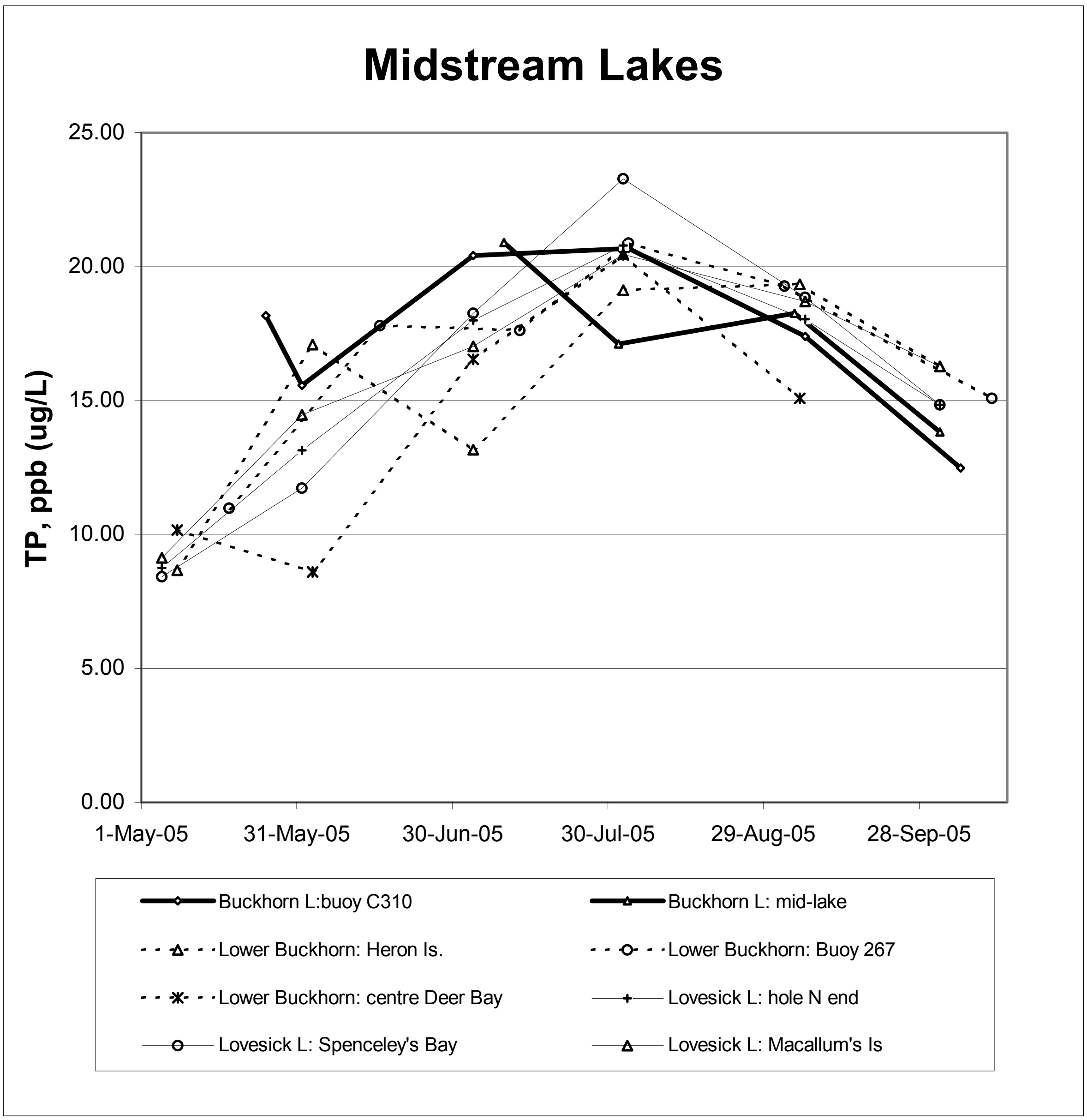
Sturgeon Lake/Snug Harbour: A special case

- This is the first year we have measured phosphorus at Snug Harbour. As seen in the graph below, phosphorus levels were somewhat high in July and August. However, in September and October, they rose to over 100 ppb, which was many times higher than any other site on any lake.
- Snug Harbour is at the south end of Sturgeon Lake, which receives water from the south through the Scugog River. There is also a very large shallow area south of the Snug Harbour site. Is phosphorus coming from some enriched sediments? Or possibly from the river? Or perhaps from a shoreline source? Directly upstream from Snug Harbour is the town of Lindsay. These high readings indicate a need to test further to find the source of the phosphorus. It is reassuring to see that these high phosphorus levels were not found in the centre of the lake.



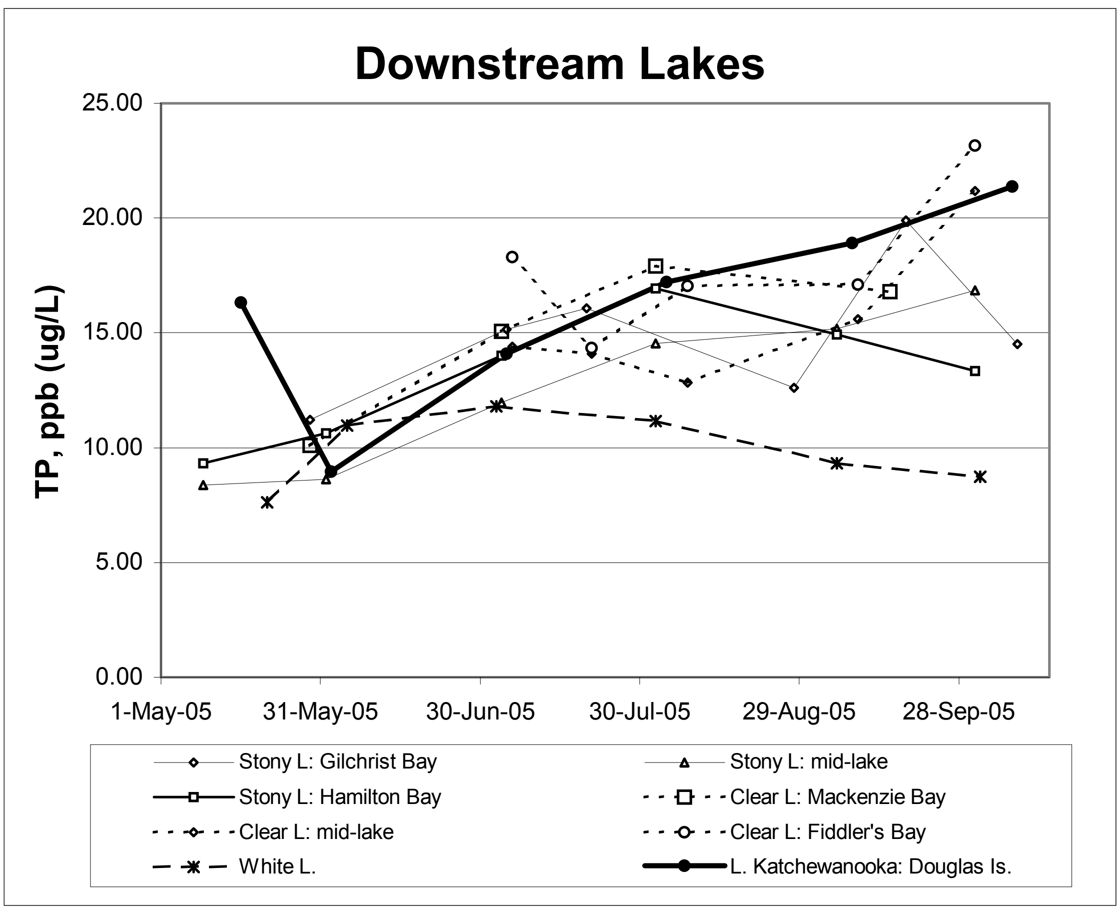
Midstream Lakes

- The Midstream Lakes have the same S-shaped phosphorus curves as the Upstream Lakes, starting with low phosphorus levels in the spring, rising through June, leveling off in July and decreasing somewhat in September.
- The Midstream Lakes have phosphorus levels about 4 ppb higher than the Upstream Lakes throughout the season. Therefore, it seems that phosphorus levels rise as the water flows downstream.
- Phosphorus levels in Buckhorn, Lower Buckhorn and Lovesick Lake were similar.



Downstream Lakes

- These lakes had lower phosphorus levels than the Midstream Lakes; their levels were similar to the Upstream Lakes. This is likely due to an input of low-phosphorus water from Upper Stoney Lake.
- The high reading in May on Katchewanooka Lake is classified as an outlier. Apparently our data shows a normal number of these inexplicable readings.
- White Lake remains a mystery. Gilchrist Bay flows directly into White Lake. White Lake is small and fairly shallow and surrounded by cottages. It is also on the border between granite and limestone; some drainage would probably come from phosphorus-rich limestone. One would expect phosphorus levels to be the same as Gilchrist Bay or even somewhat higher. However, as in 2004, White Lake has a lower phosphorus level than Gilchrist Bay, its upstream neighbour.
- Gilchrist Bay is on the border between Stony and Upper Stoney Lake. One would expect it would have drainage from both. However, its phosphorus levels are generally those of Stony. It would seem that water drains out of Upper Stoney into Stony Lake, but not into Gilchrist Bay. Gilchrist Bay's water seems to come from Stony, not Upper Stoney Lake.



Lake-by-lake comparison: Conclusion

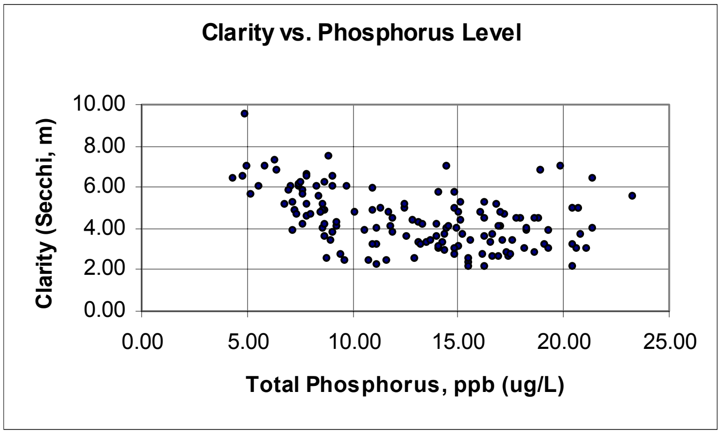
Phosphorus levels varied significantly from lake to lake, as shown below:

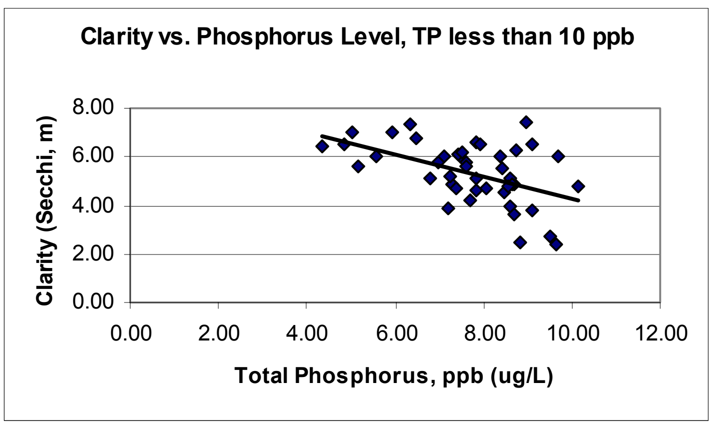
lowest phosphorus level	marl lake
	▼
	low-phosphorus lake (drainage from north)
	▼
	upstream lakes
	▼
	downstream lakes
	▼
	midstream lakes
	▼
highest phosphorus level	Snug Harbour (south end Sturgeon Lake)

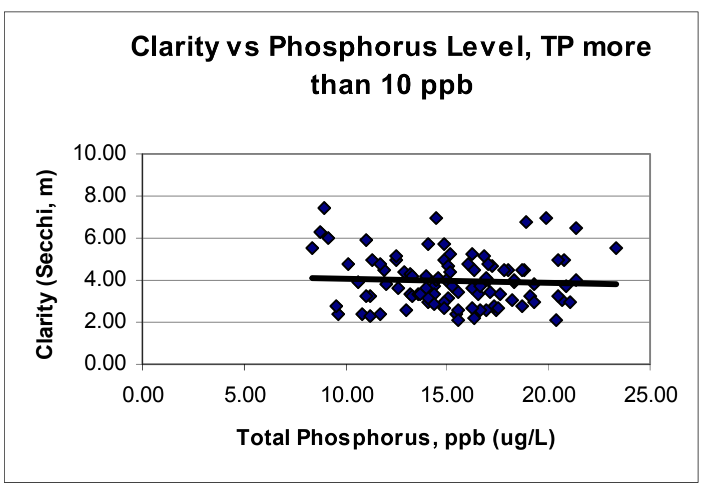
As seen in previous years, flows from the north seemed to make phosphorus levels lower; flows from the south seemed to cause phosphorus levels to rise.

Does phosphorus level determine clarity?

It is generally agreed in the scientific community that the higher the phosphorus level in a lake the less clear it will be. This is because phosphorus feeds algae, and the more algae you have the murkier your water will be. Did we find this in our results? The answer is "yes and no" (see three graphs below).







The case for YES: When looking at measurements of less than 10 ppb total phosphorus, clarity rises with a decrease in phosphorus (see trendline in graph "Clarity vs. Phosphorus Level, TP less than 10 ppb"). This was, however, not obvious in previous years.

The case for NO: When looking at measurements of more than 10 ppb total phosphorus, the correlation disappears; the trendline on the graph "Clarity vs. Phosphorus Level, TP more than 10 ppb" is almost flat! A rise in phosphorus from 10 to 25 ppb, in general, makes no difference to clarity. There is also a large amount of scatter in the graph, so the relationship between clarity and phosphorus is unclear. The presence of zebra mussels in most of these lakes is probably having an effect on the phosphorus/clarity relationship.

In the 2004 KLSA report, a Maine, US study was quoted which found that property values started to decrease at a Secchi value of about 4 m. That is, lakes having a Secchi measurement of 4 m or over, were considered clear, but as Secchi measurements fell below 4 m, property values also fell. Approximately half of the KLSA lakes with phosphorus measurements over 10 ppb had Secchi measurements of less than 4 m.

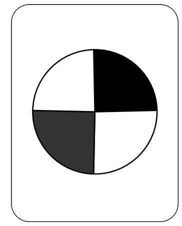
So, if you are on a lake with phosphorus levels consistently under 10 ppb, it would be a very good idea to keep them that way! You almost certainly have a Secchi measurement of over 4 m, which gives a favourable appearance of clear lake water.

If your lake is consistently over 10 ppb phosphorus, as most KLSA lakes are, there is about a 50% chance that your lake's clarity may be lower than 4 m, which is probably lower than ideal clarity for recreational purposes.

It is wise to keep phosphorus inputs under control, although a small decrease in phosphorus levels (e.g., from 20 to 18 ppb) is not guaranteed to make a noticeable difference in clarity in these lakes.

Measuring water clarity (Secchi disk depth)

Secchi disk depth is a measure of lake water clarity. A Secchi disk is a circle the size of a paint can lid. It looks like a pie cut in quarters with alternating black and white sections. The disk is lowered until it disappears from sight. This is called the Secchi disk depth. A clear lake will have a greater Secchi disk depth than a murky lake.



Lowering the Secchi disk to measure the water clarity

Green algal growth on rocks

Phosphorus Source Study Part One: Phosphorus and the Kawartha Lakes

by Michael White

Introduction

Human-induced nutrient enrichment, or eutrophication, of aquatic ecosystems has been the focus of much research over the past two decades [1-5]. Even though other nutrients are associated with eutrophication, phosphorus is of major concern as it is usually the most controlling nutrient in freshwater ecosystems [6]. The relationship between lake eutrophication (nutrient enrichment) and the abundance of phytoplankton (free-floating algae) became common knowledge about 30 years ago [7, 8] and we now understand that lakes are subject to regime shifts from clear macrophyte (aquatic plant) dominated systems to turbid phytoplankton dominated systems [9, 10]. The driving force behind the clear to turbid shift is elevated phosphorus concentrations [11-13]. The elevated phosphorus concentrations correspond to increased phytoplankton production and result in changes to lake classification (Table 1).

The phosphorus cycle

Much is known about the phosphorus cycle in lakes. The following discussion outlines the fundamental mechanics of the process and was compiled from two aquatic ecology textbooks; *Applied Aquatic Ecosystem Concepts* [14] and *Limnology* [15]. The first thing one should understand about phosphorus is that it is found in both soluble and insoluble forms, which together account for the total phosphorus (TP) in a lake ecosystem. The insoluble forms fall to the lake bottom, while the soluble forms, known as soluble reactive phosphorus (SRP), are readily used by phytoplankton and macrophytes. Almost all natural sources of phosphorus (~90%) enter a lake system in the insoluble form, whereas phosphorus from anthropogenic (human-induced) sources are predominately of the soluble form (~90%). This means that phosphorus entering aquatic systems from human sources is immediately available for primary production. The insoluble phosphorus, which has fallen to the lake sediment, can be converted to soluble form and is not trapped there permanently. The mobilization process can be quite complex, but in its simplest form, insoluble phosphorus can be reduced to a soluble state at the sediment-water interface through decreasing redox potential* and pH levels. These conditions exist when lake sediment oxygen levels decrease and become anoxic. This anoxic condition occurs in lakes when algae die and fall to the lake bottom. As the dead algae are decomposed, bacteria consume oxygen and favourable conditions for phosphorus mobilization occur. Thus, once a lake becomes eutrophic (in the turbid algal state), this negative feedback loop can make restoration efforts challenging.

So what does this tell us? It is possible to limit anthropogenic (human-induced) sources of phosphorus, creating an initial decrease in levels; however, long-term reduction may take many years as the insoluble phosphorus is mobilized and absorbed by plant species. The easiest way to restore a lake is to prevent it from becoming eutrophic in the first place. Recent studies suggest that the degree and rate at which a lake can reduce its phosphorus concentration depend on many factors; these are discussed in the following section.

Lake recovery potential

The undesirable phenomenon of lake eutrophication has led to many restoration efforts. Current research has been devoted to discovering the underlying drivers in the re-oligotrophication process. Søndergaard *et al.* [16] conducted an excellent study of 12 lakes in Denmark to determine lake response to reduced nutrient loads. Their findings demonstrate that internal loading[*] of phosphorus can significantly delay lake recovery (up to 10 years) and that lake morphology (shallow vs. deep basins) must also be considered in restoration efforts. The shallow basins do not stratify (they have one thermal layer) and are subject to more wave action, thereby altering phosphorus resuspension and remobilization. A similar study by Jeppesen *et al.* [12], which incorporated the same Danish lakes into a larger data set of 35 case studies, had similar conclusions concerning reduced nutrient loading. They found that internal loading delayed lake recovery; lower phosphorus levels did not stabilize until 10-15 years had passed. Interestingly, fish biomass was found to decline in the majority of cases; however, piscivorous species (fish that eat other fish) increased in 80% of the case studies. Phytoplankton community structure reverted back to oligotrophic species, but submerged macrophyte communities reappeared in only 50% of the lakes for which data was available. As Declerck *et al.* [13] point out, phosphorus can both directly and indirectly affect aquatic diversity. It can act directly on plants, which absorb it, or indirectly through changes in macrophyte communities, creating habitat and refuge for fish and zooplankton.

Two of the most important factors controlling lake response to reduced nutrient loads are mean depth (calculated as the lake volume divided by its surface area) and macrophyte abundance [10]. Curiously, the lakes most resistant to recovering to a clear state are lakes of intermediate size. These problematic lakes have a mean depth of around 10 meters. They are too deep to be aided by macrophytes (which decrease water turbidity by acting as nutrient traps, thus limiting the resuspension of sediment material and negatively affecting algal growth [11]) and too shallow to mitigate internal phosphorus loading through dilution in the hypolimnion *[10]. This suggests that some of the Kawartha Lakes may not be able to revert to a clear state once a shift to a turbid algal dominated one has occurred.

Table 1. Values for spring total phosphorus and average summer chlorophyll *a* levels in lakes of three trophic states. Modified from Mackie [14].

Trophic State	Total Phosphorus µg/L	Chlorophyll *a*
Oligotrophic (Clear water)	< 10	< 2
Mesotrophic	10 – 20	2 – 5
Eutrophic (Turbid water)	> 30	> 5

Suspended organic material causing foam on the Otonabee River below the dams

What about the Kawartha Lakes?

Of the many human induced sources of phosphorus, three are likely to be the significant contributors to the Kawartha Lakes phosphorus levels: agriculture (fertilizer runoff), wastewater treatment facilities and faulty septic systems. Phosphorus loading by invasive animal populations is also a concern. Emerging evidence suggest that dreissenids (Zebra mussels) can negatively affect phosphorus cycling within lakes [17]. It has been postulated that the zebra mussels retain phosphorus in nearshore areas where it can accumulate and may be linked with the nuisance filamentous green algae *Cladophora* (see "What about Zebra Mussels?", Pg 53). Similarly, there is evidence that geese can significantly elevate nutrient levels [18]; this may be a problem in the Kawartha Lakes area if populations are high. There are also other natural and unnatural sources of phosphorus (atmospheric deposition, base geology, internal loading) but these would be extremely difficult, if not impossible, to reduce.

The Kawartha Lake Stewards Association (KLSA) is concerned about the phosphorus levels in their region. The reason for the concern is that phosphorus levels are currently around 17 µg/L (or ppb) and it is possible that a concentration of 20 µg/L may lead to foul-smelling algal blooms and a shift towards a turbid algae dominated lake system [19]. Should a shift in lake regime to a turbid system occur, it would be difficult and costly, if not impossible, to remediate. The following four steps are essential in assessing phosphorus in the Kawartha Lakes: data gathering, identifying potential sources of phosphorus, ground truthing* and remediation. As part of a partnership between KLSA and Trent University, the first two steps will be conducted and recommendations will be provided on how to proceed with the remaining two.

Study methodology

The first step in assessing phosphorus levels is to assemble all historical data for the lakes of concern. Data will be acquired from local Conservation Authorities, the Ministry of the Environment, KLSA and other sources that may be uncovered in the data mining process. Once this information has been gathered, it will be possible to determine whether phosphorus levels have increased or decreased from historical accounts and where the areas of concern (AOC) are located.

The second step is to utilize KLSA's excellent five-year phosphorus data set, and any other recent data that may have been found, in a comprehensive analysis with land use patterns to determine any spatial relationships with land use and phosphorus concentration. Geographical information will be obtained through Ontario's Natural Resources and Values Information System (NRVIS) to determine land use patterns (e.g., cropland, urban, forest) for each lake in the KLSA area. Similarly, the MNR's lake database will be utilized to gather morphological information (e.g., maximum depth, mean depth, volume, area, fetch*) and other lake characteristics (e.g., residence time, cottages per lake), which influence phosphorus concentrations. Various statistical techniques (regression and ordination analyses) will be applied to the land use and lake characteristics information to identify potential phosphorus sources.

Once potential sources have been identified, detailed monitoring will be necessary to both confirm each one as a source, and determine its contribution to the lake's phosphorus load. Depending on the source, this third step could involve an array of monitoring techniques from more detailed lake sampling to surface (lysimeter) and groundwater (piezometer) sampling.

The final step involves taking direct action to reduce phosphorus import from verified source locations. The action taken will depend on the source.

On August 31, 2006, KLSA will receive a report containing the following:

- ✓ Excel spreadsheet containing gathered data.
- ✓ Watershed and land uses delineated in arcview® format.
- ✓ AOCs and hot spots identified.
- ✓ Preliminary analysis involving all available data demonstrating the patterns and potential sources of phosphorus.
- ✓ Areas identified where research should be directed, including specific studies/experiments.
- ✓ Suggestions of possible strategies to reduce phosphorus loads.

*Definitions

Redox potential – reduction/oxidation potential is measured as electrical voltage and represented as the value E_h. The change in oxidation state of many metallic ions is defined by the redox potential [14]. A negative voltage indicates reducing conditions (gain of electrons), while a positive voltage indicates oxidizing conditions (loss of electrons).

Internal loading - Recycling of nutrients among sediment, organisms and water.

Hypolimnion – Lakes usually stratify into three thermal layers; the hypolimnion is the colder, dense, deep-water layer.

Ground truthing – Verification of predicted patterns or outcomes through follow-up studies.

Fetch - The furthest distance that wind can blow over a lake before it is disrupted by land.

Literature cited

1. Hart, M. R., Quin, B. F. & Nguyen, M. L. Phosphorus runoff from agricultural land and direct fertilizer effects: a review. Journal of Environmental Quality 33, 1954-1972 (2004).

2. Schindler, D. W., Armstong, F. A. J., Holmgren, S. K. & Burunskill, G. J. Eutrophication of lake 227, experimental lakes area, Northeastern Ontario, by addition of phosphate and nitrate. Journal Fisheries Research Board of Canada 28, 1763-1782 (1971).

3. Sims, J. T., Simard, R. R. & Joern, B. C. Phosphorus loss in agricultural drainage: historical perspective and current research. Journal of Environmental Quality 27, 277-293 (1998).

4. Makarewicz, J. C. & Bertram, P. Evidence for the restoration of the Lake Erie ecosystem. BioScience 41, 216-223 (1991).

5. Beasley, D. B., Monke, E. J. & Miller, E. R. Using simulation to assess the impacts of conservation tillage on movement of sediment and phosphorus into Lake Erie. Journal of Soil & Water Conservation 40, 233-237 (1985).

6. Schindler, D. W. Evolution of phosphorus limitation in lakes. Science 195, 260-262 (1977).

7. Schindler, D. W. Detecting ecosystem response to anthropogenic stress. Canadian Journal of Fisheries and Aquatic Sciences 44, 6-25 (1987).

8. Vollenweider, R. A. Advances in defining the critical loading levels for phosphorus in lake eutrophication. Memorie dell'Istituto Italiano di Idrobiologia 33, 53-83 (1976).

9. Bayley, S. E. & Prather, C. M. Do wetland lakes exhibit alternative stable states? Submersed aquatic vegetation and chlorophyll in western boreal shallow lakes. Limnology and Oceanography 48, 2335-2345 (2003).

10. Genkai-Kato, M. & Carpenter, S. R. Eutrophication due to phosphorus recycling in relation to lake morphometry, temperature, and macrophytes. Ecology 86, 210-219 (2005).

11. Portielje, R. & Rijsdijk, R. E. Stochastic modeling of nutrient loading and lake ecosystem response in relation to submerged macrophytes and benthivorous fish. Freshwater Biology 48, 741-755 (2003).

12. Jeppesen, E. et al. Lake responses to reduced nutrient loading - an analysis of contemporary long-term data from 35 case studies. Freshwater Biology 50, 1747-1771 (2005).

13. Delerck, S. et al. Multi-group biodiversity in shallow lakes along gradients of phosphorus and water plant cover. Ecology 86, 1905-1915 (2005).

14. Mackie, G. L. Applied Aquatic Ecosystem Concepts (Kendall/Hunt Publishing Company, Dubuque, Iowa, 2001).

15. Wetzel, R. G. Limnology (W. B. Saunders Company, Toronto, 1975).

16. Søndergaard, M., Jensen, J. P. & Jeppesen, E. Seasonal response of nutrients to reduced phosphorus loading in 12 Danish lakes. Freshwater Biology 50, 1605-1615 (2005).

17. Hecky, R. E. et al. The nearshore phosphorus shunt: a consequence of ecosystem engineering by dreissenids in the Laurentian Great Lakes. Canadian Journal of Fisheries and Aquatic Sciences 61, 1285-1293 (2004).

18. Olson, M. H., Hage, M. M. & Binkley, M. D. Impact of migratory snow geese on nitrogen and phosphorus dynamics in a freshwater reservoir. Freshwater Biology 50, 882-890 (2005).

19. KLSA. (ed. Moffat, P.) Washout in the Kawarthas: lake water quality 2004 report. (Kawartha Lake Stewards Association, Peterborough, Ontario, Canada). 1-88 (2005).

Michael White is a PhD student at Trent University who is studying the effects of water drawdown on benthic macroinvertebrate community composition and water quality in hydroelectric reservoirs. Under the supervision of Prof. Marguerite Xenopoulos, he is pursuing the KLSA phosphorus sources study as a reading course towards his PhD course requirements.

Phosphorus Source Study Part Two: Sewage Treatment Plant (STP) Sources

by Kevin Walters

In last year's KLSA report, we outlined the objectives of a study we planned to undertake to discover the sources of phosphorus entering the Kawartha Lakes. One of the known sources – possibly a major one – is local municipal sewage treatment plants (STPs). While Michael White of Trent University is conducting a broad study of many possible phosphorus sources in partnership with KLSA, a team of students at Sir Sandford Fleming College is working with us to investigate the six sewage treatment plants that discharge into the Kawartha Lakes. These plants are located at Coboconk, Port Perry, Lindsay, Fenelon Falls, Bobcaygeon and Omemee.

There are two other plants upstream in the watershed at Haliburton and Minden, but they are considered too far upstream to have any significant impact on the Kawartha Lakes. Moreover, phosphorus removal in these two locations is given a high priority in order to protect the sensitive lake trout fisheries in the lakes immediately downstream of these plants. (MOE sets the effluent regulations.)

Methodology

The methodology for our STP study is straightforward:

- find out the allowable phosphorus discharge limits for the six plants,
- determine their current discharge levels, both from plant records and our own testing, and
- multiply this by the total flow discharged from each plant to determine the total phosphorus loading from the six STPs.

The resulting data can later be incorporated into the larger study being done at Trent University to establish the proportion of phosphorus in the watershed that comes from STPs relative to other sources.

Study Process

Sir Sandford Fleming College has an Ecosystem Management Technology Credit for Product Program whereby student teams are matched with not-for-profit environmental organizations needing research assistance. This partnership arrangement benefits both parties: the organization's research needs are fulfilled while the students obtain academic credit for their work.

In early January 2006, I met with Sara Kelly, a faculty member at the College, and her students enrolled in the program, to introduce them to the KLSA and its objectives as well as the proposed study. About eight other agency groups made similar presentations. The students, in teams of three, then rated each agency's assignments according to their interest levels, and then interviews between each agency and each team began. At the end of the process, each agency rated each team and a matching process took place. It was encouraging to find that many of the student teams ranked our project very highly – as one of their top three choices.

The three young women who make up our team (interestingly, there were very few young men amongst the students) are Amber-Lee DeVries, Laura Harris and Jenny Harmathy. They devote every Monday to the KLSA project. To date the team has collected data from the six sewage treatment plants including the past few years of discharge data as well as the allowable and target phosphorus discharges. As of this writing, the testing and data analysis remain to be done. The team has been asked to prepare a preliminary report by early March 2006, and their final report is to be ready by the end of March. KLSA hopes that the students will be able to present their results at our general meeting in May, in addition to a planned open house with presentations to be held in early April at Sir Sandford Fleming College.

Further investigation

If time allows, there is another phosphorus sub-study on which our team might do some preliminary work. This involves looking at urban storm water sources. I have long felt that there is little benefit in requesting cottagers to avoid fertilizing their lawns, to maintain shoreline buffer zones, and practice other phosphorus-reducing measures, when in towns such as Lindsay, residents fertilize their lawns with impunity. In urban locations the wash-off runs over the curb or down the driveway and into the storm sewers and thence into the rivers and lakes with exactly the same effect as at cottages. If time permits, our team will do some investigating to determine if any local data exists on phosphorus levels in storm water runoff – perhaps at the Conservation Authorities – and will do some testing of their own at key storm sewer outfalls in Lindsay.

We appreciate the partnership of Sir Sandford Fleming College in this project and look forward to receiving the results in the spring of 2006.

Kevin Walters is a KLSA Board member and coordinator of KLSA's phosphorus source studies.

Macrophyte Monitoring in the Kawarthas - 2005

By Eric Sager and Kristy Hogsden
Oliver Ecological Centre
Trent University

Introduction

The abundance of aquatic plants, or macrophytes, in recent years has been a great concern to many cottagers, residents and visitors to some of the Kawartha Lakes. In establishing our macrophyte monitoring program for the Kawarthas, we are being guided by two simple questions: 1) Are we seeing changes in the diversity or the extent of plants that are normally here? and 2) Do we have any non-native, and potentially invasive, species? An answer of yes to either of these questions may be reflective of deterioration in the health of the lakes.

This marked the second year that shoreline residents of the Kawarthas took an interest in exploring the composition of the aquatic plants that they found growing throughout their lakes. These plants represent one of the most visual components of the Kawartha Lakes ecosystem and also one of the more controversial. Many of the wildlife and fish species are dependent upon the habitat provided by these plants for refuge from predators and consumption of prey species. At the same time, they interfere with people's enjoyment of the lakes. It is not uncommon to see shoreline residents going through their daily routine of raking their beaches with the hopes of removing the large amounts of plant material that were deposited from the wind and wave activity of the previous day, or even raking mats of floating plants out of the water in swimming and boat docking areas.

When present in the "right" amount, macrophytes provide important structural complexity in the underwater landscape. They regulate important nutrient cycling pathways in lakes and are a key component in ensuring that the open water portions of the lake remain healthy. When present in "excessive" amounts, they can drastically alter the dynamics and integrity of the entire lake. This luxurious growth is often linked with large inputs of phosphorus (P) from the watershed, which is often a limiting nutrient to freshwater plant growth. It should be pointed out that excessive nutrient loading can also shift the lake into a completely different set of conditions, one where phytoplankton (free-floating algae) are the main form of plant life, which can lead to the creation of highly turbid water - something that can look a lot like pea soup. But for now in the Kawarthas, fortunately, we are more concerned with macrophytes. The challenge that lake managers face is defining how much macrophyte biomass is too much. Typically, it is the passionate call for help from shoreline residents that ultimately initiates some sort of control measure (i.e., mechanical removal, herbicides, shade cloths, etc.), but lake managers across Canada have initiated control measures when macrophyte biomass exceeds 100 – 500 g dry weight·m^{-2} (g·m^{-2} means grams of material in 1 square meter of area that has been dried in an oven at 40 °C). Control measures are also initiated when potentially invasive non-native species are discovered.

This past summer we partnered with members of the Lovesick Lake Association to quantify the diversity and biomass of macrophytes, as well as to monitor P and the growth of phytoplankton at a number of shoreline sites throughout the lake. Previous water quality monitoring carried out in cooperation with the Lake Partner Program of the Ministry of the Environment has highlighted the fact that Lovesick Lake typically has some of the highest total P concentrations in the Kawarthas and shoreline residents of the lake have also vocalized their concerns about the excessive weed growth that they are experiencing. In addition, volunteers from Lake Katchewanooka, White Lake, Big Bald Lake and Pigeon Lake also carried out macrophyte surveys and their data will also be presented.

Methods

Macrophyte surveys were carried out at monthly intervals starting in mid-June and ending in mid-late September. Ten sites were established in nearshore areas of Lovesick Lake (see Figure 1). In addition, individual sites were monitored on Lake Katchewanooka, Pigeon Lake, White Lake and Big Bald Lake by lake association members. Macrophyte diversity was assessed and above-ground biomass (fresh weight) was estimated by placing a 0.25 m^2 quadrat on the sediment surface and harvesting, identifying and weighing all shoots. At all locations, quadrat sampling was carried out at a water depth of approximately 1 meter. In addition, qualitative observations of abundance were carried out along a transect that ran perpendicular to the shoreline up to a water depth of 3 m or a distance of 25 m from the shoreline. At three different locations along the transect, macrophytes were sampled with the aid of a rake and the relative abundance and diversity of plants were assessed.

For the Lovesick Lake sites, water samples above the macrophyte beds were also collected to determine the concentration of dissolved P (a fraction of total P and typically recognized as the biologically available component of total P) and to estimate the biomass of phytoplankton (suspended algae as measured by the concentration of chlorophyll *a*).

What did we find?

Table 1 lists the 24 species that were recorded during surveys at the 10 sites in Lovesick Lake. This list is by no means complete and is meant to be a baseline of information that is built upon throughout successive monitoring endeavors. With the exception of *Potamogeton crispus* (curly-leaved pondweed) and *Myriophyllum spicatum* (Eurasian milfoil), all species are native to the region.

Figure 2 shows the average biomass that was observed across the 10 sampling sites in Lovesick Lake. There was considerable variation among the different sites, with the majority of the plant productivity occurring on the north shore of the lake near sites 7, 8, and 9 where soft, mucky sediments were abundant. Biomass levels approaching 10,000 $g \cdot m^{-2}$ were found. Converting these fresh-weights to dry weights yields approximate values between 400 – 1200 g dry weight$\cdot m^{-2}$ for these north shore locations. Sites located along the southern shore of the lake had substantially lower biomass present and this is likely related to the hard, rocky substrate that is present. At these sites, biomass ranged between 1500 – 4500 $g \cdot m^{-2}$, which is equivalent to dry weights of roughly 100 – 300 $g \cdot m^{-2}$. These same sites also received the highest amount of floating debris (i.e., uprooted and detached plant material) during the course of the summer and as this material sinks, it could ultimately provide potential rooting material for future colonization by plants. Macrophyte biomass of the other lakes that were surveyed was more similar to those of the south shore of Lovesick Lake, ranging from a low of 45 g dry weight$\cdot m^{-2}$ for Pigeon Lake to a high of 317 g dry weight$\cdot m^{-2}$ for White Lake.

At any given sampling location, the number of different species varied between 1 and 16, but sites were typically dominated by 3-5 species of plants (Figure 3). These same trends were observed at the individual sites that were monitored in the adjacent lakes (Figure 4). The good news is that exotic species represented a very small proportion of the plants that were sampled, with the exception of the one site in Pigeon Lake where *Myriophyllum spicatum* (Eurasian milfoil) was noted to be one of the more dominant species present. In Lovesick Lake, the most dominant species consistently were *Vallisneria americana* (tape grass), *Ceratophyllum demersum* (coontail), *Elodea canadensis* (Canada waterweed), and *Myriophyllum heterophyllum* (two-leaf water milfoil). At some sites on Lovesick Lake - namely 3, 5, and 6 – the Potamogetons (pond weeds) were found in much higher abundance in the early summer, which is reflective of their ability to start growing when water temperatures are cooler relative to the other species.

Figure 5 shows the concentrations of dissolved P and chlorophyll *a* determined for water sampled above the monitored macrophyte beds. Concentrations of chlorophyll *a,* a signature of algae, were consistently quite low throughout the summer. The highest concentrations were noted in June, which may be reflective of the fact that the submersed vegetation is just beginning to grow and thus competition for important resources such as light and nutrients is not an issue. Typically, chlorophyll *a* concentrations of < 4 $ug{\cdot}L^{-1}$ are indicative of an oligotrophic lake (one that has total P concentrations below 10 $ug{\cdot}L^{-1}$). Since we already know that total P concentrations for Lovesick Lake are typically between 18 - 25 $ug{\cdot}L^{-1}$, at the height of the summer, these low chlorophyll values likely reflect the highly productive submersed plant community that is present and their ability to out-compete phytoplankton for important resources. This is also supported by the fact that there was no statistical relationship between the concentration of chlorophyll *a* and dissolved P, whereas in open water situations they are often directly correlated.

On average, dissolved P concentrations for Lovesick Lake slowly increased over the duration of the summer (Figure 5). It is generally thought that macrophytes are initially a sink for nutrients in the water (by both creating conditions whereby particles can sink to the sediment as well as by actively taking them up through roots and leaves), but when they die off in autumn they act as a source of nutrients to the water. Figure 6 supports the role of macrophytes as sinks of P as it demonstrates an inverse relationship between macrophyte biomass and dissolved P in the water column. We did not find any relationships between changes in species diversity and increases or decreases in P concentrations. Other monitoring programs have noted the disappearance of species diversity or the dominance of a community by invasive exotics with continued nutrient enrichment and disturbance.

Where to go from here?

If our objective is to manage the Kawartha Lakes so that they closely reflect the conditions that existed historically, then it is important that we obtain information as to the diversity and amount of plant growth that occurred historically. To begin to address this, we are proposing to revisit sites that were sampled by researchers from the Ministry of Natural Resources and Ministry of Environment in the 1970s describing the macrophyte communities throughout the Kawartha Lakes. We are currently tracking down these historical reports and are proposing to revisit these same sites 30+ years later, collecting information on macrophyte communities, sediment quality and chemistry, and macrobenthos biota. These surveys were carried out prior to the introduction of *Myriophyllum spicatum* (Eurasian milfoil), and thus this study would also provide some important information as to the ecology of that invasive plant which could perhaps be applied to new aquatic plant introductions (eg., Fanwort, Frogbit). At the same time we are collaborating with elders from Curve Lake Reserve and hope to establish sampling sites in areas that were traditional fishing grounds and wild rice beds and have largely been left unmanaged since the reserve was established.

But most importantly, we continue to monitor! It will be very important to revisit these same sites over the long term and expand our sampling efforts in adjacent lakes so that we can begin to understand the long-term trends of macrophytes in the Kawarthas. We saw excessive biomass this past summer at some sites, but we also had very warm water temperatures and lots of sunlight which created optimal growing conditions in our shallow lakes for submersed vegetation. Because macrophyte populations can be highly variable, establishing long-term trends should be a goal of this program. We also need to better understand what role zebra mussels are playing in shaping these lake communities. We made a cursory attempt at trying to quantify zebra mussel colonization rates, dissolved P and plants, but our approach will have to be re-assessed. One of the proposed impacts of zebra mussels to the shallow portions of our lakes is a shifting of nutrients from the open water to the sediments where it would be available for plant uptake. This would essentially augment the ability of macrophytes to create a settling environment for suspended particles and lead to a further enrichment of sediments. Would this translate into more plant growth? Unlike with phytoplankton where nutrient enrichment can lead to immediate increases in productivity, there is often a lag of a couple of years before nutrient enrichment in the sediments translates to increased productivity. However, this highlights the need for continued research

Cladophera algae along rocks

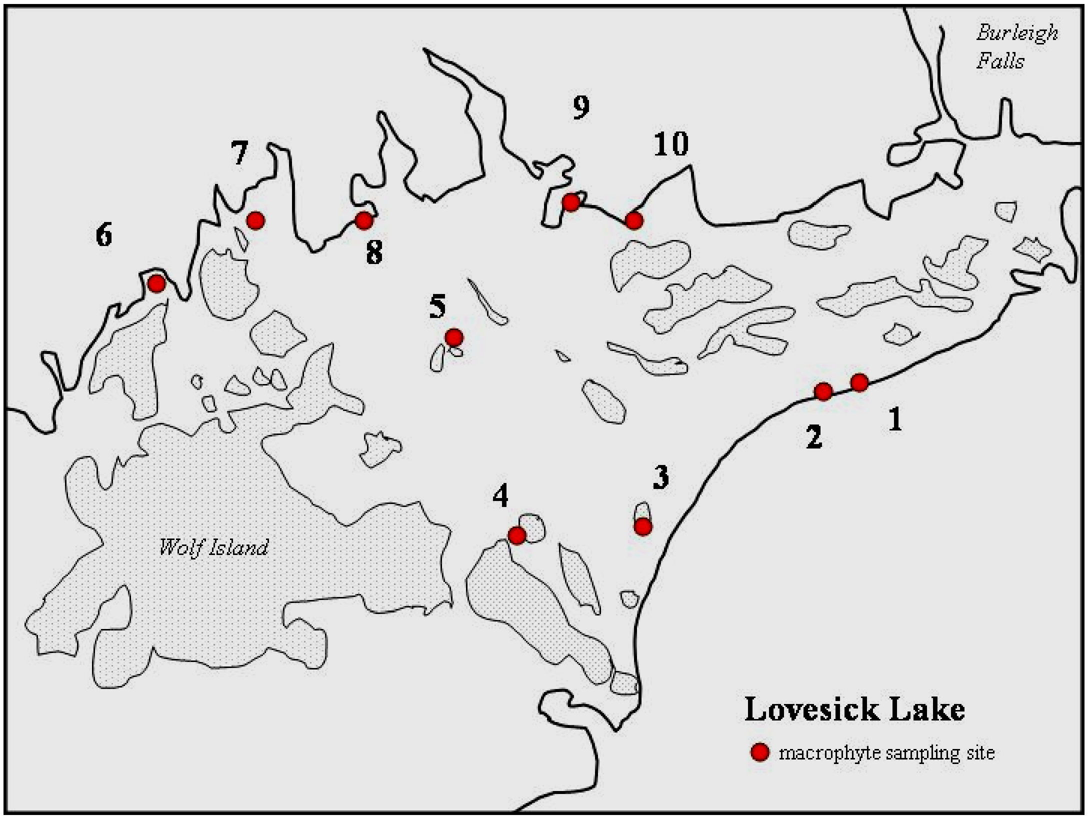


Figure 1. Map of sampling locations in Lovesick Lake monitored by Trent University and Lovesick Lake Association members. In addition, plants were monitored at individual locations in Big Bald Lake, Pigeon Lake, Katchewanooka Lake and White Lake.

Table 1. List of macrophyte species found in Lovesick Lake during surveys carried out in the summer 2005.

Common name	**Scientific name**	**Abbreviated version used in figures**
Watershield	*Brasenia schreberei*	B. schreb.
Coontail	*Ceratophyllum demersum*	C. dem.
Muskgrass	*Chara sp.*	Chara
Canada waterweed	*Elodea canadensis*	E. can.
Star duckweed	*Lemna trisulca*	L. tri.
Two-leaf water milfoil	*Myriophyllum heterophyllum*	M. het.
Northern watermilfoil	*Myriophyllum sibiricum*	M. sib.
Eurasian milfoil	*Myriophyllum spicatum*	M. spic.
Northern water mint (Water najad)	*Najas flexilis*	N. flex.
Yellow trout lily	*Nuphar variegata*	N. var.
Fragrant water lily	*Nymphaea odorata*	Ny. odor.
Broad-leaved pondweed	*Potamogeton amplifolius*	P. amp.
Curly-leaved pondweed	*Potamogeton crispus*	P. cris.
Leafy pondweed	*Potamogeton foliosus*	P. fol.
Small pondweed	*Potamogeton pusillus*	P. pus.
Richardson's pondweed	*Potamogeton richardsonii*	P. rich.
Robin's pondweed	*Potamogeton robinsii*	P. rob.
Flat-stemmed pondweed	*Potamogeton zosteriformis*	P. zos.
White water crowfoot	*Ranunculis aquatilis*	R. aqua.
Narrow-leaved burreed	*Sparganium angustifolium*	Sparg.
Sago pondweed	*Stuckenia pectinatus*	S. pect.
Eastern purple bladderwort	*Utricularia purpurea*	U. purp.
Common bladderwort	*Utricularia vulgaris*	U. vulg.
Water celery (Tape grass)	*Vallisneria americana*	V. amer.

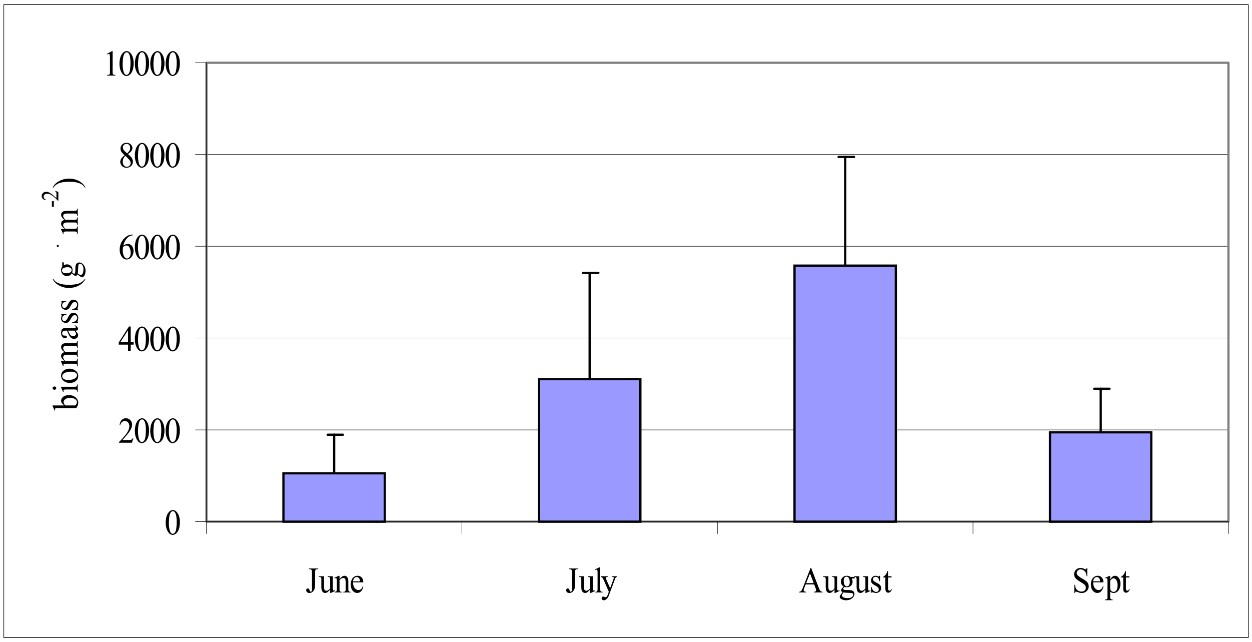


Figure 2. Average macrophyte biomass (above ground) calculated across the 10 sampling sites of Lovesick Lake. Error bars represent standard deviations.

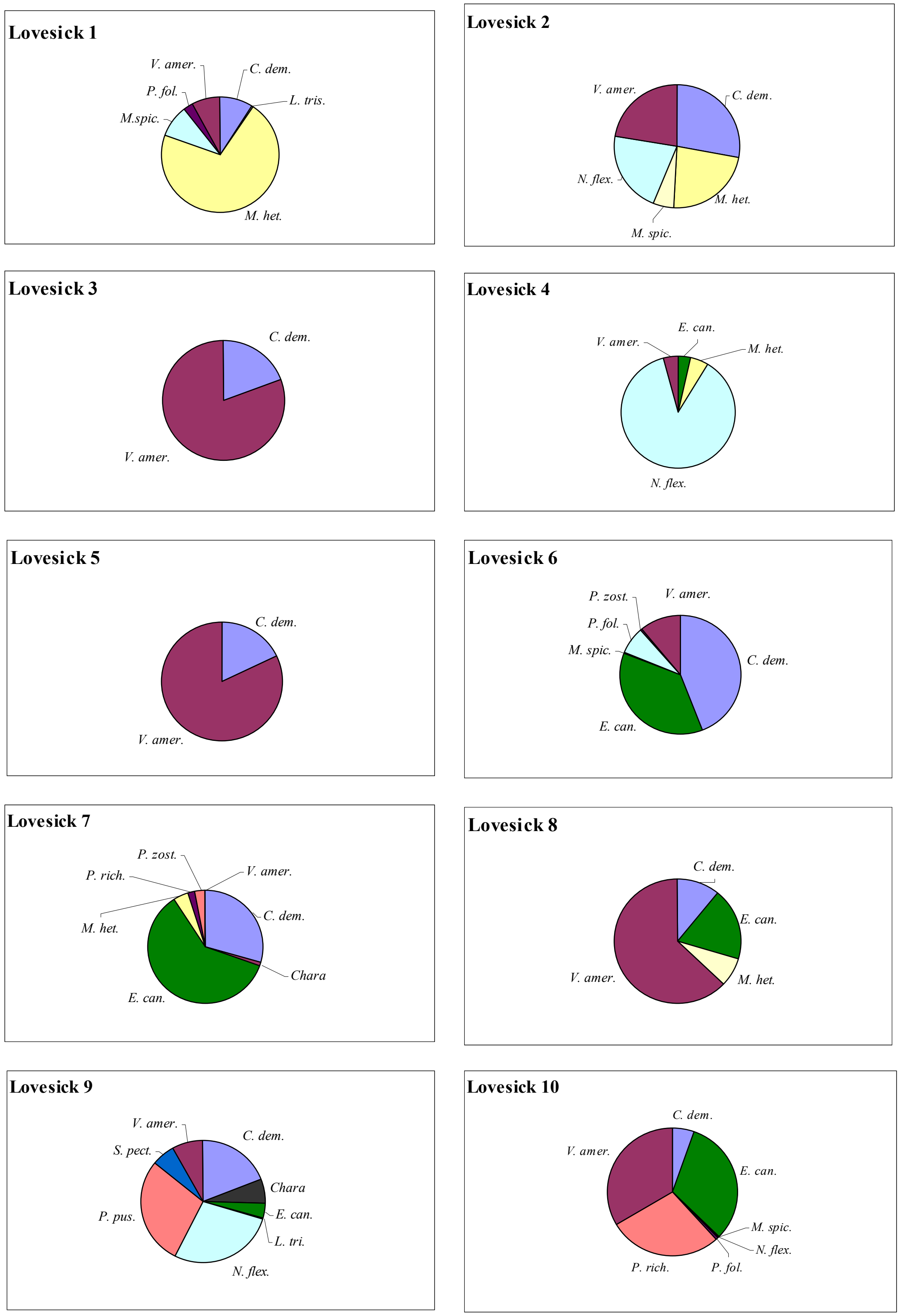


Figure 3. Species composition found during the period of peak biomass in August at the 10 sampling locations in Lovesick Lake. Please refer to Table 1 for explanation of abbreviations.

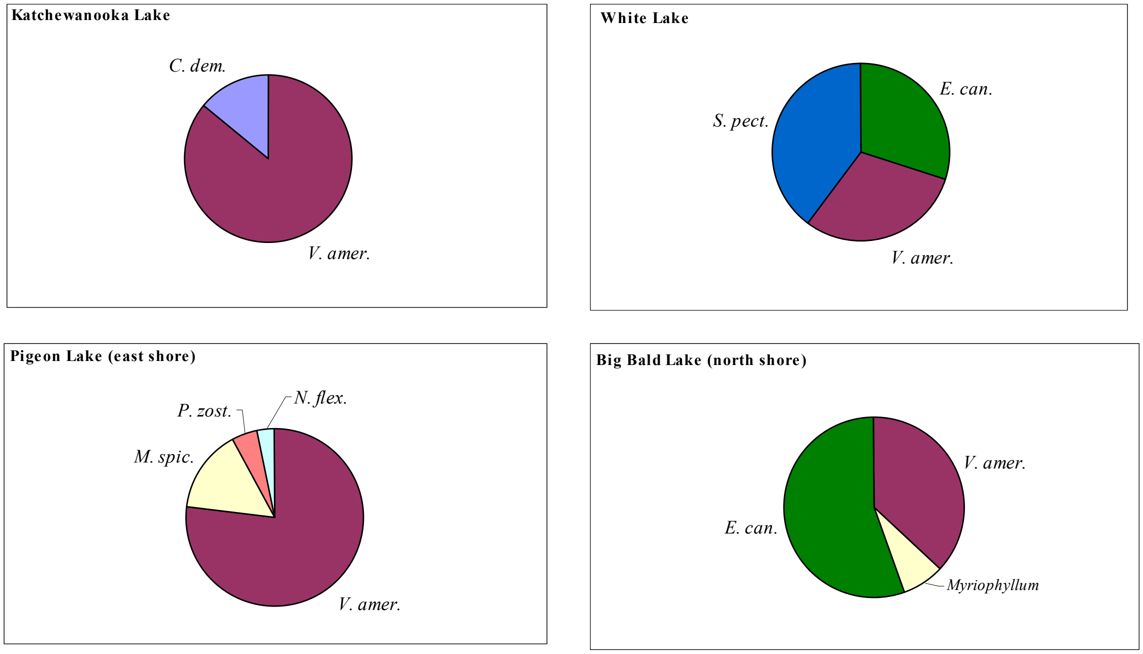


Figure 4. Species composition found in adjacent lakes during the month of August.

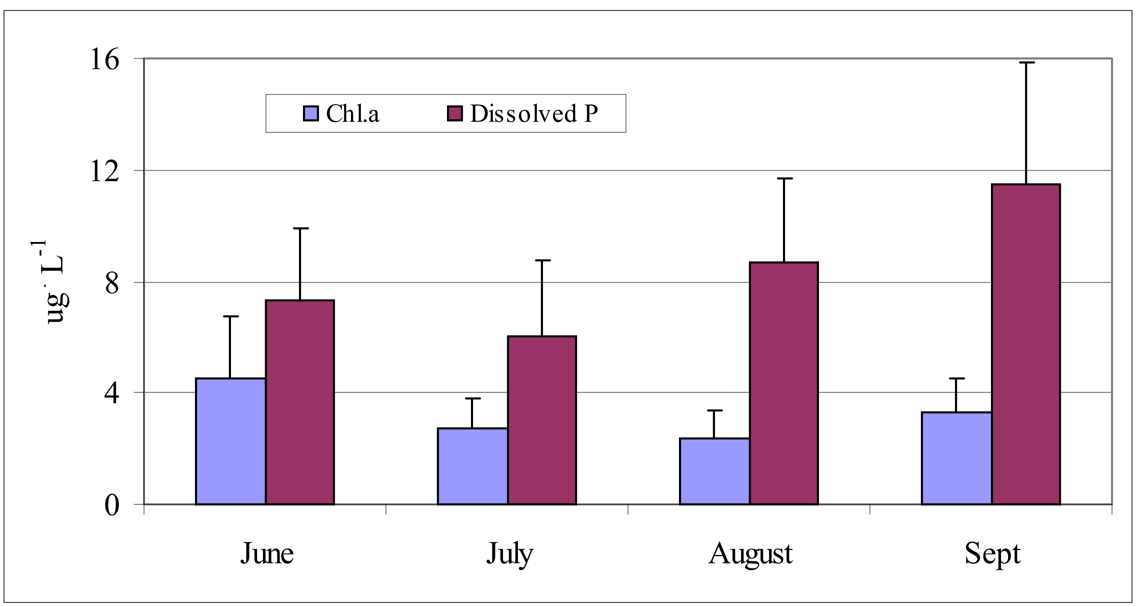


Figure 5. Average concentrations of chlorophyll *a* (a surrogate for phytoplankton biomass) and dissolved P in the water column above sampled macrophyte beds in Lovesick Lake. Error bars represent standard deviations (n=10).

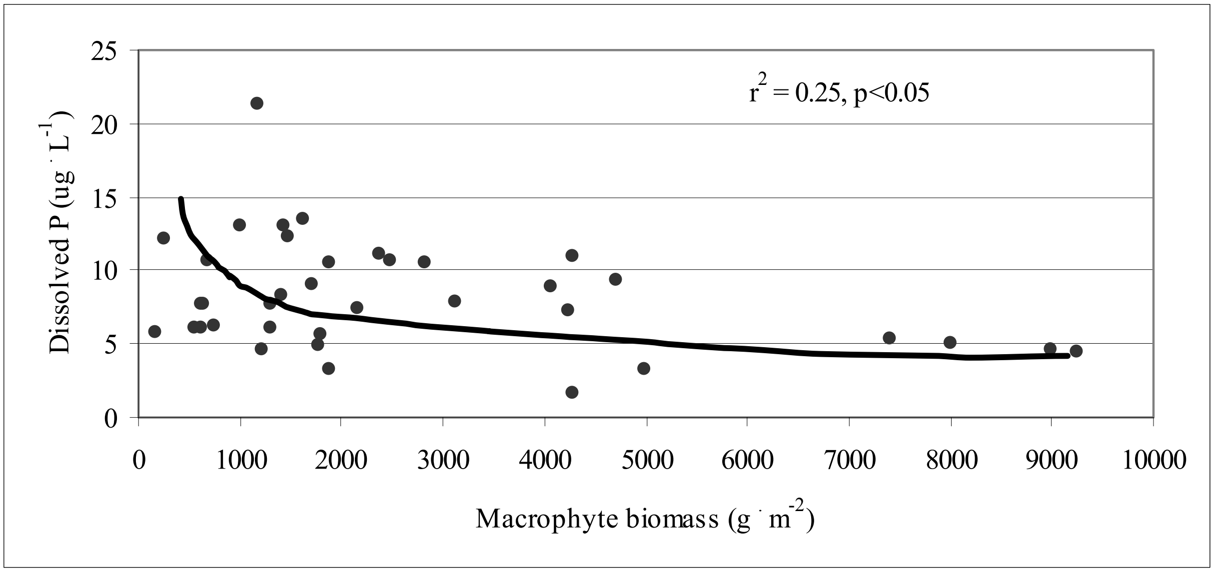


Figure 6. Relationship between dissolved P and biomass of submersed macrophytes in Lovesick Lake.

Dr. Eric Sager is a research associate at Trent University and Manager of the Oliver Ecological Centre. Kristy Hogsden, an algae specialist, is a research associate at the Oliver Centre.

Weed collection by area cottager

What about Zebra Mussels?

Cottagers and scientists alike have been wondering how the massive invasion of zebra mussels in many Ontario lakes is affecting the lake ecosystems. One scientist who has been focusing on the zebras or "dreissenid mussels" is Prof. Bob Hecky at the University of Waterloo. The work of Dr. Hecky and his colleagues has focused on Lake Erie, but appears to be applicable to any region of the Great Lakes where the zebra mussels have taken hold – such as the TSW Kawartha Lakes.

Here are some of Dr. Hecky's findings and conclusions: Zebra mussels are very effective "ecosystem engineers". By filtering microscopic algae and other particles in the near-shore water column, they make the water clearer, allowing sunlight to penetrate further and illuminating larger areas of the lake bottom. The mussels also turn inorganic phosphorus in the water into biologically available phosphorus, which stimulates plant growth. They do this through eating phytoplankton and other phosphorus-containing particles in the water and enriching the bottom sediments with mussel "poop" that is high in the dissolved form of phosphorus that plants and algae need for growth. Phosphorus is a critical nutrient that often limits plant growth, so the addition of usable phosphorus together with improved light penetration is the zebras' "double whammy" that stimulates plant growth. Dr. Hecky and his colleagues have found that zebra mussels especially encourage the growth of the nuisance alga *Cladophora*. As well as enjoying the newly available phosphorus on the lake bottom, this alga, which looks like long dark green hair, easily attaches itself to the increased surface area of the near-shore lake bottom that is provided by the crowds of zebra mussel shells. *Cladophora* grows best with higher wave energies and now, since the mussel invasion, it dominates the aquatic ecosystems along rocky shorelines in lakes Ontario, Erie and Michigan, and has made some areas there unsightly and smelly. While zebra mussels increase the amount of biologically available phosphorus in the shallow near-shore waters, at the same time their presence can *lower* the concentration of phosphorus in the offshore, deeper parts of the lake. Solid particles of organic wastes from the mussels and decomposing plant growth can be dispersed out into deep water, where they sink, and can lead to increased oxygen consumption, locking that phosphorus up in the bottom sediments.

What are the take-home messages for KLSA from Dr. Hecky's zebra mussel work? Although *Cladophora* is growing in our lakes, it has not reached the nuisance level that it has elsewhere. It is more likely, says Dr. Hecky, that in the quieter environments of small lakes like the Kawarthas, other plants such as rooted aquatics (or macrophytes, or weeds!) are benefiting from the increased light and phosphorus availability provided by the zebra mussels. Indeed, many KLSA volunteers have noted increased aquatic plant growth in recent years. As for the shallow water/deep water differences in phosphorus concentration caused by the zebras, is it possible that KLSA's deep phosphorus sampling locations might be underestimating the average concentration of phosphorus in our lakes? In his KLSA macrophyte studies, Dr. Eric Sager has been taking near-shore phosphorus samples (see previous article). We hope that over the next few years, these values can be usefully compared to our deep water readings. In the meantime, we'll keep on watching the weeds, the algae, and the zebra mussels.

Zebra mussels on wooden dock ladder

Zebra mussels on metal dock ladder

Bacteria Testing

What we did

2005 was the fifth year that KLSA has tested lake water for *E.coli* bacteria. We started the year with an orientation workshop in May to review sampling techniques and to hand out sampling bottles. KLSA volunteers collected lake water samples from 132 sites on 14 Kawartha lakes. Sites were tested six times during the summer, from the July 1st weekend until Labour Day. Samples were taken to SGS Lakefield Research, usually within a few hours, and tested the same day. Occasionally they were refrigerated overnight before being taken to the lab. Each group tested up to 17 sites, and the same sites were tested on all six dates.

Most of the sites were the same as in 2004. It was felt that most sites should remain the same to give long-term baseline data. However, some sites were changed as volunteers became more aware of where potential hot spots could be. Some sites that had consistently very low counts for several years were deleted. New sites were given different labels to prevent confusion when comparing data from various years.

Almost all sites were chosen because it was thought that they would have the highest *E.coli* counts in the lake; that is, we were "looking for trouble". Therefore, please realize that the readings shown here do not represent the *average* bacterial levels of our lakes; rather, they would represent some of the *highest* bacterial levels on our lakes.

Test sites included:

- Areas of high use (resorts, live-aboard docking areas, etc.)
- Areas of low circulation (quiet, shallow bays)
- Areas near inflows (from culverts, streams, wetlands)
- Areas of concentrated populations of wildlife (near wetlands, areas popular with waterfowl).

The goals of this testing were threefold:

- To see how safe the water was for swimming at these sites,
- To provide baseline data for ongoing monitoring in future years,
- To discover sources of elevated bacterial counts.

Please note:

- *KLSA does not test drinking water. Only surface waters are tested. All untreated surface waters are considered unsafe for drinking.*
- *KLSA results are valid only for the times and locations tested, and are no guarantee that a lake will be safe to swim in at all times and in all locations.*

Why did we test for *E.coli*?

E.coli was the bacteria of choice because:

- The presence of *E.coli* indicates fecal contamination from warm-blooded animals such as birds or mammals, including humans. It is not found, for instance, on rotting vegetation. The presence of *E.coli* indicates the possible presence of other disease-causing organisms found in fecal material, such as those causing gastrointestinal and outer ear infections.
- *E.coli* is present in fecal material in very high numbers. Healthy humans excrete about 100 million *E.coli* per ¼ teaspoon of fecal matter! Therefore, it is easier to find than most other less plentiful bacteria.
- *E.coli* itself can be dangerous. Although most strains of *E.coli* are harmless, some strains cause serious disease, such as in the Walkerton tragedy, or occasionally in ground beef "scares". The basic analysis done by SGS Lakefield Research cannot distinguish the difference between the harmless and the deadly, so we always treat *E.coli* as if we were dealing with a harmful strain.

Interpreting the results: What is a "high" *E.coli* count?

When is an *E.coli* count considered to be of concern? These are the KLSA guidelines:

1. *Of serious concern: over 100 E.coli/100 mL.* Public beaches are posted as unsafe for swimming when 5 samples taken along a beach on one day have a geometric average of over 100 *E.coli*/100 mL. Therefore, any KLSA counts over 100 are retested as soon as possible. If counts persist, KLSA informs nearby residents. We want to make them aware of the problem for their own swimming safety, and to seek their cooperation in trying to determine where the bacteria are coming from.
2. *Of some concern: between 50 and 100 E.coli/100 mL.* KLSA believes our lakes should be cleaner than public beaches, and believes that *E.coli* counts on Kawartha lakes should not exceed 50 *E.coli*/100 mL. Volunteers are notified if a reading is over 50 *E.coli*/100 mL, and are asked to retest. If counts remain high after retesting, our policy is to inform adjacent landowners of the results.

3. *Unusual: 20 – 50 E.coli/100 mL*. It is normal for a location to have a reading between 20 and 50 once or twice over the summer. However, three or more counts in this range are unusual and reason for investigation.
4. *Normal: less than 20 E.coli/100 mL*. Readings under 20 can be considered normal for surface water, indicating low levels of contamination.

What we found

For Lake-by-Lake results with commentary, please see Appendix E.

Generally, *E.coli* counts on all the lakes tested were very low throughout the summer, indicating excellent recreational water quality. There were only four sites that KLSA would not recommend for swimming due to their high frequency of elevated *E.coli* counts. Only one of these sites was in fact used for swimming. The 132 sites that were tested regularly (four or more times) could be classified as follows:

- *81 sites: "Very Clean" (no readings above 20 E.coli/100 mL).* 81 out of 132 sites were considered "very clean" surface water.
- *34 sites: "Clean" (counts rose above 20 E.coli/100 mL once or twice).* An occasional elevated count or "spike" of over 20 was not deemed of concern.
- *8 sites: "Slightly Elevated" (counts rose above 20 E.coli/100 mL three times).* At eight sites (Clear Lake Birchcliff/BB, Katchewanooka/2 and 3, Lower Buckhorn/4A and 4B, Stony/26, Sturgeon/NS2 and SB2), there were three counts over 20 during the summer.
- *5 sites: "Needing Observation" (counts rose above 20 E.coli/100 mL 4 to 6 times).*
    a. Three of these five sites (Lower Buckhorn/Site 3, North Pigeon Lake/Site 6 and Site 12) were located close to an "investigation recommended" site (see below). Cleaning up the "investigation recommended" locations would probably decrease counts at these three sites as well.
    b. Stony/Site 27 had more frequent elevated counts than last year.
    c. Sturgeon/SB1 was new this year.
- *4 sites: "Investigation recommended" (more than two counts over 100 E.coli/100 mL)*
    a. Sites 7 and 11 on North Pigeon Lake are close to each other, and neither is a swimming area. Property owners are aware of the high counts.
    b. Lower Buckhorn/Site 4C is a new location this year. Last year, extra testing was done near Site 4; 4C was the area that showed the highest counts. This year's testing confirmed that Site 4C has the highest counts in that area. It is near an inflow that drains from wetlands. Testing done upstream on the creeks has shown high counts, indicating that this is likely the source the bacteria. The local shoreline residents have been informed.

c. Sturgeon/2 had similar counts last year. The was no swimming at this site this year.

2005 vs 2004: Wet year vs. dry year

Generally, a heavy rainfall will tend to raise *E.coli* counts. In the 2004 KLSA report, we found that bacterial counts started to rise noticeably on a number of lakes when there was a rainfall of at least 10 mm in the 48-hour period before testing. As stated in previous reports, this runoff effect is well known: Peterborough closes its public beaches for at least 24 hours after any rainstorm over 15 mm.

In 2005, there were no rainfalls over 10 mm before any of the 6 main testing dates. (Sources of rainfall information were Environment Canada's Trent University site, the Oliver Centre at the north end of Pigeon Lake, and the logs recorded by our faithful volunteers.) Rainfall was generally very sparse (see chart below).

Rainfall in 2004 (wet year) and 2005 (dry year) compared to 30-year average					
Rainfall (mm)	30-year average (Trent U)	2004 (Trent U)	2004 (Oliver Centre)	2005 (Trent U)	2005 (Oliver Centre)
July	68.4	409.4	86.7	16.2	6.7
August	91.6	79.4	37.9	56.4	2.9

Geese on a lakefront lawn. It's like a salad bar for waterfowl.

If they can see it, they can get to it!

Having had such a dry summer, we expected that low runoff would result in uniformly low bacterial counts. Also, strong sunshine tends to kill bacteria. Were results much lower in 2005, a very dry year? The answer, surprisingly, seems to be "Not really". If we look at sites that were tested in both 2004 and 2005, we find that *E.coli* counts were very similar:

***E.coli* Level at Site through the Summer**	**Number of sites, 2004***	**Number of sites, 2005***
Very Clean: no readings above 20 *E.coli*/100mL	63	71
Clean: counts rose above 20 *E.coli*/100mL once or twice	35	29
Slightly elevated: counts rose above 20 *E.coli*/100mL 3 times	4	6
Needing observation: counts rose above 20 *E.coli*/100mL 4 to 6 times	6**	4
Investigation recommended: more than 2 counts over 100 *E.coli*/100mL	5**	4

*Only sites tested in both 2004 and 2005 were included in this comparison.
**In the 2004 report, there were 7 "needing observation" sites and 4 "investigation recommended". This has been corrected here. In 2004, Sturgeon/site 2 should have been classified as "investigation recommended" rather than "needing observation".

Although a heavy rain just before a testing date may raise counts on that particular date, a very dry year does not lower *E.coli* counts significantly. Possibly other factors were keeping *E.coli* counts up during the hot dry summer of 2005:

- possibly wildlife was more abundant in and around the lakes
- more people may have been using the lakes
- lower flows in general may have made water more stagnant; the *E.coli* didn't wash away as quickly.

It seems, then, that bacterial levels don't vary much from year to year, apart from somewhat elevated levels right after a heavy rainfall (at least 10 mm).

Possible causes of elevated *E.coli* counts

We can only make educated guesses about the sources of elevated *E.coli* counts. These are discussed in the Lake-by-Lake Results (Appendix E). To summarize, the sources of counts over 50 *E.coli*/100 mL appear to be:

- *Large numbers of Canada Geese or other waterfowl (9 sites).*
- *Wetland inflow (6 sites).* These 6 sites represent 2 areas, which KLSA has been sampling intensively.
- *Narrow bay after heavy rain (3 sites).* Large amounts of runoff from extensive shorelines into small volumes of water with little circulation seem to result in high counts. These rains were recorded on the volunteer logs.
- *Contamination of sample bottle (1 site)*
- *Unknown (3 sites)*

Conclusions

- Generally, the Kawartha Lakes have very low bacteria levels, despite being used intensively. Only 2 of the 132 sites tested exhibited counts that frequently exceeded the safe swimming level of 100 *E.coli*/100mL.
- Higher counts were found near large groups of waterfowl (especially Canada Geese), in narrow bays after heavy rains, and at some inflows (streams entering the lakes).
- Although heavy rains tend to cause higher bacteria counts, bacteria counts in the parched summer of 2005 were, on the whole, similar to other years. Hot, dry weather does not guarantee low bacteria counts, despite less runoff and strong bactericidal sunshine.

What can we do to keep *E.coli* counts down?

- Discourage Canada Geese. Here are some suggestions from the Canadian Wildlife Service (www.on.ec.gc.ca/wildlife):
    - Do not feed Canada Geese.
    - Cut grass slightly longer and seed with a coarse grass.
    - Maintain an unmowed shoreline buffer of grasses, shrubs and wildflowers.
    - Cover pond banks with climbing obstacles.
    - Investigate your municipality's management plan for temperate-breeding geese. The local management plan may employ the use of egg oiling programs.
    - Harassment and scare techniques can be effective: however, geese may quickly habituate to the disturbance so the effectiveness could be short-lived. Scare permits may be obtained on a case-by-case basis from Environment Canada.
- Keep your septic system working well. Avoid flushing harsh chemicals (solvents, bleaches, strong detergents or disinfectants) into it and have it pumped out every three to five years.
- Keep pet droppings away from the shoreline.

Geese on Little Lake waterfront, Peterborough

Appendix A:
KLSA Mission Statement, Executive Board & Other Volunteers

Mission Statement

The Kawartha Lake Stewards Association objects are to carry out a coordinated, consistent, water quality testing program (including bacteria and phosphorus) of lake water on lakes within the Trent Canal System watershed. The Kawartha Lake Stewards Association will ensure water quality test results, prepared by an accredited laboratory with summary analysis, are made available to all interested parties. In future years the Kawartha Lake Stewards Association may expand its water quality program and may concern itself with other related matters.

Directors

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Assoc. of Stony Lake Cottagers — email: k_mackenzie@sympatico.ca

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Norma Walker, Director — (705) 877-1082
White Lake Cottagers Association

KLSA E-mail: kawarthalakestewards@yahoo.ca

Other Volunteers

Big Bald Lake	Big Bald Lake Assoc. – Rob Arkell, John Shufelt, Ron Brown
Buckhorn Lake	Buckhorn Sands Property Owners - Mary and Mike Belas Sandbirch Estates - Keith Clark, Bryan Lytle
Chemong Lake	S-E-Lakefield Ratepayer's Assoc. – Rosalind MacQuarrie
Clear Lake	Birchcliff Property Owner's Assoc. - Jeff Chalmers Kawartha Park Cottager's Assoc. - Judith Platt Southwest Shore – Gord Evans
Julian Lake	Julian Lake Cottagers - George Loyst
Katchewanooka Lake	Peter Fischer, Lake Edge Cottages
Lovesick Lake	Lovesick Lake Association - Ann Ambler, Ron Brown, Katie Brown, Marlene Steele, Pat Moffat
Lower Buckhorn Lake	Lower Buckhorn Lake Owners' Assoc. - Mark Potter, Don McLeod, Fred Turk, Harry Shulman, Jim and Cindy Chapman, Mike Piekny, Jeff Lang, Peter Miller, Bruce Ward
Pigeon Lake	Concession 17 Cottagers Assoc. - Sheila Gordon-Dillane Gamiing - Mieke Schipper North Pigeon Lake Ratepayers' Assoc. – Tom McCarron Victoria Place - Bill Bedley, Jeff McCauley, Gary Westlake Sugar Bush - Tall Cedars - James Cole
Sandy Lake	Harvey Lakeland - Doug Russell, Dan Casey
Stony Lake	Stony Lake Cottager's Assoc. -Kathleen Mackenzie, Ralph Reed, Bob Woosnam, Gail Szego, Mary Fuller
Sturgeon Lake	Sturgeon Lake Assoc. - Rod Martin, Don Holloway, Doug Ridge, Sonny Seymour, Anne Shortt
Upper Stoney Lake	Upper Stoney Lake Cottagers' Assoc.- Karl, Kathy, Ken and Kori Macarthur
White Lake	White Lake Cottagers Assoc. – Mike Stedman and Norma Walker

Listed are our primary volunteers; many others helped on many occasions.

Appendix B: Donors and Sponsors of the KLSA

Parks Canada, Trent Severn Waterway
Mattamy Homes Limited, Pigeon Lake
Stony Lake Heritage Foundation, Upper Stoney & Lower Stony Lake
Township of Galway-Cavendish-Harvey
Township of Douro-Dummer
Lower Buckhorn Lake Owners Association
Birchcliff Property Owners Association of Douro-Dummer, Clear Lake
Township of Smith-Ennismore-Lakefield
Lovesick Lake Association, Lovesick Lake
Big Bald Lake Cottagers Association
Harvey Lakeland Cottagers Association
Victoria Place Association Inc., Pigeon Lake
North Pigeon Lake Property Owners Association
Buckhorn Sands Property Owners Association
Conc. 17 Pigeon Lake Cottagers Association
Kawartha Park Cottagers' Association, Clear Lake
Sandbirch Estates Association, Buckhorn Lake
Julian Lake Cottagers' Association, Julian Lake
White Lake Association
Eganridge Inn & Country Club
Stinson's Bay Property Owners Association
East Beehive Community Association
Carol McCanse

Thanks to all of our generous supporters.

Appendix C: Financial Report

Kawartha Lake Stewards Association
Treasurer's Report
2005 Revenue & Expenses

December 31, 2005

Date	Revenue		
	Balance Forward from December 31, 2004		$4,236.49
1-Apr-05	Buckhorn Sands Property Owners Assoc.	200.00	
30-Apr-05	Trent Severn Waterway (balance of 2004 funding)	1,200.00	
14-Jun-05	Stony Lake Heritage Foundation	1,000.00	
14-Jun-05	Jullian Lake Cottagers	150.00	
14-Jun-05	Twsp. Of Douro-Dummer	750.00	
21-Jun-05	GIC Interest	72.00	
21-Jun-05	Twsp. Of Smith-Ennismore-Lakefield	240.00	
24-Jun-05	Big Bald Lake Cottagers	300.00	
29-Jun-05	Mattamy Homes	1,500.00	
29-Jun-05	Conc. 17 Pigeon Lake Cottagers Assoc.	150.00	
12-Jul-05	Lovesick Lake Assoc.	300.00	
29-Jul-05	Twsp. Of Galway-Cavendish-Harvey	1,000.00	
30-Aug-05	White Lake Assoc.	150.00	
30-Aug-05	Birchcliff Prop. Owners Assoc. of Douro-Dummer	500.00	
8-Sep-05	Victoria Place Assoc.	300.00	
9-Sep-05	Sand Birch Estates	175.00	
23-Sep-05	GIC Interest	32.00	
5-Oct-05	Kawartha Park Cottagers Assoc.	250.00	
5-Oct-05	Harvey Lakeland Cottagers Assoc.	300.00	
5-Oct-05	Eganridge Inn & Country Club	50.00	
31-Oct-05	North Pigeon Lake ($300 for 2004 & $300 for 2005)	600.00	
31-Oct-05	Carol McCanse	50.00	
21-Nov-05	Lower Buckhorn Lake Owners Assoc.	650.00	
6-Dec-05	Stinson's Bay Property Owners Assoc.	50.00	
6-Dec-05	East Beehive Community Assoc.	50.00	
	Total Revenue	10,019.00	$10,019.00

Note: KLSA has negotiated a three-year funding agreement with Parks Canada Trent Severn Waterway for their fiscal years of 2005, 2006 and 2007. The 2005 funding from TSW will show in the 2006 KLSA revenue area.

Date	Expenses		
4-Jan-05	Bank Fees	3.75	
2-Feb-05	Bank Fees	3.75	
1-Mar-05	Bank Fees	3.75	
1-Apr-05	Bank Fees	3.75	
15-Apr-05	Ontario Environment Network Membership	40.00	
15-Apr-05	Buckhorn Community Centre	40.00	
1-May-05	Bank Fees	3.75	
9-May-05	LMS Prolink Ltd. Insurance	1,661.04	
13-May-05	Fleming College (printing 04 report)	1,675.89	
1-Jun-05	Bank Fees	3.75	
23-Jun-05	FOCA 2005 Membership	152.47	
23-Jun-05	Pat Moffat, expenses	260.20	
23-Jun-05	Jeff Chalmers, expenses	499.30	
1-Jul-05	Bank Fees	3.75	
1-Aug-05	Bank Fees	3.75	
24-Aug-05	SGS Lakefield Research Limited #10064056	2,083.92	
30-Aug-05	Ann Ambler, expenses	36.64	
1-Sep-05	Bank Fees	3.75	
19-Sep-05	Minister of Finance (Suplementary Letters Patent)	130.00	
19-Sep-05	SGS Lakefield Research Limited #10072656	3,608.13	
19-Sep-05	Pat Moffat, expenses	102.86	
19-Sep-05	Jim Keyser expernses	70.99	
1-Oct-05	Bank Fees	3.75	
18-Oct-05	SGS Lakefield Research Limited #10078934	1,055.04	
1-Nov-05	Bank Fees	3.75	
1-Dec-05	Bank Fees	3.75	
	Total Expenses	11,461.48	**$11,461.48**
	Net Balance		**$2,794.01**

Investment Account

Date	Transaction	Debit	Credit	Balance	
1-Jan-05	Balance Forward			6,000.00	
21-Jun-05	GIC Matured	4,000.00		2,000.00	
21-Jun-05	GIC Reinvestment		4,000.00	6,000.00	
23-Sep-05	GIC Matured	2,000.00		4,000.00	
23-Sep-05	GIC Reinvestment		2,000.00	6,000.00	
	Account Balance			6,000.00	**$6,000.00**

Grand Total **$8,794.01**

Financial Statements of

KAWARTHA LAKES STEWARDS ASSOCIATION

December 31, 2005

Note To The Financial Statements
December 31, 2005

BASIS OF PRESENTATION

The accompanying financial statements relate to the incorporated association registered by Letters Patent as Kawartha Lakes Stewards Association. The Association conducts co-ordinated, consistent water quality testing programs (including bacteria and phosphorus) of lake water on lakes within the Trent Canal System watershed. The association derives its revenue from those groups and individuals who are concerned about maintaining the quality of water within the watershed.

As a non-profit association under section 149(1)(l) of the Income Tax Act, the association is not responsible to pay income tax and is therefore prohibited from distributing any of its profits to, or for the personal benefit, of its members, directors or affiliates.

McCOLL TURNER

McCOLL TURNER

McColl Turner LLP
Chartered Accountants
362 Queen St., Peterborough, ON
K9H 3J6

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Website www.mccollturner.com

REVIEW ENGAGEMENT REPORT

To Mr. A. Jeffrey Chalmers, Secretary/Treasurer

KAWARTHA LAKES STEWARDS ASSOCIATION

We have reviewed the statement of financial position of Kawartha Lakes Stewards Association as at December 31, 2005 and the statement of operations for the year then ended. Our review was made in accordance with Canadian generally accepted standards for review engagements and accordingly consisted primarily of enquiry, analytical procedures and discussion related to information supplied to us by the Association.

A review does not constitute an audit and consequently we do not express an audit opinion on these financial statements.

Based on our review, nothing has come to our attention that causes us to believe that these financial statements are not, in all material respects, in accordance with Canadian generally accepted accounting principles.

McColl Turner LLP

Peterborough, Ontario
March 24, 2006

KAWARTHA LAKES STEWARDS ASSOCIATION

Statement of Financial Position - December 31, 2005

(Unaudited)

	2005	2004
ASSETS		
Current Assets		
Cash	$ 2,794	4,236
Guaranteed Investment Certificates	6,000	6,000
Amounts receivable	-	1,200
	8,794	11,436
LIABILITIES		
Current Liabilities		
Accounts payable and accrued liabilities	$ -	$ 180
NET ASSETS	8,794	11,256
	$ 8,794	$ 11,436

Statement of Operations

Year ended December 31, 2005

(Unaudited)

	2005	2004
REVENUE		
Parks Canada, Trent-Severn Waterway	$ -	$ 3,000
Municipal grants	1,990	3,600
Associations	5,125	4,300
Private contributions	1,600	1,375
Pledge receivable	-	1,200
Interest	104	68
	8,819	13,543
EXPENDITURE		
Water testing fees	6,747	7,056
Annual report costs	1,676	1,345
Registration fees, insurance and membership fee	1,844	1,070
Telephone, copies and other administrative costs	969	737
Bank charges	45	38
	11,281	10,246
EXCESS (DEFICIENCY) OF REVENUE OVER EXPENDITURE	(2,462)	$ 3,297
NET ASSETS - BEGINNING OF YEAR	11,256	7,959
NET ASSETS - END OF YEAR	$ 8,794	$ 11,256

McCOLL TURNER

Appendix D: Privacy Policy

As a result of recent Federal Privacy Legislation changes, all businesses and associations that collect personal information from their customers and members must develop and post a Privacy Policy. The following is the policy that your Board has developed to protect you and your personal information held by the Kawartha Lake Stewards Association (KLSA).

To our Membership: Your privacy is important to us. This policy tells you what information we gather about you, how we would use it, to whom we may disclose it, how you can opt out of the collection, use or disclosure of your personal information, and how to get access to the information we may have about you.

Collecting Information: We collect information about our members and volunteers such as name, address, relevant telephone numbers, e-mail address and preferred method of communication. We obtain this information through the attendance form at our workshops and AGM, and by information provided by the many volunteers assisting in our lake water quality testing programs. We may keep the information in written form and/or electronically. Keeping your email address information at our email site allows us to send you information in an efficient and low cost manner. By providing this information to us, you enable us to serve you better.

Using Information: We use the information collected to provide you with information about the association activities and related lake water issues of interest to residents of the Kawartha Lakes. We will retain your personal information only for as long as required by law or as necessary for the purposes for which it is collected. Your personal information will not be used for other purposes without your consent.

Disclosing Information: We will not disclose any personal information collected about you to anybody else, unless required to do so by law. We will comply with all laws, which require us to supply the information to government agencies and others. We will not otherwise sell, transfer or trade any mailing list, which includes your information.

Keeping Information Secure: We will keep written information in a secure place.

Access to Information: If you wish to review the personal information we keep about you please contact the association c/o "Privacy Officer" at the address set out below. At your request, subject to applicable law, we will delete your personal information from our records. The Privacy Officer is not intended to be an elected position. It is an appointment to one of the elected directors of the board providing they are in good standing and have the support of the Chair and other directors.

Obtaining Your Consent: By providing personal information to us, you are consenting to us using it for the purposes set out above and disclosing it to the parties described above. If you do not want us to use any personal information about you, or wish to limit the use or disclosure of such personal information by us, please contact the Privacy Officer at the address set out below by mail.

Contacting Us: We may be contacted by email at kawarthalakestewards@yahoo.ca or by regular mail as follows:

Jeffrey Chalmers, K.L.S.A. Privacy Officer
4 Conger Street, Peterborough, ON K9H 4Y6

Appendix E: Lake-by-Lake *E.coli* Results

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Big Bald Lake

E.coli count, *E.coli*/100 ml Test Date						
Site No.	**4-Jul-05**	**18-Jul-05**	**25-Jul-05**	**2-Aug-05**	**9-Aug-05**	**6-Sep-05**
1	<2	8	6	2	11	4
2	<2	4	14	1	5	0
3	<2	0	2	4	9	0
5	<2	0	0	0	0	4
7	<2	6	2	0	0	0
8	<2	0	4	0	17	4

As in previous years, *E.coli* readings on Big Bald Lake were consistently low.

Bird proofing attempt with little success

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Buckhorn Lake: Buckhorn Sands

E.coli count, *E.coli*/100 ml Test Date						
Site No.	4-Jul-05	21-Jul-05	26-Jul-05	3-Aug-05	8-Aug-05	6-Sep-05
B	2	4	0	14	1	**58**
C	<2	0	0	0	0	0
D	<2	2	0	2	0	0
E	<2	2	2	2	0	4

As in previous years, *E.coli* readings for the Buckhorn Sands sites were generally low. There was no apparent reason for the readings on 58 at Site B/Sep6.

Buckhorn Lake: Sandbirch Estates

E.coli count, *E.coli*/100 ml Test Date							
Site No.	5-Jul-05	18-Jul-05	21-Jul-05	24-Jul-05	2-Aug-05	7-Aug-05	5-Sep-05
A	35	**130**	6	20	4	0	6
B	4	32	x	2	0	0	4
C	19	22	x	4	8	4	6

The reading of 130 at Site A/July 18 was unusual for this group of sites, but it was very short-lived. There was no obvious reason for any of the elevated readings.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Chemong Lake: Smith-Ennismore-Lakefield Ratepayers

E.coli count, *E.coli*/100 ml Test Date					
Site No.	4-Jul-05	15-Jul-05	29-Jul-05	9-Aug-05	9-Sep-05
DW	<2	<2	0	8	1
CW	2	6	7	5	18
CP	<2	<2	11	23	7
SND	<2	<2	0	1	0
SP	2	<2	25	1	0
JB	<2	x	1	0	0
MF	6	<2	12	3	3

This is the first year testing at these sites. Although Chemong has fairly intensively developed shoreline and has less circulation than most of the other Trent-Severn Waterway lakes, counts were low.

To put the results in perspective:

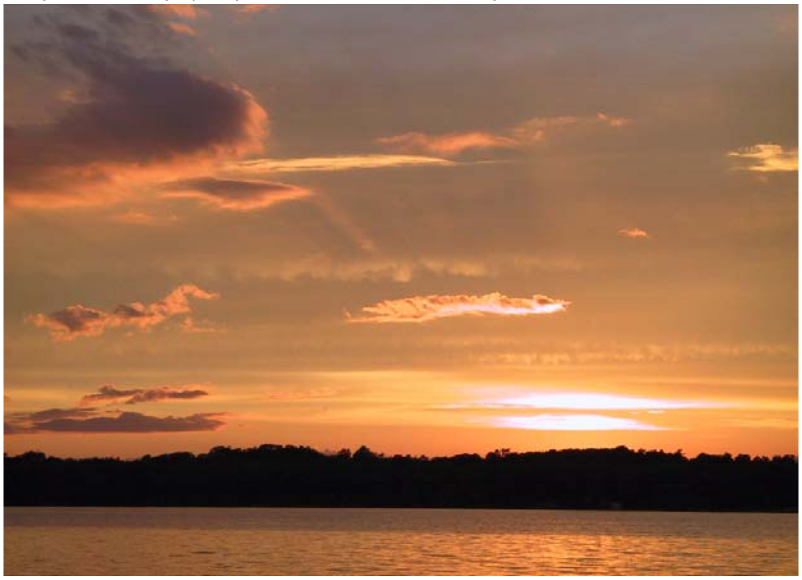
- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Clear Lake: Birchcliff Property Owners of Douro-Dummer

E.coli count, *E.coli*/100 ml Test Date						
Site No.	**6-Jul-05**	**21-Jul-05**	**5-Aug-05**	**18-Aug-05**	**24-Aug-05**	**9-Sep-05**
1	39	0	44	1		0
2	7	0	2	0		0
3	10	4	12	0		0
4	2	4	19	2		8
5	30	0	3	0		1
6	5	6	2	5		3
7	2	0	4	0		0
8	5	4	2	**540**	4,6,6,8	0
BB	49	2	27	34		0

Readings here are typical of this lake; below 20 with the occasional reading between 20 and 50. The Site 8/Aug 18 reading of 540 was unusual, but retesting showed a return to low counts. This was likely due to geese congregating on the rocks and docks in the area; a similar reading at the same time of year was noticed in 2004.

Bryson's Bay (BB) was site N on Stony Lake in 2001/2/3



To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Clear Lake: Kawartha Park Cottagers Assoc.

E.coli count, *E.coli*/100 ml Test Date						
Site No.	3-Jul-05	18-Jul-05	25-Jul-05	2-Aug-05	8-Aug-05	6-Sep-05
A	0	2	0	1	0	0
B	0	<2	26	0	2	0
D	0	<2	0	0	3	0
J	0	20	0	0	1	0
S	0	<2	2	0	0	0

As in all previous years, counts on these sites were uniformly low.

Clear Lake: Southwest Shore

E.coli count, *E.coli*/100 ml Test Date					
Site No.	4-Jul-05	18-Jul-05	2-Aug-05	15-Aug-05	29-Aug-05
1	14	<2	0	0	0
2	4	<2	6	0	4
3	4	<2	0	0	0

Site 3 has had a few high readings in the past which occurred after heavy rains. The very low readings this year may have been due to the lack of rain.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Julian Lake

E.coli count, *E.coli*/100 ml Test Date						
Site No.	**4-Jul-05**	**18-Jul-05**	**26-Jul-05**	**29-Jul-05**	**8-Aug-05**	**2-Sep-05**
A	2	6	2	1	1	0
B	4	10	6	0	3	4
C	0	4	4	0	0	1

Over four years of testing, there has not been a reading over 25 on these three sites. This is a spring-fed lake, but the shore is fairly intensively developed and there isn't a large flow through the lake. These low readings are probably a sign of good shoreline practices.

Katchewanooka Lake

E.coli count, *E.coli*/100 ml Test Date						
Site No.	**5-Jul-05**	**19-Jul-05**	**26-Jul-05**	**4-Aug-05**	**8-Aug-05**	**8-Sep-05**
1	14	14	20	27	42	0
2	16	30	24	11	14	**125**
3	36	4	40	17	24	1
4	4	4	4	2	8	1
5	10	0	4	2	4	0
6	18	4	4	5	8	15

The high count of 125 at Site 2/Sep 8 may have been due to a group of Canada Geese that had just swum by. Another volunteer had a similar experience in the past, testing immediately after a flock of geese had swum by, and the count was low, so this is only a possibility.
It is interesting that Site 5, which has had frequent counts over 100 in 2003 and 2004, had very low counts this year. This is an inflow from a wetland area, and there is a farm and golf club further upstream. It is encouraging to see the counts return to their 2001/2 levels; let's hope they stay that way!

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Lovesick Lake

E.coli count, *E.coli*/100 ml Test Date						
Site No.	**4-Jul-05**	**19-Jul-05**	**25-Jul-05**	**2-Aug-05**	**8-Aug-05**	**6-Sep-05**
1	0	0	4	0	0	x
4	0	12	4	0	0	0
5A	2	2	4	0	0	0
6	2	2	0	4	0	0
9	6	2	8	6	0	1
11	0	2	0	6	1	0

Readings were all low throughout the summer on the 6 Lovesick Lake sites, as they were in 2004. In previous years there were isolated elevated counts, but they were always short-lived and had no obvious source. There have been no recurring problem spots.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Lower Buckhorn Lake

E.coli count, *E.coli*/100 ml Test Date							
Site No.	**3-Jul-05**	**4-Jul-05**	**18-Jul-05**	**24-Jul-05**	**1-Aug-05**	**8-Aug-05**	**5-Sep-05**
1	0	x	<2	0	1	2	2
2	2	x	<2	16	3	0	20
3	12	x	40	**82**	44,43,39,43,36	**52**	**98**
4A	**98**	x	26	6	11	14	32
5	2	x	8	6	2	0	2
7	x	0	<2	2	2	0	0
8	2	x	**52**	14,16,26,**318**.14	4.4.1.7.2	0	2
9	2	x	<2	6	3	0	4
10	0	x	<2	0	x	x	x
11	2	x	<2	x	4,1,0,1,0	6,14,5,6,6	x
11N	x	x	**60**	4,**98**,8,36,18	x	x	x
12	16	x	20	6	0	7	x
13	18	x	14	26	0	6	x
14	x	x	x	2	4	2	10
15	x	x	x	4	1	x	x
16	x	x	x	x	0	0	2
4B	x	x	12	30	8	21	22
4C	x	x	**400**	**104**	**131**	**96**	**660**

Both Site 3 and 4 are at the inflows from wetlands. Tests upstream in previous years strongly indicate that counts are from the streams, not the cottages near Site 3 and 4. Site 4C is closer to the inflow and one can see how the counts are higher than 4 or 4B. Local cottagers are aware of the situation. Site 8 has not had elevated counts in previous years. There is a raft nearby which is popular with waterfowl.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Pigeon Lake: Concession 17 Pigeon Lake Cottagers Assoc.

E.coli count, *E.coli*/100 ml Test Date					
Site No.	4-Jul-05	25-Jul-05	2-Aug-05	7-Aug-05	5-Sep-05
3	0	0	1	6	0
A	0	0	0	1	2
B	0	2	0	0	0

As in previous years, Site A and Site 3 had very low counts. This is the first year of testing Site B, which had very low counts as well

Pigeon Lake: Gamiing

E.coli count, *E.coli*/100 ml Test Date					
Site	5-Jul-05	18-Jul-05	25-Jul-05	2-Aug-05	9-Aug-05
East	<2	**128**	18,18,14,16,12	9	4
West	<2	6	x	1	14
South	<2	0	x	4	12

There were many geese seen in the area near Site East/July 18, which may have accounted for this high reading.
The South site had elevated readings in 2002 and 2004; it is reassuring to see the counts low again this year

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Pigeon Lake: North Pigeon Lake Ratepayers Assoc.

E.coli count, *E.coli*/100 ml Test Date						
Site No.	**11-Jul-05**	**18-Jul-05**	**25-Jul-05**	**1-Aug-05**	**8-Aug-05**	**6-Sep-05**
5	8	42	x	x	6	0
6	6	**62**	28,50	**76,98,74**	24,20,**56**	48,28,24
7	**102**	**184**	**244**	**178**	**110**	**70**
7	x	x	**202**	**204**	**80**	**63**
7	x	x	x	**174**	**124**	**51**
8	12	0	0	0	0	0
11	**136**	**98**	**66** **52** **74**	**68** **78** **86**	**272** **390** **158**	**124** **141** **160**
12	50	**68**	**56,52**	**64,80,54**	22,32,30	7,5,5
1A	8	14	8	2	2	2

Sites 6, 7, 11 and 12 are close to each other, in an area with extensive wildlife including waterfowl. *E.*coli counts have been high here every year. There is little circulation in this backwater area. Local landowners know of the issue.

Comparing results at Sites 7, 11 and 12 between the very wet, cool 2004 summer and the very dry, warm 2005 summer, it was somewhat unexpected to see that *E.coli* readings were very similar.

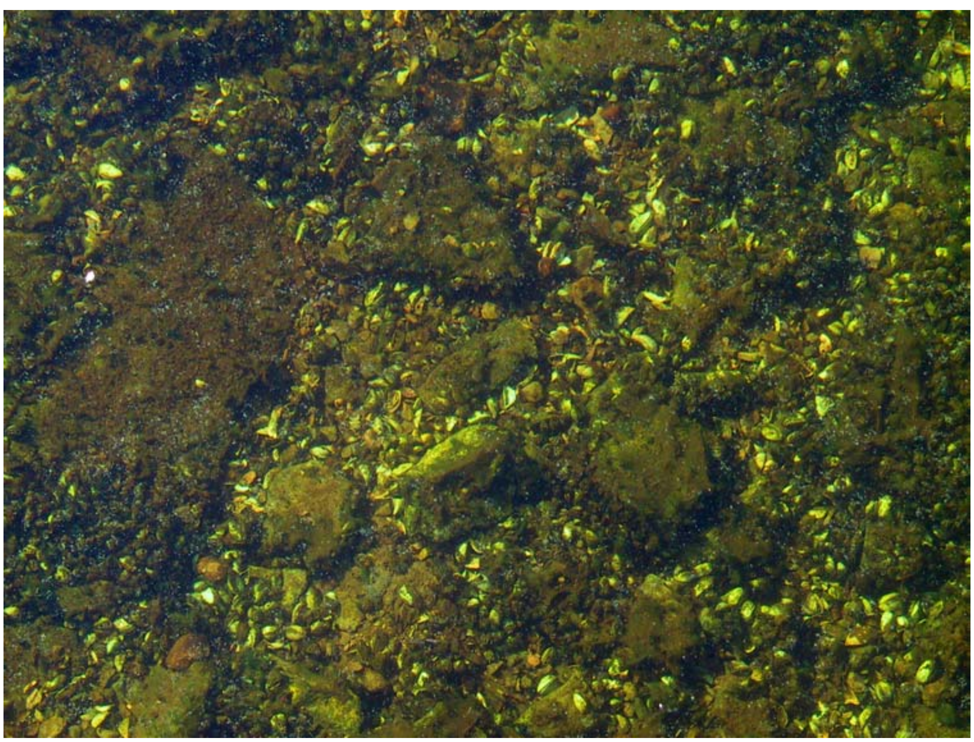
To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Pigeon Lake: Victoria Place

E.coli count, *E.coli*/100 ml Test Date					
Site No.	**6-Jul-05**	**18-Jul-05**	**2-Aug-05**	**8-Aug-05**	**7-Sep-05**
1	4	6	2	2	4
2	8	2	0	0	10
3	6	0	2	0	8
4	4	2	1	1	7
5	28	8	3	20	8

All readings were very low in 2005, following the pattern of previous years.



Zebra mussels on rocky lakebed

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Sandy Lake: Harvey Lakeland

E.coli count, *E.coli*/100 ml Test Date				
Site No.	3-Jul-05	21-Jul-05	2-Aug-05	15-Aug-05
1	0	6	0	4
2	0	40	0	4
3	0	2	0	0
4	0	2	0	0
5	0	6	0	1
6	0	0	0	0

As in the past, Site 2 had slightly higher readings than other sites. This site is near a shoal, which is frequented by waterfowl.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Stony Lake: Assoc. of Stony Lake Cottagers

E.coli count, *E.coli*/100 ml Test Date								
Site No.	5-Jul-05	11-Jul-05	18-Jul-05	25-Jul-05	27-Jul-05	3-Aug-05	8-Aug-05	6-Sep-05
A	2	x	<2	0	x	2	2	0
E	10	x	2	4	x	1	0	0
F	10	x	4	4	x	0	9	1
G	4	x	8	4	x	6	1	1
I	**50**	24,26,20,24,12	10	12	x	4	0	9
J	**60**	4,18,14,12,12	14	2	x	9	5	6
K	12	x	<2	6	x	3	13	3
L	10	x	4	0	x	0	1	0
P	4	x	26	0	x	0	1	0
24	20	x	2	2	x	2	7	2
25	**52**	14,22,32,34,64	16	44	x	0	8	15
26	**100**	22,12,20,8,30	8	22	x	4	35	8
27	**112**	26,22,54,46,36	40	**64**	**73,72,68,54,46**	8	5	33
28	30	x	<2	**284**	0,0,4,0,1	2	7	5

Before July 5, July 25, and July 27, the volunteer log recorded heavy rain within 24 hours before testing. This would probably be the reason for elevated counts on these dates. All the locations with counts over 20 on these dates were narrow bays (i.e., extensive shoreline, low circulation) with lots of human activity.
The high reading at Site 28/July 25 may have been due to contamination; the tester noticed that the small amount of powder in the bottle looked caked, as if some moisture had entered the sampling bottle.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Sturgeon Lake: North Shore Combined Group

E.coli count, *E.coli*/100 ml Test Date							
Site No.	4-Jul-05	18-Jul-05	25-Jul-05	2-Aug-05	8-Aug-05	12-Aug-05	6-Sep-05
1	<2	6	22	**174**	7,7,6,12,9	x	4
2	6	12	**112**	22	**365**	17	2
						2,000	
						1,220	
						55	
						11	
2A	40	26	18	8	3	x	**0**
3	10	4	18	18	23	x	2
4	2	48	6	0	2	x	2
5	8	0	8	**142**	62,19,**51**,**53**,30	x	4
6	<2	36	2	0	2	x	2
SPGOLF	<2	6	0	0	1	x	4
SPPD	2	8	2	0	3	x	6
WS1	<2	4	28	11	9	x	4
WS2	**142**	20	0	18	6	x	14
SB1	8	**72**	34	**59**	**78**	22	10
			32			**63**	
			28			17	
			28			42	
			18			**70**	
SB2	2	42	2	**53**	42	x	0

This was the second year of testing by this group. Site 2, a backwater area where waterfowl tend to congregate, exhibited several high counts, as it did in 2004. The owner is aware of this and is trying to discourage the geese and gulls. Site 3, which is an inflow of a creek where cattle graze, had three counts over 50 in 2004, but counts were all under 20 this year. Will this be a rain-sensitive site?

Site 5 had 4 counts over 50 in 2004, and two elevated dates in 2005. It is an area with high human activity and a place where many geese and ducks swim.

SB1, a new site this year, had several elevated counts. This is a very shallow area where cattle have been seen walking in the water.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

Upper Stoney Lake: Upper Stoney Lake Cottagers Assoc.

E.coli count, *E.coli*/100 ml Test Date						
Site No.	4-Jul-05	18-Jul-05	25-Jul-05	3-Aug-05	8-Aug-05	6-Sep-05
6	2	18	16	8	4	2
20	2	24	6	1	8	0
21	<2	10	0	1	1	0
52	4	8	4	15	16	13
56	<2	4	4	1	2	0
62	<2	2	0	1	0	1
63A	<2	6	2	1	0	0
65	<2	2	4	0	2	0
70	2	6	0	0	0	0
78A	2	2	0	1	3	0
85	2	6	0	1	0	0
99	<2	0	0	0	1	0

Over the past 5 years, the sites at Upper Stoney Lake have almost all been under 20. Heavy rain has correlated with a few somewhat elevated counts (see July 22/02, July 27/03), but otherwise counts have been and continue to be uniformly very low.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming;
- Kawartha Lake Stewards Association believes the safe swimming level for our lakes should be more stringent than this, and have set the acceptable level at 50 *E.coli*/100 mL. KLSA regards counts over 50 as cause for concern;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha lakes;
- A "-" indicates no data available for that date.

White Lake: White Lake Cottagers Assoc.

E.coli count, *E.coli*/100 ml Test Date					
Site No.	4-Jul-05	12-Jul-05	2-Aug-05	16-Aug-05	30-Aug-05
1	154	30	8	2	8
2	54	32	4	40	4

This was the first year of testing on this lake. Both locations were near an area rich in wildlife, especially birds and beaver. The birds are especially common there at the beginning of the year, which may account for the elevated counts on the first sampling date.

Appendix F: 2004 Phosphorus and Secchi Data

Following is the complete record of phosphorus and Secchi disk measurements taken in 2005. Look up your lake and ask:
How close is our lake to the 20 ppb seasonal average limit?
How well do our Secchi readings and phosphorus readings correlate?
How do your lake's phosphorus levels change throughout the season?

2005 Secchi Depth Results		2005 Total Phosphorus Results					
Secchi(m)	Date	Lake	Site Description	Date	TP1 (ug/L)	TP2 (ug/L)	TP Avg.
9.50	2-Jun-05	**Balsam lake**	**N Bay Rocky Pt.**	2-Jun-05	4.91	5.00	4.96
6.00	20-Jun-05			20-Jun-05	7.49	7.49	7.49
6.00	28-Jun-05			-	-	-	-
6.50	12-Jul-05			12-Jul-05	8.48	9.76	9.12
6.00	20-Jul-05			-	-	-	-
5.00	2-Aug-05			2-Aug-05	12.11	12.96	12.54
5.00	21-Aug-05			-	-	-	-
5.00	30-Aug-05			30-Aug-05	12.29	10.40	11.35
4.50	21-Sep-05			21-Sep-05	12.65	11.26	11.96
-	-	**Balsam Lake**	**NE End Lightning Point**	5-Jun-05	11.57	10.90	11.24
4.50	21-Aug-05			21-Aug-05	8.48	8.46	8.47
-	-			20-Sep-05	7.13	7.52	7.33
-	-			10-Oct-05	6.84	8.29	7.57
-	-	**Balsam lake**	**S Bay - Killarney Bay**	28-May-05	8.63	9.03	8.83
-	-			26-Jun-05	15.07	15.93	15.50
-	-			24-Jul-05	17.28	13.78	15.53
-	-			26-Aug-05	9.46	9.79	9.63
-	-			25-Sep-05	10.56	11.05	10.81
-	-			24-Oct-05	9.13	9.90	9.52
-	-	**Big Bald Lake**	**Mid-lake**	19-May-05	27.07	25.33	26.20
-	-			1-Jun-05	8.74	8.11	8.43
-	-			4-Jun-05	9.92	10.27	10.10
-	-			2-Aug-05	11.41	10.80	11.11
-	-			6-Sep-05	11.31	11.08	11.20
-	-			1-Oct-05	12.40	11.04	11.72
-	-	**Big Bald Lake**	**Bay near golf course**	19-May-05	10.80	10.65	10.73
-	-			1-Jun-05	10.71	8.45	9.58
-	-			4-Jul-05	10.90	11.34	11.12
-	-			2-Aug-05	12.10	12.26	12.18
-	-			6-Sep-05	10.16	10.84	10.50
-	-			1-Oct-05	10.38	12.15	11.27

2005 Secchi Depth Results			2005 Total Phosphorus Results				
Secchi(m)	Date	Lake	Site Description	Date	TP1 (ug/L)	TP2 (ug/L)	TP Avg.
-	-	**Cameron Lake**	**Mid Lake Deep Spot**	10-Jul-05	8.20	11.15	9.68
-	-		**W end, McFarland Bay**	7-May-05	10.91	12.59	11.75
-	-			5-Jun-05	14.30	15.46	14.88
-	-			10-Jul-05	13.61	14.41	14.01
-	-			7-Aug-05	10.56	10.95	10.76
-	-	**Chemong Lake**	**S end, South of Causeway**	28-May-05	11.76	11.57	11.67
-	-			26-Jun-05	15.54	14.16	14.85
-	-			23-Jul-05	19.04	15.57	17.31
-	-			20-Aug-05	15.80	14.12	14.96
-	-			10-Sep-05	19.72	25.89	22.81
-	-	**Clear Lake**	**MacKenzie Bay**	29-May-05	9.96	10.24	10.10
-	-			4-Jul-05	14.19	15.94	15.07
-	-			2-Aug-05	20.36	15.46	17.91
-	-			15-Sep-05	16.01	17.61	16.81
3.70	6-Jul-05	**Clear Lake**	**Main Basin, Mid-lake**	6-Jul-05	12.79	16.01	14.40
3.00	21-Jul-05			21-Jul-05	13.84	14.33	14.09
4.34	8-Aug-05			8-Aug-05	12.85	12.84	12.85
5.10	9-Sep-05			9-Sep-05	15.65	15.53	15.59
3.87	1-Oct-05			1-Oct-05	20.62	21.74	21.18
3.93	6-Jul-05	**Clear Lake**	**Fiddlers Bay**	6-Jul-05	18.58	18.01	18.30
3.30	21-Jul-05			21-Jul-05	14.09	14.57	14.33
4.04	8-Aug-05			8-Aug-05	14.55	19.52	17.04
>4.45	9-Sep-05	Secchi at bottom		9-Sep-05	16.99	17.24	17.12
>4.70	1-Oct-05	Secchi at bottom		1-Oct-05	22.27	24.02	23.15
4.60	13-May-05	**Jullian Lake**	**Mid-lake**	13-May-05	7.19	8.47	7.83
5.10	3-Jun-05			3-Jun-05	7.18	6.37	6.78
5.60	4-Jul-05			4-Jul-05	5.19	5.16	5.18
6.40	29-Jul-05			29-Jul-05	4.28	4.43	4.36
7.00	2-Sep-05			2-Sep-05	5.31	4.78	5.05
6.50	30-Sep-05			30-Sep-05	4.48	5.17	4.83
4.45	16-May-05	**Kathewanooka Lake**	**S/E Douglas Island**	16-May-05	18.68	13.96	16.32
7.45	2-Jun-05			2-Jun-05	9.59	8.30	8.95
4.90	18-Jun-05			-	-	-	-
5.70	5-Jul-05			5-Jul-05	13.00	15.16	14.08
4.05	19-Jul-05			-	-	-	-
4.65	4-Aug-05			4-Aug-05	17.34	17.07	17.21
6.40	16-Aug-05			-	-	-	-
6.80	8-Sep-05			8-Sep-05	19.22	18.62	18.92
6.45	8-Oct-05			8-Oct-05	19.76	22.99	21.38

2005 Secchi Depth Results		2005 Total Phosphorus Results					
Secchi(m)	Date	Lake	Site Description	Date	TP1 (ug/L)	TP2 (ug/L)	TP Avg.
6.25	5-May-05	**Lovesick Lake**	**80' deep hole N. end**	5-May-05	8.66	8.85	8.76
4.25	1-Jun-05			1-Jun-05	13.24	13.06	13.15
4.50	4-Jul-05			4-Jul-05	18.69	17.31	18.00
5.00	2-Aug-05			2-Aug-05	20.78	20.78	20.78
-	6-Sep-05			6-Sep-05	18.29	17.78	18.04
5.75	2-Oct-05			2-Oct-05	15.11	14.57	14.84
5.50	5-May-05	**Lovesick Lake**	**Spenceley's Bay**	5-May-05	8.16	8.67	8.42
4.75	1-Jun-05			1-Jun-05	11.62	11.83	11.73
4.00	4-Jul-05			4-Jul-05	18.38	18.14	18.26
5.50	2-Aug-05			2-Aug-05	22.98	23.59	23.29
4.50	6-Sep-05			6-Sep-05	18.75	18.94	18.85
5.00	2-Oct-05			2-Oct-05	15.39	14.29	14.84
6.00	5-May-05	**Lovesick Lake**	**Macallums Island**	5-May-05	9.08	9.18	9.13
4.00	1-Jun-05			1-Jun-05	13.76	15.18	14.47
4.75	4-Jul-05			4-Jul-05	17.02	17.00	17.01
5.00	2-Aug-05			2-Aug-05	20.48	20.42	20.45
4.50	6-Sep-05			6-Sep-05	18.55	18.83	18.69
5.25	2-Oct-05			2-Oct-05	17.45	15.10	16.28
4.90	8-May-05	**Lower Buckhorn Lake**	**Heron Island**	8-May-05	8.61	8.74	8.68
3.40	3-Jun-05			3-Jun-05	17.27	16.92	17.10
3.30	4-Jul-05			4-Jul-05	13.38	12.95	13.17
3.20	2-Aug-05			2-Aug-05	19.30	18.94	19.12
3.00	5-Sep-05			5-Sep-05	19.70	18.95	19.33
3.60	2-Oct-05			2-Oct-05	14.74	17.81	16.28
5.91	18-May-05	**Lower Buckhorn Lake**	**Deer Bay West Buoy C267**	18-May-05	9.30	12.65	10.98
6.27	26-May-05			-	-	-	-
3.73	5-Jun-05			-	-	-	-
4.51	16-Jun-05			16-Jun-05	18.16	17.41	17.79
4.34	2-Jul-05			-	-	-	-
3.36	13-Jul-05			13-Jul-05	17.31	17.92	17.62
4.02	28-Jul-05			-	-	-	-
3.71	3-Aug-05			3-Aug-05	21.20	20.55	20.88
3.96	25-Aug-05			-	-	-	-
3.84	2-Sep-05			2-Sep-05	19.69	18.86	19.28
4.71	12-Oct-05			12-Oct-05	15.00	15.18	15.09
7.26	21-Oct-05			-	-	-	-

2005 Secchi Depth Results			2005 Total Phosphorus Results				
Secchi(m)	Date	Lake	Site Description	Date	TP1 (ug/L)	TP2 (ug/L)	TP Avg.
4.80	8-May-05	Lower Buckhorn Lake	Deer Bay-centre	8-May-05	10.18	10.13	10.16
5.10	3-Jun-05			3-Jun-05	8.48	8.70	8.59
3.30	4-Jul-05			4-Jul-05	16.43	16.63	16.53
3.20	2-Aug-05			2-Aug-05	20.58	20.30	20.44
3.10	5-Sep-05			5-Sep-05	15.97	14.18	15.08
3.10	2-Oct-05			2-Oct-05	14.32	13.84	14.08
3.90	23-May-05	Pigeon Lake	Middle, Sandy Pt & Boyd Is.	23-May-05	6.95	7.42	7.19
4.20	4-Jun-05			4-Jun-05	7.94	7.42	7.68
3.00	3-Jul-05			3-Jul-05	14.75	14.90	14.83
2.80	2-Aug-05			2-Aug-05	16.80	17.94	17.37
2.70	5-Sep-05			5-Sep-05	17.60	17.42	17.51
3.40	9-Oct-05			9-Oct-05	14.72	16.46	15.59
-	-	Pigeon Lake	N end, 400m N of Boyd Is.	31-May-05	10.98	9.03	10.01
-	-			2-Jul-05	15.27	15.43	15.35
4.50	5-Jul-05			-	-	-	-
-	-			1-Aug-05	13.47	14.95	14.21
-	-			6-Aug-05	20.11	20.31	20.21
-	-			2-Oct-05	20.69	19.25	19.97
3.60	23-May-05	Pigeon Lake	N end, Adjacent Con 17	23-May-05	8.86	8.51	8.69
3.80	4-Jun-05			4-Jun-05	9.28	8.96	9.12
2.90	3-Jul-05			3-Jul-05	14.74	14.03	14.39
3.00	2-Aug-05			2-Aug-05	21.71	20.46	21.09
2.80	5-Sep-05			5-Sep-05	18.95	18.43	18.69
3.70	9-Oct-05			9-Oct-05	16.52	14.04	15.28
-	-	Pigeon Lake	Channel - S. end of Boyd Is.	7-Jun-05	7.16	7.17	7.17
3.20	9-Sep-05			9-Sep-05	21.74	21.59	21.67
-	-	Pigeon Lake	N end-300yds off Bottom Is.	31-May-05	7.64	8.06	7.85
-	-			1-Aug-05	16.28	16.51	16.40
-	-			5-Sep-05	18.28	20.62	19.45
-	-			1-Oct-05	20.69	21.09	20.89
-	-	Sandy Lake	Mid Lake	17-Jun-05	3.79	3.74	3.77
-	-			2-Jul-05	3.34	3.04	3.19
-	-			30-Jul-05	4.37	4.37	4.37
-	-			25-Aug-05	4.14	4.63	4.39
-	-			24-Sep-05	6.25	5.89	6.07
-	-			2-Oct-05	5.20	5.52	5.36

2005 Secchi Depth Results		2005 Total Phosphorus Results					
Secchi(m)	Date	Lake	Site Description	Date	TP1 (ug/L)	TP2 (ug/L)	TP Avg.
4.00	10-Jul-05	**Stony Lake**	**Burleigh Bay**	10-Jul-05	20.56	22.21	21.39
5.00	30-Jul-05			-	-	-	-
3.70	17-Sep-05			-	-	-	-
2.25	29-May-05	**Stony Lake**	**Gilchrist Bay**	29-May-05	11.41	11.03	11.22
4.38	5-Jul-05			5-Jul-05	15.34	14.96	15.15
4.75	20-Jul-05			20-Jul-05	16.45	15.69	16.07
3.63	28-Aug-05			28-Aug-05	12.83	12.42	12.63
7.00	18-Sep-05			18-Sep-05	24.20	15.57	19.89
7.00	9-Oct-05			9-Oct-05	14.18	14.82	14.50
6.00	9-May-05	**Stony Lake**	**Mid-lake, Mouse Island**	9-May-05	8.30	8.45	8.38
4.00	1-Jun-05			1-Jun-05	8.13	9.10	8.62
4.20	23-Jun-05			-	-	-	-
3.80	4-Jul-05			4-Jul-05	12.19	11.74	11.97
3.90	16-Jul-05			-	-	-	-
4.10	2-Aug-05			2-Aug-05	15.22	13.87	14.55
5.20	5-Sep-05			5-Sep-05	15.82	14.53	15.18
5.10	1-Oct-05			1-Oct-05	16.97	16.75	16.86
4.10	9-May-05	**Stony Lake**	**Hamilton Bay**	9-May-05	9.54	9.10	9.32
3.90	1-Jun-05			1-Jun-05	10.90	10.34	10.62
4.10	23-Jun-05			-	-	-	-
4.20	4-Jul-05			4-Jul-05	13.36	14.63	14.00
4.00	16-Jul-05			-	-	-	-
4.10	2-Aug-05			2-Aug-05	17.00	16.90	16.95
4.00	5-Sep-05			5-Sep-05	14.19	15.68	14.94
4.20	1-Oct-05			1-Oct-05	13.37	13.28	13.33
2.40	17-Jun-05	**Sturgeon Lake**	**S end, Rustic Bay**	17-Jun-05	11.68	11.68	11.68
-	-			15-Jul-05	13.33	13.28	13.31
2.15	16-Aug-05			16-Aug-05	15.85	16.74	16.30
2.60	3-Sep-05			3-Sep-05	16.32	17.63	16.98
3.20	20-Jun-05	**Sturgeon Lake**	**Muskrat Is. at Buoy C388**	20-Jun-05	11.50	10.90	11.20
3.60	5-Jul-05			5-Jul-05	14.00	14.00	14.00
2.60	2-Aug-05			2-Aug-05	16.61	16.66	16.64
1.90	15-Aug-05			-	-	-	-
3.80	6-Sep-05			-	-	-	-
2.70	2-Oct-05			2-Oct-05	15.78	16.62	16.20
3.25	20-Jun-05	**Sturgeon Lake**	**Sturgeon Point**	20-Jun-05	13.20	13.40	13.30
3.30	5-Jul-05			5-Jul-05	13.70	13.40	13.55
2.70	2-Aug-05			2-Aug-05	16.20	13.46	14.83
2.40	16-Aug-05			-	-	-	-
3.70	6-Sep-05			6-Sep-05	16.48	16.82	16.65
3.35	3-Oct-05			3-Oct-05	13.94	13.46	13.70

2005 Secchi Depth Results			2005 Total Phosphorus Results				
Secchi(m)	Date	Lake	Site Description	Date	TP1 (ug/L)	TP2 (ug/L)	TP Avg.
2.55	5-Jul-05	**Sturgeon Lake**	**S of Fenelon River-Buoy N5**	5-Jul-05	12.80	13.10	12.95
2.50	2-Aug-05			-	-	-	-
3.10	16-Aug-05			-	-	-	-
3.20	6-Sep-05			6-Sep-05	11.17	10.85	11.01
3.35	2-Oct-05			2-Oct-05	8.24	9.74	8.99
2.65	5-Jul-05	**Sturgeon Lake**	**Snug Harbour -Buoy CP6**	5-Jul-05	38.60	32.40	35.50
2.70	2-Aug-05			2-Aug-05	20.40	20.50	20.45
2.05	16-Aug-05			-	-	-	-
2.80	6-Sep-05			6-Sep-05	92.20	104.42	98.31
3.50	2-Oct-05			2-Oct-05	95.50	115.90	105.70
3.05	25-May-05	**Upper Buckhorn Lake**	**Narrows, red buoy C310**	25-May-05	12.14	24.18	18.16
2.13	1-Jun-05			1-Jun-05	13.42	17.71	15.57
2.13	4-Jul-05			4-Jul-05	22.54	18.29	20.42
3.05	3-Aug-05			3-Aug-05	21.13	20.25	20.69
2.59	6-Sep-05			6-Sep-05	17.54	17.25	17.40
5.18	6-Oct-05			6-Oct-05	11.00	13.96	12.48
-	-	**Upper Buckhorn Lake**	**Mid-lake, 30m from shore**	10-Jul-05	19.30	22.52	20.91
-	-			1-Aug-05	17.78	16.45	17.12
-	-			4-Sep-05	16.80	19.70	18.25
-	-			2-Oct-05	13.52	14.13	13.83
4.90	10-Jun-05	**Upper Stoney Lake**	**Quarry Bay**	10-Jun-05	7.21	7.37	7.29
4.70	4-Jul-05			4-Jul-05	8.63	7.49	8.06
6.00	3-Aug-05			3-Aug-05	10.80	8.62	9.71
6.60	6-Sep-05			6-Sep-05	8.19	7.48	7.84
6.80	5-Oct-05			5-Oct-05	6.80	6.17	6.49
4.90	10-Jun-05	**Upper Stoney Lake**	**Young Bay**	10-Jun-05	7.00	7.58	7.29
4.90	4-Jul-05			4-Jul-05	9.56	7.70	8.63
6.10	3-Aug-05			3-Aug-05	7.33	7.54	7.44
6.00	6-Sep-05			6-Sep-05	7.17	7.05	7.11
6.00	5-Oct-05			5-Oct-05	5.71	5.44	5.58
-	-	**Upper Stoney Lake**	**S Bay**	10-Jun-05	9.81	9.64	9.73
-	-			4-Jul-05	13.89	10.34	12.12
-	-			3-Aug-05	9.95	9.98	9.97
-	-			6-Sep-05	10.64	9.93	10.29
-	-			5-Oct-05	8.71	7.61	8.16

2005 Secchi Depth Results			2005 Total Phosphorus Results				
Secchi(m)	Date	Lake	Site Description	Date	TP1 (ug/L)	TP2 (ug/L)	TP Avg.
4.70	10-Jun-05	**Upper Stoney Lake**	**Crowes Landing**	10-Jun-05	7.57	7.22	7.40
4.80	4-Jul-05			4-Jul-05	7.81	9.28	8.55
5.80	3-Aug-05			3-Aug-05	7.23	8.03	7.63
6.20	6-Sep-05			6-Sep-05	7.30	7.77	7.54
7.00	5-Oct-05			5-Oct-05	6.23	5.60	5.92
5.20	10-Jun-05	**Upper Stoney Lake**	**Mid-lake, Deepest area**	10-Jun-05	6.91	7.57	7.24
5.10	4-Jul-05			4-Jul-05	8.32	7.36	7.84
5.80	3-Aug-05			3-Aug-05	7.14	6.85	7.00
6.50	6-Sep-05			6-Sep-05	7.44	8.37	7.91
7.30	5-Oct-05			5-Oct-05	5.75	6.96	6.36
5.60	21-May-05	**White Lake**	**South End**	21-May-05	7.71	7.55	7.63
4.90	5-Jun-05			5-Jun-05	11.10	10.84	10.97
4.10	3-Jul-05			3-Jul-05	11.19	12.40	11.80
4.80	7-Jul-05			-	-	-	-
4.00	2-Aug-05			2-Aug-05	11.42	10.90	11.16
4.30	5-Sep-05			5-Sep-05	9.47	9.17	9.32
4.20	2-Oct-05			2-Oct-05	8.69	8.79	8.74

Algal growth on weeds

Appendix G – Glossary

Aquatic plants – Plants that grow partially or entirely submerged in lakes and streams or in waterlogged, wetland soils.

Algae – Simple, one-celled or colonial plant-like organisms that grow in water, contain chlorophyll and do not differentiate into specialized cells and tissues like roots and leaves.

Algal blooms – Sudden proliferations of algae.

Anoxic conditions – Low concentrations of oxygen.

Benthic macroinvertebrates – The "bugs" (worms, larvae, snails, etc.) that live in the sediments on the bottoms of lakes and streams.

Biomass – The amount of living matter produced in a chosen area or volume of habitat. Usually measured by dry weight, biomass indicates how productive, for example, a lake, pond, forest or meadow is.

Chlorophyll *a* – A green plant pigment found in photosynthesizing organisms; the amount of chlorophyll a in surface water samples indicates the amount of free-floating algae.

***E.coli* bacteria** – A bacteria that lives in the intestines of warm-blooded animals such as birds, beavers and humans. While most are harmless, a few strains of *E.coli* cause severe gastrointestinal illness. Drinking water and recreational water are tested for the presence of this bacteria.

Eutrophication – The aging of a body of water, as it increases in dissolved nutrients like phosphorus and declines in oxygen. This is often a natural process that can be accelerated by shoreline development and other human activities.

Fetch – The farthest distance that wind can blow over a lake before it is disrupted by land.

$g \cdot m^{-2}$ – Grams of vegetation in one square meter of area, which has been dried in an oven at 40° C.

Ground truthing – Verifying predicted patterns or outcomes through follow-up studies.

Hypolimnion – Lakes usually stratify into thermal layers; the hypolimnion is the colder, dense, deep-water layer (while the epilimnion is the warmer surface water).

Internal loading – The recycling of nutrients among sediments, organisms and water.

Invasive or exotic species – Plants or animals that are not historically native to an area. Because such species often have no predators in their new environment, they can push out similar, native plants or animals and come to dominate an ecosystem.

Macrophyte – A plant, generally aquatic, that is visible to the eye, i.e., not microscopic.

Marl lake – These lakes receive drainage from limestone watersheds. If the drainage water has a high acidity, it will dissolve the limestone as it percolates through. When this high-calcium water reaches the lake, the acidity drops and the dissolved limestone precipitates out. The small particles of limestone (calcium carbonate) are called marl. See http://www.mlswa.org/lkclassifl.htm

Micrograms per litre – See below.

Oligotrophic – Applied to lakes low in nutrients, with clear water and relatively few plants. Compared to eutrophic lakes, oligotrophic lakes may be geologically young, or as yet unaffected by weathering and erosion.

Parts per billion (ppb) – A measure of concentration used for extremely small quantities of one substance within another substance. One part per billion of phosphorus, for example, means one unit of phosphorus within a billion units of water, which corresponds to one minute in 2000 years, a single penny in $10 million, or one drop of water in an Olympic-sized swimming pool. For our purposes, micrograms per litre and parts per billion are approximately equal.

Phosphorus – A widely occurring chemical element that stimulates the growth of terrestrial and aquatic plants as well as algae. Much phosphorus in the Kawarthas comes from our native limestone as well as from decaying vegetation on the bottoms of lakes and streams. Much may also be coming from human sources.

Phytoplankton ("floating plants") – Tiny, often microscopic free-floating algae that can turn lake water greenish, and are fed upon by zooplankton, zebra mussels, baby fish, etc.

Quadrat – A basic, square sampling unit for vegetation surveys; when placed on the ground (or lake bottom), all species within the quadrat are noted and various measurements are taken.

Safe swimming level – The Ontario Ministry of Environment's stated level of 100 *E.coli* bacteria per 100 millilitres of lake or river water. At that level or higher, beaches are posted as unsafe for swimming.

Substrate – The surface on which something grows, such as the bottom of a stream or lake (rocky, muddy, sandy, etc.), which provides the soil for aquatic plants.

Water column – A hypothetical cylinder of water from the surface to the bottom of a stream, river, or lake within which scientists measure its physical and/or chemical properties.

Zooplankton ("floating animals") – Tiny, sometimes microscopic free-floating animals (many look like microscopic shellfish) that eat phytoplankton and in turn provide food for young fish and other small aquatic animals.

Appendix H: Rainfall in the Kawarthas

Summer 2005 Rainfall (mm)

Oliver Centre (North Pigeon Lake), Trent Univ. (N. Ptbo.)

Water Testing Dates are in BOLD

June			July			August			September		
Date	Oliver Centre	Trent Univ.	Date	Oliver Centre	Trent Univ.	Date	Oliver Centre	Trent Univ.	Date	Oliver Centre	Trent Univ.
1			1			1		1.20	1		0.40
2			2	0.10		**2**			2		
3	0.10		3			3			3		
4			**4**	**1.20**	**2.40**	4	1.10	17.60	4		
5	0.20		5	0.30	1.60	5	3.00	0.20	**5**		
6			6	0.20		6	0.80		6		
7			7	0.10		7	0.10		7		
8	0.10		8		1.20	**8**			8	2.10	7.00
9			9	0.10	0.20	9			9		
10		0.40	10	0.10		10		5.20	10		
11			11			11		0.20	11		
12	0.10	14.40	12			12			12		
13		7.00	13	1.70		13			13		
14	0.40	5.80	14	1.30	0.80	14		1.00	14	9.90	20.40
15	0.20	16.40	15	0.10		15			15	0.10	
16		8.60	16	0.10		16			16	8.10	12.80
17	0.10	4.60	17		4.00	17			17	0.30	0.20
18		0.20	**18**	**0.10**		18			18		
19	0.10		19			19		4.20	19	0.10	0.40
20	0.10		20			20	0.10	0.60	20		
21		1.40	21			21		0.20	21		
22	0.10		22			22		0.40	22	2.40	0.40
23	0.20		23			23			23	0.10	
24	0.30		24	0.40		24			24		
25	0.30		**25**	**0.10**		25			25	11.00	12.60
26	0.20		26	0.70	4.20	26			26	30.20	35.60
27	0.20		27		1.80	27	0.10	3.80	27		
28	0.10		28	0.10		28		0.20	28	0.10	1.00
29	0.10		29			29			29	8.20	26.80
30	0.10		30			30		0.80	30		
			31			31	0.40	20.80			
Ttl	3.00	58.80	Ttl	6.70	16.20	Ttl	5.60	56.40	Ttl	72.60	117.60

The Kawarthas are beautiful lakes that are enjoyed by residents and visitors.

The prolific growth of aquatic plants will affect this enjoyment.

KLSA volunteers are working to find the cause(s) for this increased weed growth.

KLSA continues to monitor the health of the Kawartha Lakes.

Notes