Kawartha Lake Stewards Association

Winner of FOCA'S 2002 Jerry Strickland Award

# Lake Water Quality 2006 Report


April 2007

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**Special Thanks to the following Major Supporters of KLSA**

Parks Canada, Trent Severn Waterway

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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 reflected underwater environment, helping to convey the title theme of the report, **"Looking Deeper"**.

Many thanks to Ann Ambler, Ian Mackenzie and Jeff Chalmers for contributing the photographs used in the report.

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**Sheila Gordon-Dillane, Kathleen Mackenzie, Jeff Chalmers and Pat Moffat working on the 2006 report.**

## President's Message

2007 will be the seventh year of coordinated water quality testing by the Kawartha Lake Stewards Association (KLSA). We are an all-volunteer group of concerned cottagers, year-round residents, and local businesses who test lake water for phosphorus and *E.coli* bacteria. In 2006, KLSA represented about two dozen local associations on 16 lakes in the Kawarthas; we took water samples from 116 sites for bacteria and 41 sites for phosphorus.

### This report

Every year in our annual report, we attempt to make sense of the data we have been gathering. As usual, Kathleen Mackenzie, our director in charge of the water testing programs, has done a fine job of data interpretation this year in language and graphs that everyone can understand.

For the past couple of years, KLSA has also been moving into research, for we have found ourselves asking research questions as we reviewed our data. (Why are there so many weeds? Is excess phosphorus causing their growth? Where does it come from?) Water weeds (macrophytes) are a serious and ongoing concern at KLSA and indeed among cottagers, residents and tourists throughout the Kawarthas. We are very fortunate to have Dr. Eric Sager as our scientific advisor. Eric, who is director of Trent University's Oliver Ecological Centre, has been conducting studies of macrophytes for three years now on several lakes, with the help of our volunteers and colleagues from Trent. He has been trying to figure out, among other things, what factors are stimulating weed growth, and whether the copious growth noticed over the past few years is unusual historically. Eric's 2006 study, summarized in this report, is about epiphytes, the algae that cling to the water weeds. These algae, which can make swimming unpleasant, certainly bear watching as an indicator of changing lake water conditions.

This 2006 annual report also includes the results of Michael White's year-long study of phosphorus in the Kawartha Lakes, in excerpt form. Mike is a PhD candidate at Trent. We have very much appreciated working with him during the past year or so as he combed through historical data and worked out the land use patterns (which can indicate phosphorus loadings) of the 31 subwatersheds in KLSA's area of concern (Shadow/Balsam lakes southeast to Katchewanooka). He discussed his methods, goals and results with us on several occasions. Mike's final report serves as a useful base for further investigations into phosphorus, hopefully also in partnership with Trent

University. Note that Mike made use of KLSA's phosphorus data in his research into changing phosphorus levels in the lakes over time; it is for exactly this kind of purpose that KLSA gathers water quality data each year.

The results of the sewage treatment plant effluent study, done in partnership with faculty member Sara Kelly and her students at Sir Sandford Fleming College, are also presented in this report. As population pressures increase in the towns of the Kawarthas, we need to be increasingly concerned about upgrading sewage treatment plants, which can be a significant source of excess phosphorus in the lakes.

Finally, one of our directors, Kevin Walters, has been pursuing a fascinating hobby over the past few years: investigating the geology, hydrology, natural and human history of the Kawartha Lakes region. Kevin is an engineer at Dillon Consulting in Toronto, and owns land on Shadow, Sandy and Lovesick Lakes. In place of our short "Introduction to the Watershed", which usually begins these annual reports, this year we are publishing an excerpt from Kevin's extensive physical overview of the Kawarthas. We're concluding the report with Kevin's intriguing essay on a historical diversion of the Mississagua River, a nice piece of local sleuthing.

## Thanks

Many thanks to all our volunteers, to our committed financial partners (most especially Parks Canada/Trent-Severn Waterway, who provide baseline funding), and to the students and professors at Trent University and Sir Sandford Fleming College who partner with us in research efforts. Thanks to George Gillespie of McColl Turner Chartered Accountants in Peterborough for reviewing our financial records, to the Buckhorn Community Centre for providing meeting space, and to SGS Lakefield Research staff and MOE's Lake Partner Program for lab analysis and guidance. See Appendices A and B for complete lists of our Board of Directors, volunteers, and financial partners.

## May meeting

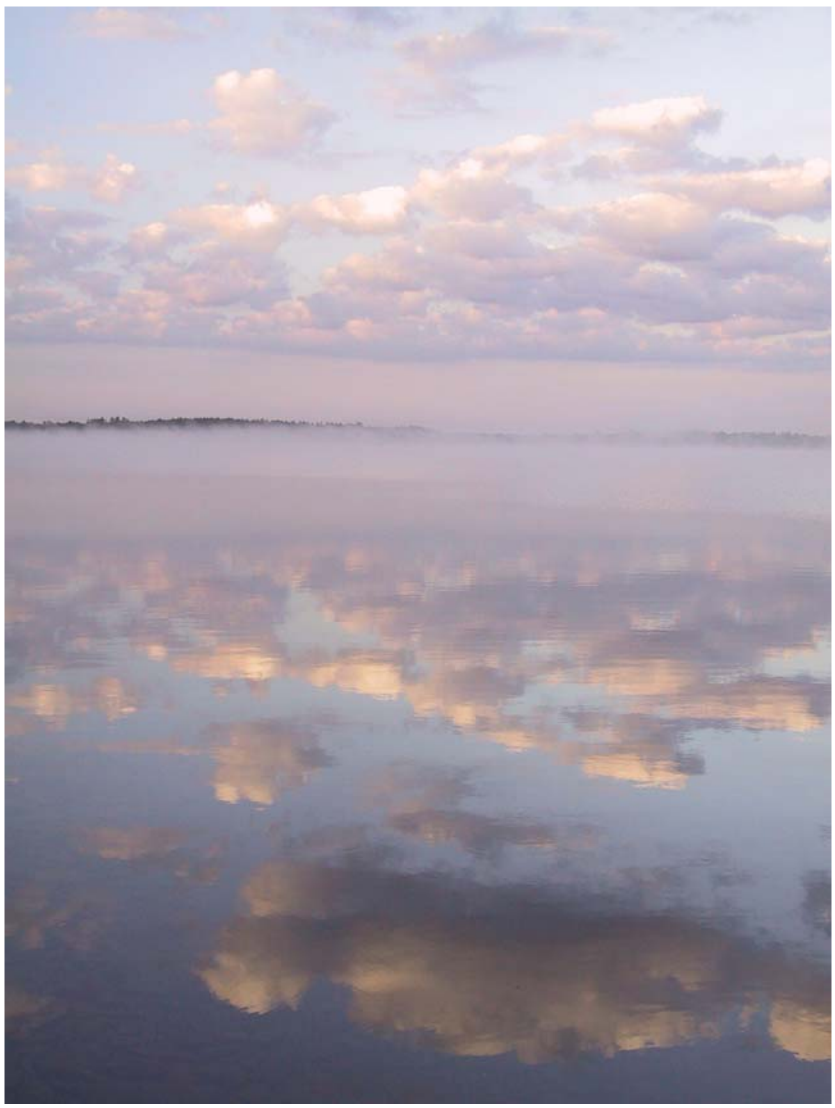
All are welcome at KLSA's spring meeting, which will be held at the
**Buckhorn Community Centre on Saturday, May 12th at 10:00 a.m.**

At the meeting, Kathleen Mackenzie will get us organized for this year's testing programs. Eric Sager will tell us about the upcoming 2007 macrophyte program, and attempt to answer all our weedy questions. Joan Chamberlain, manager of resource conservation at the Trent-Severn Waterway will talk about TSW programs such as species-at-risk and shoreline and in-water works. This second topic will include what is allowed and not allowed in controlling water weeds.

We are eager to have more water testers from all of the Kawartha/TSW lakes, especially from the southern parts of Sturgeon and Pigeon Lakes, as well as Chemong and Balsam Lakes.

Hope to see you at the meeting!

Pat Moffat
President



Early Morning on Clear Lake

# Executive Summary - 2006 Report

The Kawartha Lake Stewards Association (KLSA) is a volunteer-driven, non-profit organization representing cottage associations, year-round residents and local businesses in the Kawartha Lakes area. Established to provide a coordinated approach to lake water monitoring, the Association has continued its program of testing for phosphorus, water clarity and *E.coli* bacteria and expanded its focus to include research into various factors that affect water quality, including phosphorus and macrophytes (aquatic vegetation).

## Physical overview of the Kawarthas

The Kawartha Lakes are a unique chain of lakes occupying a broad, shallow valley running across the central part of Southern Ontario (Trent Valley). Fenelon Falls and Burleigh Falls divide the lakes into 3 distinct regions, which we can define as Upper, Central and Lower. Each region has distinct characteristics and vegetation patterns. The name Kawartha (originally Kawatha) is derived from an Ojibwa name meaning "bright waters and happy lands". The lakes lie approximately along the boundary between the Precambrian Shield to the north and the overlying Paleozoic sedimentary rock of the south. The waters feeding the Kawartha Lakes vary in composition as a result of the diverse geology. Fluctuations in flow and their effects on navigation historically were addressed by the creation of reservoirs on the upstream lakes, first by damming by the logging industry and later as part of the creation of the Trent Canal. The report, by KLSA Director Kevin Walters, discusses the history, geography and geology of the area. Another article by Kevin included in the 2006 report describes the diversion of the Mississagua River in the 1800s and its implications for Bald, Pigeon and Buckhorn Lakes.

## Phosphorus monitoring results

As part of the Ministry of the Environment's Lake Partner Program, volunteers collect water samples in their lakes 6 times per year (May to October) for phosphorus testing. At the same time, using a Secchi disk, they take measurements of water clarity. In 2006, KLSA volunteers sampled 41 sites in 16 lakes. The Ministry's Provincial Water Quality Objectives consider average phosphorus levels exceeding 20 parts per billion to be of concern since at that point excess algal growth can make lakes unattractive for recreation.

There are 3 different "phosphorus personalities" in the Kawartha Lakes:

- *low-phosphorus lakes* (below 10 ppb) that receive water mostly from the northern Canadian Shield regions, and then flow *into* the Trent-Severn Waterway (TSW);
- *high-phosphorus lakes* (10 ppb in spring, rising to over 15 ppb in summer) that receive much of their water from the main Waterway flow, and also from high phosphorus inflows from the south;
- *marl lakes*, which have a specific chemistry that keeps phosphorus levels near 5 ppb from spring to fall. This marl chemistry is probably reducing phosphorus levels somewhat in other KLSA lakes as well.

Phosphorus levels vary from lake to lake and throughout the year. In general, phosphorus rises as water flows downstream, from Balsam to Lovesick Lake, dropping somewhat in Stony Lake, rising again slightly in Clear and Katchewanooka Lakes. Shallow areas of lakes tend to have higher phosphorus levels. Lake-by-lake results show some predictable patterns and some interesting anomalies, for example, spring and fall levels that were higher than those of mid-summer at one site in Chemong Lake and inexplicably low levels in White Lake. Most of the KLSA lakes are 'high-phosphorus" lakes, starting the season with phosphorus levels between 12 and 16 ppb, climbing to between 15 and 19 ppb around July 1, and to between 17 and 23 ppb by August 1, at which point they level out.

In past years, we concluded that high water flows through the system, such as occurred in 2004, would result in lower phosphorus levels. This hypothesis does not seem to be borne out by recent data, however. KLSA continues to believe that the spring freshet (meltwater and spring rainwater) is probably the main contributor to low phosphorus levels in the spring. However, many variations in spring and summer phosphorus levels do NOT correlate with flow. Other factors affecting phosphorus levels might include biological activities in the lake, sediment absorption or release, or seasonal runoff. Additional research is required to address these questions.

## How much phosphorus enters the Kawartha Lakes from sewage treatment plants?

Students at Sir Sandford Fleming College, under the supervision of faculty member Sara Kelly, prepared a report analyzing the phosphorus discharges between 2000 and 2005 in the effluents from 6 sewage treatment plants (STPs) at Coboconk, Fenelon Falls, Port Perry, Lindsay, Omemee and Bobcaygeon. Interpretation of their analysis indicated that about 15% of the phosphorus entering Pigeon Lake from Sturgeon Lake in the low-flow summertime period is from the combined discharges of the Lindsay, Fenelon Falls and Bobcaygeon STPs.

The STPs at Omemee and Coboconk have a limited impact on the lakes because Omemee discharges most of its effluent as land irrigation and Coboconk discharges its effluent on a seasonal basis, i.e., not in the summer months. While the Port Perry facility does likewise, its volume, coupled with its loadings and minimal dilutions, make it significant. This and the other 3 plants therefore have the greatest effect on the lakes in summer. Their 3-year average discharge for the last 3 years is Lindsay: 1.6 kg/day, Port Perry: 0.8 kg/day, Fenelon Falls: 0.17 kg/day and Bobcaygeon: 0.5 kg/day. The total, 3.1 kg/day, is roughly equivalent to the effect of 1000 cottages discharging their sewage directly to the lakes. Therefore, while a great deal of phosphorus is being removed at the STPs, a substantial amount is still being discharged. KLSA should continue to monitor the situation and press for improvements as required.

## Phosphorus and the Kawartha Lakes

Michael White, a PhD student at Trent University, worked with KLSA to document current phosphorus concentrations in the lakes and study historical data, lake characteristics and land use patterns that contribute to phosphorus loading. The study looked at 31 subwatersheds and 21 different land uses occurring in them. Some of the findings of the report are that drainage from agricultural land and wetlands (more prevalent in the southern Kawartha Lakes) appears to cause the greatest increase in lake phosphorus concentrations while forested areas (northern Kawartha Lakes) have lower concentrations. Phosphorus levels also are higher in shallower areas and they increase as water flows down the chain of lakes. Phosphorus concentrations of the Kawartha Lakes are lower now than in the 1970s. It appears, however, that most of the decrease happened in the 1970s and early 1980s due to province-wide phosphate regulation and STP improvements, and levels have remained steady since then.

## How much algae sticks to macrophytes in the Kawartha Lakes?

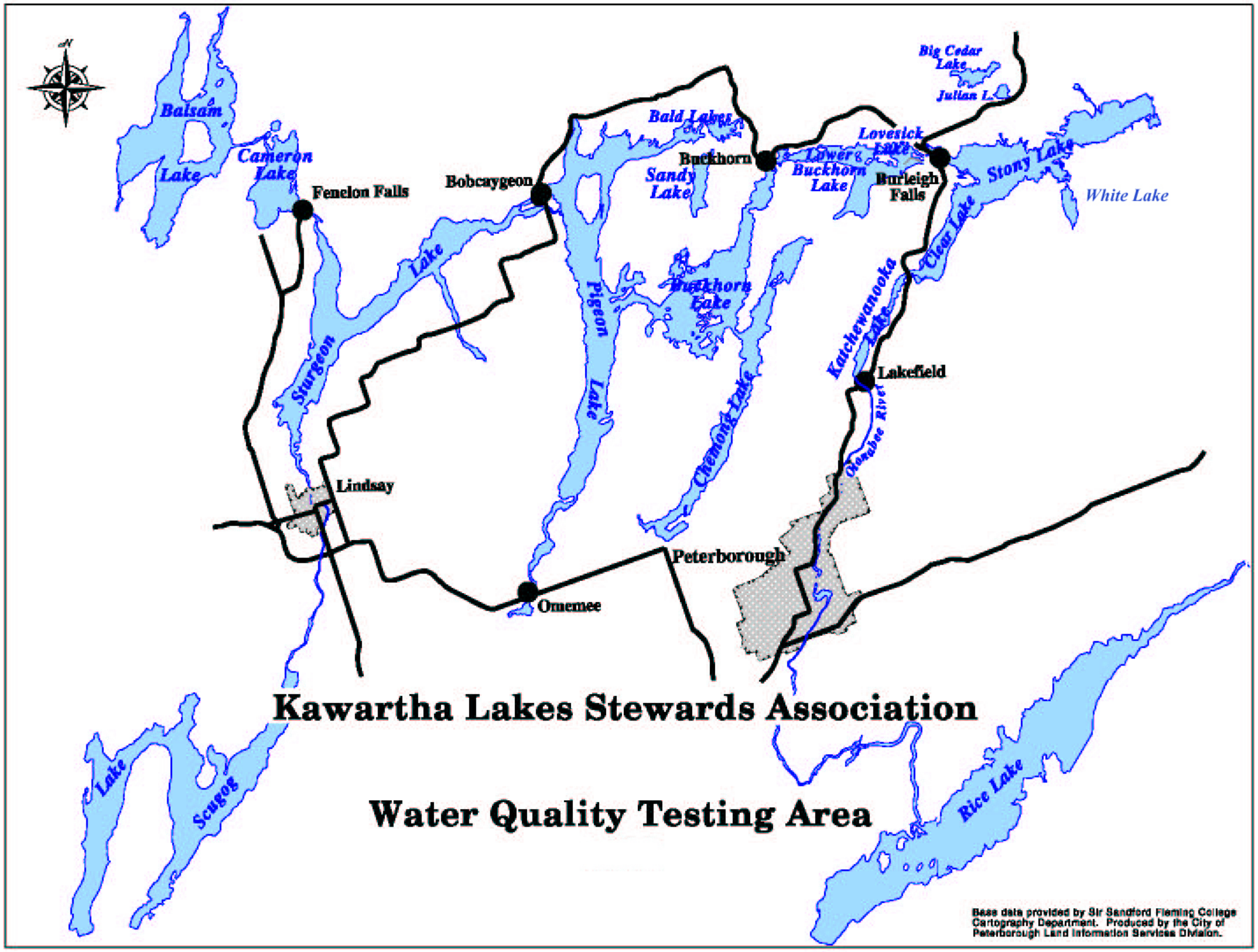
Dr. Eric Sager of Trent University and his colleague, Wynona Marleau of the Oliver Centre, continued previous research with KLSA of aquatic vegetation. In 2006 they studied *epiphyton*, algae that grows on weeds, and *metaphyton*, algae that originates as floating populations but gets tangled up with weeds and floating debris. Excessive growth of these types of algae can inhibit weed growth, encouraging the growth of phytoplankton, suspended algae in the water column. The study measured levels of algal biomass on tapegrass and Eurasian milfoil and then compared differences in biomass levels across four lakes. The results were somewhat surprising. The researchers had expected to find more algal growth on the milfoil but higher amounts were found on the tapegrass, possibly due to the effects of zebra mussels increasing light in the water column, the excretion of algae-resistant compounds by the Eurasian milfoil or grazing insects on the milfoil. Further research is needed. The second part of the study showed large differences within the four lakes studied (Pigeon, Lovesick, Stony and Sturgeon). This research provides useful baseline data for monitoring the risk of transition of the Kawartha Lakes to an algae-dominated state.

## *E.coli* bacteria test results

KLSA volunteers tested 116 sites in 14 lakes 6 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. In 2006, *E.coli* levels continued to be low with 77 of the sites considered "very clean", 23 "clean", 3 "slightly elevated" and 8 "needing observation". Most of the higher counts were likely due to waterfowl (mainly Canada Geese and ducks) or poor water circulation in shallow, dead-end bays.

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

## Map of the Kawartha Lakes 2006 Testing Area



## Physical Overview of the Kawartha Lakes

by Kevin Walters

The Kawartha Lakes are a unique chain of lakes occupying a broad shallow valley running across the central part of Southern Ontario, known as the Trent Valley. The exact definition of the limits of the Kawartha Lakes can vary, from Lake Simcoe east to the scattered related lakes of Hastings County, and south to include Scugog and Rice Lakes. This description will confine itself, essentially, to those lakes lying along the main stream of the Trent River system from the top of the Indian and Otonabee Rivers, west and north to the abrupt rise in the river system at Norland just above Shadow Lake. Most, but not all, of these lakes have been linked up for navigation by the Trent-Severn Waterway (TSW), formerly called the Trent Valley Canal.

The name “Kawartha” is not a particularly old name for the area. It was originally “Kawatha” and the “r” has crept in over time, perhaps yielding a truly homebred name. It is apparently an Ojibwa name deliberately chosen for the area, and reportedly means “bright waters and happy lands” or other variations.

The lakes occupy an area with considerable exposed bedrock, which has largely ensured their existence and determined their shape and the means by which they interconnect. They lie approximately along the boundary between the Precambrian Shield to the north and the overlying Paleozoic sedimentary rock of the south, and this boundary often forms the southern edge of the lakes, especially in the east.

The lakes were largely the creation of a huge flood, and are the remnants of a late-glacial period spillway that discharged the drainage from a glacial-lake stage of the upper Great Lakes down this valley, washing the rock bare in places and creating scour pools, which today remain as the lakes. Sediments subsequently filled in much of the pools, leaving the current lakes relatively shallow. Multiple paths for the discharge of this great flood can be seen on topographic maps; each lake often had a second or third outlet to the next downstream lake. Aside from short, residual twin-outlets at places such as Bobcaygeon, Buckhorn and Burleigh Falls, today the only remaining vestige of this multi-pathed drainage system is in the Indian and Otonabee Rivers, both taking drainage from Stony Lake south to Rice Lake.

The 500 million year old Paleozoic limestone cap rock derived from the ancient Ordovician (a period between the Age of Trilobites and the Age of Fishes) Iapetus Ocean, is itself stepped back from its boundary with the Shield, revealing a series of subsequently deposited formations named for area locales. The Shadow Lake formation is the base layer of softer red and green shales and limestones in direct contact with the Shield, although it is not often exposed except in a few road cuts in the area. Above that is the hard grey-white Gull River formation, which, along with a similar hard layer in the bottom of the Bobcaygeon formation, forms the cap of much of the escarpment bordering the lakes. Above that layer are the dark grey or brown and more rubbley looking Bobcaygeon, Verulam and finally Lindsay formations that appear in smaller scarps to the south and border the southeast shore of Sturgeon Lake.

The glaciers and their runoff have created a distinct escarpment out of the edge of the limestone, and this escarpment is second only to the Niagara Escarpment in terms of height. It is often referred to as the Kawartha Escarpment, although this name does not appear to be in universal use. It is alternatively referred to as the Black River Escarpment, as the Black River, a tributary of the Severn River, follows the toe within that watershed. The Kawartha Escarpment is at least as beautiful as the Niagara, given the setting with scenic lakes at its foot, often containing islands and islets of Precambrian Shield rock.

Beneath this cap-rock is more Shield rock, which happens to have, in the western part of the area, a series of long parallel knobby ridges or spines that run in a diagonal northeast to southwest pattern. Where the limestone is thinner, especially under the lakes, these spines protrude through the limestone and/or lake water to create 'inliers' in the form of rounded rock hills or islands and shoals, well removed from the contiguous Shield country exposed farther north.

The section of the billion-year-old-plus Shield in the Kawartha Lakes area is referred to as the Central Metasedimentary Belt, which has its western limit more or less coinciding with the west edge of the Kawartha Lakes and tributaries. This rock is extremely diverse, composed of extensively metamorphosed rock derived from older plutonics (cold chunks of broken Shield), and more recent volcanics and sedimentary rocks such as limestone, now converted to marble. True granite is actually rare in this area, having been metamorphosed by heat and pressure, while buried deeper below the surface into other rocks, especially gneiss (*pronounced "nice"*).

The waters feeding the Kawartha Lakes vary in composition as a result of the diverse geology. Water draining from the northern Shield country is typically soft, low in nutrients and hardness. Generally it is not acidified, due to buffering by the limestone-metamorphosed-into-marble located there, although some smaller streams draining wetlands and having little buffering rock in their watersheds will be acidic. Water originating from the south, though, has considerable dissolved nutrients and minerals.

As these waters mix in the Kawartha Lakes, the water becomes moderately hard. This hardness reveals itself in a most beneficial way. During warm summer conditions, the extraction of dissolved carbon dioxide from the water due to warm surface water temperatures and photosynthesis by algae growing on shallow surfaces causes the calcium carbonate in the water to precipitate out as a whitish coating on rocks and shoals, making their existence highly visible to the boater in the high boating season.

The water of most of the lakes is stained somewhat from the abundant wetlands in the watershed, and the water can be quite dark brown in the spring runoff period. During the summer, especially very dry summers, when flows from the unregulated streams reduce to near nothing and limited source water is arriving from the upstream reservoir lakes, this colour fades until the water leaving the Kawartha Lakes is a more pure-water aqua blue, faintly visible in the frothing water below the dams.

Historically, the flow between these lakes ceased during dry summer weather, as evaporation off the Kawartha Lakes and off the lakes along its upstream tributary streams absorbed all available inflow, and then some. Lake levels would actually drop below the level of falls and rapids, leaving the connecting streams and rivers like the Otonabee or Indian high and dry.

In the spring, a different sort of problem arose. The vast watershed of the Trent upstream contributed an enormous amount of water and lake levels rose substantially, as all that water fought its way out of the connecting channels in a sort of aquatic traffic jam. Large amounts of low-lying land would flood around the lakes, until the spring runoff subsided. This was a particular problem for the early logging industry, which needed a substantial flow for an extended period of time in order to float their logs down the system. The lumber milling industry, too, needed a steady flow of water, but without significant flooding, to operate their mills. Navigation, especially important during this time, relied on relatively constantly high water levels for watercraft to operate.

These problems were solved with the creation of reservoirs on the upstream lakes on many of the tributary streams, and in particular, along the main stream of the Trent, called the Gull River from Balsam Lake upstream. This has allowed a strong summertime flow to be maintained along the Kawartha chain of lakes, and lake levels as well as river levels are maintained at more or less constant elevations throughout the summer.

In addition, all of the lakes along the main paths of the TSW were raised by damming, first by the milling or logging industry, and later by the Trent Canal, more or less up to their natural springtime high water mark or above, further facilitating navigation.

What we have today, as a legacy, is a most unnatural river system, in spite of initial appearances, with highly regulated flows and water levels, like nothing ever experienced in nature.

The effects of human settlement on the lakes have also been significant in increasing the amounts of nutrients reaching the waters. The southern agricultural areas have been cleared, and farming has resulted in vastly increased amounts of nutrients and soil washing off into the waters. Towns contribute stormwater runoff and sewage treatment plant discharges. The northern areas, once cleared by lumbermen, were then subject to frequent devastating fires and failed farming attempts that resulted in the wash off of almost all topsoil and mineral soils that once covered the vast rocky areas. This soil filled in a large number of smaller lakes, and has led to today's landscapes of barren rocky areas to the west of the Gull River Watershed, and the areas to the north of Pigeon Lake and eastward. Between the rock ridges there are now marshes or marshy lakes, and the higher rate of runoff from the rock, coupled with the marshes, increases the nutrients and organic colour discharged downstream. What is usually thought to be a "natural" landscape is actually far from it.

The streams feeding the lakes tend to produce an annual average flow of 1 cubic foot per second (cfs) per sq. mile of drainage basin[1], a little more coming from the Shield, a little less from the south, due to differences in rainfall, and opportunities for soil absorption for subsequent evapotranspiration. In the natural unregulated state, stream flow tends to reduce to about 1% of this average annual rate during dry

[1] The numbers in this discussion are usually in imperial units, because in these units there is a tidy numerical relationship between drainage areas and mean or minimum flows, as well as in lake surface area to evaporation rates. As well, lock and dam heights were always constructed in neat imperial units.

summer weather. Evaporation off the lakes amounts to about one-half inch per week, or about 2 cfs per square mile of surface area.

Fenelon Falls

Most of the lakes spill from one to another via short segments of river channels with minor drops of less than 12 feet (4 metres) controlled by the bedrock and now dams, but two larger cataracts exist at Fenelon Falls and Burleigh Falls. These drops are both 24 feet (7.3 metres) as modified by construction of the Trent-Severn Waterway. In fact, the TSW was undertaken largely as a result of the ideal waterway construction conditions provided by a chain of large lakes having such short connecting channels and modest elevation differences.

Perhaps appropriately, one of the falls is located on the Paleozoic limestone and produces the typical curtain effect in a graceful arc, due to a hard layer overlying softer layers, while the other is on the Precambrian Shield, and tumbles in a more random and chaotic fashion as dictated by the unyielding rock.

Burleigh falls

The cataracts effectively divide the lakes into 3 distinct regions, which we can define as Upper, Central, and Lower. Each region has characteristics distinct from the others, and to a large extent, like the lakes of Africa's Great Rift Valley, each lake is unique and distinct from the others as well. Each such section happens to contain 3 main basins or sheets of water, each of which may be comprised of a number of sub-basins, with the number three figuring prominently once again.

The vegetation in the area is unique as well, as southern species meet northern species, and many tree species from either range can be found growing side by side here. Southern species like Butternut, Red Cedar and White Oak are plentiful along the Kawartha Lakes, but cannot be found more than a few kilometers north.

Kevin Walters, B.A.Sc., P.Eng., is a KLSA Board member and an engineer at Dillon Consulting in Toronto. This essay is part of a larger document he has been researching and writing for some time on the physical history of the Kawartha Lakes.

# Phosphorus Testing

by Kathleen Mackenzie

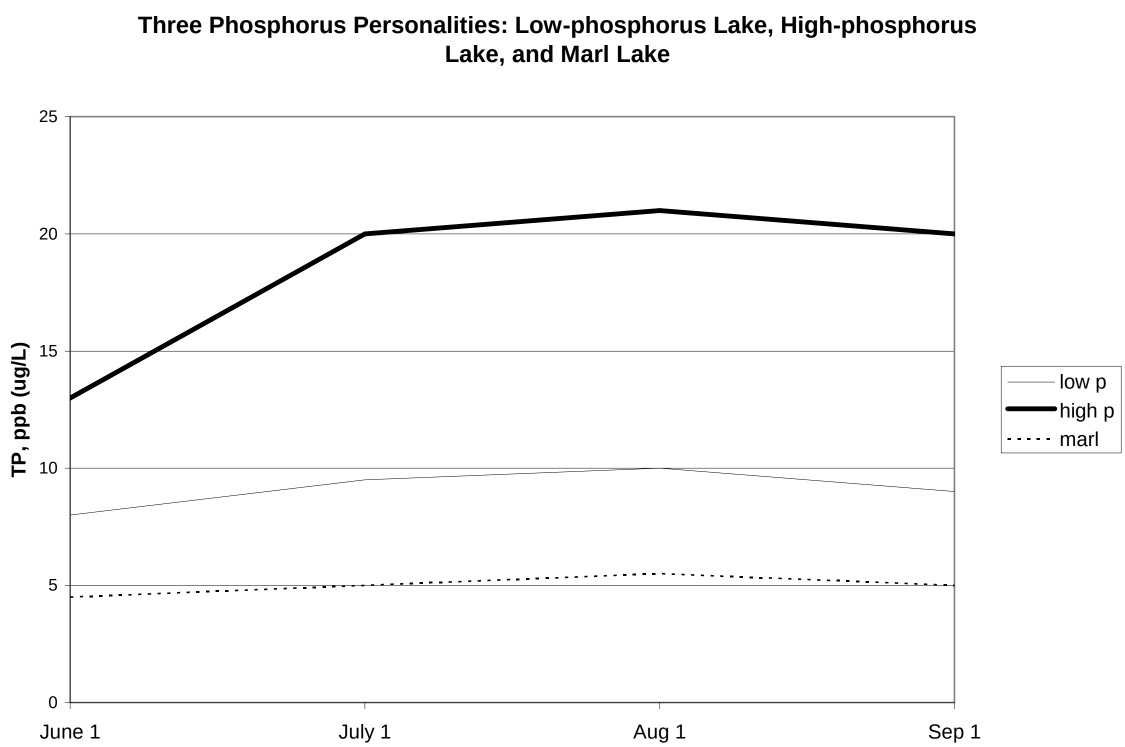
Phosphorus is an important nutrient for our lakes, but excess phosphorus can make a lake murky and accelerate the formation of thick, rich sediments. This is why KLSA volunteers, and hundreds of others throughout Ontario, monitor phosphorus by annually submitting samples of lake water to be analyzed through the Ontario Ministry of the Environment's Lake Partner Program (www.ene.gov.on.ca/envision/water/lake_partner/).

## Three different "phosphorus personalities"

In 2006, KLSA volunteers measured phosphorus 6 times, from mid-May to early October, at 41 sites on 16 lakes. As in the past, we found the lakes had 3 distinct phosphorus "personalities":

- *Low-phosphorus lakes* receive water mostly from the north, and then flow *into* the Trent-Severn Waterway. Northern water flows from low-phosphorus Canadian Shield regions. Phosphorus levels in these lakes remain below 10 ppb throughout the summer;
- *High-phosphorus lakes* receive much of their water from the main Waterway flow, and also from inflows coming from the south. Southern inflows drain from land covered in limestone and glacial till, rocks and soil that are higher in phosphorus. Also, lands south of the Kawartha Lakes tend to have more farms and more urban areas, both sources of high-phosphorus runoff. These lakes have levels around 10 ppb in the spring, but this rises to over 15 ppb during the summer;
- *Marl lakes* have a specific chemistry that keeps phosphorus levels near 5 ppb from spring to fall (see discussion on marl lakes in KLSA report 2005). These lakes receive drainage from a calcium carbonate-rich watershed. During parts of the summer, calcium carbonate precipitates out of the water and phosphorus co-precipitates, keeping phosphorus levels very low. The name of this powdery precipitate is *marl*. Sandy Lake could be considered a "classic" marl lake. It has a typical milky appearance during the summer due to suspended marl precipitate and powdery marl sediments. Some KLSA lakes such as Chemong and the south ends of Pigeon and Sturgeon Lake also exhibit marl-type sediments. However, their lake water has much higher phosphorus levels than those seen in Sandy Lake. Is this due to higher phosphorus inputs or due to less marl precipitation than in Sandy Lake? At this point, it is very difficult

to estimate how much phosphorus is being removed from our lakes through marl precipitation, but it is probably a significant amount in certain areas.




## Changing as we flow: phosphorus levels vary from lake to lake

As the water flows downstream from Balsam to Katchewanooka Lake (see graphs "Low-phosphorus Lakes", "Upstream Lakes", "Midstream Lakes", "Downstream Lakes"), we see phosphorus levels gradually change. The two main conclusions we can draw from these graphs are:

- The phosphorus level rises as water flows downstream from Balsam to Lovesick. It then drops somewhat in Stony Lake due to low-phosphorus water flowing in from Upper Stoney Lake, rising again slightly in Clear and Katchewanooka;
- Shallow areas of the lakes (south end of Pigeon and Sturgeon, around Nogie's Creek, South Bay on Upper Stoney, south end of Chemong), which are usually surrounded by wetland regions, tend to have higher phosphorus levels. Is this due to rich sediments, or to input from nearby agricultural lands or wetlands, high concentrations of wildlife on and near the water, or some other cause?

If we take a more detailed look at lake-to-lake phosphorus levels, we can see some predictable results, and some interesting anomalies.

*Balsam Lake: low phosphorus water at the north end, high at the south end*

- Very low-phosphorus water flowing in from the north keeps phosphorus levels below 10 ppb at Lightning Point throughout the summer.
- At the south end of the lake, Killarney Bay, phosphorus levels are much higher during July and August. Might this be due to high-phosphorus drainage from the south? Alternately, might the phosphorus be leaching from sediments in this relatively shallow area?

*Cameron Lake: similar to Balsam Lake*

- Levels are very similar to the north Balsam levels, showing little influence from the south Balsam water, likely due to dilution by the inflowing Burnt River from the north.

*Sturgeon Lake: levels rise as water flows through; high phosphorus at south end*

- Sturgeon Lake is 'Y' shaped, and the north leg receives its water from Cameron Lake, while the south leg receives much of its water from the Scugog River. The east leg is a mixture of both. The "Cameron E end" and "Sturgeon S of Fenelon River" are very close, but phosphorus rises as the water flows downstream. This may be due to higher phosphorus inputs from south Sturgeon, represented by Snug Harbour. Are the higher phosphorus readings at Snug Harbour due to phosphorus flowing in from the south, or due to the shallower water underlain by phosphorus-rich sediments, or some combination of both?

*Big Bald Lake: a feeder lake for the Waterway*

- It is interesting to see that the phosphorus levels in Big Bald Lake are about 5 ppb below those of its neighbour, Pigeon Lake. There are no stream inflows from the north into Bald Lake (see report on the Mississagua diversion p. 54) , so it is likely that it is fed by relatively low-phosphorus springs, and that Big Bald water flows *into* the Waterway.

*Pigeon Lake: high and low phosphorus from the north; phosphorus levels don't change*

- The water flowing through Pigeon Lake has phosphorus levels very similar to Sturgeon Lake. There are 2 inflows into Pigeon Lake from the north, Little and Big Bald Lakes and Nogie's Creek. It is interesting to compare the phosphorus levels of these two inflows. Big Bald's water averages about 12 ppb, while Nogie's Creek water, measured at Bottom Island, averages about 18 ppb. Why? It may be because Nogie's Creek is a slow-moving creek, draining an area with many wetlands, which are often a source of phosphorus, whereas Big Bald Lake has low-phosphorus water. (See paragraph above.) Pigeon Lake also collects water from the south via the Pigeon River.

*Buckhorn Lake and Lower Buckhorn Lake: phosphorus levels rise*

- Phosphorus levels in Buckhorn Lake and Lower Buckhorn Lake are 3 to 4 ppb higher than in Pigeon Lake.

*Chemong Lake: low in the north, high in the south*

- Chemong Lake is a "dead-end" lake connected to the Trent-Severn Waterway and divided into two lakes by a causeway. At certain times of the year Chemong flows into the TSW; at other times, TSW water flows into Chemong; that is, the flow between Buckhorn Lake and Chemong Lake changes direction periodically during the year. The two points measured on Chemong Lake had very different phosphorus levels. Poplar Point is a new testing site in 2006. It is near the middle of the lake, just south of the channel to Buckhorn. Its phosphorus levels were below 15 ppb throughout the summer. Levels actually dropped a bit in July and August and were slightly higher at the beginning and end of the season, which is most unusual for one of the TSW lakes. There is no obvious reason for the low July and August readings. Perhaps it is connected to calcium carbonate (marl) precipitation, known to reduce phosphorus in the summer. The other point, "S. end deep spot", is in a narrow bay at the southern tip of the lake. It is very shallow in this bay, the "deep spot" being only about 2 m. There is little circulation, it is shallow, the shore is densely populated with homes, and a stream runs into the end of the bay from farmland. All of these factors may contribute to the higher phosphorus readings.

*Lower Buckhorn and Lovesick Lakes: phosphorus levels rise*

- Lower Buckhorn Lake and Lovesick Lake share the same lake basin; the water from Lower Buckhorn spills into Lovesick over a chain of dams linking islands that separate the two lakes. Lower Buckhorn collects low phosphorus water from the Mississagua River but in spite of this, phosphorus levels rise slightly. As in previous years, the phosphorus readings in Lovesick Lake are somewhat higher than in Buckhorn and Lower Buckhorn.

*Stony and Upper Stoney: phosphorus levels drop*

- Up to this point, the water flowing downstream has seen gradually increasing phosphorus levels. However, this trend reverses in Stony Lake, which has mid-summer phosphorus levels about 8 ppb lower than Lovesick Lake. This is almost certainly due to water flowing into Stony Lake from Upper Stoney. Upper Stoney receives all of its water from the north through Eel's Creek and Jack's Creek. This low-phosphorus water then flows into Stony Lake, lowering phosphorus levels. South Bay in Upper Stoney has somewhat higher phosphorus levels, as it is shallow and has fairly low circulation.

*Clear and Katchewanooka: phosphorus levels rise slightly*

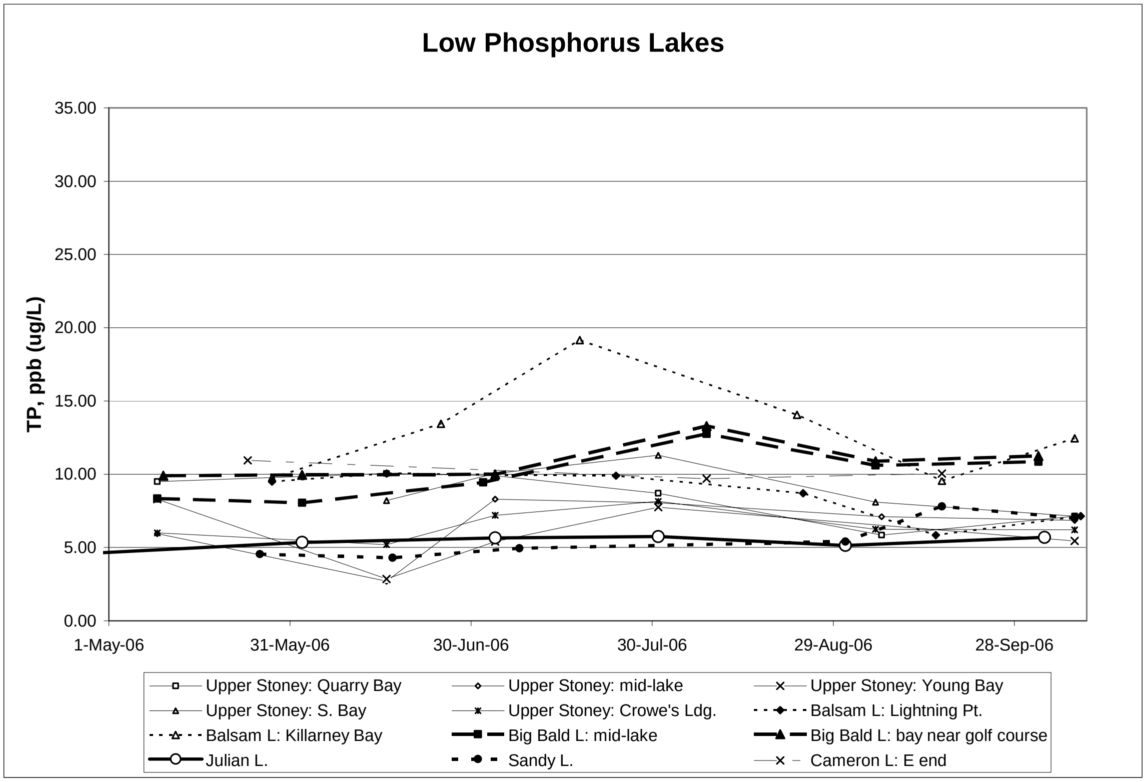
- As the water flows through the last of the chain of Kawartha Lakes, levels increase slightly in Clear Lake and again in Katchewanooka Lake.

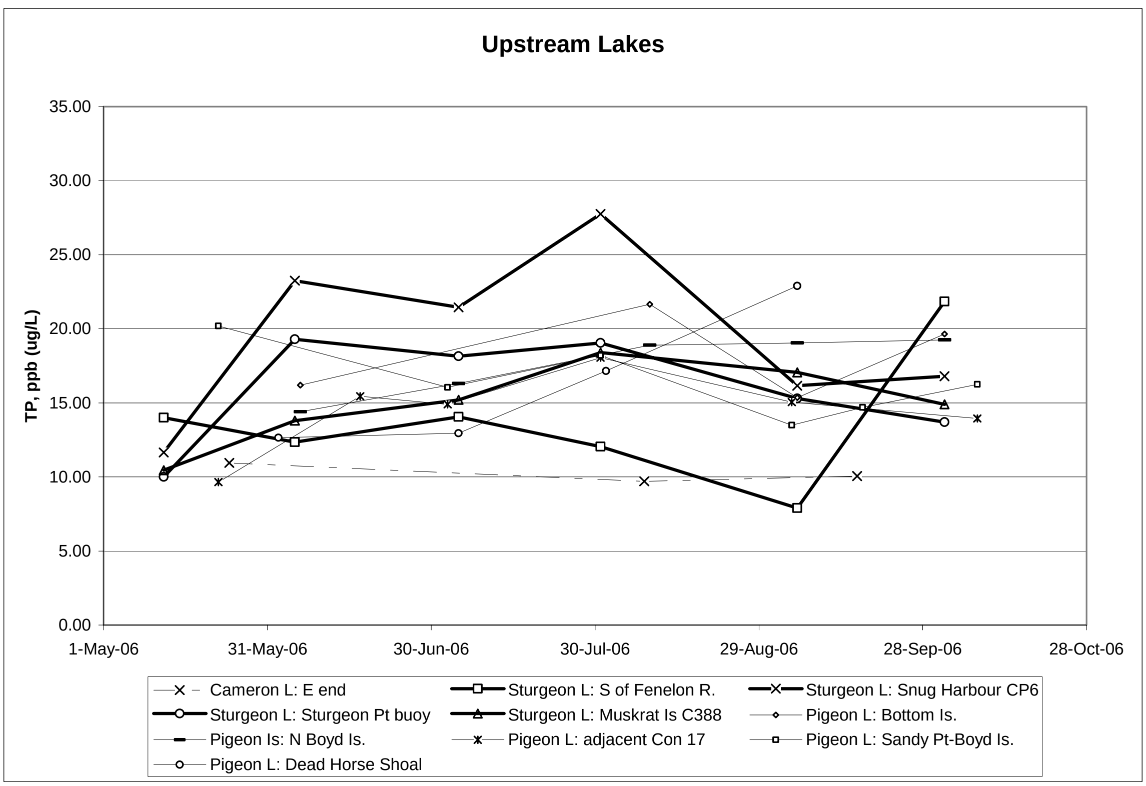
*White Lake: inexplicably low phosphorus levels*

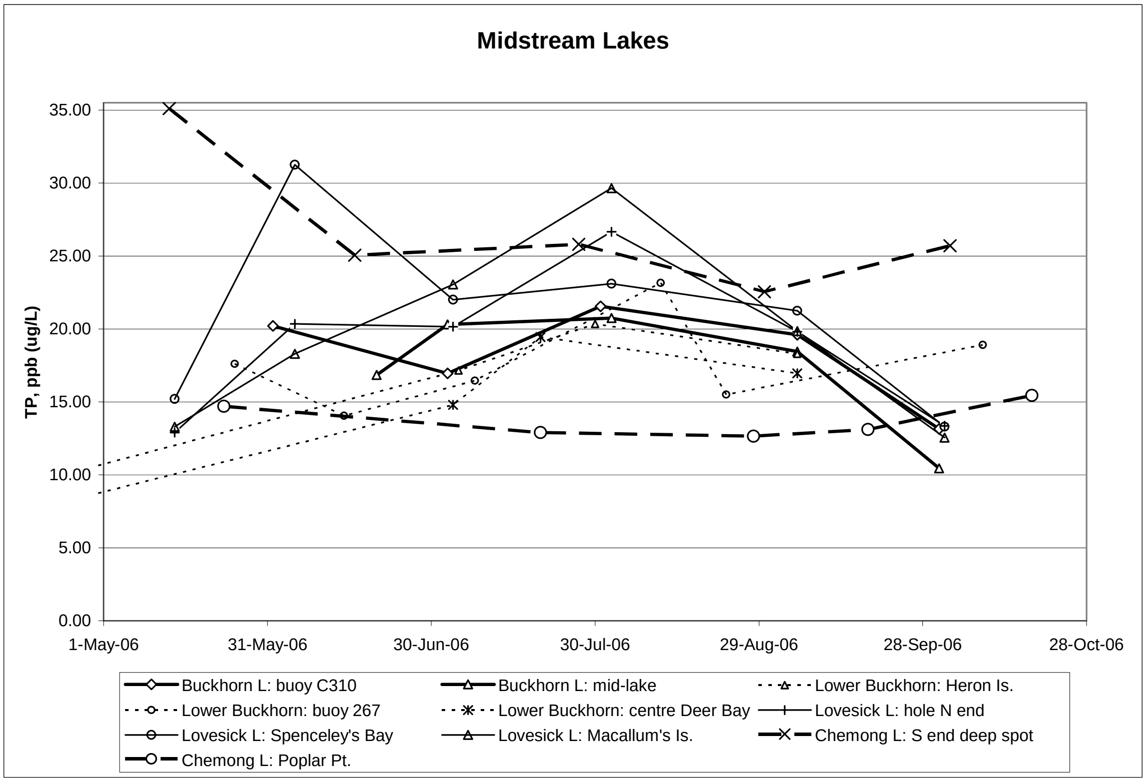
- White Lake receives its water directly from Gilchrist Bay in Stony Lake. One would expect phosphorus levels to rise in White Lake because it is shallow and fairly silty with a very developed shoreline. However, for the third year in a row, White Lake has phosphorus levels below those of Gilchrist Bay. Interestingly, for three years now phosphorus levels have dropped between July 1 and August 1, a trend not observed over several years on any other KLSA lake. What keeps phosphorus levels low in White Lake?

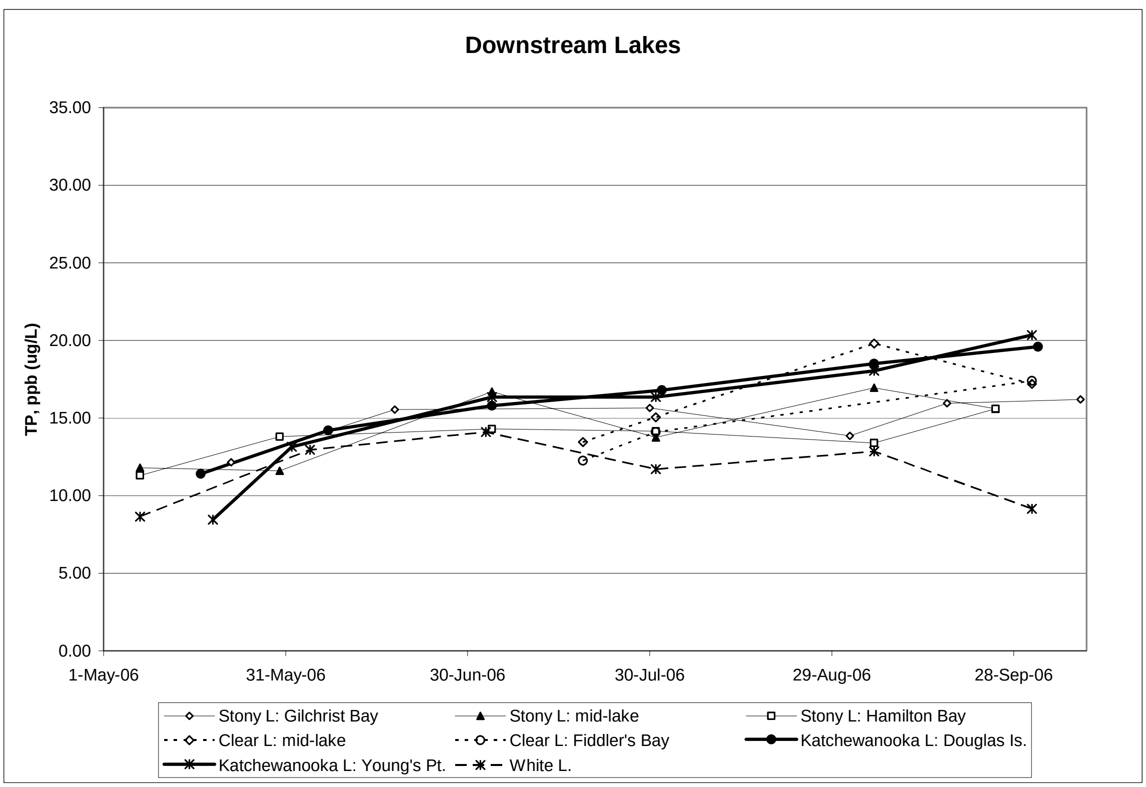
*Sandy Lake and Julian Lake: marl lakes*

- Both these lakes have extremely low phosphorus levels. This is probably due to inputs from relatively low-phosphorus spring water and a characteristic chemistry that leaches phosphorus out of the lake and binds it into the sediments. For a more thorough discussion, please see KLSA Report 2005.


Low Phosphorus Lakes
TP, ppb (ug/L)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1-May-06
31-May-06
30-Jun-06
30-Jul-06
29-Aug-06
28-Sep-06
Upper Stoney: Quarry Bay
Upper Stoney: mid-lake
Upper Stoney: Young Bay
Upper Stoney: S. Bay
Upper Stoney: Crowe's Ldg.
Balsam L: Lightning Pt.
Balsam L: Killarney Bay
Big Bald L: mid-lake
Big Bald L: bay near golf course
Julian L.
Sandy L.
Cameron L: E end


Upstream Lakes
TP, ppb (ug/L)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1-May-06
31-May-06
30-Jun-06
30-Jul-06
29-Aug-06
28-Sep-06
28-Oct-06
Cameron L: E end
Sturgeon L: S of Fenelon R.
Sturgeon L: Snug Harbour CP6
Sturgeon L: Sturgeon Pt buoy
Sturgeon L: Muskrat Is C388
Pigeon L: Bottom Is.
Pigeon Is: N Boyd Is.
Pigeon L: adjacent Con 17
Pigeon L: Sandy Pt-Boyd Is.
Pigeon L: Dead Horse Shoal


Midstream Lakes
TP, ppb (ug/L)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1-May-06
31-May-06
30-Jun-06
30-Jul-06
29-Aug-06
28-Sep-06
28-Oct-06
Buckhorn L: buoy C310
Buckhorn L: mid-lake
Lower Buckhorn: Heron Is.
Lower Buckhorn: buoy 267
Lower Buckhorn: centre Deer Bay
Lovesick L: hole N end
Lovesick L: Spenceley's Bay
Lovesick L: Macallum's Is.
Chemong L: S end deep spot
Chemong L: Poplar Pt.


Downstream Lakes
TP, ppb (ug/L)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1-May-06
31-May-06
30-Jun-06
30-Jul-06
29-Aug-06
28-Sep-06
Stony L: Gilchrist Bay
Stony L: mid-lake
Stony L: Hamilton Bay
Clear L: mid-lake
Clear L: Fiddler's Bay
Katchewanooka L: Douglas Is.
Katchewanooka L: Young's Pt.
White L.

## The high flow/low phosphorus theory: let's look again

Most of the KLSA lakes, and the ones we are most concerned about, are high-phosphorus lakes. They start the season with phosphorus levels between 12 and 16 ppb (see graph below, "Phosphorus Levels, over 5 Years"). Levels climb to between 15 and 19 ppb around July 1, and to 17 and 23 ppb by August 1, at which point they level out. (Note: these are the average readings for a number of lakes; some of these lakes have readings much higher.)

Why are spring levels so low, and where does the mid-summer phosphorus come from?

Looking at the "Flow vs Phosphorus" graphs (below), one might conclude that low spring phosphorus is a result of the "spring freshet", which pours meltwater and spring rainwater into the Trent-Severn Waterway in May and June. Most of the freshet water is from the north, which is the larger part of our watershed. This northern Canadian Shield drainage water never exceeds 10 ppb, even in mid-summer, e.g., Balsam Lake, Lightning Point.

The average time that water remains in a lake before it flows out is called the "flushing period". During the months of May and June, the flushing period for our lakes is just a few weeks. So, in the spring, the Kawartha Lakes are "flushed out", possibly several times, with low-phosphorus freshet water.

In 2004, there was a large pulse of water that went through the Waterway in July (this was the year of the Peterborough flood, and the whole watershed experienced a wet July). We noticed that 2004 phosphorus levels were generally lower than in the previous two years, and concluded that the extra water flowing through the system was responsible, i.e.:

high flow → low phosphorus

However, the idea of high flow/low phosphorus doesn't seem to be bearing up under additional years of data. If it were true, then:

- One would have expected the huge 2002 freshet to have resulted in extremely low July readings for that year. Why didn't it?
- One would have expected generally lower water flows in 2005 and 2006 to have resulted in high phosphorus years, but these were the second- and third-lowest years for phosphorus. Why?

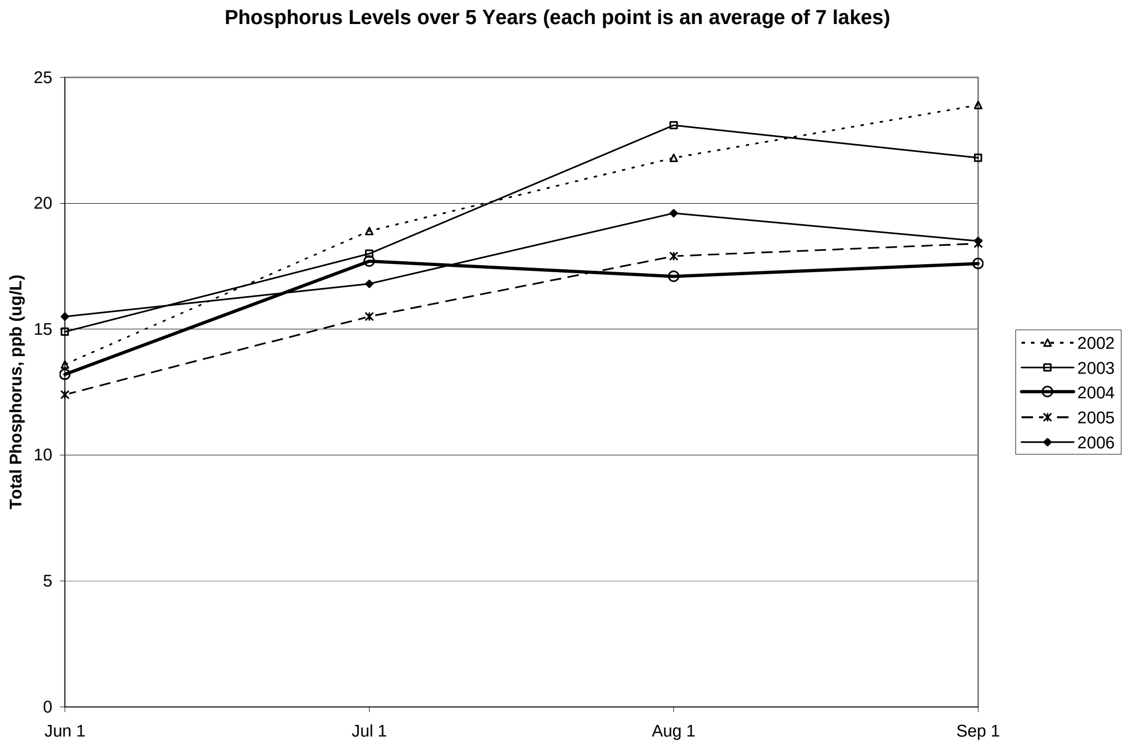
In fact, the more one looks at the "Flow vs Phosphorus" graphs, the less correlation one sees between flow and phosphorus, apart from the time of the spring freshet.

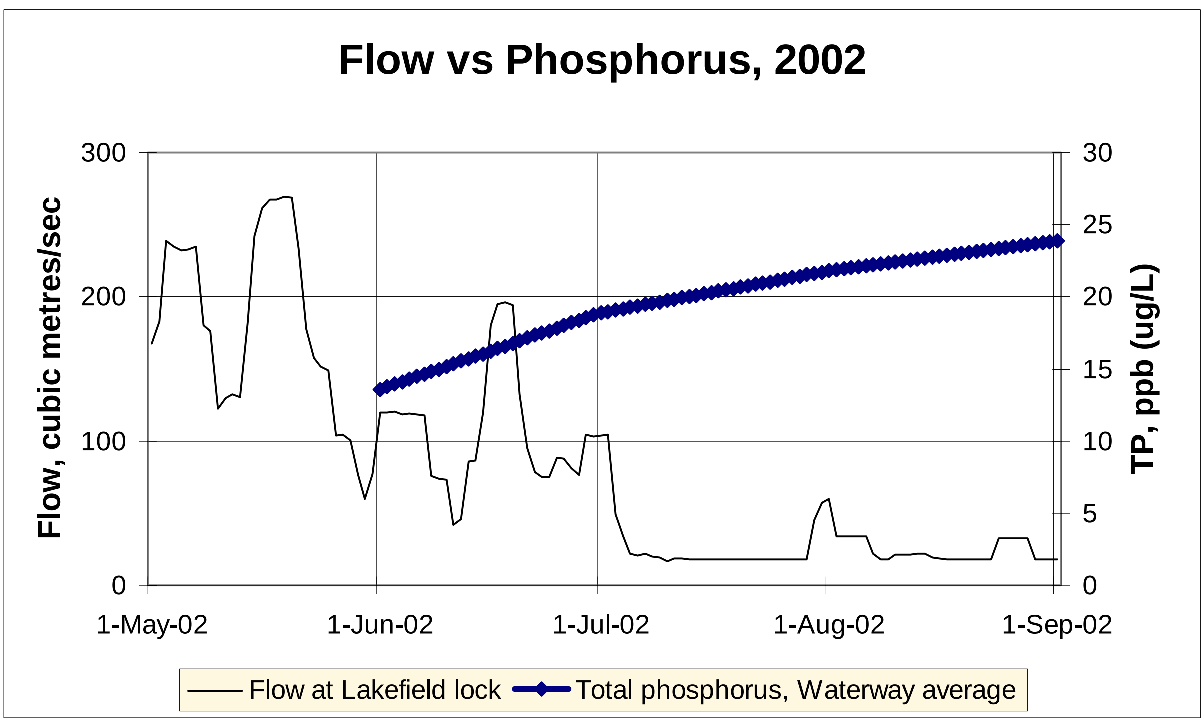
KLSA continues to believe that the spring freshet is probably the main contributor to low phosphorus levels in the spring. However, many variations in spring and summer phosphorus levels do NOT correlate with flow. Other factors must be involved. But what are they?

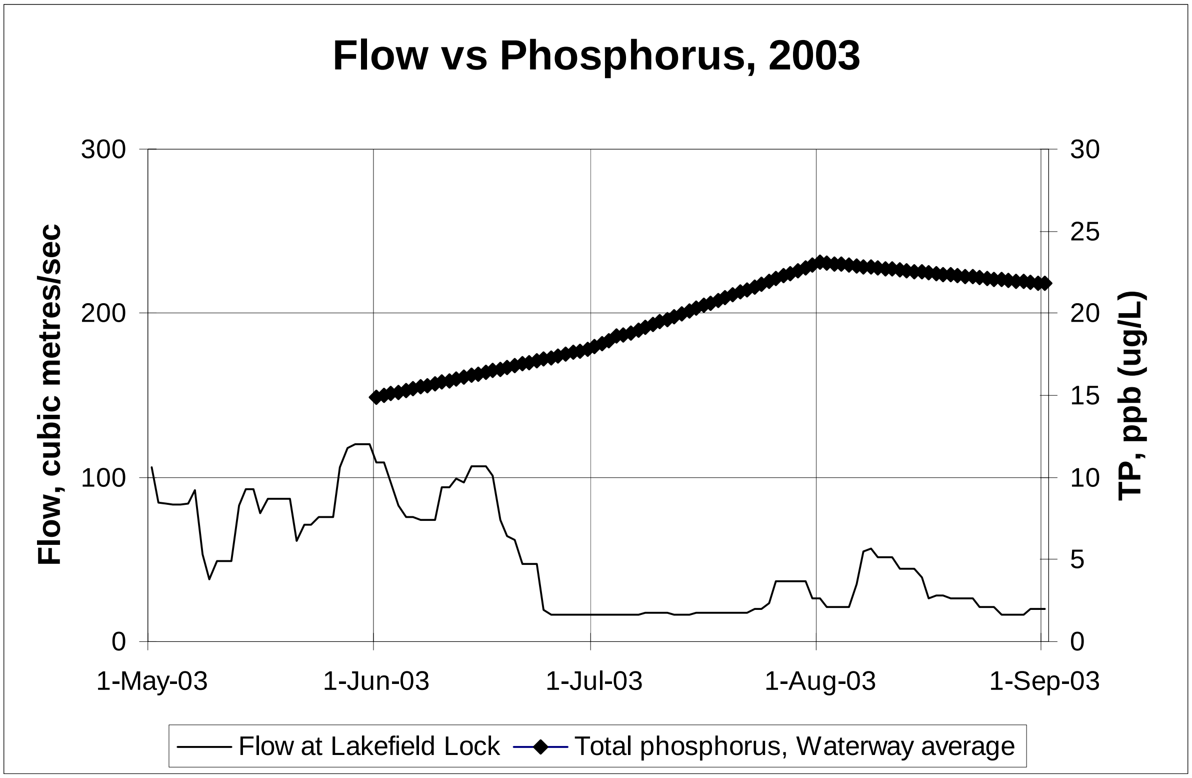
- Biological activities in the lake (absorption and release of phosphorus by plants and animals)?
- Absorption into or release from sediments?
- Seasonal inputs from runoff?
- STP discharges?

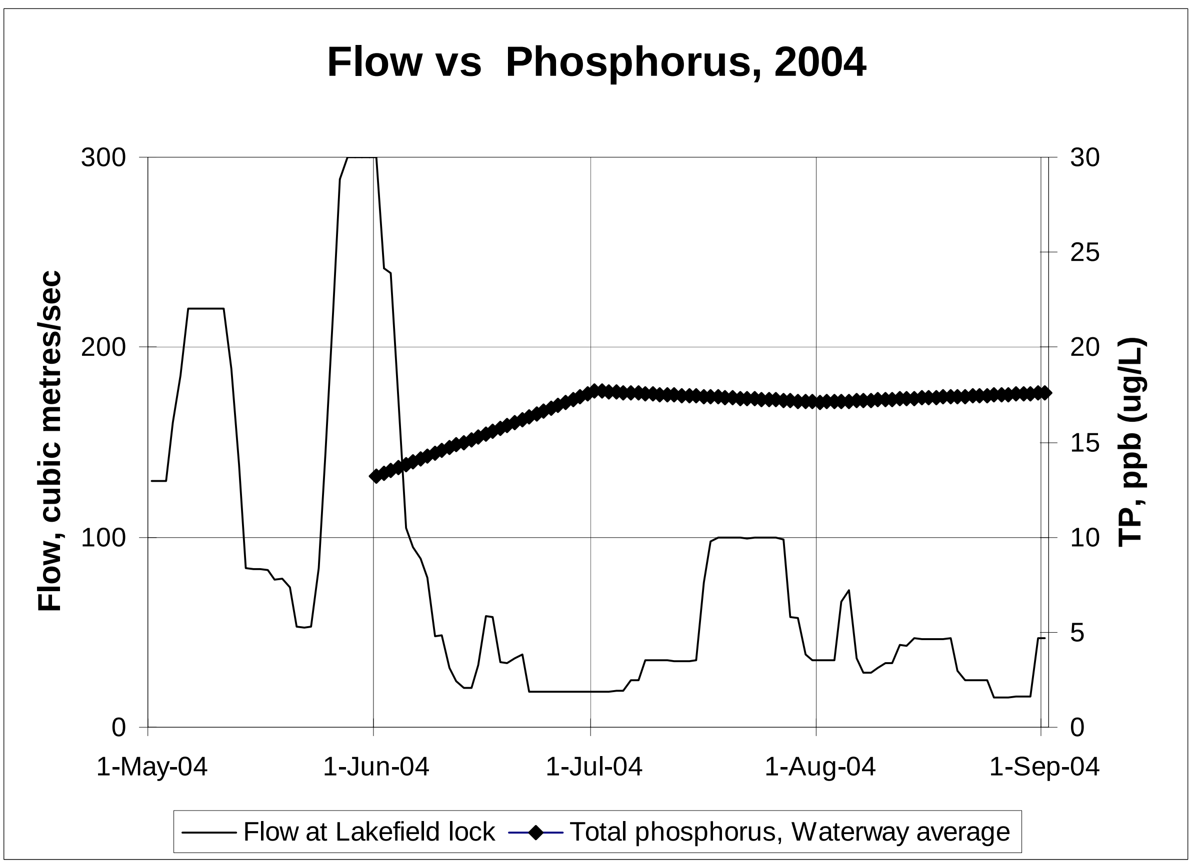
At this point, these are only hypotheses, and KLSA continues to work towards finding sources of phosphorus, both through our own monitoring efforts and through research with students and senior scientists.

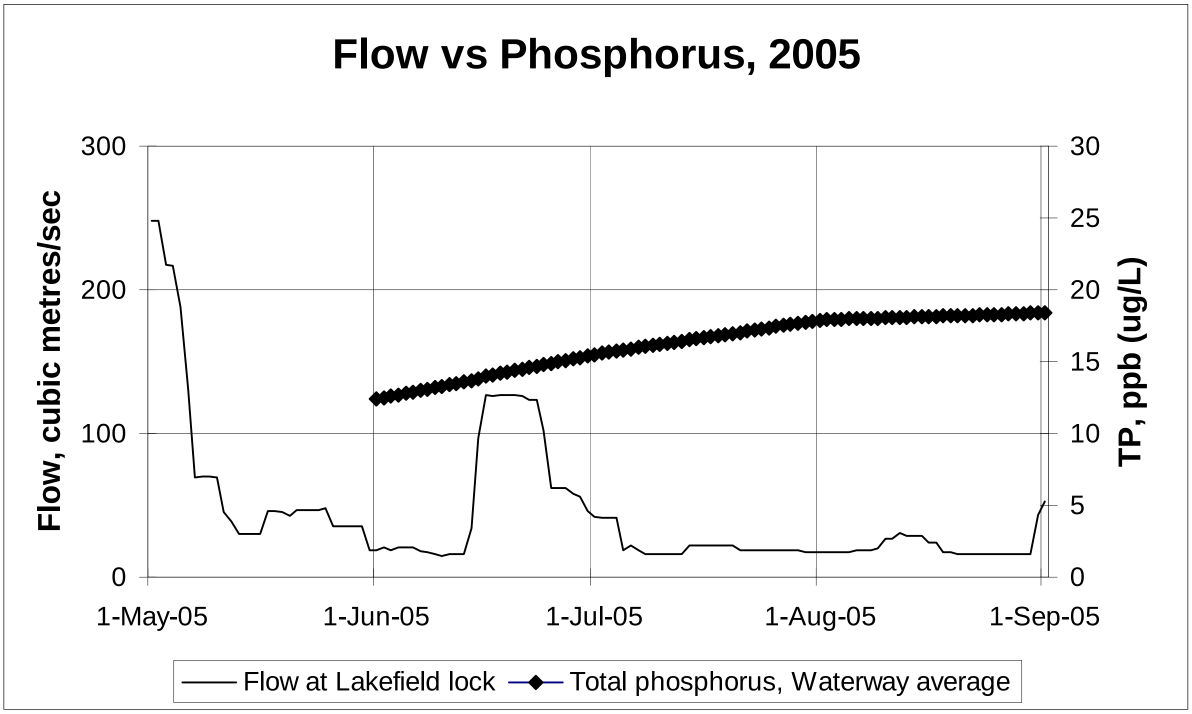
Farmland by the Otonabee River, south of Lakefield
(foam from suspended organics forms below dams)

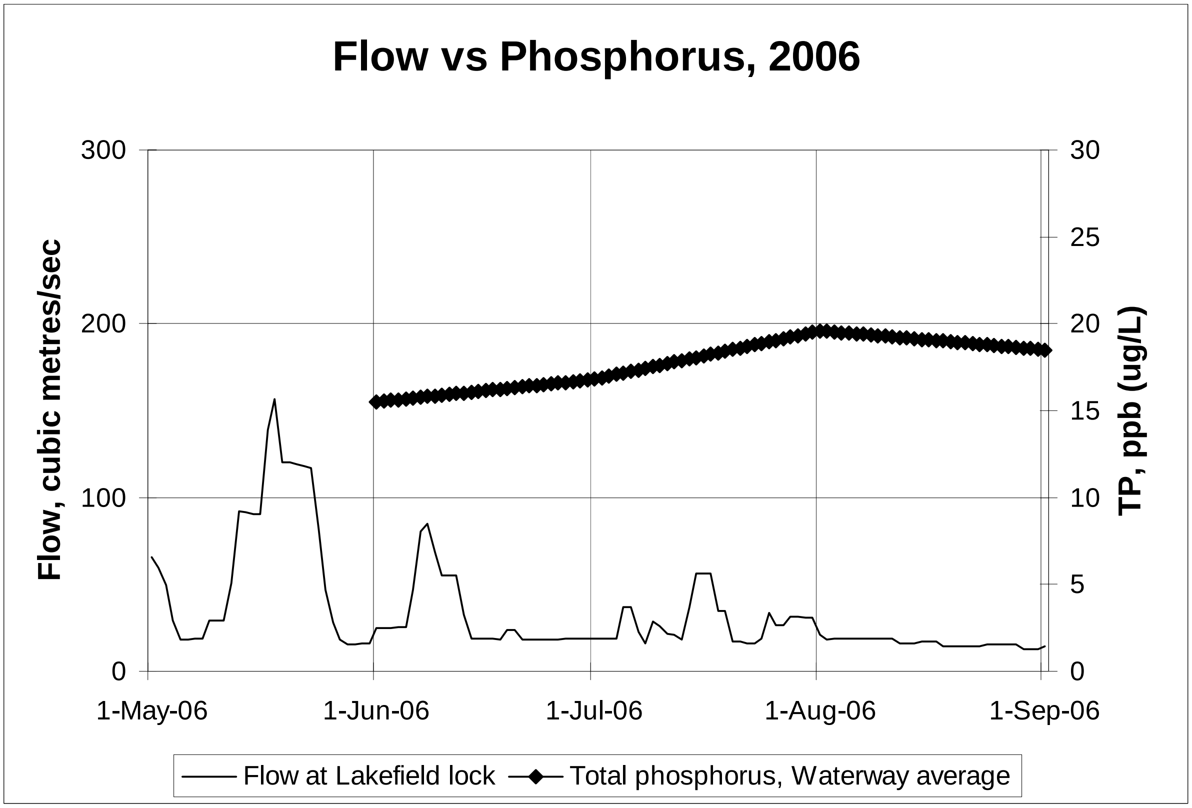

Phosphorus Levels over 5 Years (each point is an average of 7 lakes)
Total Phosphorus, ppb (ug/L)
25
20
15
10
5
0
Jun 1
Jul 1
Aug 1
Sep 1
2002
2003
2004
2005
2006


Flow vs Phosphorus, 2002
Flow, cubic metres/sec
300
200
100
0
30
25
20
15
10
5
0
TP, ppb (ug/L)
1-May-02
1-Jun-02
1-Jul-02
1-Aug-02
1-Sep-02
Flow at Lakefield lock
Total phosphorus, Waterway average


Flow vs Phosphorus, 2003
Flow, cubic metres/sec
TP, ppb (ug/L)
300
200
100
0
30
25
20
15
10
5
0
1-May-03
1-Jun-03
1-Jul-03
1-Aug-03
1-Sep-03
Flow at Lakefield Lock
Total phosphorus, Waterway average


Flow vs Phosphorus, 2004
Flow, cubic metres/sec
TP, ppb (ug/L)
300
200
100
0
30
25
20
15
10
5
0
1-May-04
1-Jun-04
1-Jul-04
1-Aug-04
1-Sep-04
Flow at Lakefield lock
Total phosphorus, Waterway average


Flow vs Phosphorus, 2005
Flow, cubic metres/sec
TP, ppb (ug/L)
300
200
100
0
30
25
20
15
10
5
0
1-May-05
1-Jun-05
1-Jul-05
1-Aug-05
1-Sep-05
Flow at Lakefield lock
Total phosphorus, Waterway average


Flow vs Phosphorus, 2006
Flow, cubic metres/sec
TP, ppb (ug/L)
300
200
100
0
30
25
20
15
10
5
0
1-May-06
1-Jun-06
1-Jul-06
1-Aug-06
1-Sep-06
Flow at Lakefield lock
Total phosphorus, Waterway average

# How Much Phosphorus Enters the Kawartha Lakes from Sewage Treatment Plants?

by Kevin Walters

In 2006, students at Sir Sandford Fleming College, under the supervision of faculty member Sara Kelly, prepared a report for KLSA analyzing the phosphorus discharges in the effluents from six sewage treatment plants (STPs) discharging to the upper and central Kawartha Lakes. The students, Jenny Harmathy, Amber-Lee DeVries and Laura Harris, received a course credit for their work, and KLSA received valuable information.

The STPs studied were those at Coboconk, Fenelon Falls, Port Perry, Lindsay, Omemee and Bobcaygeon. There are two additional plants upstream in the watershed, at Haliburton and Minden, but they are considered too far upstream to have much impact on the Kawartha Lakes. Also, because their receiving bodies are considered to be more sensitive to nutrients, the certificates of approval for these plants require a higher quality effluent.

In last year's KLSA report, we outlined the methodology of the Sir Sandford Fleming College study. Here we summarize and interpret the results of the students' completed report.

The six plants under consideration discharge varying amounts of phosphorus depending on the size of the town served, the treatment capacity of the plant (or lagoons in some cases) and the treatment effectiveness at any given time. The time period reviewed by the report is from 2000 to 2005, although data for the earlier years are lacking in certain cases.

It is known that phosphorus discharges in past decades were very high, prior to the introduction of both phosphorus removal facilities and phosphate reductions in detergents. While phosphorus discharges have decreased substantially since the 1970s, the population of certain towns served by these facilities has been increasing, leading again to increased loadings to the lakes.

Many other sources of phosphorus to the lakes contribute primarily during the spring and fall periods (including septic systems), when surface and groundwater flows are higher and when dilution and flushing then ameliorate the phosphorus concentrations. The sewage treatment plants, on the other hand, contribute on a more or less constant and steady basis, leading to a higher impact in the drier summer months. It may be surprising that we believe that septic systems mainly contribute outside of the summer season when they are less used, but it is expected that the effluent from them is primarily immobilized in the summer due to uptake by vegetation, especially trees, and by the high evapotranspiration occurring in summer. As a result, there is little subsurface groundwater flow to area streams and lakes, until soil moisture again reaches saturation in the fall.

An analysis of the contribution of phosphorus from the area STPs in the summer indicates that about 15% of the phosphorus entering Pigeon Lake from Sturgeon Lake in the low-flow summertime period is from the combined discharges of Lindsay, Fenelon Falls and Bobcaygeon. This assumes no contribution from the Scugog River (which typically provides no flow other than that coming through the locks in the summer), and a base water quality in Sturgeon Lake equivalent to that of the incoming Fenelon River, which brings most of the water into Sturgeon.

Of the six plants, Omemee discharges its effluent primarily or entirely as land irrigation, presumably leading to far lesser impacts on the receiving waters, the Pigeon River and Pigeon Lake. This plant contributes phosphorus more like agricultural runoff than a direct discharge.

Coboconk discharges its effluent to the Gull River and thus Balsam Lake on a seasonal discharge basis, i.e., not in the summer months. Furthermore, due to the size of the facility and fairly high rate of phosphorus removal, it has relatively little impact on the lakes. Coboconk discharges approximately .03 kg per day of phosphorus on an annualized basis, although, as stated, there is no summer discharge. Phosphorus discharges have increased steadily and significantly over the past 5 years however.

While the Port Perry plant, like Coboconk, discharges on a seasonal basis, its volume, coupled with its loadings and minimal dilution, makes it significant. This and the other 3 plants therefore have the greatest effect on the lakes in summer; they also contribute more phosphorus and on a more continuous basis. They can be expected to have a measurable or noticeable impact on water quality in the Kawarthas.

Below are the phosphorus contributions recorded for these plants. The numbers represent a 3-year average of the last 3 years of data:

Lindsay: 1.6 kg/day
Port Perry: 0.8 kg/day
Fenelon Falls: 0.17 kg/day
Bobcaygeon: 0.5 kg/day

The total for the 4 plants is thus about 3.1 kg/day. This is roughly equivalent to the effect that we might expect were 1000 cottages discharging their sewage directly to the lake, and so, while a great deal of phosphorus is being removed at the sewage treatment plants, a great deal is still being discharged.

The Lindsay plant has shown a steady increase in phosphorus discharges, save for a big increase in 2004 followed by a small reduction in 2005. Since 2001, phosphorus discharges have increased by 75%. Overall, given the size of the town served, the discharges are not excessive, although the increasing amounts are cause for concern. Lindsay is experiencing growth pressures; we should be very concerned about growth without further improvements in phosphorus removal.

Port Perry uses lagoons discharging to the Nonquon River, which drains to Lake Scugog. These are seasonal-discharge lagoons. However, the flow rate through Lake Scugog is far less than in the other Kawartha Lakes, and therefore the seasonality aspect has less benefit. Port Perry's discharges have increased 62% since 2002. Foul-looking and -smelling discharges to the Nonquon River have been observed. Given the very poor water quality seen in western Lake Scugog, it is likely that the Nonquon lagoons are a significant source of phosphorus pollution, and require upgrading. Sewage lagoons are an archaic method of sewage treatment and a modern plant along with seasonal holding facilities would be a far better treatment method.

Bobcaygeon has, conversely, seen no increase in phosphorus discharges over the past 5 years, and in fact, save for 2003, it has seen a slight reduction. 2005 values were 22% lower than in 2000. However, given the small population served, the discharges are higher than desirable. The effect of the higher discharges of phosphorus was evident in 2003, when levels matched those in Port Perry. In that summer, pea-soup conditions were observed stretching across Pigeon Lake from Bobcaygeon to Big Island, and algae coated the rocks on the shores. Water in Sturgeon Lake upstream exhibited far better quality. It is hoped that we will continue to see further annual reductions in phosphorus discharges from this plant, and if not, it may be overdue for major upgrading.

Fenelon Falls has similarly exhibited a downward trend in phosphorus discharges, 2005 being down 37% from 2000. It is hoped that this trend continues.

Sewage treatment plant discharges are likely the most controllable large source of phosphorus to our lakes. KLSA should continue to monitor the phosphorus discharges from the STPs and press for improvements when and where warranted.

Upper Stoney Lake

**Phosphorus and the Kawartha Lakes:**
Land Use, Lake Morphology and Phosphorus Loading
by Michael White

The following document was prepared for the Kawartha Lake Stewards Association to address concerns over possible elevated phosphorus concentrations in the Kawartha Lakes. The project was undertaken by Michael White, Ph.D. candidate in the Watershed Ecosystems Graduate Program (WEGP) at Trent University, Peterborough, in partial fulfillment of a reading course requirement supervised by Dr. Marguerite Xenopoulos.

Editor's Note: *In the 2005 KLSA report,* Weeding Out the Answers, *Michael White introduced his study of sources of phosphorus in the Kawartha Lakes. The section (most of Chapter 1) included in the 2005 report described the problem of nutrient enrichment of the lakes, primarily from human-induced sources, and the resulting turbidity due to algae growth. The full study addressed the following questions:*

1. *What are the land use characteristics of the Kawartha Lakes watersheds?*
2. *Is land use correlated with phosphorus concentrations in lakes within the Kawartha Lakes watershed?*
3. *What lake morphological variables are correlated with phosphorus concentrations?*
4. *Have phosphorus levels been increasing or decreasing in the lakes within the Kawartha Lakes watershed?*
5. *What patterns in lake phosphorus concentrations can be determined from the archived data?*

*Excerpts of Chapters 2-6 of Michael White's report are included here. The full report can be accessed at the Oliver Ecological Centre website: www.trentu.ca/olivercentre.*

## Chapter 2: Watershed land classification and delineation

The first step in determining land use relationships with lake phosphorus concentrations is establishing where and what kinds of land use are prevalent. This chapter is devoted to determining both the quantity and location of quaternary (MNR's most detailed watershed delineation) watersheds, and the land use within each.

Ontario's Natural Resources and Values Information System (NRVIS) database (MNR, 2002) and the Water Resources and Information Project (WRIP) (MNR, 2006) were utilized to acquire land class information and watershed delineations. These data were then overlaid and analysed using ArcMap® to determine watershed boundaries and the land uses within them.

It was found that the Kawartha Lakes watershed (8,990 $km^2$) consists of 31 quaternary watersheds. As seen in Figure 2.1, of the possible 28 land uses identified by the NRVIS data, the Kawartha Lakes watershed is represented by 21 different land uses. Interestingly, the chain of lakes running west/east through the middle of the watershed (Trent-Severn Waterway) runs parallel with a transition zone between forested Canadian Shield (metamorphosed limestone and/or granite) catchments to the north and agricultural glacial till catchments to the south. This transition zone includes a significant limestone alvar plain that runs through the Kawartha Lakes watershed.

Previous models of lake phosphorus concentrations and catchment-related phosphorus dynamics would be problematic if applied to the Kawartha Lakes area. This is due to the unique situation of having lakes located between two extreme geological features combined with unusually shallow lake systems. Most have artificially high water levels due to dam creation for the Trent-Severn Waterway; this causes the historical floodplain to be inundated with water, forming large areas of shallow water where macrophytes (aquatic plants) can proliferate. The landscape to the south of the Kawartha Lakes is dominated by cultivated land with glacial till, while the area to the north is dominated by forested areas and impermeable bedrock.

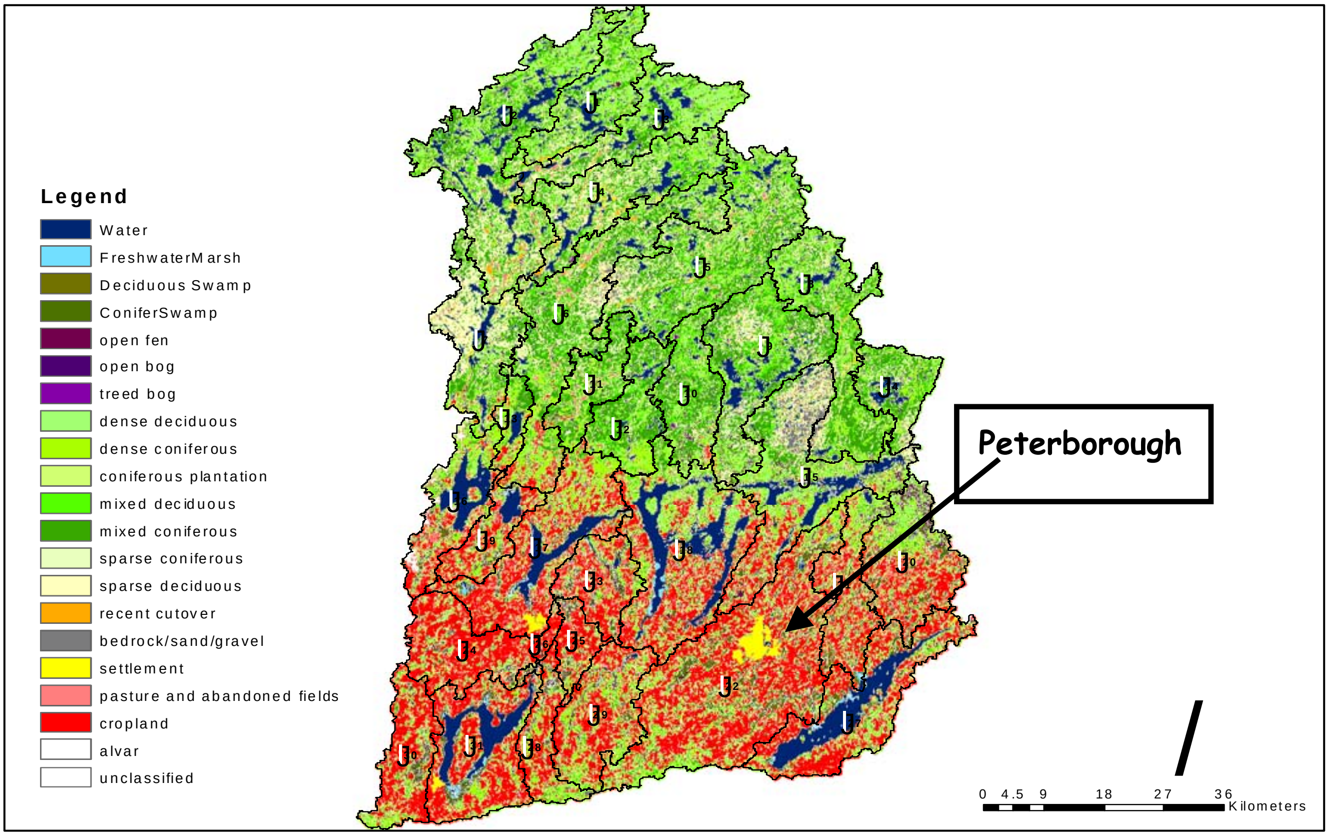



**Figure 2.1** NRVIS land classification for the 31 watersheds of the Kawartha Lakes region. Note that forested areas are located in the north on the Canadian Shield and agricultural areas are located to the south on glacial till. Watershed IDs are depicted in white pentagons.

## Chapter 3: Phosphorus loading potential

The eutrophication of aquatic systems has been a known phenomenon for many years and much research has been undertaken to predict the potential influence of land use on aquatic phosphorus loading. An excellent application of this research in southern Ontario predicts the phosphorus loading potential of a watershed based on base flow (minimum amount of water available to streams) and cropland.

The predictive model utilized in this chapter is a direct application of research conducted by Metcalfe et al. (2005) and assigns a value to a watershed based on its potential to contribute phosphorus to watercourses. The values range from 1 – 15, with 1 having a low potential to contribute phosphorus and 15 having the highest potential. This scale was developed after analysing real data from thirteen reference watersheds scattered from Kitchener, ON to Cornwall, ON. The model incorporates the Base Flow Index (BFI) and percent cropland for a watershed to calculate its phosphorus loading potential (Table 3.1).

It then applies the equation:

| **Phosphorus Susceptibility Index = (% Cropland Class – BFI Class) + 8** |
| --- |

Thus, once you figure out the % Cropland and BFI value of a watershed (using available government-provided geospatial landscape data) you can predict its phosphorus loading potential.

Editor's note: *Base flow of rivers is the flow that would remain if there has been no rain (and therefore no runoff) for a period of time. It represents the water in the river that comes from groundwater and springs. This is usually low-phosphorus water. Therefore, a river containing relatively high levels of groundwater (high BFI), will have relatively low phosphorus levels. If a river's water derives more from runoff with relatively less groundwater, it will have a low BFI and higher phosphorus levels. For example, an area with 73% cropland and a base flow of only 20% would have a PSI of (4 – 2) + 8 = 10. An area with only 30% cropland and a base flow of 60% would have a PSI of (3 – 7) + 8 = 4. In layperson's terms, this model says that areas with large amounts of cropland are prone to having high phosphorus inputs into their waterways.*

**Table 3.1** Arbitrary division of classes used in determining the phosphorus loading potential of a watershed. Modified from (Metcalfe et al., 2005).

| Class | % Cropland | Class | Upper Boundary BFI (%) |
| --- | --- | --- | --- |
| 1 | 32.5 | 1 | 12.4 |
| 2 | 50.7 | 2 | 20.2 |
| 3 | 63.4 | 3 | 28.0 |
| 4 | 73.2 | 4 | 35.8 |
| 5 | 81.8 | 5 | 43.6 |
| 6 | 87.8 | 6 | 51.4 |
| 7 | 93.6 | 7 | 59.2 |
| 8 | 100 | 8 | 100 |

Although the Kawartha Lakes watershed has a relatively low phosphorus loading potential when compared to the majority of southern Ontario, it is unique in that it has an altered waterway (permanently flooded historical flood plain) with which to concentrate its nutrient loading. The 31 quaternary watersheds had percent cropland classes between 1 and 3, and BFI classes between 4 and 8. This resulted in a range of phosphorous susceptibility index values from 1 to 7. Comparable to the land classification results in chapter 2, we see a distinct separation along the chain of lakes, with low phosphorus loading potential to the north and high loading potential to the south (Figure 3.2). This model predicts that the southern watersheds will contribute more phosphorus to the Kawartha Lakes than the northern watersheds.

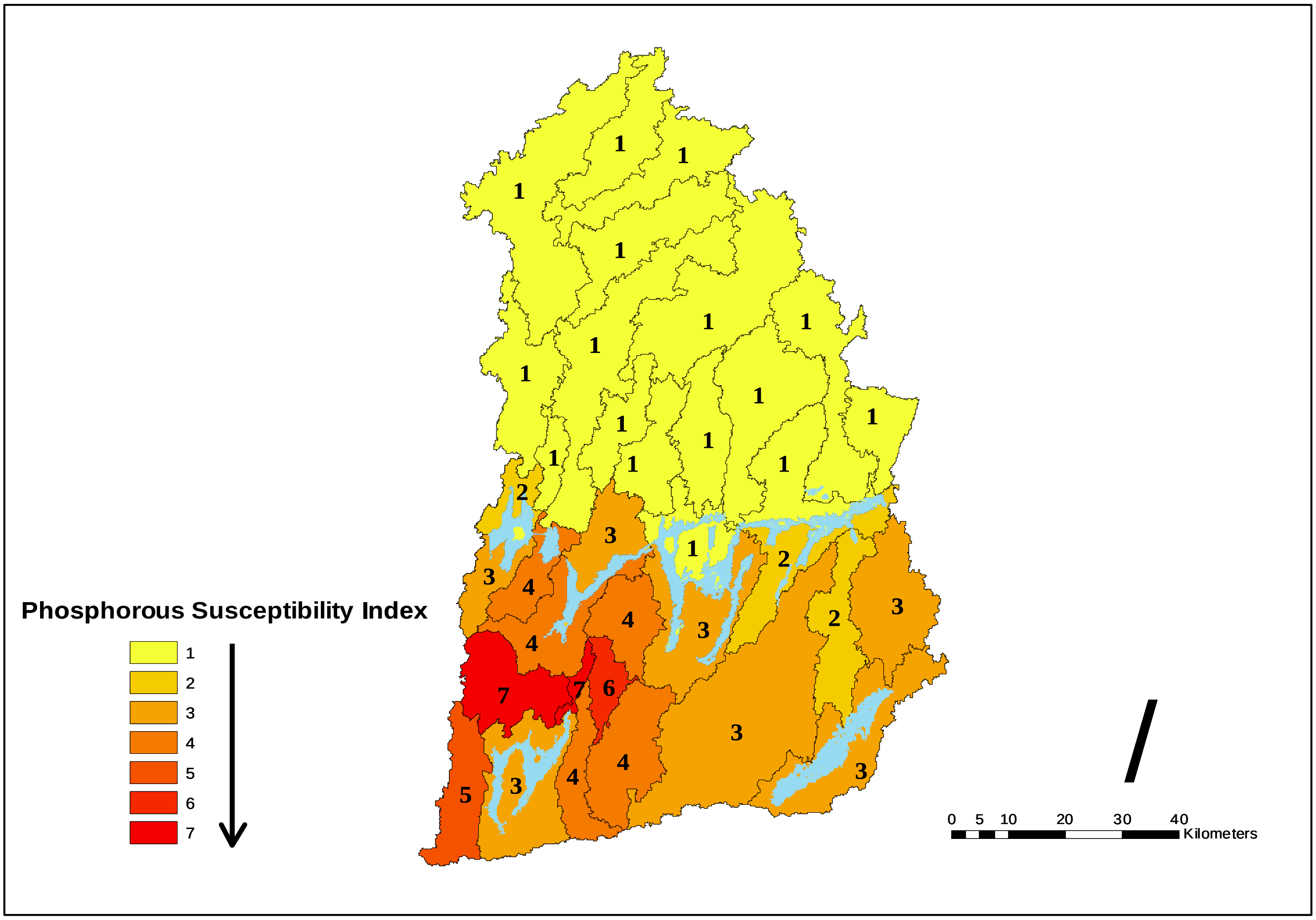



**Figure 3.2** Phosphorus susceptibility for the 31 quaternary watersheds of the Kawartha lakes. Susceptibility is determined through modeled base flow and percent agricultural landscape. Note, water entering the Kawartha Lakes from southern catchments is more likely to have higher phosphorus concentrations.

This model should be interpreted with caution as it does not take into account other morphological variables (e.g., shallow lakes, drainage basin ratio) that may compound the phosphorus loading issue. Although there are many factors that can contribute phosphorus to a watershed - sewage treatment plants, aerial deposition, faulty septic systems and animal feces (beef, poultry, hog operations and large populations of geese and zebra mussels) - clearly arable land is an important component in elevating phosphorus concentrations in water bodies.

## Chapter 4: Land class and lake morphology correlations with phosphorus

Chapter 4 focuses on one of the major goals of this report, which was to utilize the NRVIS database to determine what relationships exist between land use and phosphorus concentrations in the Kawartha Lakes, because nutrient concentrations in watercourses have often been attributed to the land use surrounding them (Beasley et al., 1985; Cooke and Prepas, 1998). A second focus was to resolve any relationships that phosphorus concentrations may demonstrate with lake morphology, similar to findings in other geographic areas (Genkai-Kato and Carpenter, 2005).

Multiple linear regression analyses were employed to determine the relationship between phosphorus concentrations and land use/lake morphology characteristics. The "dependent" variable phosphorus was tested for a linear relationship with each "independent" land use/lake morphology variable. Land use information was gathered from the NRVIS database, lake morphology information from the MNR's lake database, and phosphorus concentrations were mean August 2005 values taken from KLSA's dataset. Three analyses were performed to test for linearity with phosphorus concentrations: increasing watershed contributions, lake buffer of land use (200 m), and lake morphology. In order to test the relationship of watershed accumulation with phosphorus concentration, it was necessary to establish which watersheds contribute to each particular lake. Similarly, surrounding land use, from shore to 200m, was calculated for each lake using ArcMap®. Finally, a linear model was created using four significant variables, from the above-mentioned analyses, that demonstrated the highest $r^2$ value [correlation] for the model.

Phosphorus concentrations in the Kawartha Lakes watershed are highly correlated with land cover; in particular, wetlands, fens, bogs and marshes are good predictors of phosphorus in the Kawartha Lakes. Phosphorus concentrations increased in lakes as the percentage of arable land (cropland/pasture/abandoned fields) contributing to its hydrologic input increased. Congruently, lakes decreased in phosphorus concentration as the percent forest cover increased among their contributing watersheds. Wetlands clearly play a role in elevating a lake's phosphorus concentration; however, the shallower a lake is, the more likely it will have an abundance of wetlands, making it difficult to say whether it is increased wetlands that elevate phosphorus, or shifts in a lake's nutrient cycling capacity as a result of having a shallower lake basin. It is likely that a combination of the two factors is influencing lake phosphorus concentrations in the Kawartha Lakes watershed.

Although settlement and developed land did not demonstrate a significant relationship with phosphorus concentration, they should still be investigated as possible areas of concern during various times of the year.

**Cultivated Land + Shallow Lakes = Elevated Phosphorus Concentrations**

Clearly other sources of phosphorus need to be explored including urban storm water runoff, waste treatment facilities, golf courses, faulty septic systems, biofouling (Zebra mussels, Canada Geese) and atmospheric deposition before it is possible to assess the particular mechanisms behind phosphorus concentrations in the Kawartha Lakes watershed. The message from this chapter is simply that the lakes belonging to the TSW and south of the system are subject to having higher phosphorus concentrations because they are artificially shallow systems in an agricultural area. It is also important to remember that regression analysis is an excellent tool for determining relationships between environmental variables but it does not prove causality.

## Chapter 5: Past and present phosphorus levels in the Kawartha Lakes

This is the final chapter to present new data, and focuses on elucidating patterns in phosphorus concentrations across both time and the lake continuum (Balsam to Katchewanooka Lake).

Appropriate historical data were found from two sources (Hutchinson et al., 1994; MOE, 1976). Data from 1972, 1976 (MOE, 1976) 2003, 2004 and 2005 (KLSA, 2006) were compared using two techniques: analysis of variance (ANOVA) with Tukey's tests for significance, and interpretation of spline curve scatter plot. Similarly, consistently sampled phosphorus concentrations for Sturgeon Lake 1971-1991 (Hutchinson et al., 1994) were analysed using linear regression. A second linear regression was performed using the 1971-1991 data along with KLSA's data from 2003-2005. Finally, non-linear regression was employed to determine if any patterns exist in phosphorous concentration along the lake continuum (Balsam-Katchewanooka). ANOVA analyses could only be conducted to compare three different years of data, 1972, 1976 and 2005. Other years could not be utilized, as the data were incomplete for a legitimate analysis. Similarly, the following ten lakes were utilized in the

ANOVA analysis as no suitable data were found for other lakes: Balsam, Big Bald, Buckhorn, Cameron, Clear, Katchewanooka, Pigeon, Upper Stoney, Stony and Sturgeon.

The majority of the archived data and subsequent analyses used suggest that phosphorus levels have declined in the Kawartha Lakes watershed, which is congruent with the finding of Robillard and Fox (2006); however, the results should be interpreted cautiously. There is evidence that phosphorus levels are closely linked with precipitation patterns, where wet years have higher phosphorus concentrations than dry years (Novotny and Olem, 1994). According to Environment Canada, the Kawartha Lakes area had a much higher average rainfall in 1972 than it did in either 1976 or 2005. Similarly, 1976 had a higher average rainfall than 2005; however, it is possible that phosphorus levels have been decreasing over time. Fortunately, the data from Sturgeon Lake were collected annually and demonstrate a clear decreasing trend in phosphorus concentrations over time. It would appear that phosphorus concentrations have remained relatively stable in Sturgeon Lake from 1988 through to 2005 at approximately 17 $\mu$g/L.

Finally, the results authenticate that lake phosphorus concentrations increase as water flows east through the lake continuum from Balsam Lake to Lovesick Lake. The increasing logistic pattern is then disrupted as low-phosphorus water enters the system from Upper Stoney Lake and dilutes the high-phosphorus water of Lovesick Lake below Burleigh Falls in Stony Lake. The lakes' phosphorus concentrations continue to increase after dilution at Stony Lake as demonstrated by the successively higher phosphorus concentrations in Clear and Katchewanooka Lakes.

Phosphorus levels have declined approximately 7 $\mu$g/L over the past 20 years and are currently around 14 $\mu$g/L. Phosphorus concentrations are known to increase in wet years and decrease in dry years: 2005 was a dry year. Phosphorus concentrations increase as water flows from Balsam Lake along the Trent-Severn Waterway to Rice Lake. There is a slight dilution and resultant reduction in phosphorus concentration as low-phosphorus water enters the system from Upper Stoney Lake via Stony Lake.

## Chapter 6: Conclusions

The Kawartha Lakes watershed is a unique chain of lakes unlike any that have been extensively studied. Many lake models have been developed; however, to this author's knowledge none has been developed to fully incorporate the diverse array of characteristics particular to the Kawartha Lakes:

- "Unnaturally" shallow basin with lake mean depth between 1.8 and 6.3 m.;
- Regulated water level due to canal traffic between Georgian Bay and Lake Ontario;
- North shore of lakes exposed to bedrock, south shores exposed to glacial till;
- Southern half of watershed used mainly for agriculture, northern half mostly forested (Figure 2.1);
- Highly inhabited and intensively used for recreational purposes (close proximity to major urban centres).

The findings of this report deal predominantly with land use and lake morphology relationships with phosphorus concentrations. It is evident that lake phosphorus concentrations increase when the proportion of cropland contributing to its hydrological budget increases. Phosphorus concentrations also increase as mean lake depth decreases. Phosphorus concentrations of the Kawartha Lakes are lower now than in the 1970s. It appears, however, that most of the decrease happened in the 1970s and early 1980s and levels have remained steady since then. The decrease, which occurred province-wide, was probably due to the introduction of phosphate regulation in the late 70s and early 80s, which drastically decreased phosphorus inputs from sewage treatment plants.

Finally, phosphorus concentrations increase as water flows through the TSW. The dilution effect at Stony Lake is convincing evidence that landscape controls (i.e., land use) dictate elevated phosphorus concentrations. This report is a summation of available information and should not be considered a final resolution regarding phosphorus concentrations in the Kawartha Lakes watershed. Many other avenues should be explored, as the potential for unconsidered/untested major sources of phosphorus are anticipated. The findings of this report resolve the importance of lake depth and land use with phosphorus concentrations in lentic systems [still waters such as lakes, ponds, etc.] within the Kawartha Lakes watershed.

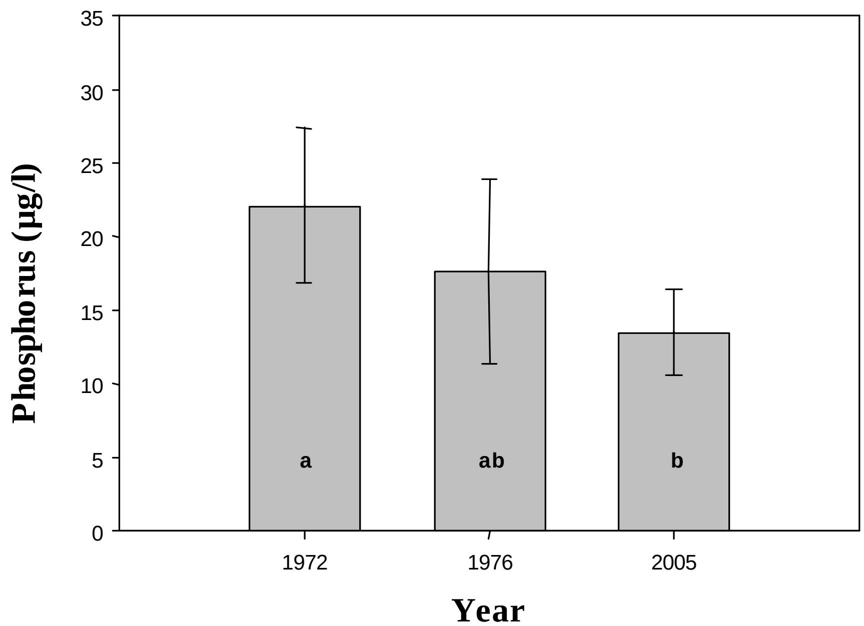



**Figure 5.1** Bar graph showing mean August total phosphorus concentrations and standard deviations for ten Kawartha lakes (Balsam, Big Bald, Buckhorn, Cameron, Clear, Katchewanooka, Pigeon, Sturgeon, Upper Stoney and Stony) for 1972, 1976 and 2005. Different letters denote significant differences between means following ANOVA procedure and Tukey's test (p = 0.001)(N=10).

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## How Much Algae Sticks to Macrophytes in the Kawartha Lakes?

by Wynona Marleau and Eric Sager

In the 2004 KLSA report, Bev Clark of the Ontario Ministry of the Environment very eloquently described the alternative states in which shallow lake systems can exist – either a macrophyte (water weeds) dominated state such as we have in the Kawarthas or a phytoplankton (suspended algae) dominated state such as existed in Lake Erie in the late 1970s. (Previous KLSA reports can be found at the KLSA page on the Oliver Centre website: www.trentu.ca/olivercentre.) The latter state often gives the water

the appearance of thick pea soup. Under high loadings of nutrients, mainly phosphorus, the potential exists for lakes to shift from a clear-water, macrophyte dominated state to one that is dominated by suspended algae. It is believed that one of the precursors to this shift is the excessive growth of *epiphyton* (algae that is attached to submersed macrophytes) and *metaphyton* (algae that commonly originates from true floating algal populations but gets tangled up among macrophytes and other floating debris). This excessive growth can lead to photo-inhibition of the macrophytes – they don't get enough sunlight – which then allows *phytoplankton*, the suspended algae in the water column, to grow. This further blocks sunlight and makes life more difficult for rooted vegetation growing on the lake bottom.

As we have been carrying out our macrophyte monitoring activities across the Kawartha Lakes, we have received many comments from shoreline residents about the "green cotton-candy like algae" that is attached to the floating and submersed vegetation. We have also noticed this phenomenon but didn't find it uniformly distributed throughout the Kawartha Lakes that we'd been working on (Lovesick, Pigeon, Buckhorn and Sturgeon).

Physico-chemical factors of the water column that can have a direct effect on epiphyte growth rates include nutrient availability, temperature, depth, wave activity and light. Thus, with financial help from KLSA, we set out to determine:

1) What are the levels of algal biomass (both epiphyton and metaphyton) that are associated with submersed vegetation in the Kawartha Lakes?

2) Are there any differences in these levels across the different lakes?

With respect to our first objective, we chose to focus our efforts on two of the more abundant species of submersed plants that we find in the Kawarthas, *Vallisneria americana* (tape grass or wild celery) and *Myriophyllum spicatum* (Eurasian milfoil). It is known that the morphology and architecture of the host plant also plays a role in controlling epiphytic algal biomass; macrophytes with finely dissected leaves, such as the milfoils, tend to develop greater epiphytic biomass than simpler plants like *Vallisneria*, partly due to their high surface-to-biomass ratio. Likewise, the morphology of the host plants can influence the light environment for the epiphytic community by where they are growing in the water column. Those that have the bulk of their biomass at the surface of the water column (i.e., milfoils) may provide more favourable conditions relative to those that concentrate their biomass closer to the sediments (i.e. *Vallisneria*).

With respect to our second objective, we sampled sites that were representative of the trophic gradient, that is, lakes with differing concentrations of total phosphorus. (See Kathleen Mackenzie's article, "Changing as we flow: Phosphorus levels increase as water flows down the Trent-Severn Waterway," in the 2005 KLSA Report). We characterized our Pigeon Lake and Sturgeon Lake sites as intermediate with respect to phosphorus concentrations in the water, although we know that the two southern sites for both lakes (Pigeon Lake S and Sturgeon Lake S) have historically had higher concentrations of total phosphorus. Stony Lake typically has lower phosphorus concentrations and Lovesick Lake higher concentrations relative to the other Kawartha Lakes. Other researchers have had conflicting results using epiphyte biomass as an indicator of phosphorus concentrations in lakes, but there is some evidence that suggests that it can be a fairly good indicator of localized sources of nutrients.

Sampling was carried out during the first week of September, which is the time when this particular community can be found in its greatest abundance.

Table 1. Location of sampling sites across the Kawartha Lakes.

| | |
|---|---|
| **Pigeon Lake S** | Emily Provincial Park |
| **Pigeon Lake C** | Gannon's Narrows |
| **Pigeon Lake N** | Oliver Ecological Centre |
| **Sturgeon Lake S** | Snug Harbour Marina |
| **Sturgeon Lake C** | Greenhurst Thurstonia |
| **Sturgeon Lake N** | Birch Point |
| **Lovesick Lake 1** | McCallum's Island |
| **Lovesick Lake 2** | Ardagh Cottage Resort |
| **Lovesick Lake 3** | Feathers Island |
| **Stony Lake 1** | Northey's Bay Rd - public boat launch |
| **Stony Lake 2** | off FR 26 (off Northey's) |
| **Stony Lake 3** | Viamede Resort |

Table 1 shows the location of sampling sites that were visited for this year's assessment of epiphyton and metaphyton biomass. We chose sites that were similar with respect to turbulent energy (i.e., the degree of exposure to wind and wave activity), macrophyte community and bottom sediment characteristics. Sampling at all sites occurred at a water depth of approximately 1 m. For determination of algal biomass on the shoots of two species, we harvested the top 25 cm of intact shoots, placed them into a container of clean water and agitated the container. We then determined the amount of algae as indicated by chlorophyll *a* (an important plant pigment involved in photosynthesis) that was left in the water and used this as a surrogate for the total biomass of algae that was present on the shoots. Harvested macrophyte shoots were then dried in an oven and weighed. You'll notice that we present the data in units of μg chl *a* /g dry wt [micrograms of chlorophyll *a* per gram of dry weight]. This allows us to standardize the amount of attached algae per unit of dry weight biomass of macrophyte. We also determined the amount of suspended algae in the water column (*phytoplankton*), as high concentrations of this group could reduce the amount of light available for those plants and algae growing below.

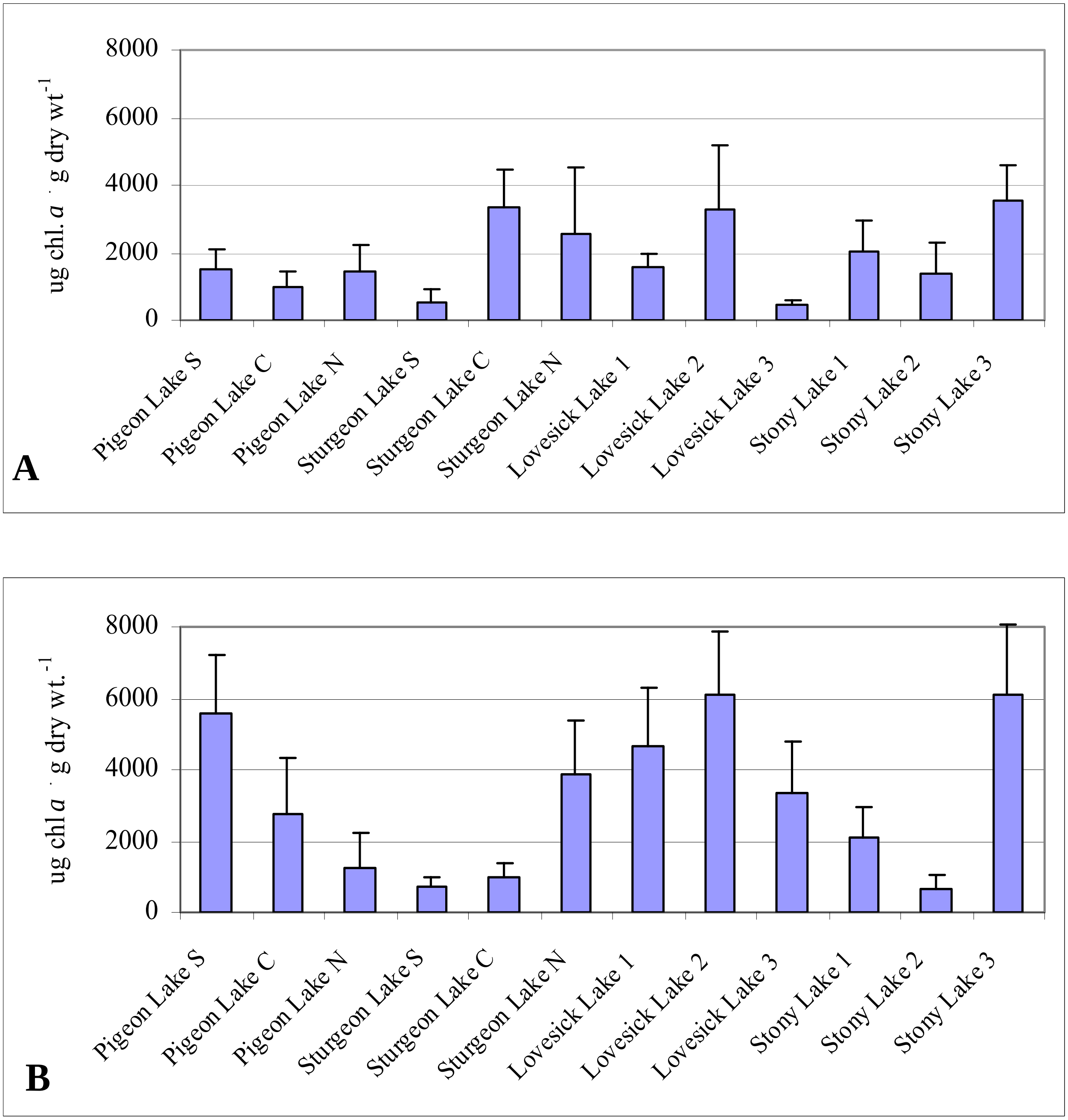



Figure 1. Biomass of algae (epiphyton and metaphyton) attached to shoots of **A**) *Myriophyllum spicatum* and **B**) *Vallisneria americana* at sites of the Kawartha Lakes. Refer to Table 1 for explanation of site locations. Bars represent the averages of 5 shoots that were sampled from each site while error bars represent standard deviations.

The results from our initial surveys were quite interesting and have raised more questions for future investigations.  Figure 1 shows the results for algal biomass associated with the two species of macrophytes at the different sites. We weren't surprised to find differences between the two species of macrophytes. However, based upon plant morphology and leaf architecture, we expected to find the greatest amount of epiphyton and metaphyton growth on the milfoil, not on the *Vallisneria*. Chlorophyll *a* concentrations per unit biomass were nearly two times greater on the latter (3200 $\mu g$ chl $a \cdot g$ dry weight $^{-1}$ vs. 1800 $\mu g$ chl $a \cdot g$ dry weight $^{-1}$). Thus, even though *Vallisneria* is generally found growing closer to the sediments (and thus potentially in a lower light environment from the perspective of the attached algae), the light environment does not appear to be a limiting factor. This is likely an indicator of a healthy zebra mussel population that is increasing the levels of light through the water column. Another explanation could be related to the biochemistry of *Myriophyllum spicatum*. Researchers have demonstrated that this plant secretes a group of compounds that actually inhibit the growth of algae (a process referred to as allelopathy). It could also be related to potentially different macroinvertebrate communities associated with the two species of macrophyte. There could have been a greater density of grazing insects associated with the milfoil, which would result in reduced amounts of attached algal biomass. This is certainly a result that warrants further investigation.

Looking at the site differences also yields some interesting results, and the two species of macrophytes are not necessarily showing the same trends. The first trend that became apparent was that there were large differences within each of the larger lakes, which is not surprising given their size. This large in-lake variation could be indicative of differences in water-borne nutrients (e.g., Pigeon Lake S having higher phosphorus concentrations in the water compared to Pigeon Lake C and Pigeon Lake N; Stony Lake 3 getting more nutrient-rich Lovesick Lake water relative to the other the Stony 1 and 2 sites), but we can't substantiate those claims with our current data set. However, there are suggestions of a possible trophic gradient in our data set, with Lovesick Lake generally having higher concentrations of attached algae relative to the other lakes.

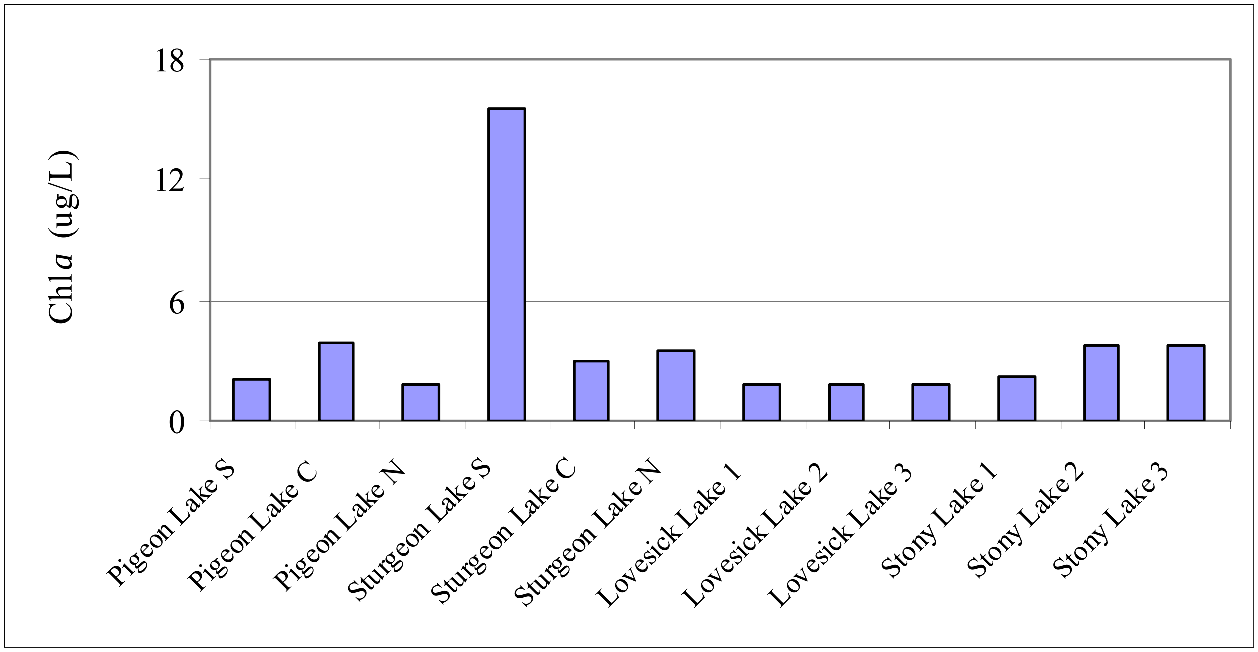



Figure 2. Concentration of phytoplankton at sampled sites.

We were very surprised to see such low concentrations of attached algae on the plants growing at Snug Harbour in Sturgeon Lake (Sturgeon Lake S) as this site has historically had some of the highest concentrations of total phosphorus throughout the Kawarthas. Looking at phytoplankton concentrations (Figure 2) may offer a possible explanation. This same site had the highest concentrations of phytoplankton by several orders of magnitude. Thus the relatively low amount of epiphytes and metaphyton associated with the macrophytes at Snug Harbour is likely related to a more turbid water column where light is a limiting factor for successful growth. To put those numbers in context, chlorophyll *a* concentrations in the pea-soup days of the Great Lakes routinely exceeded 100 $\mu g \cdot L^{-1}$. As you can see from Figure 2, this was many times higher than today's levels.

Are our lakes at risk of switching from a macrophyte dominated state to a phytoplankton dominated state? This study has certainly provided us with a baseline that subsequent years of observation can build upon, but it doesn't allow us to draw conclusions as to where the lakes will go in the future. As is the case with many ecological monitoring exercises, this has raised more questions, which we hope to address in the coming years. As we carry out macrophyte monitoring activities on some of the Kawartha Lakes, we enjoy hearing (and have come to depend upon) the observations of shoreline residents as they are out taking advantage of these rare and beautiful Kawartha Lakes.

Wynona Marleau is a recent graduate of Trent University with an Honours B.Sc. in Biology. Dr. Eric Sager is a research associate at Trent University, manager of the Oliver Ecological Centre, and KLSA's scientific advisor.

## Bacteria Testing

### What we did

2006 was KLSA's sixth year of testing for *E.coli* bacteria. In total, our volunteers tested 116 sites on 14 lakes, and each site was tested up to 6 times through the summer. Please see the basic rationale for testing and the complete results in Appendix E. Samples were taken to SGS Lakefield Research for analysis.

### 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. The 111 sites that were tested regularly (4 or more times) could be classified as follows:

| **Site Classification** | **Number of sites** | **Comments** |
|---|---|---|
| *"Very Clean":* no readings above 20 *E.coli*/100 mL | 77 | This indicates very clean surface water. |
| *"Clean":* 1 or 2 readings between 21 and 100 *E.coli*/100 mL, plus 0 or 1 reading over 100 *E.coli*/100 mL | 23 | It is normal for Kawartha Lakes to have the occasional reading over 20. |
| *"Slightly elevated":* 3 readings between 21 and 100 *E.coli*/100 mL, plus 0 or 1 reading over 100 *E.coli*/100 mL | 3 | All sites were near shallow areas with plentiful wildlife. |
| *"Needing Observation":* 4 to 6 readings between 21 and 100 *E.*coli/100 mL, AND/OR 2 or more readings over 100 | 8 | Probable causes of these higher counts:<br>• drainage from agricultural area: Sturgeon WS1 and SB1, Balsam A1<br>• high levels of waterfowl: Balsam A1, Sturgeon 2, White 1 and 2<br>• near inflow from large wetland area: Lower Buckhorn 3, 4A and 4B<br>• narrow bay with reduced circulation: Stony 27 |

Generally, then, the water in the Kawartha Lakes is very swimmable, though not directly ndrinkable. To keep *E.coli* counts low near your shoreline, it is important to remember to:wqw 1

- minimize places where waterfowl can congregate. Short grass is very inviting to geese; it tastes good and will not conceal predators.
- encourage *E.coli* testing at streams coming in from agricultural areas. Farmers have created excellent programs to train for and partially fund stream management programs. Make sure your upstream farmers are following these "best management practices".

## The Mississagua River Diversion of the 1800's: Water quality implications today for the Bald, Pigeon and Buckhorn Lakes

by Kevin Walters

I have been investigating some interesting physiographical anomalies in the Buckhorn area that led me to the conclusion that the Mississagua River, which currently enters the main Kawartha Lake system just downstream of Buckhorn into Lower Buckhorn Lake, once split into two paths. One headed to Lower Buckhorn as it does today, while the other branched west to Big Bald Lake.

There is sufficient physical evidence proving that the river once utilized a channel leading into Big Bald Lake. Its most discernable legacy is the marshy delta located just north of the village of Buckhorn, visible just west of County Rd 36, and the connecting broad channel leading into Big Bald Lake, known as Catalina Bay.

But was this route to the Bald Lakes or its diversion into one channel natural or man-made? The key to determining that humans had in fact caused the diversion would be finding a dam or other man-made structure located within an otherwise natural branch of the river that would have resulted in the current singular course.

I did indeed find such a structure in the location I predicted: a barrier or "blind" dam of earth and stone crossing the top end of what was clearly a natural, western channel, located about 1 km north of the old Scotts Mills dam. (See map pg. 56)

Further investigations suggest that both east and west channels of the Mississagua River were likely approximately equal in terms of volume of discharge originally, and the river may have naturally switched from one channel to the other from time to time, as we know that, historically, blockages of deadwood abounded on our area rivers.

While this still needs to be fully researched, my hypothesis is that lumbermen constructed this barrier around the time of the founding of Hall's sawmill at Buckhorn, circa 1830. Presumably they wanted to send all the logs heading down the Mississagua River to the mills at Buckhorn without losing any to the Bald Lakes.

Scotts Mills, located on the river above Buckhorn, but founded 24 years later, likely took advantage of this arrangement too. Without the diversion dam, their mill-dam would have backed up the water and sent it all down the west channel to Big Bald

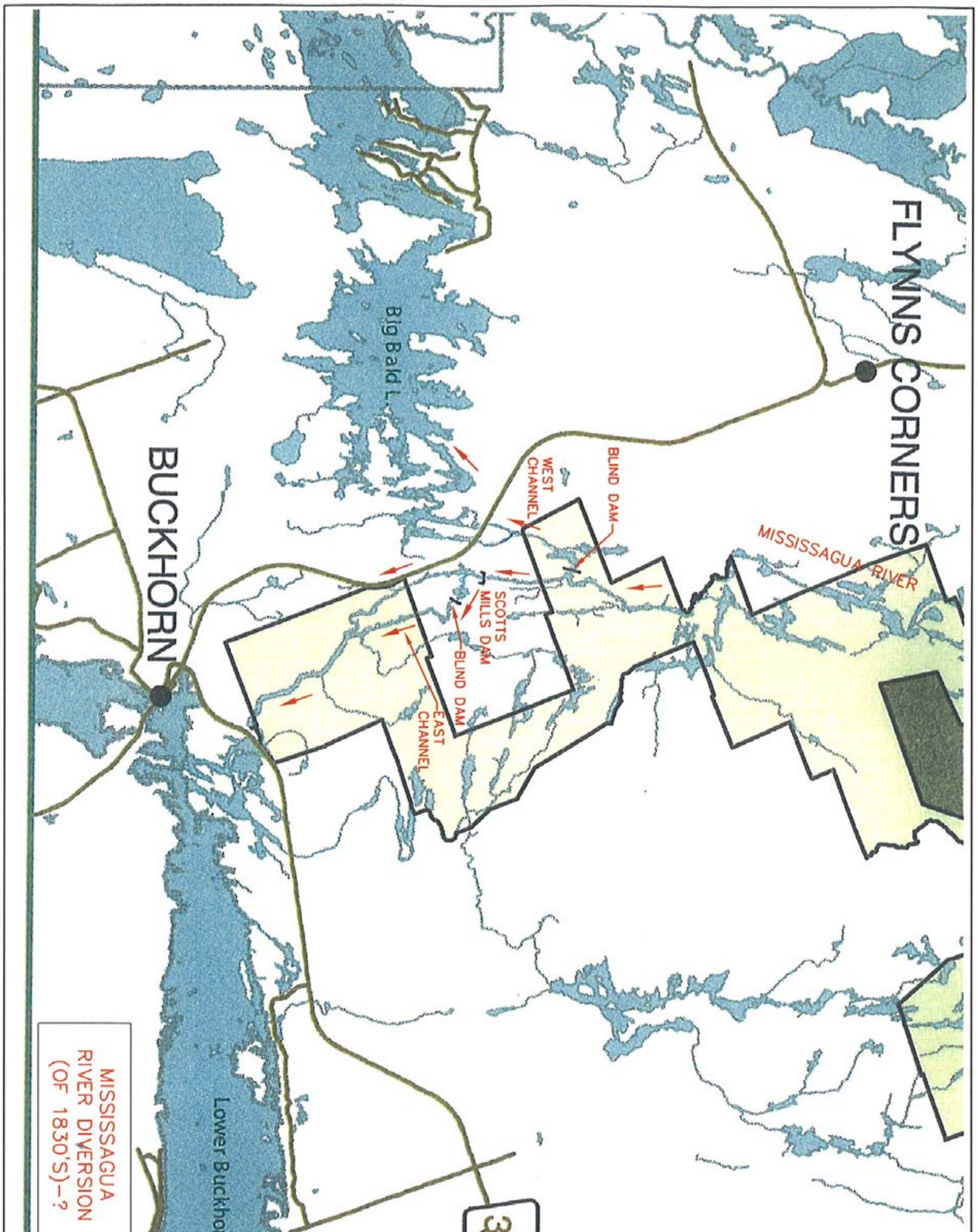
Lake, instead of through their sawmill. Following the logging era, no one bothered – or remembered – to put the river back to the way it was originally.

This historical river diversion has had impacts on the quality of lake water in Big and Little Bald Lakes, Pigeon Lake and Buckhorn Lake, and to a minor degree Chemong Lake, which gets some of its water from Buckhorn Lake.

The Mississagua River is a clear, soft-water, low-nutrient river, one of the "cleanest" flowing into our lakes. It has the effect of diluting the higher nutrient and mineralized water originating from the south. Currently, this benefit is not seen until Lower Buckhorn Lake is reached, where the river now enters the system, but in the days when the river had an outlet to Big Bald Lake, this benefit was extended to these upstream lakes as well. In particular, the Bald Lakes would have experienced constant flushing with this "clean" water, and would have had a water quality comparable to the river itself.

Investigation into the costs and benefits of restoring the lost west channel of the Mississagua River may be a worthwhile project.

One important clue as to the natural state of the river is that the name "Mississagua" or its many variants, means in Ojibwa "river of the north of many mouths."


FLYNNS CORNERS
BUCKHORN
Big Bald L.
Lower Buckhorn
MISSISSAGUA RIVER
BLIND DAM
WEST CHANNEL
SCOTTS MILLS DAM
BLIND DAM
EAST CHANNEL
36
MISSISSAGUA RIVER DIVERSION (OF 1830'S)–?

## 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

| | |
|---|---|
| Pat Moffat, Chair | (519) 884-6549, (705) 654-4012 |
| Lovesick Lake Association | email: patmoffat@yahoo.com |
| Kathleen Mackenzie, Vice-Chair | (416) 283-7659, (705) 654-3051 |
| Assoc. of Stony Lake Cottagers | email: k_mackenzie@sympatico.ca |
| Ann Ambler, Secretary | (705) 654-4537 |
| Lovesick Lake Association | email: annambler@hotmail.com |
| Jeff Chalmers, Treas. | (705) 743-8671, (705) 652-8992 |
| Birchcliff Prop. Owners' Assoc. (Clear Lake) | email: jeffreychalmers@yahoo.ca |
| Mark Potter, Director | (416) 232-4007, (705) 654-4340 |
| Newcomb Dr. Cottagers' Assoc. (Lwr Buckhorn) | email: potter4@sympatico.ca |
| Sheila Gordon-Dillane, Director | (416) 225-9236, (705) 657-1389 |
| Conc. 17 Pigeon Lake Cottagers Assoc. | email: sgdillane@rogers.com |
| Kevin Walters, Director | (416) 778-5210 |
| Lovesick and Harvey Lakeland | email: kwalters@dillon.ca |
| Mike Stedman, Director | (705) 877-1735 |
| White Lake Cottagers Association | email: mike.stedman@sympatico.ca |
| Norma Walker, Director | (705) 877-1082 |
| White Lake Cottagers Association | |
| Tiina Pertmann, Director | (705) 738-3655 |
| Sturgeon Lake, Kelly's Bay Association | schnauzer.r@rogers.com |

KLSA E-mail: kawarthalakestewards@yahoo.ca

## Other Volunteers

| | |
|---|---|
| Balsam Lake | Jim and Kathy Armstrong |
| Big Bald Lake | Big Bald Lake Assoc. – Mark Thiebaud, John Shufelt, Ron Brown |
| Buckhorn Lake | Buckhorn Sands Property Owners – Mary and Mike Belas<br>Sandbirch Estates – Keith Clark |
| Chemong Lake | Smith-Ennismore-Lakefield Ratepayers' Assoc. – Rosalind Macquarrie<br>Lakeside Common – Jo Hayward-Haines |
| Clear Lake | Birchcliff Property Owners' Assoc. – Jeff Chalmers<br>Kawartha Park Cottagers' Assoc. – Judith Platt<br>Southwest shore – Gord Evans |
| Julian Lake | Julian Lake Cottagers – George Loyst |
| Katchewanooka Lake | Peter Fischer, Lake Edge Cottages<br>Mike Dolbey |
| Lovesick Lake | Lovesick Lake Assoc. – Ann Ambler, Ron Brown, Pat Moffat, Bev Richards, Marlene Steele |
| Lower Buckhorn Lake | Jim and Cindy Chapman, Robert Green, Wally Kralik, Jeff Lang, Peter Miller, Mike Piekny, Mark Potter, Harry Shulman, Dave Thomson, Bruce Ward |
| Pigeon Lake | Concession 17 Pigeon Lake Cottagers' Assoc. – Sheila Gordon-Dillane<br>North Pigeon Lake Ratepayers' Assoc. – Tom McCarron, Francis Kerr<br>Victoria Place – Bill Bedley, Gary Westlake, Ralph Erskine, Jeff McCauley |
| Sandy Lake | Dan Casey |
| Stony Lake | Assoc. of Stony Lake Cottagers – Gail Szego, Ralph Reed, Bob Woosnam |
| Sturgeon Lake | Sturgeon Lake Assoc. - Don Holloway, Rod Martin, Doug Ridge, Sonny Seymour, Ann Shortt |
| Upper Stoney Lake | Upper Stoney Lake Assoc. – Karl, Kathy, Ken and Kori Macarthur |
| White Lake | White Lake Cottagers' Assoc. – Mike Stedman, Norma Walker |

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

**Appendix B: Financial Partners**

Parks Canada, Trent-Severn Waterway
Stony Lake Heritage Foundation, Upper Stoney & Lower Stony Lake
Township of Galway-Cavendish-Harvey
Township of Douro-Dummer
Birchcliff Property Owners Association of Douro-Dummer, Clear Lake
Lower Buckhorn Lake Owners Association
Big Bald Lake Cottagers Association
Kawartha Park Cottagers' Association, Clear Lake
North Pigeon Lake Property Owners Association
Victoria Place Association Inc., Pigeon Lake
Anne Shortt – Bayview Estates Association, Sturgeon North Shore
Buckhorn Sands Property Owners Association
Eganridge Inn & Country Club
Sandbirch Estates Association, Buckhorn Lake
Township of Smith-Ennismore-Lakefield
Julian Lake Cottagers' Association, Julian Lake
Lovesick Lake Association, Lovesick Lake
Pigeon Lake Cottagers Association
Katch Fund – Katchewanooka Lake
White Lake Association
Balsam Lake Association
Carol and Don McCanse – Katchewanooka lake
Dr. Dolbey – Katchewanooka Lake
Stinson's Bay Property Owners Association
Snug Harbour Residents
Mrs. Alice DiGangi

Thanks to all of our generous supporters.

## Appendix C: Financial Report

# Kawartha Lake Stewards Association
# Treasurer's Report
## 2006 Revenue & Expenses

December 31, 2006

| Date | Revenue | | |
|---|---|---|---|
| | Balance Forward from December 31, 2005 | | $2,794.01 |
| 06-Jan-06 | Buchkorn Sands Property Owners Assoc. | 200.00 | |
| 06-Jan-06 | Anne Shortt (Bayview Estates Assoc., Sturgeon North Shore) | 100.00 | |
| 29-Mar-06 | Anne Shortt (Bayview Estates Assoc., Sturgeon North Shore) | 100.00 | |
| 25-Apr-06 | Deposit from GIC account | 2,015.24 | |
| 28-Apr-06 | Trent Severn Waterway (first installment of 2005 funding) | 1,800.00 | |
| 04-May-06 | Trent Severn Waterway (final installment of 2005 funding) | 1,200.00 | |
| 31-May-06 | Balsam Lake Assoc. | 50.00 | |
| 31-May-06 | Eganridge Inn & Country Club | 200.00 | |
| 31-May-06 | Twsp. of Galway-Cavendish-Harvey | 1,000.00 | |
| 05-Jun-06 | Twsp. of Smith-Ennismore-Lakefield | 170.00 | |
| 05-Jun-06 | Victoria Place Assoc. | 300.00 | |
| 14-Jun-06 | Katch Fund - Katchewanooka Lake | 100.00 | |
| 14-Jun-06 | George Loyst - Jullian Lake | 150.00 | |
| 14-Jun-06 | Pigeon Lake Cottagers Assoc. | 150.00 | |
| 14-Jun-06 | Twsp. of Douro-Dummer | 750.00 | |
| 20-Jul-06 | White Lake Assoc. | 100.00 | |
| 20-Jul-06 | Big Bald Lake Assoc. | 300.00 | |
| 20-Jul-06 | Dr. Dolbey -Katchewanooka Lake | 50.00 | |
| 20-Jul-06 | Lovesick Lake Assoc. | 150.00 | |
| 17-Aug-06 | Stony Lake Heritage Foundation ($1000 tests, $100 donation) | 1,100.00 | |
| 08-Sep-06 | Mrs. Alice DiGangi | 20.00 | |
| 08-Sep-06 | Birchcliff Property Owners Assoc. (Clear Lake) | 500.00 | |
| 15-Sep-06 | North Pigeon Lake Ratepayers Assoc. | 300.00 | |
| 21-Sep-06 | Stinson's Bay Property Owners Assoc. | 50.00 | |
| 21-Sep-06 | Sand Birch Estates | 175.00 | |
| 30-Nov-06 | Don McCanse | 20.00 | |
| 30-Nov-06 | Snug Harbour residents 2 x $20 | 40.00 | |
| 30-Nov-06 | Kathleen Mackenzie (overpayment credit) | 29.27 | |
| 30-Nov-06 | Kawartha Park Cottagers Assoc. | 50.00 | |
| 30-Nov-06 | Kawartha Park Cottagers Assoc. | 250.00 | |
| 12-Dec-06 | Carol McCanse | 50.00 | |
| 21-Dec-06 | Lower Buckhorn Lake Owners Assoc. | 500.00 | |
| | Total Revenue | 11,969.51 | $11,969.51 |

| Date | Expenses | | |
|---|---|---|---|
| 04-Jan-06 | Bank Fees | 3.75 | |
| 30-Jan-06 | Kathleen Mackenzie (expenses) | 172.38 | |
| 02-Feb-06 | Bank Fees | 3.75 | |
| 01-Mar-06 | Bank Fees | 3.75 | |
| 12-Mar-06 | Sheila Gordon-Dillane (expenses) | 32.00 | |
| 29-Mar-06 | LMS Prolink Ltd. (insurance) | 1,688.04 | |
| 01-Apr-06 | Bank Fees | 3.75 | |
| 25-Apr-06 | GIC Purchase | 2,015.24 | |
| 01-May-06 | Bank Fees | 3.75 | |
| 18-May-06 | Kevin Walters expenses | 15.24 | |
| 19-May-06 | Mike Steadman expenses | 174.80 | |
| 30-May-06 | Buckhorn Community Centre (rental) | 100.00 | |
| 30-May-06 | Pat Moffat expenses | 73.15 | |
| 1-Jun-06 | Monthly Service Charges | 3.75 | |
| 1-Jun-06 | Ontario Envirnment Network | 40.00 | |
| 12-Jun-06 | Fleming College (printing 300 reports) | 2,042.01 | |
| 19-Jun-06 | Kathleen Mackenzie expenses | 29.27 | |
| 19-Jun-06 | Mike Steadman expenses | 235.79 | |
| 4-Jul-06 | Monthly Service Charges | 3.75 | |
| 28-Jul-06 | SGS Lakefield Research | 85.34 | |
| 1-Aug-06 | Monthly Service Charges | 3.75 | |
| 3-Aug-06 | Kathleen Mackenzie expenses (replacement) | 29.27 | |
| 9-Aug-06 | SGS Lakefield Research | 1,790.71 | |
| 9-Aug-06 | SGS Lakefield Research | 906.88 | |
| 1-Sep-06 | Monthly Service Charges | 3.75 | |
| 8-Sep-06 | SGS Lakefield Research | 1,721.54 | |
| 18-Sep-06 | Ann Ambler expenses | 104.50 | |
| 18-Sep-06 | F.O.C.A. | 174.90 | |
| 18-Sep-06 | Jeff Chalmers expenses | 48.59 | |
| 18-Sep-06 | Mike Steadman expenses | 384.15 | |
| 1-Oct-06 | Monthly Service Charges | 3.75 | |
| 1-Nov-06 | Monthly Service Charges | 3.75 | |
| 1-Dec-06 | Monthly Service Charges | 3.75 | |
| 10-Dec-06 | Wynona Marleau (weed studies) | 500.00 | |
| 10-Dec-06 | Ann Ambler expenses | 13.71 | |
| 10-Dec-06 | SGS Lakefield Research | 853.11 | |
| 10-Dec-06 | Pat Moffat expenses | 52.26 | |
| | Total Expenses | 13,327.88 | $13,327.88 |
| | **Net Balance** | | **$1,435.64** |

## 2006 Investment Account

| Date | Transaction | Debit | Credit | Balance | |
|---|---|---|---|---|---|
| 01-Jan-06 | Balance Forward | | | 6,000.00 | |
| 25-Apr-06 | Withdrawal GIC @ 1.30% (15.24 interest) | 2,000.00 | | 4,000.00 | |
| 25-Apr-06 | Investment GIC @ 2.50% | | 2,015.24 | 6,015.24 | |
| 31-Dec-06 | Estimated Interest to year end | | 72.00 | 6,087.24 | |
| | Account Balance | | | 6,087.24 | $6,087.24 |
| | **Grand Total** | | | | **$7,522.88** |

A. Jeffrey Chalmers, Treasurer
Kawartha Lake Stewards Association

**Financial Statements of**

# *KAWARTHA LAKES STEWARDS ASSOCIATION*

**December 31, 2006**



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***Note To The Financial Statements***
**December 31, 2006**

## 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 assets or 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

Telephone 705 743 5020
Facsimile 705 743 5081
Email info@mccollturner.com
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, 2006 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

Licensed Public Accountants

Peterborough, Ontario
April 23, 2007

# KAWARTHA LAKES STEWARDS ASSOCIATION

## *Statement of Financial Position - December 31, 2006*

| | (Unaudited) 2006 | 2005 |
|---|---|---|
| **ASSETS** | | |
| Current Assets | | |
| Cash | $ 1,436 | 2,794 |
| Guaranteed Investment Certificates | 6,087 | 6,000 |
| | 7,523 | 8,794 |
| **NET ASSETS** | 7,523 | 8,794 |
| | $ 7,523 | $ 8,794 |

## *Statement of Operations*
## Year ended December 31, 2006

| | (Unaudited) 2006 | 2005 |
|---|---|---|
| **REVENUE** | | |
| Parks Canada, Trent-Severn Waterway | $ 3,000 | $ - |
| Municipal grants | 1,920 | 1,990 |
| Associations | 3,950 | 5,125 |
| Private contributions | 1,084 | 1,600 |
| Pledge receivable | - | - |
| Interest | 88 | 104 |
| | 10,042 | 8,819 |
| **EXPENDITURE** | | |
| Water testing fees and weed studies | 5,858 | 6,747 |
| Annual report costs | 2,042 | 1,676 |
| Registration fees, insurance and membership fee | 1,903 | 1,844 |
| Telephone, copies and other administrative costs | 1,465 | 969 |
| Bank charges | 45 | 45 |
| | 11,313 | 11,281 |
| **EXCESS OF EXPENDITURES OVER REVENUE** | (1,271) | (2,462) |
| **NET ASSETS** - beginning of year | 8,794 | 11,256 |
| **NET ASSETS** - end of year | $ 7,523 | $ 8,794 |

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

**Rosie Fishing**

# Appendix E: Basic Rationale for E.coli Testing and Lake-by-Lake Results

## Choosing sites

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

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 on 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, protected bays)
- Areas near inflows (from culverts, streams, wetlands)
- Areas of concentrated populations of wildlife (near wetlands, areas popular with waterfowl)

*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 $\frac{1}{4}$ 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.

## 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.

| **Balsam L: Killarney Bay** | | | | | |
|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing<br>E.coli/100 mL | | | | | |
| **Site No.** | **03-Jul-06** | **11-Jul-06** | **17-Jul-06** | **23-Jul-06** | **31-Jul-06** |
| Al | **280** | **400**, 9, **62**, 48, 21 | 2, 4, 7, 3, 7 | 4 | 7 |

**Balsam Lake: Killarney Bay**

This is the first year of testing in this area. When volunteers returned to retest after the July 3 high reading of 280 *E.coli*/100 mL, a sign had been placed there by Haliburton Kawartha Pine Ridge District Health Unit, indicating that the area was not recommended for swimming due to high bacterial counts.

There was heavy rain at the time of the July 3 reading. Although geese are not often seen there, they were on the dock that day.

The retests were taken along a 300-metre stretch of shore near the original high reading. Interestingly, the lowest readings of the five, only 9 *E.coli*/100 mL, was at the original site, while the other, higher readings were nearby.

There is some agricultural runoff into this water.

Possible sources of bacteria, then, would be waterfowl and agricultural runoff.

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** | | | | | | |
|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing<br>E.coli/100 mL | | | | | | |
| **Site No.** | **4-Jul-06** | **17-Jul-06** | **24-Jul-06** | **31-Jul-06** | **8-Aug-06** | **5-Sep-06** |
| **1** | 8 | 1 | 0 | 4 | 1 | 0 |
| **2** | 6 | 0 | 2 | 10 | 3 | 0 |
| **3** | 4 | 0 | 0 | 2 | 2 | 1 |
| **5** | 12 | 0 | 0 | 6 | 0 | 5 |
| **7** | 6 | 0 | 4 | 1 | 0 | 1 |
| **8** | 0 | 0 | 0 | 1 | 5 | 5 |

**Big Bald Lake**

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

| **Buckhorn L: Buckhorn Sands** | | | | | |
|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing<br>E.coli/100 mL | | | | | |
| **Site No.** | **3-Jul-06** | **17-Jul-06** | **31-Jul-06** | **8-Aug-06** | **5-Sep-06** |
| **B** | **82** | 3, 7 | **63** | 47, ll, 8, 4, 7 | 0 |
| **C** | 8 | 0 | 1 | 0 | 7 |
| **D** | 4 | 3 | 3 | 6 | 0 |
| **E** | 16 | 6 | 2 | 2 | 5 |

**Buckhorn Lake: Buckhorn Sands**

Over 6 years of testing 4 sites, there have been only 3 readings over 50 *E.coli*/100 mL, all at Site B. There have been no obvious reasons for these elevated readings. It is interesting to note that there were 40 to 50 geese on shore near Site D on July 17, but the reading was 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.

| **Buckhorn L: Sandbirch Estates** | | | | | | |
|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing<br>E.coli/100 mL | | | | | | |
| **Site No.** | **4-Jul-06** | **16-Jul-06** | **23-Jul-06** | **30-Jul-06** | **7-Aug-06** | **4-Sep-06** |
| **4** | 4 | 16 | 2 | 1 | 0 | 3 |
| **2** | 2 | 4 | 2 | 0 | 0 | 6 |
| **19** | 19 | 18 | 26 | 11 | 0 | 30 |

**Buckhorn Lake: Sandbirch Estates**

Counts were uniformly low on all these sites, similar to previous years.

| **Chemong L: Lakeside Common** | | | |
|---|---|---|---|
| 2006 E.coli Lake Water Testing<br>E.coli/100 mL | | | |
| **Site No.** | **4-Jul-06** | **11-Aug-06** | **11-Sep-06** |
| ***CC1*** | 24 | 13 | 30 |

**Chemong Lake: Lakeside Common**

This is the first year of testing for this group. Counts were perhaps slightly elevated compared to most other KLSA sites tested in 2006 (where most counts were well below 20), but more readings would give a better indication of the bacterial status of this site.

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 L: Smith-Ennismore-Lakefield Ratepayers Assoc.** | | |
|---|---|---|
| 2006 E.coli Lake Water Testing E.coli/100 mL | | |
| **Site No.** | **7-Jul-06** | **28-Jul-06** |
| **DW** | 0 | 1 |
| **MF** | 3 | 2 |
| **SND** | 0 | 1 |
| **CW** | 0 | 1 |

**Chemong Lake: Smith-Ennismore-Lakefield Ratepayers**

Counts were very low at all 4 sites on the 2 dates, as they were in 2005.

| **Clear L: Birchcliff Property Owners of Douro-Dummer** | | | | | | |
|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing E.coli/100 mL | | | | | | |
| **Site No.** | **20-Jul-06** | **25-Jul-06** | **31-Jul-06** | **3-Aug-06** | **8-Aug-06** | **8-Sep-06** |
| **BB** | 3 | 4 | 15 | - | 1 | 0 |
| **1** | 1 | 0 | 1 | - | 1 | 0 |
| **2** | 0 | 1 | **89** | 0, 1, 2, 4, 0, 1 | 1 | 0 |
| **3** | 0 | 2 | 3 | - | 0 | 26 |
| **4** | 0 | 9 | 12 | - | 0 | **66** |
| **5** | 0 | 2 | 2 | - | 40 | 0 |
| **6** | 0 | 1 | 1 | - | 0 | 0 |
| **7** | 1 | 0 | 1 | - | 0 | 0 |
| **8** | 0 | 2 | 1 | - | 1 | 3 |

**Clear Lake: Birchcliff Property Owners of Douro-Dummer**

The elevated readings for Site 2/July 31 and Site 4/Sep 8 had no apparent cause, and there is no history of high counts at either site. Similar to other years, counts were generally below 10 *E.coli*/100 mL, indicating a very low level of bacterial pollution at these sites.

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 L: Kawartha Park** | | | | | |
|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing E.coli/100 mL | | | | | |
| **Site No.** | **13-Jul-06** | **18-Jul-06** | **1-Aug-06** | **9-Aug-06** | **6-Sep-06** |
| **A** | 0 | 0 | 0 | 0 | 0 |
| **B** | 0 | 1 | 0 | 0 | 2 |
| **C** | 0 | 0 | 0 | 2 | 0 |
| **D** | 3 | 32 | 8 | 4 | 2 |
| **P** | 0 | 0 | 2 | 0 | 0 |
| S | 6 | 1 | 2 | 0 | 0 |

**Clear Lake: Kawartha Park**

As in previous years, counts were uniformly low. This is interesting, as some of the sites were in bays with fairly low circulation and close to wetland areas.

| **Clear L: South-west Shore** | | | | | | |
|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing E.coli/100 mL | | | | | | |
| **Site No.** | **4-Jul-06** | **17-Jul-06** | **24-Jul-06** | **31-Jul-06** | **8-Aug-06** | **5-Sep-06** |
| **1** | 6 | 0 | 0 | 0 | 0 | 4 |
| **2** | 10 | 2 | 2 | 4 | 3 | 3 |
| **3** | 2 | 4 | 0 | 0 | 0 | 0 |

**Clear Lake: Southwest Shore**

As in previous years, counts were uniformly 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.

| **Julian Lake** | | | | | |
|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing E.coli/100 mL | | | | | |
| **Site No.** | **4-Jul-06** | **17-Jul-06** | **31-Jul-06** | **8-Aug-06** | **5-Sep-06** |
| **A** | 4 | 1 | 0 | 1 | 5 |
| **B** | 4 | 2 | 4 | 4 | 1 |
| **C** | 4 | 1 | 2 | 2 | 0 |

**Julian Lake**
Over 5 years of testing at 3 sites, there has never been a count of over 25 *E.coli*/100 mL on Julian Lake. This relatively small lake is ringed with cottages and has fairly limited inflow and outflow, indicating that septic systems are probably working effectively.

| **Katchewanooka Lake** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing E.coli/100 mL | | | | | | | | |
| **Site No.** | **4-Jul-06** | **17-Jul-06** | **18-Jul-06** | **24-Jul-06** | **31-Jul-06** | **1-Aug-06** | **8-Aug-06** | **5-Sep-06** |
| **1** | 14 | 1 | - | 3 | 0 | - | 4 | 4 |
| **2** | 26 | - | 11 | - | - | 16 | - | 14 |
| **3** | 6 | - | 5 | - | - | 4 | - | 3 |
| **4** | 2 | - | 13 | - | - | 1 | - | 5 |
| **5** | 8 | - | 24 | - | - | 15 | - | 6 |
| **6** | 8 | - | 19 | - | - | 15 | - | 1 |
| **7** | 16 | 7 | - | 0 | 4 | - | 3 | 6 |

**Katchewanooka Lake**
This year's readings were uniformly low. It is interesting that the mouth of a stream, Site 5, which had high counts recurring in 2003 and 2004, has had very low counts in 2005 and 2006.

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** | | | | | | |
|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing E.coli/100 mL | | | | | | |
| **Site No.** | **4-Jul-06** | **17-Jul-06** | **24-Jul-06** | **2-Aug-06** | **8-Aug-06** | **5-Sep-06** |
| **9** | 2 | 1 | 7 | 12 | 1 | 2 |
| **13** | 2 | 7 | 0 | 6 | 0 | 1 |
| **14** | 2 | 3 | 1 | 8 | 0 | 1 |

**Lovesick Lake**

Counts were consistently low, as they have been for the previous two years.

Sunny Day on Lovesick

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** | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing E.coli/100 mL | | | | | | | |
| **Site No.** | **4-Jul-06** | **7-Jul-06** | **17-Jul-06** | **24-Jul-06** | **30-Jul-06** | **8-Aug-06** | **4-Sep-06** |
| **1** | 14 | - | 3 | 2 | 4 | 1 | 6 |
| **2** | 0 | - | 6 | 1 | 1 | 2 | 1 |
| **3** | 38 | - | 30 | 37 | 35 | **67** | 42 |
| **4A** | 36 | - | 36 | 28 | 20 | 7 | 29 |
| **4B** | **100** | 45, **56**, **54**, **61**, **54** | **85** | **72** | - | 32 | 39 |
| **5** | 2 | - | 3 | 0 | 0 | 2 | 4 |
| **7** | 14 | - | 1 | - | - | - | - |
| **8** | 20 | - | 2 | 8 | 5 | 13 | 2 |
| **9** | 4 | - | 7 | 0 | 13 | 0 | 4 |
| **10** | 0 | - | 0 | 0 | 4 | 0 | 0 |
| **11** | 28 | - | 11 | 3 | 2 | 5 | 7 |
| **12** | 16 | - | 4 | 2 | 7 | 5 | 2 |
| **13A** | 16 | - | 5 | 4 | 3 | 0 | 1 |
| **14** | 2 | - | 7 | 1 | 3 | 11 | 1 |

**Lower Buckhorn Lake**

Sites 3 and 4 were the only sites with counts over 50. These sites have had recurring high counts over the years, probably due to being near the mouths of creeks flowing from rich wildlife areas. Counts fall quickly in sites downstream the mouth of the inflow. Local landowners have been informed of this issue.

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 L: Concession 17 Pigeon Lake Cottagers' Assoc.** | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing<br>E.coli/100 mL | | | | | | | |
| **Site No.** | **3-Jul-06** | **9-Jul-06** | **16-Jul-06** | **24-Jul-06** | **31-Jul-06** | **7-Aug-06** | **4-Sep-06** |
| **A** | 20 | - | 2 | 1 | 2 | **59** | 1 |
| **B** | 24 | - | 10 | 0 | 1 | 17 | 27 |
| **C** | **240** | 0, 0 | 8 | 0 | 1 | 16 | 1 |

**Pigeon Lake: Concession 17 Pigeon Lake Cottagers' Assoc.**

The count of 240 *E.coli*/100 mL on July 3 was very unusual for Site 3. There were geese and ducks observed at the site when it was tested, and there had been heavy rain just prior to testing.

The count of 59 at Site A/Aug 7 was unusual for this site, which has had consistently low counts in the past. It was very windy, so the water had been churned up, which may have introduced bacteria from the sediments into the water column.

| **Pigeon L: North Pigeon Lake Ratepayers Assoc.** | | | | |
|---|---|---|---|---|
| 2006 E.coli Lake Water Testing<br>E.coli/100 mL | | | | |
| **Site No.** | **5-Jul-06** | **18-Jul-06** | **9-Aug-06** | **5-Sep-06** |
| **1** | 4 | 2 | 1 | 1 |
| **5** | 21 | 28 | 32 | 10 |
| **6** | 4 | 40 | - | 52 |
| **8** | 0 | 0 | 0 | 0 |
| **13** | 43 | 16 | 0 | 8 |

**Pigeon Lake: North Pigeon Lake Ratepayers Assoc.**

The readings were generally low, as in previous years. Site 6 is a recurring warm spot, and the two readings of 40 and 52 were normal for this area.

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 L: Victoria Place** | | | | | | |
|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing E.coli/100 mL | | | | | | |
| **Site No.** | **4-Jul-06** | **20-Jul-06** | **24-Jul-06** | **31-Jul-06** | **8-Aug-06** | **5-Sep-06** |
| **1** | 0 | 6 | 0 | 3 | 1 | 3 |
| **2** | 2 | 4 | 0 | 3 | 0 | 0 |
| **3** | 0 | 0 | 1 | 4 | 0 | 0 |
| **4** | 2 | 0 | 0 | 1 | 1 | 0 |
| **5** | 2 | 2 | 0 | 2 | 6 | 1 |

**Pigeon Lake: Victoria Place**

Counts were extremely low; it is unusual to see so many readings less than 10 *E.coli*/100 mL in the surface waters of the Kawartha Lakes.

| **Stony L: Association of Stony Lake Cottagers** | | | | | | |
|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing E.coli/100 mL | | | | | | |
| **Site No.** | **4-Jul-06** | **17-Jul-06** | **24-Jul-06** | **31-Jul-06** | **8-Aug-06** | **5-Sep-06** |
| **A** | 4 | 0 | 0 | 0 | 3 | 2 |
| **E** | 6 | 0 | 12 | 1 | 2 | 1 |
| **F** | 4 | 0 | 2 | 1 | 3 | 0 |
| **G** | 2 | 2 | 1 | 0 | 3 | 2 |
| **I** | 14 | 10 | 7 | 16 | 8 | 0 |
| **J** | 10 | 21 | 1 | 4 | 37 | 10 |
| **K** | 2 | 23 | 0 | 1 | 0 | 0 |
| **L** | 12 | 1 | 0 | 0 | 1 | 0 |
| **P** | 2 | 3 | 0 | 1 | **98** | 1 |
| **24** | 0 | 0 | 0 | 0 | 1 | 2 |
| **25** | 18 | 2 | 0 | 12 | 1 | 1 |
| **26** | 8 | 9 | 5 | 6 | 7 | 5 |
| **27** | 34 | 24 | 22 | 2 | 42 | 3 |
| **28** | 0 | 1 | 0 | 2 | 7 | 1 |

**Stony Lake**

Counts were unusually low throughout Stony Lake in 2006. Over the past few years, there have been occasional high counts in Sites J, 25, 26, 27 and 28. These are fairly confined bays with high human activity. No counts over 50 were seen in these areas 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.

| **Sturgeon L: North Shore Combined Group** | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing<br>E.coli/100 mL | | | | | | | |
| **Site No.** | **4-Jul-06** | **10-Jul-06** | **17-Jul-06** | **24-Jul-06** | **31-Jul-06** | **8-Aug-06** | **5-Sep-06** |
| **1** | 22 | - | **67** | 0, 1, 2, 0, 0 | 4 | 3 | 2 |
| **2** | 8 | - | **117** | 45, **64**, **56**, 47, **53** | **60** | 2 | 113 |
| **2A** | **74** | 22, 18, 13, 13, 16 | 5 | 2 | 18 | 15 | 4 |
| **3** | **52** | - | 24 | 12 | 33 | 16 | 11 |
| **4** | 4 | - | 0 | 1 | 1 | 0 | 0 |
| **5** | 42 | - | **63** | 2, 3, 3, 5, 1 | 1 | 0 | 3 |
| **6** | 4 | - | 5 | 0 | 2 | 0 | 0 |
| **SPGOLF** | 2 | - | - | 0 | 1 | 0 | 0 |
| **SPPD** | 2 | - | 7 | 4 | 4 | 12 | 3 |
| **WS1** | 40 | - | **111** | **218, 186, 201, 175, 192** | 6 | 1 | 47 |
| **SB1** | **216** | 38, 32, 27, 30, **55** | 16 | **207** | 17 | 9 | 8 |
| **SB2** | 20 | - | 5 | 10 | 1 | 11 | 1 |

**Sturgeon Lake: North Shore Combined**

Most of the sites on Sturgeon Lake would be considered normal for the Kawartha Lakes, with most counts below 20 and one or two counts between 20 and 50. However, Sites 2, SW1 and SB1 had higher counts than this over the summer, and have had high counts at least once before.

Site 2 is an open grassy area where Canada Geese congregate. The owner is trying to discourage waterfowl, but the problem continues.

WS1 had a count of over 100 on July 24/04; could the cause possibly be the same as this year's high counts on July 14 and July 24? The site is near some small streams that drain from agricultural land. It would be interesting to investigate these streams, but the high counts tend to come and go very quickly.

SB1 had higher counts than last year. This is an area where cows 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 Assoc.** | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing<br>E.coli/100 mL | | | | | | | |
| **Site No.** | **4-Jul-06** | **17-Jul-06** | **24-Jul-06** | **31-Jul-06** | **8-Aug-06** | **5-Sep-06** | **6-Sep-06** |
| **6** | 6 | 4 | 6 | 6 | 10 | 0 | - |
| **20** | 17 | 7 | 3 | 0 | 5 | 0 | - |
| **21** | 11 | 2 | 0 | 5 | 3 | 0 | - |
| **52** | 5 | 14 | 11 | 12 | 10 | - | 17 |
| **56** | 2 | 3 | 1 | 0 | 2 | 1 | - |
| **62** | 0 | 19 | 0 | 6 | 0 | 5 | - |
| **63A** | 3 | 1 | 0 | 0 | 0 | 0 | - |
| **65** | 1 | 42 | 0 | 3 | 23 | 1 | - |
| **70** | 7 | 0 | 0 | 1 | 3 | 0 | - |
| **78A** | 1 | 2 | 6 | 2 | 0 | 0 | - |
| **85** | 1 | 1 | 0 | 2 | 1 | - | 0 |
| **99** | 0 | 2 | 0 | 1 | 2 | - | 1 |

**Upper Stoney Lake**

As in other years, counts throughout Upper Stoney Lake were uniformly 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.** | | | | | | |
|---|---|---|---|---|---|---|
| 2006 E.coli Lake Water Testing<br>E.coli/100 mL | | | | | | |
| **Site No.** | **4-Jul-06** | **17-Jul-06** | **24-Jul-06** | **31-Jul-06** | **8-Aug-06** | **5-Sep-06** |
| **1** | 28 | 21 | 10 | 46 | 10 | 10 |
| **2** | 36 | 29 | 16 | 41 | 19 | 3 |

**White Lake**

The two sites on White Lake showed counts that would be considered somewhat higher than the average for the KLSA lakes. Generally, KLSA sites in 2006 had many readings under 10 *E.*coli/100 mL. However, the White Lake sites were in an area of shallow water, rich in wildlife, so the many counts between 20 and 50 would be considered normal for this type of area. The heavy rain before July 4 recorded by the volunteer may have raised the counts somewhat. However, there was also heavy rain before the September 5 low counts.

## Appendix F: 2006 Phosphorus and Secchi Data

Following is the complete record of phosphorus and Secchi disk measurements taken in 2006. 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?

| LAKE NAME | Site Description | Date | Secchi (m) | TP (ug/L) | TP (ug/L) | TP Avg. |
|---|---|---|---|---|---|---|
| UPPER STONEY | Quarry Bay | 2006/05/09 | 4.6 | 6.2 | 6.7 | 6.5 |
| UPPER STONEY | Quarry Bay | 2006/06/16 | 6.6 | 5.8 | 7.5 | 6.7 |
| UPPER STONEY | Quarry Bay | 2006/07/04 | 4.1 | 6.6 | 6.5 | 6.6 |
| UPPER STONEY | Quarry Bay | 2006/07/31 | 5.5 | 7.3 | 8.1 | 7.7 |
| UPPER STONEY | Quarry Bay | 2006/09/06 | 6.5 | 6.8 | 5.8 | 6.3 |
| UPPER STONEY | Quarry Bay | 2006/10/08 | 7.0 | 5.9 | 5.3 | 5.6 |
| UPPER STONEY | Young Bay | 2006/05/09 | 4.5 | 7.1 | 9.5 | 8.3 |
| UPPER STONEY | Young Bay | 2006/06/16 | 7.1 | 3.1 | 2.6 | 2.9 |
| UPPER STONEY | Young Bay | 2006/07/04 | 4.4 | 5.4 | 5.4 | 5.4 |
| UPPER STONEY | Young Bay | 2006/07/31 | 4.0 | 7.8 | 7.7 | 7.8 |
| UPPER STONEY | Young Bay | 2006/09/06 | 7.0 | | | |
| UPPER STONEY | Young Bay | 2006/10/08 | 8.6 | 5.2 | 5.7 | 5.5 |
| UPPER STONEY | S Bay, deep spot | 2006/05/09 | 3.3 | 19.4 | 11.4 | 15.4 |
| UPPER STONEY | S Bay, deep spot | 2006/06/16 | 3.3 | 7.0 | 9.4 | 8.2 |
| UPPER STONEY | S Bay, deep spot | 2006/07/04 | 3.3 | 8.7 | 11.4 | 10.1 |
| UPPER STONEY | S Bay, deep spot | 2006/07/31 | 3.3 | 11.0 | 11.6 | 11.3 |
| UPPER STONEY | S Bay, deep spot | 2006/09/05 | 3.3 | 8.5 | 7.7 | 8.1 |
| UPPER STONEY | S Bay, deep spot | 2006/10/08 | 3.3 | 7.2 | 7.1 | 7.2 |
| UPPER STONEY | Crowes Landing | 2006/05/09 | 5.2 | 6.4 | 5.6 | 6.0 |
| UPPER STONEY | Crowes Landing | 2006/06/16 | 6.7 | 5.2 | 5.2 | 5.2 |
| UPPER STONEY | Crowes Landing | 2006/07/04 | 4.0 | 7.5 | 6.9 | 7.2 |
| UPPER STONEY | Crowes Landing | 2006/07/31 | 5.0 | 8.4 | 7.9 | 8.2 |
| UPPER STONEY | Crowes Landing | 2006/09/05 | 6.5 | 6.4 | 6.1 | 6.3 |
| UPPER STONEY | Crowes Landing | 2006/10/08 | 7.3 | 6.0 | 6.4 | 6.2 |
| UPPER STONEY | Mid Lake, deep spot | 2006/05/09 | 4.6 | 5.7 | 6.2 | 6.0 |
| UPPER STONEY | Mid Lake, deep spot | 2006/06/16 | 6.6 | 2.4 | 3.0 | 2.7 |
| UPPER STONEY | Mid Lake, deep spot | 2006/07/04 | 4.4 | 9.3 | 7.3 | 8.3 |
| UPPER STONEY | Mid Lake, deep spot | 2006/07/31 | 4.0 | 8.2 | 7.9 | 8.1 |
| UPPER STONEY | Mid Lake, deep spot | 2006/09/06 | 7.0 | 6.9 | 7.3 | 7.1 |
| UPPER STONEY | Mid Lake, deep spot | 2006/10/08 | 7.0 | 7.5 | 6.2 | 6.9 |
| BALSAM LAKE | N/E end-Lightning Point | 2006/05/28 | 3.1 | 9.2 | 9.8 | 9.5 |
| BALSAM LAKE | N/E end-Lightning Point | 2006/06/16 | 3.2 | 11.4 | 8.7 | 10.1 |
| BALSAM LAKE | N/E end-Lightning Point | 2006/07/24 | 3.0 | 9.6 | 10.2 | 9.9 |
| BALSAM LAKE | N/E end-Lightning Point | 2006/08/24 | 4.7 | 10.1 | 7.3 | 8.7 |
| BALSAM LAKE | N/E end-Lightning Point | 2006/09/15 | 6.4 | 5.4 | 6.3 | 5.9 |

| LAKE NAME | Site Description | Date | Secchi (m) | TP (ug/L) | TP (ug/L) | TP Avg. |
|---|---|---|---|---|---|---|
| BALSAM LAKE | N/E end-Lightning Point | 2006/10/09 | 6.2 | 7.2 | 7.1 | 7.2 |
| BALSAM LAKE | South Bay-Killarney Bay | 2006/05/28 | 3.7 | 9.7 | 9.6 | 9.8 |
| BALSAM LAKE | South Bay-Killarney Bay | 2006/06/25 | 3.1 | 15.2 | 11.7 | 13.5 |
| BALSAM LAKE | South Bay-Killarney Bay | 2006/07/18 | 1.4 | 19.1 | 19.2 | 19.2 |
| BALSAM LAKE | South Bay-Killarney Bay | 2006/08/23 | 3.4 | 14.2 | 13.9 | 14.1 |
| BALSAM LAKE | South Bay-Killarney Bay | 2006/09/16 | 3.4 | 9.9 | 9.2 | 9.6 |
| BALSAM LAKE | South Bay-Killarney Bay | 2006/10/08 | 3.2 | 11.5 | 13.4 | 12.5 |
| CAMERON LAKE | E end, deep spot | 2006/05/24 | | 11.0 | 10.9 | 11.0 |
| CAMERON LAKE | E end, deep spot | 2006/08/08 | | 9.7 | 9.7 | 9.7 |
| CAMERON LAKE | E end, deep spot | 2006/09/16 | | 10.4 | 9.7 | 10.1 |
| PIGEON LAKE | Middle, Sandy Pt/Boyd Is. | 2006/05/22 | 3.0 | 19.5 | 20.9 | 20.2 |
| PIGEON | Middle, Sandy Pt/Boyd Is. | 2006/06/17 | 2.7 | 15.1 | 14.3 | 14.7 |
| PIGEON LAKE | Middle, Sandy Pt/Boyd Is. | 2006/07/03 | 2.9 | 14.8 | 17.3 | 16.1 |
| PIGEON LAKE | Middle, Sandy Pt/Boyd Is. | 2006/07/31 | 2.6 | 17.6 | 18.8 | 18.2 |
| PIGEON LAKE | Middle, Sandy Pt/Boyd Is. | 2006/09/04 | 2.8 | 14.2 | 12.8 | 13.5 |
| PIGEON | Middle, Sandy Pt/Boyd Is. | 2006/10/08 | 3.3 | 15.4 | 17.1 | 16.3 |
| PIGEON | N-400m N of Boyd Is. | 2006/06/06 | 3.8 | 15.7 | 13.1 | 14.4 |
| PIGEON | N-400m N of Boyd Is. | 2006/07/05 | 3.0 | 16.7 | 15.9 | 16.3 |
| PIGEON | N-400m N of Boyd Is. | 2006/07/18 | 4.0 | | | |
| PIGEON | N-400m N of Boyd Is. | 2006/08/09 | 4.0 | 19.3 | 18.5 | 18.9 |
| PIGEON | N-400m N of Boyd Is. | 2006/09/05 | 4.5 | 18.8 | 19.3 | 19.1 |
| PIGEON | N-400m N of Boyd Is. | 2006/10/02 | 3.2 | 19.0 | 19.5 | 19.3 |
| PIGEON | N end, Adjacent Con 17 | 2006/05/22 | 2.9 | 9.2 | 10.1 | 9.7 |
| PIGEON | N end, Adjacent Con 17 | 2006/06/17 | 2.8 | 15.7 | 15.2 | 15.5 |
| PIGEON | N end, Adjacent Con 17 | 2006/07/03 | 3.0 | 14.9 | 14.9 | 14.9 |
| PIGEON | N end, Adjacent Con 17 | 2006/07/31 | 2.4 | 17.7 | 18.4 | 18.1 |
| PIGEON | N end, Adjacent Con 17 | 2006/09/04 | 3.0 | 15.0 | 15.1 | 15.1 |
| PIGEON | N end, Adjacent Con 17 | 2006/10/08 | 3.6 | 14.0 | 13.9 | 14.0 |
| PIGEON | C 340 off Dead Horse Shoal | 2006/06/02 | 4.0 | 13.5 | 11.8 | 12.7 |
| PIGEON | C 340 off Dead Horse Shoal | 2006/07/05 | 4.0 | 12.1 | 13.8 | 13.0 |
| PIGEON | C 340 off Dead Horse Shoal | 2006/08/01 | | 16.3 | 18.0 | 17.2 |
| PIGEON | C 340 off Dead Horse Shoal | 2006/09/05 | 3.9 | 23.1 | 22.7 | 22.9 |
| PIGEON | N-300yds off Bottom Is. | 2006/06/06 | 3.2 | 18.9 | 13.5 | 16.2 |
| PIGEON | N-300yds off Bottom Is. | 2006/07/05 | 3.8 | | | |

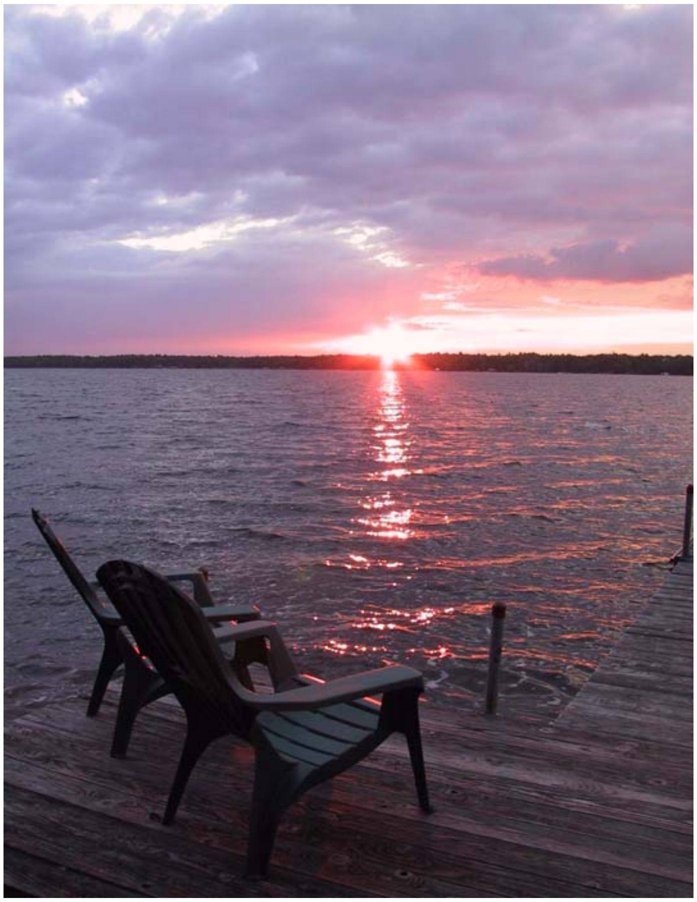
| LAKE NAME | Site Description | Date | Secchi (m) | TP (ug/L) | TP (ug/L) | TP Avg. |
|---|---|---|---|---|---|---|
| PIGEON | N-300yds off Bottom Is. | 2006/07/18 | 3.8 | | | |
| PIGEON | N-300yds off Bottom Is. | 2006/08/09 | 4.5 | 20.8 | 22.5 | 21.7 |
| PIGEON | N-300yds off Bottom Is. | 2006/09/05 | 4.5 | 15.4 | 15.3 | 15.4 |
| PIGEON | N-300yds off Bottom Is. | 2006/10/02 | 3.7 | 20.4 | 18.9 | 19.7 |
| STURGEON | Muskrat Is. at Buoy C388 | 2006/05/12 | 3.8 | 10.3 | 10.6 | 10.5 |
| STURGEON | Muskrat Is. at Buoy C388 | 2006/06/05 | 3.7 | 12.1 | 15.5 | 13.8 |
| STURGEON | Muskrat Is. at Buoy C388 | 2006/07/05 | 4.0 | 15.0 | 15.4 | 15.2 |
| STURGEON | Muskrat Is. at Buoy C388 | 2006/07/31 | 2.8 | 18.8 | 18.0 | 18.4 |
| STURGEON | Muskrat Is. at Buoy C388 | 2006/09/05 | 3.6 | 17.0 | 17.1 | 17.1 |
| STURGEON | Muskrat Is. at Buoy C388 | 2006/10/02 | 3.0 | 15.2 | 14.6 | 14.9 |
| STURGEON | Sturgeon Point Buoy | 2006/05/12 | 2.8 | 10.3 | 9.7 | 10.0 |
| STURGEON | Sturgeon Point Buoy | 2006/06/05 | 2.7 | 16.3 | 22.3 | 19.3 |
| STURGEON | Sturgeon Point Buoy | 2006/07/05 | 2.6 | 16.6 | 19.7 | 18.2 |
| STURGEON | Sturgeon Point Buoy | 2006/07/31 | 2.7 | 18.1 | 20.0 | 19.1 |
| STURGEON | Sturgeon Point Buoy | 2006/09/05 | 3.3 | 16.5 | 14.1 | 15.3 |
| STURGEON | Sturgeon Point Buoy | 2006/10/02 | 3.5 | 13.2 | 14.2 | 13.7 |
| STURGEON | S of Fenelon R-Buoy N5 | 2006/05/12 | 1.8 | 14.6 | 13.4 | 14.0 |
| STURGEON | S of Fenelon R-Buoy N5 | 2006/06/05 | 3.0 | 12.1 | 12.6 | 12.4 |
| STURGEON | S of Fenelon R-Buoy N5 | 2006/07/05 | 3.5 | 14.1 | 14.0 | 14.1 |
| STURGEON | S of Fenelon R-Buoy N5 | 2006/07/31 | 3.5 | 11.5 | 12.6 | 12.1 |
| STURGEON | S of Fenelon R-Buoy N5 | 2006/09/05 | 5.0 | 7.8 | 8.0 | 7.9 |
| STURGEON | S of Fenelon R-Buoy N5 | 2006/10/02 | 3.3 | 22.0 | 21.7 | 21.9 |
| STURGEON | Snug Harb Pr-Buoy CP6 | 2006/05/12 | 2.1 | 11.0 | 12.3 | 11.7 |
| STURGEON | Snug Harb Pr-Buoy CP6 | 2006/06/05 | 1.5 | 21.6 | 24.9 | 23.3 |
| STURGEON | Snug Harb Pr-Buoy CP6 | 2006/07/05 | 2.1 | 22.8 | 20.1 | 21.5 |
| STURGEON | Snug Harb Pr-Buoy CP6 | 2006/07/31 | 1.6 | 27.9 | 27.6 | 27.8 |
| STURGEON | Snug Harb Pr-Buoy CP6 | 2006/09/05 | 1.5 | 16.2 | 16.1 | 16.2 |
| STURGEON | Snug Harb Pr-Buoy CP6 | 2006/10/02 | 1.5 | 17.1 | 16.5 | 16.8 |
| BIG BALD | Mid Lake, deep spot | 2006/05/09 | | 8.6 | 8.1 | 8.4 |
| BIG BALD | Mid Lake, deep spot | 2006/06/02 | 5.5 | 8.2 | 7.9 | 8.1 |
| BIG BALD | Mid Lake, deep spot | 2006/07/02 | 6.7 | 8.7 | 10.2 | 9.5 |
| BIG BALD | Mid Lake, deep spot | 2006/08/08 | 2.8 | 12.5 | 13.0 | 12.8 |

| LAKE NAME | Site Description | Date | Secchi (m) | TP (ug/L) | TP (ug/L) | TP Avg. |
|---|---|---|---|---|---|---|
| BIG BALD | Mid Lake, deep spot | 2006/09/05 | 4.0 | 10.9 | 10.3 | 10.6 |
| BIG BALD | Mid Lake, deep spot | 2006/10/02 | 4.3 | 11.0 | 10.7 | 10.9 |
| BIG BALD | Bay nr golf course | 2006/05/10 | | 9.6 | 10.2 | 9.9 |
| BIG BALD | Bay nr golf course | 2006/06/02 | | 9.6 | 10.3 | 10.0 |
| BIG BALD | Bay nr golf course | 2006/07/04 | | 10.6 | 9.4 | 10.0 |
| BIG BALD | Bay nr golf course | 2006/08/08 | | 13.0 | 13.6 | 13.3 |
| BIG BALD | Bay nr golf course | 2006/09/05 | | 10.6 | 11.2 | 10.9 |
| BIG BALD | Bay nr golf course | 2006/10/02 | | 11.7 | 10.8 | 11.3 |
| CHEMONG | S end, S of Causeway | 2006/07/21 | | 14.6 | 13.8 | 14.2 |
| CHEMONG | S end, S of Causeway | 2006/08/02 | | 22.2 | 23.1 | 22.7 |
| CHEMONG | S end, deep spot | 2006/05/13 | | 35.1 | 35.1 | 35.1 |
| CHEMONG | S end, deep spot | 2006/06/16 | | 26.2 | 23.9 | 25.1 |
| CHEMONG | S end, deep spot | 2006/07/27 | | 25.7 | 25.9 | 25.8 |
| CHEMONG | S end, deep spot | 2006/08/30 | | 22.2 | 22.9 | 22.6 |
| CHEMONG | S end, deep spot | 2006/10/03 | | 28.8 | 22.6 | 25.7 |
| CHEMONG | Poplar Pt. | 2006/05/23 | 1.5 | 13.3 | 16.1 | 14.7 |
| CHEMONG | Poplar Pt. | 2006/07/20 | 1.0 | 12.6 | 13.2 | 12.9 |
| CHEMONG | Poplar Pt. | 2006/08/28 | 1.0 | 12.4 | 12.9 | 12.7 |
| CHEMONG | Poplar Pt. | 2006/09/18 | 1.2 | 13.2 | 13.0 | 13.1 |
| CHEMONG | Poplar Pt. | 2006/10/18 | 1.4 | 14.6 | 16.3 | 15.5 |
| CLEAR | MacKenzie Bay | 2006/07/26 | | **21.2** | **21.5** | |
| CLEAR | MacKenzie Bay | 2006/08/09 | | **38.5** | **30.9** | |
| CLEAR | Main Basin, deep spot | 2006/07/19 | 3.2 | 14.1 | 12.8 | 13.5 |
| CLEAR | Main Basin, deep spot | 2006/07/31 | 3.3 | 14.7 | 15.4 | 15.1 |
| CLEAR | Main Basin, deep spot | 2006/09/05 | | 19.8 | 19.8 | 19.8 |
| CLEAR | Main Basin, deep spot | 2006/10/01 | 3.8 | 17.5 | 16.9 | 17.2 |
| CLEAR | Fiddlers Bay | 2006/07/19 | 3.2 | 12.4 | 12.1 | 12.3 |
| CLEAR | Fiddlers Bay | 2006/07/31 | 3.3 | 14.3 | 13.9 | 14.1 |
| CLEAR | Fiddlers Bay | 2006/10/01 | 4.3 | 17.1 | 17.7 | 17.4 |
| WHITE (DUMMER) | S end, deep spot | 2006/05/07 | 3.1 | 8.8 | 8.5 | 8.7 |
| WHITE (DUMMER) | S end, deep spot | 2006/06/04 | 3.0 | 12.6 | 13.3 | 13.0 |
| WHITE (DUMMER) | S end, deep spot | 2006/06/21 | 3.1 | | | |
| WHITE (DUMMER) | S end, deep spot | 2006/07/03 | 3.9 | 14.7 | 13.5 | 14.1 |
| WHITE (DUMMER) | S end, deep spot | 2006/07/31 | 4.3 | 11.7 | 11.7 | 11.7 |
| WHITE (DUMMER) | S end, deep spot | 2006/09/05 | 4.4 | 14.0 | 11.7 | 12.9 |
| WHITE (DUMMER) | S end, deep spot | 2006/10/01 | 4.7 | 9.5 | 8.8 | 9.2 |
| LOWER BUCKHORN | Heron Island | 2006/04/30 | 4.8 | 10.7 | 10.6 | 10.7 |
| LOWER BUCKHORN | Heron Island | 2006/07/05 | 3.1 | 17.5 | 16.8 | 17.2 |
| LOWER BUCKHORN | Heron Island | 2006/07/30 | 2.1 | 21.0 | 19.7 | 20.4 |
| LOWER BUCKHORN | Heron Island | 2006/09/05 | 2.6 | 18.4 | 18.2 | 18.3 |
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/05/25 | 2.3 | 16.7 | 18.5 | 17.6 |

| LAKE NAME | Site Description | Date | Secchi (m) | TP (ug/L) | TP (ug/L) | TP Avg. |
|---|---|---|---|---|---|---|
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/06/04 | 2.9 | | | |
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/06/14 | 3.6 | 15.6 | 12.5 | 14.1 |
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/07/08 | 4.0 | 16.8 | 16.1 | 16.5 |
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/07/18 | 4.5 | | | |
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/07/28 | 2.7 | | | |
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/08/11 | 3.6 | 22.5 | 23.8 | 23.2 |
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/08/23 | 3.2 | 16.4 | 14.6 | 15.5 |
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/09/15 | 4.4 | | | |
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/09/23 | 5.3 | | | |
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/10/09 | 5.4 | 19.0 | 17.8 | 18.9 |
| LOWER BUCKHORN | Deer Bay W-Buoy C267 | 2006/10/21 | 6.7 | | | |
| LOWER BUCKHORN | Deer Bay-centre | 2006/04/30 | 4.3 | 8.7 | 8.8 | 8.8 |
| LOWER BUCKHORN | Deer Bay-centre | 2006/07/04 | 3.5 | 15.5 | 14.1 | 14.8 |
| LOWER BUCKHORN | Deer Bay-centre | 2006/07/20 | 2.1 | 18.7 | 20.2 | 19.5 |
| LOWER BUCKHORN | Deer Bay-centre | 2006/09/05 | 2.1 | 17.4 | 16.5 | 17.0 |
| JULIAN | Mid Lake, deep spot | 2006/04/30 | | 5.1 | 4.2 | 4.7 |
| JULIAN | Mid Lake, deep spot | 2006/06/02 | | 5.3 | 5.4 | 5.4 |
| JULIAN | Mid Lake, deep spot | 2006/07/04 | | 5.6 | 5.7 | 5.7 |
| JULIAN | Mid Lake, deep spot | 2006/07/31 | | 5.7 | 5.8 | 5.8 |
| JULIAN | Mid Lake, deep spot | 2006/08/31 | | 5.0 | 5.3 | 5.2 |
| JULIAN | Mid Lake, deep spot | 2006/10/03 | | 5.8 | 5.6 | 5.7 |
| KATCHEWANOOKA | S/E Douglas Island | 2006/05/17 | 3.7 | 11.4 | 11.4 | 11.4 |
| KATCHEWANOOKA | S/E Douglas Island | 2006/06/07 | 4.3 | 15.2 | 13.2 | 14.2 |
| KATCHEWANOOKA | S/E Douglas Island | 2006/06/19 | 5.2 | | | |
| KATCHEWANOOKA | S/E Douglas Island | 2006/07/04 | 4.7 | 15.9 | 15.7 | 15.8 |
| KATCHEWANOOKA | S/E Douglas Island | 2006/07/18 | 5.1 | | | |
| KATCHEWANOOKA | S/E Douglas Island | 2006/08/01 | 4.3 | 16.9 | 16.7 | 16.8 |
| KATCHEWANOOKA | S/E Douglas Island | 2006/08/15 | 4.5 | | | |
| KATCHEWANOOKA | S/E Douglas Island | 2006/09/05 | 6.5 | 18.4 | 18.6 | 18.5 |
| KATCHEWANOOKA | S/E Douglas Island | 2006/10/02 | 6.0 | 19.4 | 19.8 | 19.6 |
| KATCHEWANOOKA | S/E Douglas Island | 2006/10/05 | 5.6 | | | |
| KATCHEWANOOKA | Young Pt near locks | 2006/05/19 | 4.4 | 8.7 | 8.2 | 8.5 |
| KATCHEWANOOKA | Young Pt near locks | 2006/06/01 | 5.1 | 14.6 | 11.7 | 13.2 |
| KATCHEWANOOKA | Young Pt near locks | 2006/06/15 | 4.3 | | | |

| LAKE NAME | Site Description | Date | Secchi (m) | TP (ug/L) | TP (ug/L) | TP Avg. |
|---|---|---|---|---|---|---|
| KATCHEWANOOKA | Young Pt near locks | 2006/07/04 | 4.5 | 15.3 | 17.4 | 16.4 |
| KATCHEWANOOKA | Young Pt near locks | 2006/07/18 | 4.5 | | | |
| KATCHEWANOOKA | Young Pt near locks | 2006/07/31 | 4.3 | 16.7 | 16.0 | 16.4 |
| KATCHEWANOOKA | Young Pt near locks | 2006/08/12 | 5.0 | | | |
| KATCHEWANOOKA | Young Pt near locks | 2006/08/24 | 5.2 | | | |
| KATCHEWANOOKA | Young Pt near locks | 2006/09/05 | 5.0 | 17.8 | 19.3 | 18.1 |
| KATCHEWANOOKA | Young Pt near locks | 2006/10/01 | 4.9 | 20.2 | 20.5 | 20.4 |
| KATCHEWANOOKA | Young Pt near locks | 2006/10/16 | 5.1 | | | |
| LOVESICK | 80’ hole at N. end | 2006/05/14 | 3.5 | 14.5 | 11.3 | 12.9 |
| LOVESICK | 80’ hole at N. end | 2006/06/05 | 2.5 | 22.6 | 18.1 | 20.4 |
| LOVESICK | 80’ hole at N. end | 2006/07/04 | 4.0 | 20.4 | 19.9 | 20.2 |
| LOVESICK | 80’ hole at N. end | 2006/08/02 | 2.5 | 25.0 | 28.3 | 26.7 |
| LOVESICK | 80’ hole at N. end | 2006/09/05 | 4.3 | 19.2 | 20.4 | 19.8 |
| LOVESICK | 80’ hole at N. end | 2006/10/02 | 5.5 | 13.1 | 13.6 | 13.4 |
| LOVESICK | Spenceley’s Bay | 2006/05/14 | 3.5 | 16.2 | 14.2 | 15.2 |
| LOVESICK | Spenceley’s Bay | 2006/06/05 | 2.8 | 33.7 | 28.8 | 31.3 |
| LOVESICK | Spenceley’s Bay | 2006/07/04 | 5.0 | 22.5 | 21.5 | 22.0 |
| LOVESICK | Spenceley’s Bay | 2006/08/02 | 3.3 | 22.8 | 23.4 | 23.1 |
| LOVESICK | Spenceley’s Bay | 2006/09/05 | 4.8 | 21.2 | 21.3 | 21.3 |
| LOVESICK | Spenceley’s Bay | 2006/10/02 | 4.5 | 12.9 | 13.7 | 13.3 |
| LOVESICK | McCallum Island | 2006/05/14 | 3.5 | 13.5 | 13.1 | 13.3 |
| LOVESICK | McCallum Island | 2006/06/05 | 2.5 | 18.1 | 18.5 | 18.3 |
| LOVESICK | McCallum Island | 2006/07/04 | 4.5 | 27.1 | 19.0 | 23.1 |
| LOVESICK | McCallum Island | 2006/08/02 | 2.5 | 29.0 | 30.3 | 29.7 |
| LOVESICK | McCallum Island | 2006/09/05 | 4.5 | 19.7 | 20.0 | 19.9 |
| LOVESICK | McCallum Island | 2006/10/02 | 5.3 | 12.5 | 12.6 | 12.6 |
| BUCKHORN (U) | Narrows, red buoy C310 | 2006/06/01 | 2.1 | 19.4 | 21.0 | 20.2 |
| BUCKHORN (U) | Narrows, red buoy C310 | 2006/07/03 | 3.0 | 17.4 | 16.5 | 17.0 |
| BUCKHORN (U) | Narrows, red buoy C310 | 2006/07/31 | 0.6 | 22.4 | 20.7 | 21.6 |
| BUCKHORN (U) | Narrows, red buoy C310 | 2006/09/05 | 2.4 | 19.9 | 19.3 | 19.6 |
| BUCKHORN (U) | Narrows, red buoy C310 | 2006/10/01 | 4.3 | 13.1 | 13.2 | 13.2 |
| BUCKHORN (U) | Mid, 30m from shore | 2006/06/20 | | 18.9 | 14.8 | 16.9 |
| BUCKHORN (U) | Mid, 30m from shore | 2006/07/03 | | 21.4 | 19.2 | 20.3 |
| BUCKHORN (U) | Mid, 30m from shore | 2006/08/02 | | 20.8 | 20.7 | 20.8 |
| BUCKHORN (U) | Mid, 30m from shore | 2006/09/05 | | 19.0 | 17.9 | 18.5 |
| BUCKHORN (U) | Mid, 30m from shore | 2006/10/01 | | 10.4 | 10.5 | 10.5 |
| STONY | Gilchrist Bay | 2006/05/22 | 4.0 | 12.2 | 12.1 | 12.2 |
| STONY | Gilchrist Bay | 2006/06/18 | 3.5 | 17.5 | 13.6 | 15.6 |
| STONY | Gilchrist Bay | 2006/07/30 | 3.6 | 15.7 | 15.6 | 15.7 |
| STONY | Gilchrist Bay | 2006/09/01 | 3.0 | 13.2 | 14.5 | 13.9 |
| STONY | Gilchrist Bay | 2006/09/17 | 4.0 | 15.5 | 16.4 | 16.0 |

| LAKE NAME | Site Description | Date | Secchi (m) | TP (ug/L) | TP (ug/L) | TP Avg. |
|---|---|---|---|---|---|---|
| STONY | Gilchrist Bay | 2006/10/09 | 4.9 | 19.3 | 13.1 | 16.2 |
| STONY | Mouse Is. | 2006/05/07 | 3.1 | 12.2 | 11.4 | 11.8 |
| STONY | Mouse Is. | 2006/05/30 | 4.0 | 11.6 | 20.6 | 11.6 |
| STONY | Mouse Is. | 2006/07/04 | 3.8 | 16.6 | 16.8 | 16.7 |
| STONY | Mouse Is. | 2006/07/31 | 3.2 | 13.4 | 14.1 | 13.8 |
| STONY | Mouse Is. | 2006/09/05 | 3.0 | 17.7 | 16.2 | 17.0 |
| STONY | Mouse Is. | 2006/09/25 | 4.5 | 16.7 | 14.5 | 15.6 |
| STONY | Hamilton Bay | 2006/05/07 | 3.1 | 11.9 | 10.7 | 11.3 |
| STONY | Hamilton Bay | 2006/05/30 | 4.1 | 15.6 | 12.0 | 13.8 |
| STONY | Hamilton Bay | 2006/07/04 | 4.0 | 13.7 | 14.9 | 14.3 |
| STONY | Hamilton Bay | 2006/07/31 | 3.2 | 13.7 | 14.6 | 14.2 |
| STONY | Hamilton Bay | 2006/09/05 | 4.0 | 13.4 | 13.4 | 13.4 |
| STONY | Hamilton Bay | 2006/09/25 | 4.2 | 16.4 | 14.8 | 15.6 |
| SANDY | Mid Lake, deep spot | 2006/05/26 | 4.1 | 5.2 | 3.9 | 4.6 |
| SANDY | Mid Lake, deep spot | 2006/06/17 | 5.0 | 4.1 | 4.5 | 4.3 |
| SANDY | Mid Lake, deep spot | 2006/07/08 | 3.7 | 5.3 | 4.6 | 5.0 |
| SANDY | Mid Lake, deep spot | 2006/08/31 | 3.0 | 5.4 | 5.4 | 5.4 |
| SANDY | Mid Lake, deep spot | 2006/09/16 | 3.6 | 8.7 | 6.9 | 7.8 |
| SANDY | Mid Lake, deep spot | 2006/10/08 | 4.1 | 6.6 | 7.4 | 7.0 |
| | | | | | | |



End of the day

## Appendix G: Glossary

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

**Algae** – Aquatic one-celled or colonial plant-like organisms that contain chlorophyll and do not differentiate into specialized cells and tissues like roots and leaves.

**Algal blooms** – Sudden proliferations of algae.

**Allelopathy** – A process in which host plants excrete chemical compounds that inhibit the growth or germination of other plants on or near them; some plants excrete substances toxic to grazing insects or animals.

**Alvar plain** – A drought-prone, rare prairie-like environment located on almost bare limestone bedrock.

**Base flow** – Amount of water flowing in a stream during extended dry weather. This water is not runoff, but seepage from groundwater, wetlands or nearby large bodies of water.

**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.

**Canadian Shield** – Also called the Precambrian or Laurentian Shield, it covers as bedrock much of central and northeastern Canada and the United States. It is one of the oldest geological formations in the world, composed of metamorphosed rocks originally laid down between 4.5 billion and 540,000 million years ago. Often covered with forest, it provides relatively low-phosphorus water to the Kawartha Lakes.

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

***E.coli* bacteria** – Bacteria living 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 these bacteria.

**Epiphytes** – Algae that cling to and grow on submerged aquatic vegetation.

**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.

**Evapotranspiration** – The part of the hydrologic cycle in which water vapour moves from the Earth to the atmosphere, evaporating off surface water and rising from trees and other plants through pores in their leaves (transpiration).

**Flushing period** – The average amount of time that water remains in a lake before flowing out.

**Freshet** – Meltwater and rainwater that pours into watercourses in the spring.

**Glacial till** – Geological deposit of unsorted sand, clay and rocks carried along by a glacier and dumped when it melts.

**Lake morphology** – Factors relating to the physical structure of a lake, such as depth, shape, amount of shoreline, etc.

**Lentic systems** – Still-water environments such as ponds and lakes.

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

**Marl lake** – These lakes receive drainage from limestone dominated watersheds. Acidic rainfall dissolves the limestone as it percolates through the rocks or soil. When the high-calcium water in the lake warms in the summer, the carbon dioxide-forming carbonic acid is reduced and the dissolved limestone precipitates out. This limestone (calcium carbonate) that collects on the lake bottom is called marl.

**Metaphyton** – Floating algae that can get tangled up in beds of macrophytes and floating debris.

**Paleozoic** – Era of geologic time from about 540 to 250 million years ago in which major life forms evolved, such as invertebrates, trilobites, fish, reptiles and land plants. In the Kawartha Lakes area, the limestone is Paleozoic and often contains fossils of sea creatures.

**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 means one unit of phosphorus within a billion units of water, which corresponds to one drop of water in an Olympic-sized swimming pool. For our purposes, micrograms per litre and parts per billion are 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 the atmosphere, from within the bedrock (especially the 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 free-floating algae that can turn lake water greenish, and are fed upon by zooplankton, zebra mussels, baby fish, etc.

**Regression analysis** – A statistical method of modeling the association between different variables.

**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.

**Secchi disk** – A circular disk with alternating black and white quarters, which is lowered to specific depths in surface water and used to estimate water clarity.

**Trophic gradient** – A gradual change in the level of nutrients (usually phosphorus) and autotrophs (phytoplankton or macrophytes) in the water. The gradient in the Kawarthas is established by higher phosphorus concentrations in lakes fed by agricultural watersheds mixing with lower phosphorus water fed by watersheds of the Canadian Shield.

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

## Notes