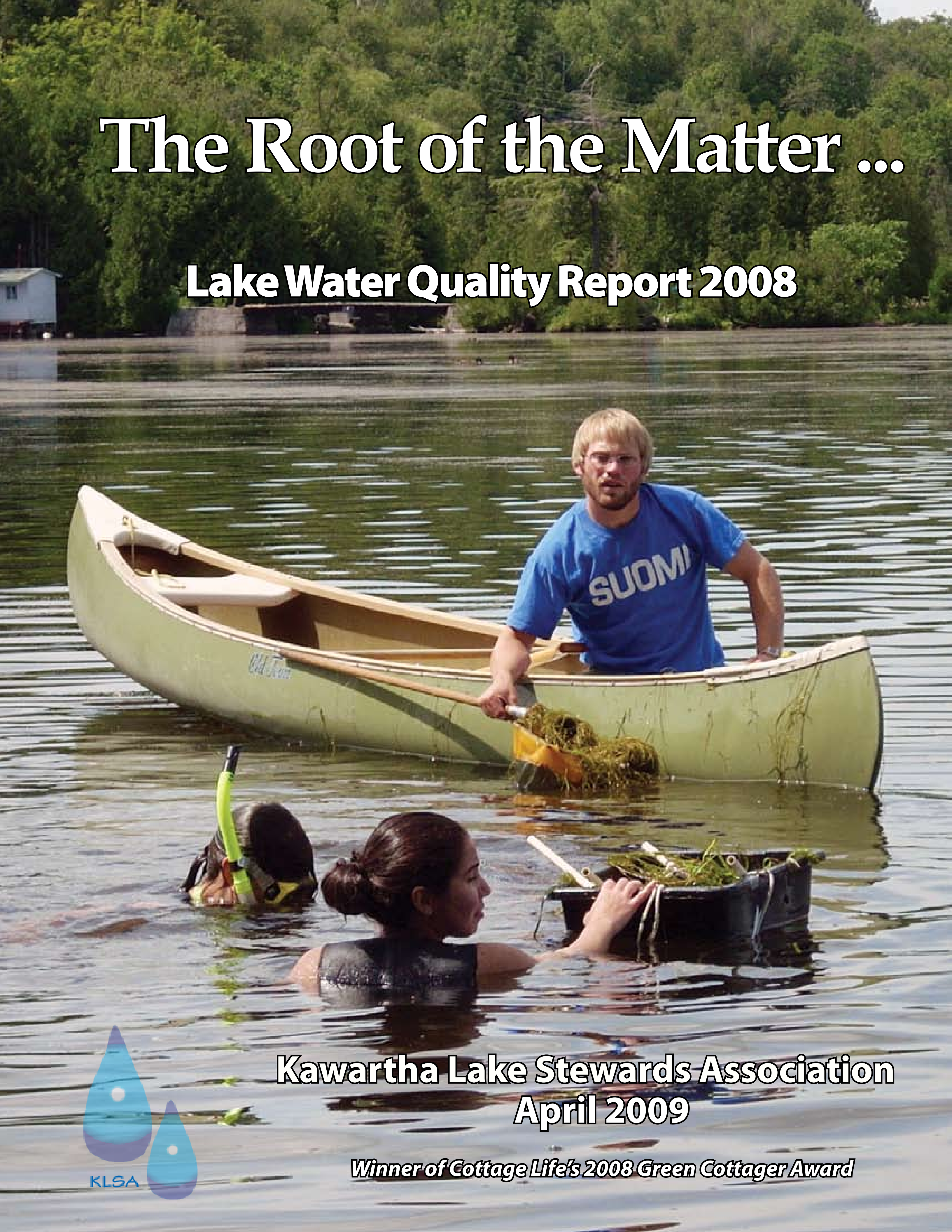
The Root of the Matter ...

Lake Water Quality Report 2008



Kawartha Lake Stewards Association
April 2009

Winner of Cottage Life's 2008 Green Cottager Award

Kawartha Lake Stewards Association
Lake Water Quality Report - 2008

KLSA

Please Note: To obtain copies of our report or to find out more about KLSA please contact:

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You can view Adobe pdf versions of KLSA reports on the web at the KLSA website:

http://klsa.wordpress.com

Our cover:

In 2008, KLSA embarked on an ambitious program to understand the ecology and management of aquatic plants in the Kawartha Lakes. The findings of our study provide some answers, and many questions. They point to the need to take a holistic approach to thinking about our lakes: aquatic plants provide fish habitat and breeding areas while at the same time they can be an impediment to recreational activities in our lakes. The Aquatic Plants Guide is a first step, but certainly more work needs to be done to get to the Root of the Matter.

The Ontario Trillium Foundation
La Fondation Trillium de l'Ontario

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The KLSA Editorial Committee at work: (standing, l-r) Kathleen Mackenzie, Kevin Walters; (seated, l-r) Sheila Gordon-Dillane, Simon Conolly, Pat Moffat.

Chair's Message

The Kawartha Lake Stewards Association (KLSA) is a 9-year old all-volunteer organization of cottagers, year-round residents, and business owners in the portion of the watershed of the Trent-Severn Waterway that runs from Shadow and Balsam Lakes downstream to Katchewanooka and White Lakes. We represent lakes in this watershed that are within the canal system or are direct feeders into the system. In 2008, KLSA represented 27 associations from 16 different lakes. We tested for *E.coli* bacteria at 98 sites in 12 lakes and for phosphorus and water clarity at 37 sites in 15 lakes.

The Aquatic Plants Study
What a year 2008 was for KLSA! We undertook our first major research and public education project, supported by an Ontario Trillium Foundation (OTF) grant of $50,000. The project, coordinated by Master's candidate Andrea Hicks of Trent University, with four undergraduate team members, evaluated the different methods of aquatic weed control that shoreline owners are using in the Kawarthas. The project combined in-the-water field work with lab analysis and identification. KLSA undertook this practical project after several years of initial research headed by our scientific advisor, Dr. Eric Sager, of Trent University and Fleming College. KLSA members, like most of the public living on or visiting the Kawartha Lakes, had become increasingly frustrated by the copious weed growth that has marred our enjoyment of the lakes. What could we do to decrease the amount of near-shore weeds effectively, without harming the aquatic habitat? That was the main question that motivated the study.

Members of the Aquatic Plants Study team at work during the summer, 2008.

We have now completed the first year of the project – the research stage – and are entering the public education phase, with the publication of KLSA's Aquatic Plants Guide. This spring and summer we will be distributing this booklet to as many shoreline owners as possible in the Kawarthas, with the help of many partners, including Lakeland Alliance, Gamiing Centre for Sustainable Lakeshore Living, Kawartha Protect Our Water (KPOW), the Federation of Ontario Cottagers' Associations (FOCA), and local municipalities and libraries. The purpose of the Guide is to present and summarize our research findings clearly so that individuals can make informed decisions about which weed control methods to use, if any. See the article on page 30 for a more detailed description of KLSA's Aquatic Plants Study.

Expanding KLSA's reach and programs
A wonderful by-product of the Aquatic Plants Study has been the new partnerships that KLSA has formed.

Foremost among them is the new relationship between our organization and the City of Kawartha Lakes. KLSA was originally founded by networking volunteers among the lower lakes, primarily Lower Buckhorn, Lovesick, Stony, Clear and Katchewanooka. For several years, the KLSA Board of Directors has pondered how to extend the reach of our testing programs and public education into the "upper lakes" in the watershed such as Sturgeon, Cameron, Shadow, and Balsam. It seemed an impossible goal to achieve without the help and commitment of the City of Kawartha Lakes Council – which we now have!

A specific financial need arising in the Aquatic Plants project led to the City of Kawartha Lakes donating $4,000 towards the preparation and distribution of the Aquatic Plants Guide. This partnership was achieved after considerable dialogue between KLSA and members of Council and Committees. Even more exciting, the City of Kawartha Lakes is now committing generous, ongoing annual support to KLSA. This money will enable us to do what we have long hoped to do: extend our programs into the upper lakes, making contact with cottage and residents' associations there, so that KLSA will become much more representative of the entire watershed. The City's commitment is a welcome endorsement of KLSA's effectiveness as a volunteer water monitoring and public education organization. We look forward to this coming year of expansion and new members!

New mapping project with Fleming College students

Admire the new maps of our testing area on pages 72 and 73 (Appendix I). They represent stage 1 in a new GIS mapping project, a partnership between KLSA and Fleming College. The KLSA Board has long felt the need for a more comprehensive map of our area, especially showing water sources for our lakes – inflows and outflows – so that we can follow the routes of nutrients like phosphorus. The students will create layers of maps, to be delivered in final form in August, showing, in addition to inflows and outflows, such features as the underlying geology of the land and lakes, land use patterns, location of sewage treatment plants, our phosphorus testing sites – and perhaps even a 3-D version of the map to be viewed on the computer. Congratulations to Kathleen Mackenzie for spearheading this project, including writing the successful application to the Co-op Project Program. She and Kevin Walters have met with the students and will continue to work with them through the completion of the project.

This annual report
We hope you will enjoy our 2008 report. Introducing the report is a third section from the essay on the **physical overview of the Kawartha Lakes** by KLSA Vice-Chair Kevin Walters. (If you missed the earlier parts of this essay, visit the KLSA website and look up the 2006 and 2007 annual reports.) As usual, Kathleen Mackenzie makes sense of the **results of the *E.coli* and phosphorus testing** for us in two articles, with the raw data presented in appendices. Dr. Eric Sager contributes a description of his fascinating research on **nitrogen isotopes** in aquatic plants. I present **the story of KLSA's "weeds study"** from its conception, through the OTF application process, the research stage itself, to the "product," the Aquatic Plants Guide. Mike Stedman contributes a **lively sidebar** to this history, from his perspective as the owner of one of the research sites. MNR scientists give us an **update on the 2007 carp die-off**. Finally, Kevin Walters writes about some **local aquatic curiosities**.

Thank-yous
In addition to our sincere thanks extended to the Ontario Trillium Foundation and the City of Kawartha Lakes, KLSA thanks the Trent-Severn Waterway (TSW) for its financial partnership, which funds our basic programs each year, and the townships of Galway-Cavendish and Harvey, Douro-Dummer, and Smith-Ennismore-Lakefield for ongoing support. Special thanks this year to the Peterborough County Stewardship Council and the Stony Lake Heritage Foundation, both of which contributed substantially to the Aquatic Plants Study. A great many businesses and individuals also contributed to this project. Please see the Aquatic Plants Guide for a complete list. For other valued contributors to KLSA's ongoing programs, see Appendix B in this report.

Many thanks to all the KLSA Board members and volunteers who work so hard to make our programs successful. Special thanks to Dr. Eric Sager for his continuing hard work and enthusiasm, and to Andrea Hicks, who coordinated the Aquatic Plants Study so well. We are grateful to Simon Conolly of the *Lakefield Herald,* who handles the production work for our publications: our brochures, this annual report, and the new Aquatic Plants Guide.

Thanks to George Gillespie of McColl Turner Chartered Accountants in Peterborough for serving as our volunteer accountant and reviewing our financial records, to MOE's Lake Partner Program for phosphorus sample analysis and guidance. Thanks to the Buckhorn Community Centre for space for our 2008 fall and spring meetings.

Spring meeting
In keeping with our new partnership with the City of Kawartha Lakes, and our aim of increasing membership in the upper lakes, KLSA's spring meeting will take place in Bobcaygeon rather than Buckhorn this year.

All are welcome on **Saturday, May 9th at 10:00 a.m. at the Bobcaygeon Arena, 51 Mansfield Street, Bobcaygeon**. The meeting will serve as the formal launch of KLSA's Aquatic Plants Guide, presented by either Andrea Hicks or Dr. Eric Sager. Our guest speaker will be Dave Ness, Water Control Engineer at the TSW, who will talk about the challenges of managing water levels in the canal system, a topic that impacts KLSA's major concerns of water quality and aquatic habitat. We also hope to have students from the Fleming College map project at the meeting.

Pat Moffat
KLSA Chair

Kyle Borrowman of the Aquatic Plants Study team meets some local fauna during his field work in the summer, 2008.

Executive Summary - 2008 Report

The Kawartha Lake Stewards Association (KLSA) is a volunteer-driven, non-profit organization of cottagers, year-round residents and local business owners on the Kawartha Lakes. Established to provide a coordinated approach to lake water monitoring, the Association tests lake water for phosphorus, water clarity and *E.coli* bacteria during the spring, summer and early fall. In recent years, KLSA has expanded its activities significantly, primarily into the areas of research and public education. KLSA research initiatives have investigated various factors that affect water quality such as sources of phosphorus and, in 2008, methods of aquatic plant management. Public education initiatives have included the preparation of an aquatic plant manual and a map, showing flows into and out from the Kawartha Lakes, that is included in this report.

Introduction to the Watershed: The Central Lakes 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). In our 2006 report, KLSA published an overview of the lakes, written by Board member Kevin Walters. In the 2007 report, Kevin discussed the upper lakes of the Kawarthas, those located north of Fenelon Falls.

In this report, Kevin continues his journey through the Central Lakes: Sturgeon, Pigeon, Little and Big Bald, Sandy, Buckhorn and Chemong Lakes and the Mississagua River. The central lakes have a combined surface area of 180 square kilometres (70 square miles). They share a number of common characteristics including low mean depths and nutrient enrichment. Sturgeon Lake is a large "Y" shaped lake with 3 towns, Lindsay, Bobcaygeon and Fenelon Falls at each end of the branches of the "Y". Its geology is primarily limestone with an outcropping of Shield to the north. The three sub-basins in the middle of the Kawartha Lakes, Pigeon, Buckhorn and Chemong, were once known as one lake, which Kevin calls 'Lake Kawartha'. Together, along with Big and Little Bald Lakes, it comprises about 40% of the entire surface area of the Kawartha Lakes. The north end of this area is in the Canadian Shield, the middle section passes through the limestone plain and the south end is seated in the glacial deposits of drumlins and moraine. The Mississagua River was once an important logging route, connecting with Big Bald Lake. Scotts Mills dam, the last remnant of a sawmill community established in about 1852, is located just west of Big Bald Lake on the river. Finally, Sandy Lake, with its emerald-turquoise spring water, high mineral content and marly bottom, is a particularly unique feature of the Kawarthas. The article provides highlights of the history, geology and geography of the region.

***E.coli* Bacteria Testing**

In 2008, KLSA volunteers tested 98 sites in 12 lakes. Each site was tested up to 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. In general, *E.coli* levels were low throughout the summer, consistent with other years. Of the 93 sites tested 4 or more times during the summer, 66 were "very clean" (no readings above 20), 13 were "clean" (1 or 2 readings over 20), 6 were "slightly elevated" (3 readings between 20-100) and 8 were designated as "needing observation" because they had more than 2 counts over 100 or more than 3 counts over 20. The high results are generally due to pollution from waterfowl or cattle or runoff from wetlands or agricultural areas. On one date, high levels were found in several sites in Sturgeon Lake, possibly due to stirred-up sediments. On the whole, 2008 bacteria levels in the Kawartha Lakes were low, despite the heavy rainfall and high runoff. Detailed lake and site results can be found in Appendix E.

Phosphorus Testing

In 2008, as part of the Ministry of the Environment's Lake Partner Program, volunteers collected water samples 6 times per year (May to October) at 37 sites on 15 lakes for phosphorus testing. Samples were analyzed by the Ministry lab. Volunteers also measured water clarity, using a Secchi disk. The Ministry's Provincial Water Quality Objectives consider average phosphorus levels exceeding 20 parts per billion to be of concern since at that point algal growth can adversely affect enjoyment of the lakes. Detailed results are provided in Appendix F.

Similar to previous years, the lakes displayed three different "phosphorus personalities": *marl lakes* with phosphorus levels below 10 ppb due to their chemistry and a low-phosphorus watershed, *low-phosphorus lakes* (below 15 ppb) that receive water only from the northern Canadian Shield regions and then flow *into* the Trent-Severn Waterway and *high-phosphorus lakes* that have low spring levels that rise in mid-summer, declining in the fall. Phosphorus levels in the high-phosphorus lakes (most of the Kawarthas) rise about 8 ppb between June and August. Levels also increase as water flows down the Waterway.

In 2008, compared to previous years, phosphorus levels throughout the Waterway were slightly higher in May, June and July. However, phosphorus levels showed an unusual decline during August, resulting in relatively low phosphorus levels by September 1. The reason for this is unclear.

The KLSA is grateful to the many volunteers who participate in our monitoring programs.

What Macrophytes (Aquatic Plants) Can Tell Us about Nitrogen Sources in the Kawartha Lakes

If too many nutrients are introduced into a lake ecosystem, eutrophication can occur, resulting in reduced water clarity, algal growth and increased amounts of aquatic plants. The two key nutrients are nitrogen (N) and phosphorus (P). One way to identify the sources of nutrients that are entering the lakes is through the analysis of stable isotope ratios. Nitrogen primarily exists in the form of two stable isotopes, ^{14}N and ^{15}N. The relative abundance of ^{15}N to ^{14}N can help to determine the source of the nitrogen. Nitrogen from human and animal waste has the highest ratio, nitrogen from atmospheric deposition is in the middle and nitrogen from inorganic fertilizers has the lowest ratio.

With financial help from KLSA and the analytical facilities of the Worsfold Water Quality Centre at Trent University, Dr. Eric Sager and his students conducted a study to determine whether the N isotope ratio and the N and P contents of submersed aquatic plants could be used to identify current sources of nutrients. Seven different Kawartha Lakes were sampled during July of 2007. At each site, about 50 shoots of coontail, Eurasian milfoil and variable-leaved milfoil were collected. One coontail sample was also taken from the Brighton Municipal Wetland Treatment site for comparison purposes. The study showed that the plants are absorbing high amounts of both P and N. Compared to concentrations in the 1970s, however, plants taken from Pigeon and Chemong Lakes have much higher nitrogen concentrations and lower phosphorus, probably reflecting a combination of legislated reductions in phosphorus in detergents and increased N emission due to fossil fuel combustion. Isotope ratios of N in several lakes were indicative of sewage sources, while in some residential areas, local fertilizer use was the likely source. In 2009, the next phase of the study will examine the impact of different sources of nutrients on aquatic plant growth and variety of species.

KLSA's Aquatic Plants Study

Aquatic weeds have been a concern to KLSA and its members since the organization began almost 10 years ago. For the past several years, Dr. Eric Sager and his colleagues and students at Trent University have worked with KLSA to understand the increased weed growth. In the fall of 2007, the KLSA Board of Directors submitted an application for funding to the Ontario Trillium Foundation (OTF) to study methods currently being used to control aquatic plants and the effectiveness and safety of various control methods. A $50,000 grant was approved and was used to hire Andrea Hicks, a Trent University graduate student and several undergraduate students to conduct scientific studies of current methods of weed control being used in the Kawarthas, and to publish the results in a user-friendly booklet to educate shoreline owners.

A survey of shoreline owners was conducted and 20 test sites in 9 lakes were chosen. Comparison sites where no control methods had been used were also selected. The students worked hard, assessing the impact on weed growth throughout the summer of control methods such as herbicides, harvesters and cutters, benthic mats and scattering corn to attract carp to tear up the weed beds.

Funds were obtained from the City of Kawartha Lakes for KLSA to hire Andrea Hicks for an additional month to write the aquatic plant manual, and to contract with local artists to paint watercolours illustrating each control method, and pen and ink sketches of the aquatic plants described in the booklet. Some of the interesting findings were that benthic mats may increase algal growth and herbicide use may result in more weeds, not fewer. A scientific paper is being prepared to present the results of the study. As a result of this initiative, many new partnerships have been developed with environmental organizations, cottage associations and government agencies that will assist with the distribution of the booklet.

In this article, Pat Moffat describes the process that led to the preparation of the manual and Mike Stedman provides a cottager's view of the field work involved in the study. Congratulations and much appreciation go to Pat Moffat, Mike Stedman and Dr. Eric Sager for their outstanding work in leading this project.

The Latest on the 2007 Carp Die-Off
In the summer of 2007, a large die-off of carp was observed on several Kawartha Lakes, including Scugog, Sturgeon, Pigeon, Big and Little Bald, Buckhorn, Chemong and Sandy Lakes. In this year's report, Dan Taillon and colleagues (Ministry of Natural Resources) have provided an update on the die-off and the article published in last year's report. In 2007, it was estimated that 12,000 to 24,000 carp were taken to municipal landfills. In 2008, MNR received about 800 reports of dead and dying carp. Different lakes and rivers along the TSW were affected, primarily Katchewanooka Lake, the Otonabee River, Little Lake, Rice Lake, Seymour Lake, the Trent River, Lake Simcoe, Lake Couchiching and Sparrow Lake. Adjacent Dalrymple, Young and White Lakes were also affected. Once again, large numbers of carp died, 19,000 in Lake Simcoe alone.

In 2007, the bacterium *Flavobacterium columnare* was the first confirmed pathogen found in the fish. Later tests found a second pathogen, koi herpesvirus in one carp from each of Pigeon Lake and Lake Scugog. In 2008, carp from eight water bodies were tested and all that displayed signs of disease were infected with koi herpesvirus. Many also had bacterial infections. The environmental conditions occurring during these two years, including rapid changes to water and air temperatures, storms, spawning stress and high populations helped to make carp susceptible to a disease outbreak.

Lake Animals Masquerading as Plants
An interesting article by Kevin Walters concludes the report. It describes algae, bryozoans and sponges found in the Kawartha Lakes. Chara looks like a weed but is actually a form of algae. Sponges are multi-celled animals. Some look like algae or fish egg masses. Bryozoans are colonies of organisms like corals. Some look like grey or brown jelly-like blobs attaching to things like leaves, docks or boat bottoms.

Thank you
KLSA could not achieve its goals without the extraordinary support of the many volunteers who participate in our monitoring programs and our member cottage and ratepayer associations, municipalities and businesses that provide financial support. We are also very grateful to the Trent-Severn Waterway for its ongoing partnership and to the Ontario Trillium Foundation for funding our aquatic plants project. Thank you also to Dr. Eric Sager and his colleagues at Trent University and Fleming College for their scientific advice and ongoing support of our work, and to staff at the Ministry of the Environment Lake Partner Program.

The Central Lakes of the Kawarthas (Part 1)

In previous editions of the Annual Report, KLSA Director Kevin Walters outlined the physical geography and some early history of the Kawartha Lakes region (2006) and described in detail the upper lakes of Shadow, Balsam and Cameron (2007). You can review these online at http://klsa.wordpress.com. This year Kevin tackles some of the central lakes, defined herein as those lakes located between the two major changes in elevation, at Fenelon Falls and at Burleigh Falls. See the map on pages 72 and 73. Kevin is a civil engineer with Dillon Consulting in Toronto.

BY KEVIN WALTERS B.A. SC., P. ENG.

Moving east from the upper lakes to below Fenelon Falls, we reach an area that encompasses most of the surface area of the lakes in the Kawarthas. As with the upper lakes, there are three main basins in this central area, with a total surface area of about 180 square kilometres(70 square miles).

The central lakes have a number of common characteristics including low mean depths and nutrient enrichment. This has produced turbid eutrophic conditions in past decades, and air photos from the 1940s through the 1970s reveal severe algal blooms in these waters. At least in part due to zebra mussels, and likely assisted by improved sewage treatment facilities, the water is now usually clear, but weeds abound in these shallow basins.

The steep-sided gorge found below the falls of Fenelon is cut into the limestone bedrock and is mostly filled with water. This gorge contains the deepest water found in the Kawartha Lakes at over 36 metres (120 feet), and was cut during the great flood that followed the draining of a vast glacial lake to the west. At one time the flow continued east before turning south to enter Sturgeon Lake, but with that channel blocked by glacial deposits, the flow has short-circuited to its current outlet. Hence the Fenelon River gorge extends east of the outlet to Sturgeon Lake.

Sturgeon Lake

Sturgeon Lake, having a maximum depth of 11 metres (35 feet), is the hub of the Trent-Severn Waterway (TSW) system. It is a large basin at about 44 square kilometres (17 square miles), and distinctly 'Y' shaped. Locks to other parts of the TSW, as well as towns, the largest within the Kawartha Lakes, are found at each end of the branches of the 'Y.' Unfortunately, the urban development also produces undesirable enrichment effects from urban runoff and sewage treatment facilities.

One early native name for this lake that appears on a 19th century U.S. Coastal map is 'Nummey Saukyagun.' A preliminary interpretation of this name by the Curve Lake natives is a religious place. Other maps identified in 'The Valley of the Trent' by the Champlain Society note it name as 'Annlequion Checom', meaning 'good long pike to eat.' Perhaps this is the origin of the name Sturgeon.

The main Trent River system flow enters from the northwest branch, leaves via the east, and a major tributary – the Scugog River - enters from the south. This river is called 'Yawbashkaokawk' on that same early map.

The 3 branches of the 'Y' have, as a result, differing water conditions in each. The northwest has mainly low nutrient and low mineral water originating mostly on the Shield, the south branch has high nutrient and mineral content, while the east branch has a mixture of both waters.

While Sturgeon is essentially 'Y' shaped, it also has another smaller and lesser-known arm reached from the eastern branch under a bridge in a road (former railroad) causeway. This is **Emily Creek**, a broad marshy channel largely flooded by waterway construction, leaving navigation here more difficult rather than easier. This marshy valley in itself forms another distinct 'Y,' of part marsh, part open water. The northwest leg of open water leads into **Emily Lake**, found at the crotch of the 'Y,' a small marshy-shored lake of about 1 square kilometre (0.4 square miles) in area. As no cottages line its shores, and few access points exist, Emily Lake sits as the largely unknown Kawartha Lake.

Emily Lake, along with the northwest and northeast branches of the 'Y,' occupies a former alternate outlet for the water from Sturgeon Lake during those flood times, which spilled from there into Pigeon Lake's Long Point Bay, creating a large island south of Bobcaygeon. Emily Lake was likely formed by the scouring of the channel by this flood water as it rounded the bend to head to Pigeon Lake. Today it is shallow, being mostly filled in with marl.

Were the waters of Sturgeon Lake to rise a mere metre, water would again flow out through this low broad passage. Emily Creek also extends along the south branch of the 'Y,' collecting and feeding more southern drainage into Sturgeon Lake, the waters of Emily Creek thus flowing in the reverse direction from those formative days.

Sturgeon Lake is also entirely within the limestone, with aforementioned scarps forming the shoreline in places, but a high outcropping of Canadian Shield rock exists just to the north – called Red Rock about a mile northeast of Verulam Park, and visible for miles; it may also form the foundation of the pair of islands in the eastern arm. These outcroppings are tall towers of Shield that appear to have been thrust up through the limestone and the glacial overburden and/or lake water, depending on where they are located. These rock knobs would have been shoals or islands in the Ordovician seas until rising sea levels caused them to be buried completely by sediments; those sediments later became limestone, and still later were stripped away by erosion, revealing those rock knobs again.

Three sizable and clear-water streams and another smaller one also enter Sturgeon Lake from the north, but these do not drain Shield country, but rather, the hummocky terrain of the Dummer Moraine located on a limestone-bedrock plain. These streams, **Hawkers**, **Martin** and **Rutherford**, tend to contribute flow year-round due to ground water emerging from the moraine, whereas the **Scugog River** contributes virtually nothing in dry summer weather due to the very high evaporation occurring on Lake Scugog. Normally, the river above the dam at Lindsay has no flow over that dam during summer. What does get through into Sturgeon Lake is mainly lockage water, along with dam and lock leakage. As well, Lindsay's water treatment facility, which draws water from the Scugog River just upstream of town, effectively bypasses the dam by discharging effluent into Sturgeon Lake via the sewage treatment plant located north of town.

At Bobcaygeon, the waters of Sturgeon Lake split around a large island of essentially bare limestone containing much of that town, and pour into the next basin, only 1.5 metres (5 feet) below. Here we see red cedar, a southern evergreen tree in the juniper family, which appears as a scattered tree following the route of the Trent-Severn Waterway from Lake Ontario to Georgian Bay, growing in great abundance, although it is threatened by expansion of the town.

Some reports say that a large amount of water flows through or under the rock at Bobcaygeon on its way to the next lake. This is quite possibly true, as the fissured limestone is prone to allowing the passage of water. Ultimately, erosion of these fissures can result in the main pathway being underground, as we see in a number of area streams in limestone plain country.

"Lake Kawartha"

This next basin, in the approximate geographic centre of the Kawartha Lakes, is another, even more unique body of water. Vast, but frequently shallow, it is made up of a number of individually named sub-basins separated by large peninsulas, all connected by broad straits which are typically significantly deeper than the adjoining lake sub-basins. We know the three main sub-basins as Pigeon, Buckhorn and Chemong Lakes.

This is an unusual situation except in very shallow lakes, as it is much more common to find narrows between lakes being both much shallower and typically narrower. These deep straits, then, form small basins of their own. Altogether they form a very ragged lake system with a number of arms, which, at 122 square kilometres (47 square miles) total area, approximately the same as Lake Muskoka, comprises about 40% of the entire surface area of the Kawartha Lakes.

Had this "lake-of-lakes" been located in the less populous north, or as an isolated body, it might have carried only one name, with the various arms being named Northwest Arm, Southeast Arm and so on. Accordingly, "Lake Kawartha," or perhaps "Lake Kawatha," the original version of this adopted name, seems an appropriate name for this lake continuity.

In fact we see that, at one time at least, it did carry one singular name. On that 19th century U.S. Government Survey map, our "Lake Kawartha" was called, in addition to the names we know it as today, 'Shebaughtickwyong,' with the Pigeon portion referred to as the 'Shebaughtickwyong West Lake' and the Chemong portion as 'Shebaughtickwyong East Lake.' A preliminary interpretation of this name by the Curve Lake natives is a reference to 'points of land,' appropriate given that it is the large points containing the communities of Lakehurst, Ennismore and Curve Lake that are the most distinctive land features of this water body.

However, the individual distinct basins are today called Pigeon, the Pigeon River, Buckhorn (including a currently nameless basin at the north end , once called 'Little' Buckhorn and likely also called 'Lower' Buckhorn), Chemong, Upper Chemong, Little Bald, Big Bald, and perhaps even Sandy Lake. Each sub-basin has its own features and characteristics, but the deep straits – called Narrows – allow the water of the lakes to move between them, although no longer with the same ease.

Before flow regulation by the Trent-Severn Waterway, there was often no flow through the lakes during the dry summer months, leaving the waters of the lakes free to slosh from one basin to the other due to wind set-up or atmospheric pressure changes. The current TSW policy of constant minimum flows has greatly reduced this back-and-forth action between Pigeon and Buckhorn, and between Buckhorn and its northern nameless basin. Causeways have further reduced the exchange of water.

The dam at Buckhorn controls the water levels on all of its parts, although Sandy Lake, having the more typical narrow, shallow connecting channel, can only drop a half-metre or less, when the others drop further, due to the presence of a shield-rock sill within Sandy Creek.

The north end of our Lake Kawartha is founded within the Shield rock – although the limestone cap rock is never far away – while the midsection passes through limestone plains with its scarp and karst features. The south end is seated in the glacial deposits of drumlins and moraine.

Pigeon Lake

The south end of the **Pigeon Lake** section was once mainly marsh, with a broad meandering channel of the Pigeon River flowing within it. This marsh was flooded with the construction of the dam at Buckhorn, at a time preceding construction of the Trent Valley Canal, and today it is the source of many a floating cattail island, as the shoreline continues to adjust to its sudden rise in water level. Here enters the second major southern tributary stream, the **Pigeon River**, as well as the much smaller **Potash Creek**. Both streams drain agricultural lands as well as extensive wetlands.

At one time a floating bridge, like two others once existing on 'Lake Kawartha,' crossed the south end of the lake, then referred to as Pigeon Creek.

In the Pigeon River just south of Emily Provincial Park, we see a small basin without a name, having a maximum depth of 3 metres (10 feet). A dam forms the end of navigation in Omemee, which has raised the waters of the Pigeon River to create a large millpond, or a man-made lake, of some 300 acres.

Raising of the water level has left another mark on the larger basins making up 'Lake Kawartha.' Original shoreline with low-lying land in behind usually had ice-push ridges, comprised of rocks and other material bulldozed by the ice of the frozen lakes, forming an armoured berm along the shoreline. The sudden rise in water has flooded these ridges and low lying lands behind, resulting in a linear barrier of rocks, barely submerged, making boat access to the new inland shoreline hazardous. These rock ridges are often mistaken for submerged farmers' fences.

The north end of the lake, by contrast, is rugged with high limestone escarpment shores and Shield rock below and beyond. Rock islands and ragged points pointing southwest occur toward the northeast leading to the **Bald Lake Narrows**, the straits connecting to the Bald Lake basins. The huge island - Big (Boyd) Island - within this deeper northcentral part is another limestone mesa like Grand Island, although a Shield rock outcrop occurs at the northeastern tip.

The deepest water in this lake agglomeration, at 17 metres (57 feet), is found here, just beyond the high scarp of Dropping Springs, a karst feature in the limestone plain located between Pigeon and Sandy Lakes.

davidwoolverton

The Bald Lakes

The northeastern arm comprised of the Bald Lakes is solidly bedded in the Shield, but patches of limestone cap-rock outliers remain just beyond these lakes. The two small basins are very different.

Little Bald Lake has very dark tannic water from the formerly named **Squaw River**, which drains a large area of barren rock and marshy basins, providing a great deal of reddish brown silt and organic staining. Its bleak watershed has had much of the topsoil washed away, likely as a result of former forest fires, particularly those that plagued the area during the logging period. The sediment has filled many of the small lakes, turning them into marshes, and has largely filled Little Bald Lake itself, resulting in marshland in the vicinity of the stream's outlet. While the name of the stream was recently changed from Squaw River to **Miskwa Ziibi**, meaning 'Red River,' it is really not a river, but only a large creek by local standards. Like the Staples 'River,' this stream acquired the title 'River' by virtue of the broad river-like channel that coursed through the marshland, here in Little Bald Lake. It is now defined by natural levees snaking through a grassy water body. While the creek itself would be most aptly named Miskwa Ziibi Creek, the broad levied-channel feature within the lake should retain the name Squaw River, preserving the historical context.

The stream flow of Miskwa Ziibi Creek is unregulated, and hence flows reduce to near-nothing in dry summer weather, but during the wet seasons it spills voluminously, directly into the Squaw River channel within Little Bald Lake via a scenic waterfall. This location was the site of a former lumber mill, and it is likely that some of the sediments in the lake are the result of years of sawdust dumping.

The Little Bald Lake sub-basin of 'Lake Kawartha' is on the Shield, but the rock is mostly softer volcanic rocks that have weathered so as to produce deeper soils much more rapidly. The numerous grooves and crevices would have greatly assisted in retaining soil following the conflagrations, and hence relatively little exposed bare rock is seen. Maximum depth in this lake is 7.5 metres (25 feet).

This lake today is actually slightly larger than adjoining Big Bald Lake, and the reason for this is that at the time of naming, the marshy northeast part of Little Bald Lake was not counted as 'lake', whereas following inundation caused by the construction of the dam at Buckhorn, the marsh is now much more evidently lake surface.

Big Bald Lake is different. It is founded within mainly granite-origin gneissic type rocks that weather very slowly, hence much of the surfaces scoured smooth by the great flood still remain devoid of soil, and the shoreline appears 'bald'. Maximum depth in this lake is 10 metres (31 feet).

A cul-de-sac basin having no source streams, much of the water in this lake is flow draining out of the limestone cap-rock to the north and south, and the water is relatively hard. Some does also enter from a marshland to the east. A fair amount is also backflow from Little Bald Lake, i.e. from Miskwa Ziibi creek, entering via **Big Bald Narrows** during the spring rise in water levels, during wind set-up, and periods of high evaporation.

While today it is a cul-de-sac basin, it once served as an outlet for the water of the great flood on its way to the next downstream basin, with the flow arriving at Buckhorn coming in from either the Buckhorn Lake path or via the Bald Lakes and the lower end of the **Mississagua River**.

The Mississagua River

Most intriguingly, prior to the control of the Mississagua River through the construction of logging dams, it is evident that this river once had a system of outlet channels similar to the convoluted French River where it enters Georgian Bay.

This river's name is usually pronounced 'Mississauga' like the suburban city to the southwest, but the original pronunciation here was undoubtedly 'Mrs. S*ag* wa', or perhaps 'Mrs. *Sog* wa' (an 'a' seems to have been used interchangeably for the soft 'o' sound) and hence the local variant spelling. The river's name is derived from a native word understood to mean 'river of many mouths,' a clue that the river once outletted via a maze of channels.

Big Bald Lake formerly received flows from this river that now passes it by to the east. The first evidence for this is in the fairly deep, river-like dogleg channel entering Big Bald Lake at its northeast end, where the Catalina Bay resort is located. This channel would not exist if it weren't for some significant flow of water through it in the recent past, to keep it from filling in as marsh over time. In fact, it is clear that this is the bottom end of the former West Channel, likely from time to time the former main channel of the Mississagua River.

In its natural state, the unregulated river would have produced huge flood flows from time to time, and water would have spilled wherever an available channel existed, using a number of outlets at any given time. Such floods would have also resulted in the formation of natural dams in certain channels, formed from fallen trees and debris, a frequent obstruction to early river travelers. These would have forced the river to change outlet channels from time to time. Note that such channel switching by a river can only happen when alternate outlets are available; otherwise, the water simply builds up until the obstruction is breached or flushed out.

Today the river is heavily controlled by a number of reservoir dams upstream, including the largest on the mouth of the lake bearing the same name. As a result of this and other works, and very efficient management by the TSW, flood occurrences along this stream are rare today, and the river produces an even flow with little variation.

At various times, no doubt the entire flow of the Mississagua River would have changed course, with Big Bald Lake occasionally receiving it all. It is a bit of a geologic toss-up that a path selected around a single rock ridge can determine whether the flows went to the Bald Lakes or to the Lovesick basin downstream.

The early loggers and sawmill operators were aware of this changeability. It was a problem for them if they didn't know which way their logs would go, or when their logs caused a jam and re-routed the river. They needed to stabilize the situation.

Scotts Mills dam

Just to the west of Big Bald Lake on the Mississagua River sits the Scotts Mills dam, the last remnant of the sawmill community that once existed there, established around 1852. The current concrete dam, built in 1912, is still in excellent condition, and owned by the TSW. Formerly it raised the level of the river upstream of the dam by about six feet. Raising the water would have allowed the river to escape entirely via the now-dry West Channel to Big Bald Lake, if it did not already do so. To prevent this, a barrier dam would have been needed across the west channel to confine the waters to the east channel. In fact, we find today an earth and stone dam, perhaps 30 metres long, placed across the narrowest point of the west channel, about 1 km upstream of the Scotts Mills dam and about 100 metres west of the current channel. It is positioned behind a couple of large boulders within the channel which may have been the site of a natural log jam, facilitating the construction. However, this facility was likely in place already, constructed by the previous loggers who would have wanted to send all their logs to Hall's Mill in Buckhorn, established some 20 years earlier, and not to the Bald Lakes. Of course, approvals for such works were rarely required or sought.

It appears that this west channel itself split into two paths around an island located about midway along the 1.5 km route, either on a permanent or intermittent basis.

The large marsh just west of County Road 36 north of Buckhorn is almost certainly the product of the west channel of the river, as this would have been a small lake originally, scoured deep by the great flood. Over time, it has filled in with river-borne sediments. In fact, early 19th century maps indicate that the marsh was indeed a small lake, 'Baby Bald Lake' perhaps. It thus appears likely that within a very short period of time, the loss of soil following the fires that followed the logging filled this small lake with choking sediment brought down by the west channel; save for its north end, kept open by the flow of the river. The top end, at the bottom of both of the branches of the channel referred to above, remains open water today, although choked with lily-pads, providing the evidence that simultaneous flows once existed here.

After 150 years, the old channel is now largely obscured, occupied by beaver ponds and a small creek, except for the bottom end entering Big Bald Lake, which will continue to fill in over extended time.

It is unfortunate perhaps that this channel is no longer in use. If the waters of the Mississagua were to re-enter the Bald Lakes, the excessive nutrient levels in Lake Kawartha would be diluted somewhat; the water quality of the Bald Lakes would match that of the Mississagua/Catchecoma basin upstream; and the waters of Little Bald Lake would not be the dark, often murky tea color that we see today. As well, evaporation off Lake Kawartha would be compensated for by the flow coming from the Mississagua River, allowing for continuous flow through the dam at Buckhorn.

Restoration of this channel would only require breaching the old earth/stone dam, clearing the 1 km long channel of deposited sediment and trees, constructing a suitable culvert (or two, one for each branch of the channel) beneath County Road 36, and reactivating the Scotts Mills dam in order to regulate the distribution of water in an appropriate manner between the two outlet channels.

As a result, were reasonable flow to occupy the west channel today, the peninsula containing the village of Lakehurst would again effectively be an island. Sandy Lake within it would effectively be a lake within an island, and, accordingly, the islands within Sandy Lake would be islands within a lake within an island! A fine canoe route would exist, with canoeists able to enter the Mississagua River from either the Bald Lakes or the Lovesick basin downstream, circumnavigating the resulting 'Harvey Island.'

Rarely visited, the Scotts Mills dam is located northeast of the curve in County Rd 36 just north of the 'Baby Bald marsh.' It is on public (TSW) property, but the property limits and access road have become overgrown and obscured and it is therefore not easy to find. Were this dam to be reactivated, with public access permitted, a very scenic and historic visitor spot would be another benefit of restoring the west channel of the Mississagua.

At the mouth of this channel where it opens into Big Bald Lake is the largely submerged remains of a wharf where lumber milled at Scotts Mills was transferred by a short railroad and loaded onto barges for transport via the lakes. It is quite evident on the TSW waterway charts.

Just to complicate the situation further, it appears that 'Baby Bald Lake' disgorged some water received from the Mississagua River via a small channel to a bay of Big Bald Lake to the south, as well as back to the east channel via a small channel now passing under Road 36. The lack of open channels in the marsh today suggests however that this occurred only during flood events, or had ceased to occur during the infilling of 'Baby Bald Lake' with sediments.

There is yet more to tell on this river's convoluted outlets, as covered in the next section.

Chemong Lake

Chemong Lake and **Upper Chemong Lake** form another, larger cul-de-sac basin. Similar to any large embayment nearly isolated from the main water body, this basin, which receives little inflow save for a pair of nameless creeks at the south end, imports water from Buckhorn Lake during dry summer weather to offset the evaporation from its surface. Chemong Lake and Upper Chemong Lake are marl lakes similar to Scugog, given that the local source of water comes from the local limestone and glacial deposits. That they were once called Mud Lake and Little Mud Lake further indicates this, given the soft mud-like consistency of marl lake bottoms. They act as evaporation pans in summer. Before the construction of a dam at Buckhorn raised the water level, early records report that the water was so shallow at times that it was difficult to float a canoe. Deep deposits of marl often accumulate in marl lakes to the point of very little water remaining, until they eventually fill in completely. Maximum depth in these shallow sub-basins is 6.4 and 6.7 metres (21 and 22 feet) respectively.

Chemong Lake has unfortunately suffered the gross indignity of being cut in two with a crude lake-fill causeway constructed in 1949. Only a small bridge at one end allows water, fish or boat passage. Like a similar expedient crossing that replaces a former floating and environmentally benign bridge at **Gannon's Narrows**, one can only hope that someday these insults will be removed and replaced by proper bridges, spanning rather than damming the water.

At the north end of Upper Chemong Lake, a former postglacial spill channel leads directly to **Deer Bay** in the next downstream lake basin. During those floodwater times, 'Lake Kawartha' accordingly had three outlets to the downstream lake: Buckhorn, as per today, the Bald Lakes/Mississagua outlet, and the Upper Chemong Lake outlet.

Sheila Gordon-Dillane

Gannon's Narrows bridge.

It also appears that yet another outlet may have existed at least for a time, with water escaping from the east shore of Chemong Lake and short-circuiting to **Katchewanooka** Lake via the Miller Creek valley.

On the east side of the lake at about its midpoint is an old steamboat landing and railroad terminus. Prior to the construction of locks and dams along the difficult and lengthy Burleigh Falls to Buckhorn section, a railroad took travelers and materials directly between Peterborough and Chemung Landing, connecting to a further journey up the lake system. Today, the remains of the wharf can be seen on waterway charts, but this once important site has passed into obscurity.

Buckhorn Lake

In the centre of this lake system we find the shallow main **Buckhorn Lake** basin, having a maximum depth of 6.7 metres (22 feet), with numerous islands of Dummer Moraine material and series of shoals like strings of pearls, formed by those diagonal trending Shield rock knobs. Most of the islands are Indian Reserve land, belonging to either the Curve Lake Reserve or the ubiquitous Islands in the Trent Waters Reserve, as are a great many undeveloped islands found within the Kawartha Lakes from Shadow Lake to the outlet lakes; but most notably in the next basin downstream.

At the north end of this basin just beyond the rocky **Buckhorn Narrows** is a smaller but deeper and nameless basin. In the past it was likely known to locals as Lower Buckhorn Lake or **Little Buckhorn Lake;** the latter name appears on 1933 charts of the Trent Canal. Prior to the raising of the lakes by the Buckhorn dam, this basin would have been much more distinctly separate from the main Buckhorn Lake, and Lower Buckhorn would have been an appropriate name for it. In the 1950s, this name was applied to the upper portion of the next basin, below the rapids and dam at Buckhorn.

The now-nameless basin is founded in the bedrock of the Shield, but like the main Buckhorn Lake, the very hummocky terrain of the Dummer Moraine forms the landscape just beyond the shores. Maximum depth here is 14.7 metres (49 feet).

In 'Lake Kawartha' we also find a couple of eskers, those glacial melt-water riverbeds. One crosses the south end of Pigeon Lake and then traverses Buckhorn Lake, forming a number of islands including the Seaweed Islands, and the south end of centrally located Fox Island. Another is situated in the south end of Chemong Lake and creates Fife's Bay.

Sandy Lake

In the north central part of Lake Kawartha we have the most unusual basin. Being surrounded by water from the main basin, it is almost a lake within an island. This is **Sandy Lake** or 'Lake of Spirits,' a body of emerald-turquoise spring water, high mineral content, and mostly marly bottom. Everything on the lake bottom has a white coating of calcium precipitate (marl): rocks, logs, and even clams. Even the few scattered weeds become coated in summer. Peculiar, lightweight limey concretions called tufa wash up on the shores.

Sandy Lake appears small on a map, surrounded by the huge Lake Kawartha basin, but at nearly 1000 acres (4 square kilometres) it is as large or larger than many other Kawartha Lakes. It is a product of its physical situation, with all surrounding streams having been intercepted by the surrounding lake system. The limestone karst topography that flanks the east and west shores allows water, unstained by decaying organic material, to enter via springs and seeps. Hence the water is essentially aqua-blue, tinged green perhaps by a little organic colour from a small creek on the east shore draining water from the limestone escarpment, or from backflow from Sandy Creek Bay on Buckhorn Lake. In summer, the calcium precipitates out, producing a milky appearance, the water increases in luminescence and the colour becomes especially vibrant. This colour varies between turquoise and almost emerald green, depending on the season and amount of rainfall.

There are a few other lakes in Ontario with similar characteristics, but Sandy may be the largest, save for Lake Couchiching which is fed almost solely by the hard waters of Lake Simcoe (originally 'Lake Toronto'). A similar but larger lake in Manitoba called Little Limestone Lake is considered quite extraordinary, and is proposed for inclusion in a new national park.

Sandy Lake is connected to the rest of 'Lake Kawartha' by narrow **Sandy Creek** being only a couple of feet deep (even less, over that rock sill), just enough for an aluminum fishing boat to pass through. Water from time to time flows backward into Sandy Lake from Sandy Creek Bay, producing a noticeable tea stain in the south end of the lake. The narrow shallow channel of course means that this lake is somewhat distinct from the balance of Lake Kawartha, made so apparent from the colour of the water.

During the period of the great flood, Sandy Lake was not at all a separate body of water, but was well connected with the balance of Lake Kawartha via a broad channel where Sandy Creek now is, as well as with channels at its north end with each of Little Bald Lake and Big Bald Lake, creating an island out of the land mass where the village of Lakehurst is located.

Like Buckhorn Lake, it too has a series of diagonal shoals from knobs on the submerged Shield rock spines. Maximum depth in Sandy Lake is recorded as 13 metres (43 feet).

A feature of the Central Lakes is abundant inflow from the south. It enters Sturgeon Lake via the Scugog River, and to a lesser extent Emily Creek, and the 'Lake Kawartha' basin via the Pigeon River. All these streams drain heavily agricultural lands having abundant wetlands in their flat shallow valleys, all of which contribute significant amounts of phosphorus to these lakes and those downstream.

No rivers enter this 'Lake Kawartha' basin from the north, but there are several creeks. Aside from the tea colored Miskwa Ziibi Creek, **Nogies Creek** provides northern inflow of low colour and high clarity, along with the much smaller **Eels Creek**. In spite of the added flows from the streams entering this lake group, the summertime flows that pass through the dam at Buckhorn are reduced to less than that entering it from Sturgeon Lake, by the high evaporation that takes place on this 130-plus square kilometres (50 square miles) of water surface and adjoining wetlands.

Buckhorn

At Buckhorn, the former rapids are mostly submerged, but the raised waters have created a scenic side-channel to the east of the main spillway. It is likely too that another side channel ran across the main street south of the present locks into the tip of Lower Buckhorn Lake just east of the traffic lights intersection, and was filled in for convenience. There remains however the opportunity to recreate a small open ornamental channel through this area, across and under the main street, complete with rapids and waterfalls, as a scenic landscape feature to enhance the scenic aspect of the village.

The drop at Buckhorn is indicated on early maps as "4 feet" (1.2 metres), with another rapid occurring downstream at Monroe Point, now eliminated by canal construction and damming. Today, a total drop of 3.3 metres (11 feet), now mainly accommodated by the dam at Buckhorn, leads into the third central basin, located between Buckhorn and the falls at Burleigh.

Discussion of this third basin, and of Lake Scugog and other waters to the south, must wait for another time.

davidwoolverton

E.coli Bacteria Testing

By Kathleen Mackenzie

During the summer of 2008, KLSA volunteers tested 98 sites in l2 lakes for *E.coli*. For information on the protocol and the complete results, please see Appendix E. Each site was tested up to 6 times over the summer, and samples were analyzed by SGS Lakefield Research.

2008 was a very wet summer (see Appendix H). Usually, more runoff equates with higher bacteria. However, in 2008 *E.coli* counts remained at their historically low levels. There were 93 sites that were tested 4 - 6 times. Results can be summarized as follows:

Site Rating	Number of Sites	Comments
"Very clean": all readings less than 20	66 sites	These are very low counts for surface water in a productive area such as the Kawartha Lakes, with a diverse population of warm-blooded animals. These counts indicate excellent recreational quality.
"Clean": 1 or 2 readings over 20"	13 sites	These are normal counts for the Kawartha Lakes, indicating excellent recreational quality.
"Somewhat elevated": 3 readings over 20	6 sites	These sites have occasional high counts which quickly return to normal indicating good recreational quality. Usually there is no obvious reason for these temporary elevated counts.
"Needing observation": More than 2 counts over 100, or more than 3 counts over 20	8 sites	These sites should continue to be monitored. It should be noted that many of these sites are not swimming areas, and that in all cases local residents have been informed of the high counts. • Three of these sites (Lower Buckhorn Lake) are very close to one another. High counts are caused by a stream entering the lake. The high counts originate upstream in an extensive wetland region (see KLSA report 2004). • One site is almost certainly polluted by a large population of waterfowl that congregate on a number of small rock islets. • Two sites (Pigeon Lake NPLRA) are close to one another. The source of their *E.coli* seems to be a marshy area in a bay very nearby with plentiful wildlife including many waterfowl. • One site is near an inflow that comes from an agricultural area. Sediment suspension may be a factor. • One site is at the end of a bay near an agricultural stream that cows wade in. Sediment suspension may be a factor.

On one notable testing date on Sturgeon Lake, a large number of sites had very high readings. The sites were fairly widespread, indicating a regional cause for the high counts. The water was observed to be unusually turbid on that date. Recent research is suggesting that *E.coli* can survive in lake sediments. Could the high counts on that day have been due to suspension of the sediments?

In general, though, bacteria levels in the Kawartha Lakes were very low throughout the summer as in previous years, despite this summer's high rains and resulting high runoff.

Phosphorus Testing

By Kathleen Mackenzie

In 2008, KLSA volunteers collected water samples at 37 sites on 15 Kawartha Lakes, on six dates from May to October. During a summer of frequent and sudden rainstorms, this was quite an accomplishment! Samples were analyzed free of charge by the Ontario Ministry of the Environment's Lake Partner Program, a program that is available to all Ontario lakes. Please see Appendix F for the lake-by-lake analysis and the complete phosphorus and Secchi data, which indicates water clarity.

Three Consistent Phosphorus Patterns

As in previous years, we observed three phosphorus patterns (see full discussion in KLSA report 2007, available online at http://klsa.wordpress.com/):

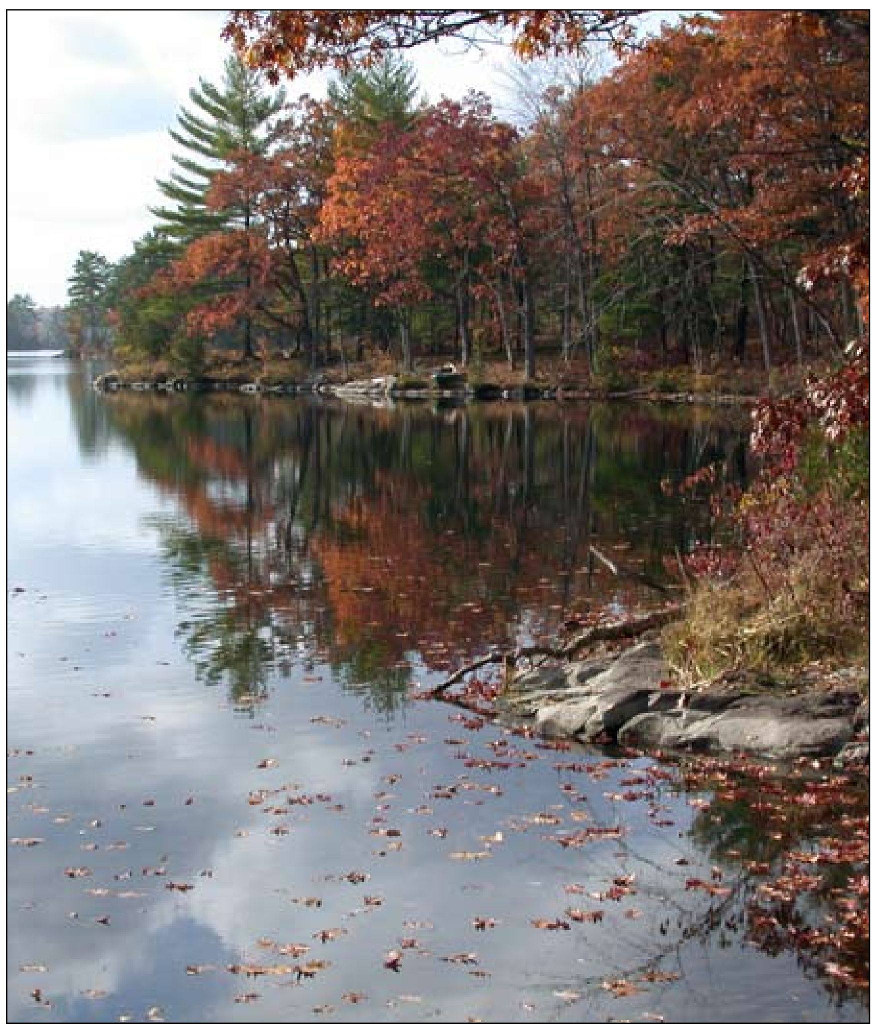
1. Three phosphorus personalities. The lakes divided themselves into three categories based on phosphorus level. Sandy Lake and Julian Lake (marl lake category) had phosphorus levels lower than 10 parts per billion (ppb) due to a low-phosphorus watershed and marl chemistry. Upper Stoney, Big Bald and Balsam Lakes (low phosphorus lake category) had phosphorus levels lower than 15 ppb due to their low-phosphorus watersheds. The other 10 lakes (high phosphorus lake category) had summer phosphorus levels greater than 15 ppb due to higher phosphorus inputs from their watersheds.

2. Phosphorus levels increase about 8 ppb between June and August in the high-phosphorus lakes. The low spring levels are probably due to a 'flushing' of the Waterway with the spring freshet.

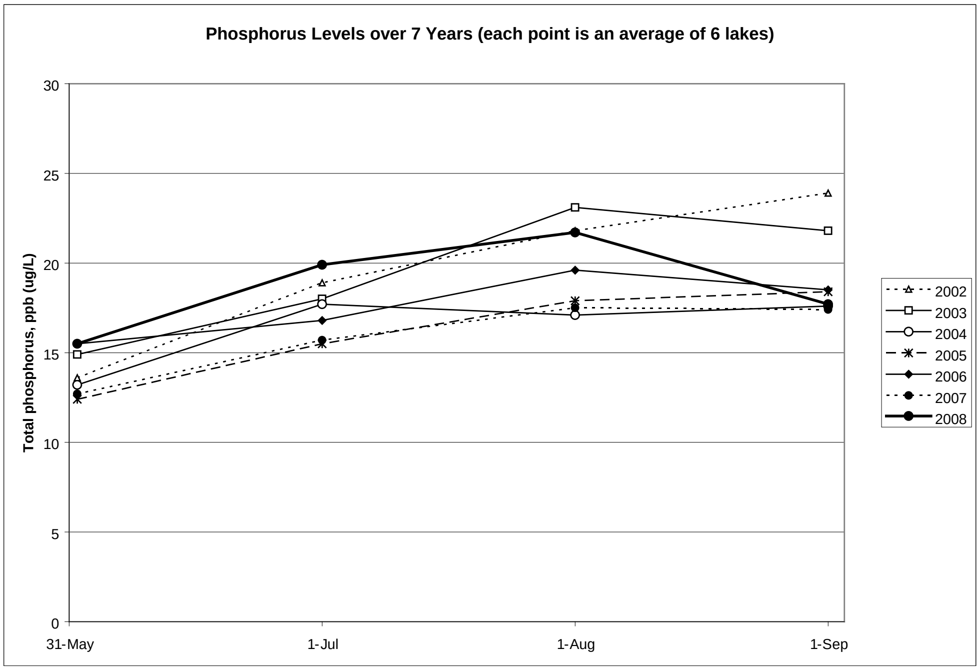
3. Phosphorus levels increase as water flows down the Waterway from Balsam to Katchewanooka. This downstream increase is interrupted in Stony Lake due to a low-phosphorus input from Upper Stoney Lake, but levels then continue to increase again from Stony Lake downstream.

What was Different in 2008?

The graph below, "Phosphorus Levels over 7 Years" shows us that, compared to other years, the Waterway as a whole in 2008 started out slightly higher in phosphorus, but the phosphorus levels dropped much more than usual between August 1 and September 1.



davidwoolverton



What might have caused this?

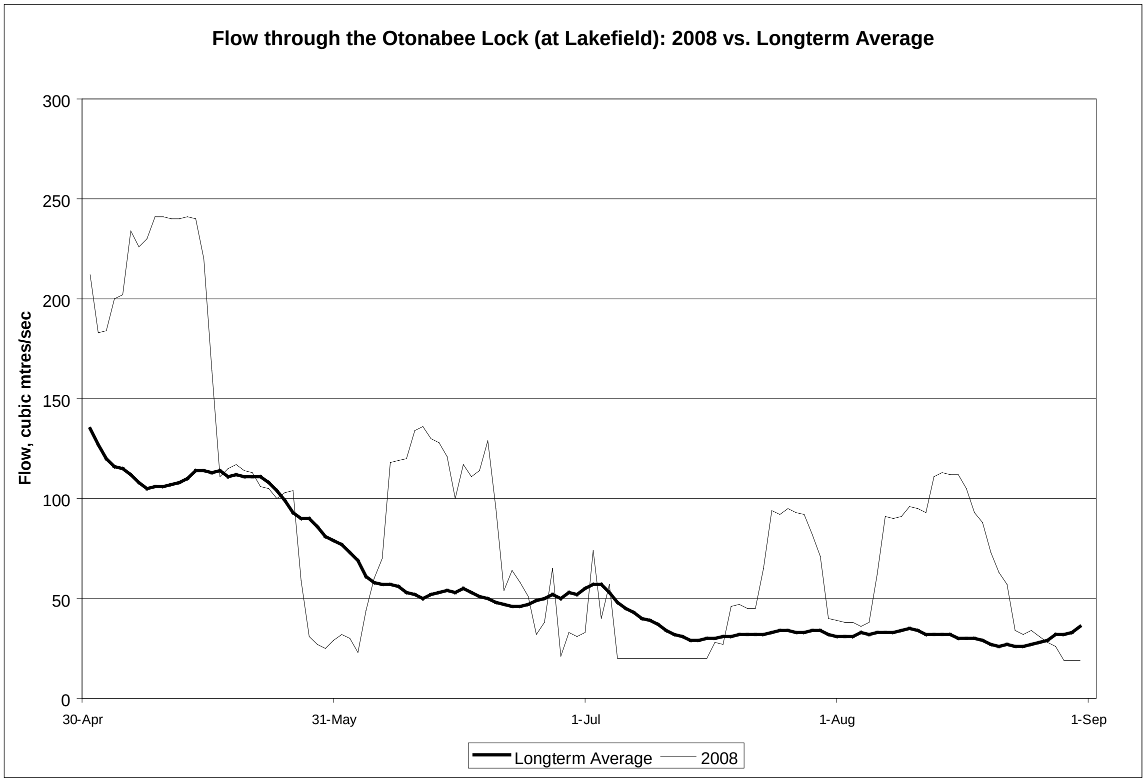
Theory 1: Perhaps high rainfall diluted the Waterway. 2008 was a summer of storms, from June to mid-August (see Appendix H for daily rainfall). Monthly rainfall in May, June and July was well above average (see chart below).

	Rainfall, mm				
Month	**Trent University: longterm average**	**Trent University 2008**	**Oliver Centre 2008**	**Stony Lake 2008**	**Lindsay 2008**
May	77.0	89.7	89.4	121.2	99.4
June	78.9	120.8	116.2	164.6	114.1
July	68.4	81.9	106.2	112.5	91.5
Aug.	91.6	103.1	47.6	91.8	95.2

However, the larger-than-normal spring flush of 2008 did NOT produce a lower-than-normal spring phosphorus level. In fact, the average phosphorus level on June 1/08 was slightly higher than in other years. If high rainfall didn't reduce phosphorus levels in June and July, we can't hold it responsible for the low September phosphorus level.

Theory 2: Perhaps higher rainfall caused more runoff, which increased phosphorus levels. May, June and July had much higher rainfall than normal, and these phosphorus levels were somewhat elevated compared to other years. However, August rainfall was close to normal, so there was no reason here for the dramatic decrease in September levels.

Theory 3: During most summers, huge volumes of water are 'siphoned off' the feeder lakes to the north in order to maintain navigation levels on the Trent-Severn Waterway. In a normal year, 50% of storage capacity in reservoir lakes is needed. Because of the high rainfall in 2008, though, very little water was required from the feeder lakes. With less low-phosphorus water flowing in from the north, local conditions would cause a rise in phosphorus. However, this theory is also suspect. As seen in the graph "Flow through the Otonabee Lock", there were larger than average volumes flowing through the system in May and June. These did not result in lower June 1 and July 1 phosphorus levels. Also, there was a large pulse of water through the system during the latter part of July that did not result in lower August 1 phosphorus levels. Therefore, it's unlikely that high flows through the Waterway in August caused the drop in phosphorus levels between August 1 and September 1.



Other Theories: At certain times of the year, plants and animals in the lake absorb phosphorus; at other times there is a net release of phosphorus. Under certain conditions, the lake sediments release phosphorus. Sometimes precipitation itself can be a significant source of phosphorus.

And at this point, we have run out of theories! Do you have one? We would like to hear it!

Conclusion

Phosphorus levels on the Kawartha Lakes were somewhat higher than average in June and July, but somewhat lower than average by the end of August. These differences do not seem to be related to the unusually high rainfall or high Waterway flows experienced in the spring and summer of 2008.

What Macrophytes (Aquatic Plants) Can Tell Us about Nitrogen Sources in the Kawartha Lakes

BY DR. ERIC SAGER, OLIVER ECOLOGICAL CENTRE, TRENT UNIVERSITY, AND RESTORATION ECOLOGY PROGRAM, FLEMING COLLEGE

There are different ways to manage and maintain the health of lake ecosystems. Some focus on the more structural aspects, such as shoreline naturalization, in-lake habitat augmentation and species manipulations. Others focus on chemicals, including nutrients and contaminants. We all know that these two categories are arbitrary – for example, shoreline naturalization has direct impacts on nutrient run-off – but for the development of management plans, these loose categories do provide some benefits.

The concepts of "excessive nutrient loading," "eutrophication" and "phosphorus enrichment" are likely familiar to residents of the Kawartha Lakes as they are all terms that have been used over the years to describe our lakes. All of these concepts refer to the fact that if there are too many nutrients introduced into a lake ecosystem, then that ecosystem can undergo many changes that lead to an "undesirable" state, with diminished water clarity, alterations in biological communities, increases in nuisance species, etc. The two nutrients that receive the most attention are phosphorus (P) and nitrogen (N) and this is because they most often represent the limiting factors that control rates of primary productivity in the ecosystem (i.e. the greater the availability of N or P, the greater the biomass of algae or aquatic plants). Typically it is argued that P is the limiting nutrient to primary productivity in freshwater lakes, but regions that have received historically high loadings of P can switch to be an N-limited ecosystem. From our perspective in the Kawartha Lakes, N and P tend to travel together in that they are coming from the same types of local sources.

Most of the time, excessive loadings of both of these important nutrients are directly related to human activities, and the culprits are very well known. Agricultural and municipal fertilizers and ineffective disposal of wastewater are some of the obvious contributors of N and P to aquatic systems in our region, while the combustion of fossil fuels in urban regions leads to increased deposition of N-containing compounds from the atmosphere. The impacts of the first two culprits tend to be felt at a more local level (i.e. shoreline or lakes) while atmospheric deposition tends to occur at a more regional level.

If managers are interested in controlling the amount of nutrients that are entering our lakes, it is important to identify their sources. One way to do this is through the analysis of *stable isotope ratios*. While we are not able to use this approach to track sources of phosphorus, the chemistry of nitrogen makes it an excellent case study. Nitrogen primarily exists in the form of two stable isotopes, ^{14}N and ^{15}N, which compose 99.634% and 0.366% of atmospheric nitrogen gas (N_2), respectively. The abundance of ^{15}N relative to ^{14}N in a given material, typically expressed as a $\delta^{15}N$ value in parts per thousand ($^0/_{00}$), can then be used as a tracer to determine the source of the nitrogen. This is due to the fact that different masses of the two isotopes cause them to behave differently in chemical reactions. For example, ^{14}N is preferentially lost during the creation of wastewater derived from sewage treatment plants or septic systems, resulting in nitrogen that is enriched in ^{15}N. With that in mind, research has identified that N derived from wastewater typically has a $\delta^{15}N$ of +10 to +22 $^0/_{00}$. This range is significantly higher than the $\delta^{15}N$ of N derived from atmospheric deposition and from inorganic fertilizer.

Nitrogen from human and animal waste has the highest δ value: +10 to +22 $^0/_{00}$
Nitrogen from atmospheric deposition: +2 to +8 $^0/_{00}$
Nitrogen from inorganic fertilizers: -3 to +3 $^0/_{00}$

With financial help from KLSA and the analytical facilities of the Worsfold Water Quality Centre at Trent University, I set out to determine whether we could use the $\delta^{15}N$ signature and the N and P contents of submersed aquatic macrophytes (plants) in some of our Kawartha Lakes to shed light on current sources of nutrients. We sampled seven different Kawartha Lakes during July of 2007, and focused our efforts on three macrophyte species: *Ceratophyllum demersum* (Coontail), *Myriophyllum spicatum* (Eurasian milfoil), and *M. heterophyllum* (variable-leaved milfoil). (See Table 1.) We were also able to collect a single sample of coontail from the Brighton Municipal Wetland Treatment site. We are assuming that the effluent that plants would be exposed to at this site would be comparable to that coming from septic fields and municipal sites in the Kawarthas. At each site, approximately 50 shoots of each plant species that were present were collected, rinsed of epiphytes (attached algae) and returned to the lab. All shoots were further rinsed with distilled water prior to being dried in an oven for 2-3 days. Dried samples were then ground up, sub-sampled and analyzed for the concentration of N, P, and $\delta^{15}N$ at the Worsfold Water Quality Centre.

We've chosen to summarize the data by lake for this first survey (see Table 2), but it should quickly become apparent that there are considerable differences within each lake for all of our measured variables, especially concentrations of N and P. This is not surprising given the range of development that was present at each of the sites that were sampled. The values that we obtained at all sites tell us that the plants are largely in "luxury consumptive mode." That is, there are plenty of nutrients available; the plants are not limited in growth by a lack of N or P.

However, when we compare current concentrations of N and P to those obtained in the 1970s, we see some dramatic changes in the average concentration of N in aquatic plants for Pigeon and Chemung Lakes; N levels are much higher now. This is likely reflective of the P controls that were put in place to control eutrophication in the 1980s, affecting products such as household detergents, while the same sorts of restrictions were not put in place for N discharge. Also, we've seen substantial increases in the atmospheric deposition of N across central Ontario over that time period due to increased emissions associated with fossil fuel combustion.

We also see some of the same sorts of trends that KLSA has reported over the years with respect to total P concentrations in the water column and their identification of "high," "medium" and "low" phosphorus lakes. This is most apparent in Lovesick Lake, where concentrations of N at all four sites were consistently some of the highest that we sampled; the $\delta^{15}N$ signatures are indicative of the N source being from human or animal sewage. When we compare these values to the $\delta^{15}N$ for human and animal waste outlined above, it appears that we are closer to the range identified for atmospheric deposition. We need to remember that all the potential sources of N are contributing to the nitrogen that ultimately is taken up by the plants, but what we are hoping to do is determine if one source is making a greater contribution. Typically this is accomplished by applying a mixing model where you measure the $\delta^{15}N$ of all potential sources and then run the mixing model to back-calculate from the $\delta^{15}N$ that was measured in the plant tissue (i.e. if you had a can of grey paint, we could run a mixing model that determined how much white paint and black paint was used to make that particular shade of grey).

We weren't able to run a mixing model with our data, but were able to utilize other published studies that did. One such study in the Finger Lakes region of upstate New York (where levels of atmospheric deposition are similar to ours) looked at the $\delta^{15}N$ of Tapegrass (*Vallisineria americana*) and found that the more positive the $\delta^{15}N$ value (values ranging from 4 to 7 $^0/_{00}$), the more it reflected inputs from septic sewage waste, while the more negative values (values ranging from -2 to 3) reflected fertilizer inputs as the dominant source of N. For comparison's sake, the sample collected from the Brighton Municipal Wetland Treatment facility, where we know there are inputs of N from human sewage, had a $\delta^{15}N$ of 6.2.

In our study, we also found values from Pigeon, Lovesick, and Stony Lakes of 7.9, 7.3, and 6.9, respectively, again identifying human or animal waste as the dominant source of N. Interestingly, when we found $\delta^{15}N$ that were more negative (e.g. -3.8 in Big Bald Lake), these sites tended to be closer to residential developments, and the lower ratios perhaps reflected local fertilizer use. Interestingly, all lakes had a site (or sites) that had macrophytes with $\delta^{15}N$ that were reflective of sewage inputs, even those lakes (Big Bald, Little Bald, Lovesick) that do not receive wastewater from municipal treatment plants.

The next step in this research is to find out if these different sources of nutrients are having impacts at the level of the aquatic community. That is, are we seeing increases in the total biomass of species as it relates to local nutrient sources? Are we seeing changes in species diversity in aquatic plant communities, and more specifically increases in the metaphyton (large clumps of filamentous algae) that can be attributed to types and amounts of nutrients being introduced? These are just some of the questions we are hoping to explore this coming summer. See you in the macrophtyes!

Table 1. Locations of sampling sites across Kawartha Lakes, and species of submersed aquatic macrophytes that were sampled.

Lake	**Sampling location**	**Species sampled**
Sturgeon	1. Snug Harbour – adjacent to residential development 2. Snug Harbour – channel 3. Sturgeon Point adjacent to residential development 4. near Bobcaygeon Lock	Coontail (*Ceratophyllum demersum*), Eurasian milfoil (*Myriophyllum spicatum*), Variable-leaved milfoil (*M. heterophyllum*)
Chemung	1. North Ennismore Waterfront Park 2. South Ennismore Waterfront Park 3. Southwest of causeway adjacent to agricultural land 4. Southeast of causeway adjacent to residential development	Coontail, Eurasian milfoil, Variable-leaved milfoil
Pigeon	1. North of Nogies Creek bridge 2. South of Nogies Creek bridge 3. West of Crowes Line bridge 4. Tates Bay 5. Mouth at Bobcaygeon 6. Gannon's Narrows 7. Pigeon River – Emily Provincial Park 8. Mallard Bay	Coontail, Eurasian milfoil, Variable-leaved milfoil
Big Bald	1. Catalina Bay 2. North central bay adjacent to residential development 3. Southeast Bay adjacent to forested shoreline 4. Mouth of outlet to Little Bald	Coontail, Eurasian milfoil
Little Bald	1. North central bay adjacent to residential development 2. South bay adjacent to forested shoreline 3. Outlet to Pigeon Lake 4. Channel from Big Bald	Coontail, Eurasian milfoil, Variable-leaved milfoil
Lovesick	1. Inlet at lock 2. Inlet at Black Duck Bay 3. Rose Islands 4. Outlet to Stoney Lake	Coontail, Variable-leaved milfoil
Stoney	1. Burleigh Island Lodge 2. Viamede Resort 3. Upper Stoney – north shore 4. Upper Stoney – south shore 5. Upper Stoney - central	Coontail, Eurasian milfoil
Brighton	Municipal Sewage Treatment wetland	Coontail

Table 2. Average and range in concentrations (minimum – maximum) of nitrogen (N), phosphorus (P), and $\delta^{15}N$ in submersed macrophytes collected from sites at each of the Kawartha Lakes. Data is also provided from the Brighton municipal wastewater treatment wetland for comparison. See Table 1 for total number of sites used to calculate lake averages as well as species that were sampled. Data from the 1970s for Pigeon and Chemung comes from the Kawartha Lakes Management Study – Water Quality Assessment (1972-1976) conducted by the Ontario Ministry of the Environment and Ministry of Natural Resources.

Lake	**Total N ($mg \cdot g^{-1}$)**	**Total P ($mg \cdot g^{-1}$)**	**$\delta^{15}N$**
Sturgeon	29.3 (25.4 – 34.4)	1.9 (0.9 – 2.7)	2.3 (0.7 – 5.1)
Chemung	30.0 (24.0 – 35.7)	1.8 (1.0 – 3.3)	-0.45 (-1.7 – 3.8)
Pigeon	29.5 (23.2 – 40.4)	2.0 (1.2 – 3.9)	2.5 (-1.4 – 7.9)
Big Bald	27.2 (22.7 – 32.8)	1.3 (1.0 -1.9)	-0.45 (-3.8 – 5.8)
Little Bald	22.7 (15.6 – 27.9)	1.2 (0.6 – 1.4)	3.0 (-0.2 – 5.5)
Lovesick	33.2 (29.7 – 38.6)	2.1 (1.7 – 2.9)	6.6 (5.5 – 7.3)
Stoney	27.9 (20.9 – 34.1)	2.0 (1.1 – 3.2)	5.2 (2.8 – 6.9)
Brighton	51.4	0.6	6.2
Pigeon – 1970s	20.4	2.1	Not available
Chemung – 1970s	18.1	2.2	Not available

davidwoolverton

KLSA's Aquatic Plants Study

By Pat Moffat

From its beginnings 10 years ago, KLSA has been concerned about aquatic weeds. At the very first KLSA meeting in 2000, several people brought in plastic bags filled with plants. We now know such plants as tape grass or milfoil or Canadian water weed. But back then, we only knew that in some places on the lakes, these weeds were becoming so thick by late summer that swimming and boating became difficult. We began a simple program of "eyeballing" the weed beds off our shores: estimating how dense the weeds were at intervals of a few weeks throughout the summer, and trying to identify different weed species with the help of keys we had found online.

How far KLSA has come since then! As the aquatic weeds problem seemed to increase over the years, so did our knowledge, our organization's expertise, and our desire to learn what to DO about the weeds, while remaining responsible shoreline owners. Our increase in expertise was due in huge part to the guidance of Dr. Eric Sager, an aquatic biologist at Trent University's Oliver Ecological Centre, who became KLSA's scientific advisor in 2005. In the fall of 2007, we took a big new step. We applied for a $50,000 Ontario Trillium Foundation (OTF) grant to hire a graduate student project coordinator and four undergraduates to conduct a scientific study of the different methods of aquatic plant control people were using in the Kawarthas, and to publish the results of the study in a reader-friendly booklet that would educate shoreline owners about

Team leader Andrea Hicks hard at work at the Oliver Centre.

aquatic plants and the methods of controlling them. We wanted to know how effective each method was, and how it affected the lake habitat.

Applying for a grant

Filling out an OTF application is a daunting procedure. On a fall afternoon in 2007, Eric Sager, fellow KLSA Board member Mike Stedman and I spread our materials out over a large table at the Lakefield Curling Club while Eric took notes on his laptop. There were so many unknowns we needed to write about with seeming confidence! How many hours would the students be working? What materials would they need? How many volunteer hours would KLSA members be spending on the summer project? How much money did we expect to raise from other sources? How many copies of our aquatic plants guide would we print and how would we distribute them? What effects would the final project have on the public?

After weeks of rewriting, recalculating, and consulting with others, and a meeting with OTF officials in Peterborough, we sent in the lengthy application with a sigh of relief. But then, just before Christmas, an email from an OTF official threw me into a panic. It contained 11 tough follow-up questions to be answered by January 4th! Many of the questions required phoning government agency offices – most of which were closed during the holidays, as the OTF offices themselves were. Yet these demanding questions forced us to reach out to other organizations in the area, asking them to be partners with us in the project, either as experts to review our Aquatic Plants Guide before it went to the printer or to help us distribute thousands of copies in the spring and summer of 2009. Consequently, we now have new friends and partners in local agencies, including two Conservation Authorities, the Ministry of Natural Resources, the Ministry of Environment, and other volunteer groups such as Lakeland Alliance and Kawartha Protect Our Water (KPOW).

Starting the study

In early March, 2008, we got the good news that our application had been approved for the full $50,000! Eric and a personnel manager at Trent immediately set about hiring the team of students. KLSA board member Janet Duval posted a detailed public survey on our website, asking shoreline owners about their practices of aquatic weed control and whether they would be willing to let us use their property as a test site. Janet found "Survey Monkey" an excellent web site for gathering and compiling this kind of data in a user-friendly way. Our money-raising also continued. KLSA Past Chair Jim Keyser spearheaded a personal appeal to local businesses and individuals to help support the "weeds project," an appeal that eventually raised more than $4,000.

The project got off the ground swiftly and moved along without snags through the summer, thanks to Eric's oversight, the excellent project coordination by Andrea Hicks, and the hard work and enthusiasm of the team members: Kyle Borrowman, Colleen Middleton, Lynn Woodcroft and Naheed Mirebrahimi (who left the project in midsummer, to be replaced by Jessica Middleton). Andrea was an ideal choice for team leader. Familiar with Ontario cottage lakes since childhood, she had majored in Environmental Science at McGill University and was working on her Master's degree at Trent University in the Watershed Ecosystems program when we hired her. Her thesis focused on the effects of lakeshore residential development on aquatic plant communities and nutrients. The KLSA Board and membership were impressed with Andrea's organizational skills, her knowledge of aquatic biology, and her public speaking and writing skills during our months of working with her.

Doing the field work

Using the information from KLSA's online survey, the students chose 20 test sites in 9 different lakes, to evaluate control methods such as herbicides, different types of harvesters and cutters, benthic mats and other means of smothering plant growth, and even the controversial scattering of kernels of corn to attract carp, which then tear up the weed beds in a feeding frenzy. Nearby reference sites served as scientific controls – areas with similar conditions that were not managed in any way. The study team spent much of their time out in the field (that is, the lakes!), diving and collecting aquatic plants, water samples, and benthic invertebrates, the bugs that live in the sediments. They devoted almost equal time to species identification and lab work at Trent's Oliver Ecological Centre, which was their main base during the project. In mid-summer, at a lunch hosted by KLSA secretary Ann Ambler, the students gave the Board an informative progress report on the project. The more we saw of these young people, the more we were impressed with their knowledge and motivation. At that meeting, we heard the startling preliminary conclusion that one method of aquatic weed control, the benthic mats, might actually be encouraging the growth of algae.

Approaching City of Kawartha Lakes

Sometime during the busy summer of 2008, it dawned on me that we had asked OTF for money to print the plants guide but not to actually write it or distribute it. I had been assuming that our already overloaded publications committee could write and edit the guide based on the scientific paper about the project that Andrea would be writing in the fall. Reality hit, though – and we began casting about for funds to spare our volunteer writers and editors nervous breakdowns. Luckily, Councillor Gerald McGregor from the City of Kawartha Lakes had come to our spring meeting at the urging of Mayor Ric McGee, and expressed a desire to help us and to get involved in our programs. Councillor McGregor and I began talking, and two presentations later, with six KLSA Directors and Andrea involved as well, the City of Kawartha Lakes Council voted to provide KLSA with $4000 for the production and distribution of the Aquatic Plants Guide. That money supported Andrea for another month to write an excellent draft of the Guide, and allowed us to hire local artist Gail Hawkins to paint original watercolours of the eight weed control methods, and team members Colleen and Jessica Middleton to make pen and ink drawings of the most common plants for the plant ID key at the back of the Guide. We still have some money left over from City of Kawartha Lake's contribution to help with mailing costs.

Producing the Guide

We owe many thanks to the Ontario Trillium Foundation, to the City of Kawartha Lakes, the Peterborough County Stewardship Council, the Stony Lake Heritage Foundation, and to the many local businesses, associations, and private individuals who donated anywhere from $25 to $500 each towards this project. Thank you!

KLSA is proud of its first major research and public education project. We hope you will find the Aquatic Plants Guide informative, useful and entertaining. You may find some of the conclusions surprising – Benthic mats may encourage the growth of algae? Herbicides can create more weeds than before?

We will be distributing the guide through Lakeland Alliance, the Federation of Ontario Cottagers' Associations (FOCA), the Ontario Federation of Anglers and Hunters (OFAH), Kawartha Protect Our Water (KPOW), Gamiing Centre for Sustainable Lakeshore Living, as well as many local cottage organizations and other groups, and at fairs and public events. Public libraries throughout Peterborough County and the City of Kawartha Lakes will receive copies, as well as everyone on our mailing list. If you would like copies for your association, please contact us at kawarthalakestewards@yahoo.com.

The Guide will also be posted in downloadable form on our website: http://klsa.wordpress.com.

As with our annual reports, the Aquatic Plants Guide is free, but donations of support are always welcome.

Observations from the Shore

by Mike Stedman

June 2008 was too cold to be swimming, but here they were, five university students from KLSA's summer project about to undertake an aquatic plant survey on our White Lake cottage shoreline, with most of the activity taking place in the water. Our location along with our volunteer neighbours offered the students test conditions for several control techniques, including mechanical harvesting, raking, benthic mats, corn for carp, and the required "do nothing" reference site.

It wasn't long before many of the shoreline residents dropped by to gawk: to inspect the variety of testing equipment, the meticulous field records the students kept of all observations, the samples of the "uglies" we didn't even know existed in the lake, and of course the water weeds that the students had pulled up from the bottom. If any were skeptical of the study, the students' youthful enthusiasm and in-depth knowledge of the subject soon won us over.

Later in the summer and during subsequent test visits, we saw a much more sophisticated student test team. Wet suits had replaced waders, test protocols were expertly executed, the hand-recorded field data book was bulging, and the team's observations were starting to take shape. Best of all, with warmer summer temperatures, the in-water testing was a pleasure – except for the muddy bottoms and little critter bites.

Those of us providing our shorelines, docking areas and bays as test sites and working with this Trent University student team knew that we had a successful project just by watching and listening to this enthusiastic and knowledgeable team. We ended the summer convinced that this close collaboration between property owners represented by the KLSA and students with environmental science backgrounds was a most cost-effective way of applying science to better understand our environmental issues. We are already busy defining our next project.

The 2007 Carp Die-off

by Dan Taillon, Matthew Garvin and Dr. Elizabeth Wright

In the summer of 2007, a large die-off of carp *(Cyprinus carpio)* was observed on a number of the Kawartha Lakes, including Lake Scugog, Sturgeon, Cameron (including the Burnt River), Balsam, Mitchell, Canal, Pigeon (including Big and Little Bald Lakes), Buckhorn, Chemung and Sandy Lake. Estimates based on municipal waste collections and public reports indicate that 12,000 to 24,000 carp were taken to municipal landfills between early June and early September. The size range of carp affected was varied, with fish as small as 30-35 cm (12-14 inches) and exceeding 75 cm (~30 inches) being observed on area waterbodies. Reports and observations of other affected fish species including pumpkinseed and bluegill sunfish, largemouth and smallmouth bass, muskellunge, walleye and brown bullheads were few.

In 2008, MNR received approximately 800 reports from members of the public regarding dead and dying carp in Ontario waterways. The areas impacted by the carp die-off were primarily portions of the Trent-Severn Waterway (TSW) including Lake Katchewanooka, the Otonabee River, Little Lake, Rice Lake, Lake Seymour, the Trent River, Lake Simcoe, Lake Couchiching and Sparrow Lake. Smaller adjacent waterbodies were also involved including Dalrymple Lake, Young Lake and White Lake (Dummer Twp.). In total, there were 15 waterbodies affected by the carp die-off. Based on the number of carp deposited at waste disposal and transfer facilities, the number of carp that died in Rice Lake exceeded 3,000 and the die-off on Lake Simcoe killed in excess of 19,000 carp.

A combination of stressors including rapid changes to water/air temperatures, storm events, spawning stress and high population abundance have likely combined to increase the stress and susceptibility of carp to a disease outbreak. In 2007, the bacterium *Flavobacterium columnare* was the first confirmed pathogen found in carp sent to the laboratory for testing. A second confirmed pathogen, koi herpesvirus, was found in one carp collected from Lake Scugog and in one carp from Pigeon Lake. In 2008, carp were submitted for testing from eight different bodies of water. All the carp that displayed signs of disease were infected with koi herpesvirus. Many of the sick carp also had bacterial infections caused by one or a combination of the following bacteria: *Aeromonas species (sp), Enterococcus sp., Acinetobacter sp.,* and/or *Shewanella sp.* Koi herpesvirus, caused by a virus that affects only carp, koi and goldfish, was first detected in Ontario in 2007. The bacteria identified are commonly found in water and mud. The environmental conditions were conducive to growth of bacteria in the carp.

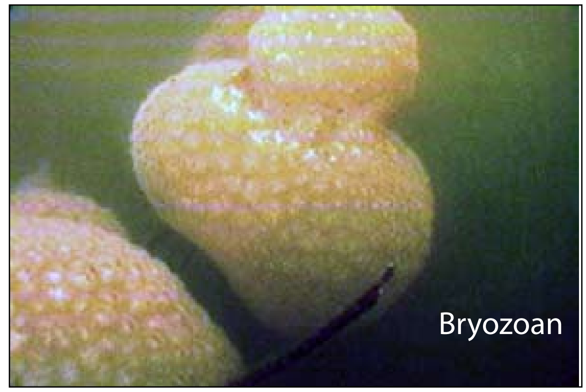
The authors are biologists with the Ontario Ministry of Natural Resources

Lake Animals Masquerading as Plants

By Kevin Walters

Most of us are concerned about algae and aquatic weeds in the lakes. But there are a few other intriguing organisms that you might see in the water that appear to be some form of plant or algae, but are actually animals. Sometimes they might even be both!

Some algae look like plants – such as Chara, which is highlighted in KLSA's new Aquatic Plants Guide. We're calling it a "water weed," but it is actually an alga. Then there is blue-green algae, which often looks like milky green paint spilled on the water's surface. We hope to see very little of this because it is toxic. Just to confuse the issue, blue-green algae are actually a bacteria, a cyanobacteria to be precise.



Bryozoan

Bryozoan

Then there are the bryozoans and sponges.Yes, surprisingly perhaps, there are 30 different freshwater sponges in North America. Sponges are multi-celled animals. Some look like algae, appearing as bright green patches on rocks or logs. Touch this and it feels peculiar, a little rough but slimy at the same time. While this is a sponge, it contains an algae, which give it the bright green color. Other sponges may appear as white blotches or blobs, and might be mistaken for some kind of fish egg mass. At least one type of sponge looks like a branched green plant.

Sponges are likely to be increasing in our lakes, because of the increasing water clarity partly due to zebra mussels. In Lake Erie, some sponges have been observed to out-compete and actually kill zebra mussels, when both are attached to vertical surfaces like lock walls.

Freshwater sponge

The bryozoans have similarly numerous forms, with about 20 freshwater species known in North America. These critters are colonies of organisms like corals. Some look like brown moss or roots from some sort of plant covering your boat bottom, or they may be brown or grey jelly-like blobs growing on just about anything. Some will even attach to the leaves of pond weeds, and some form huge colonies.

Freshwater sponge

While they may be unsightly, bryozoans are not a water pollution problem and in fact help to filter water.

Algae that look like plants, sponges and bryozoans – all are part of the fascinating underwater scene off our shores and docks.

Appendix A:

KLSA Mission Statement, Executive Board & Other Volunteers

Mission Statement

The Kawartha Lake Stewards Association was founded to carry out a coordinated, consistent, water quality testing program (including bacteria and phosphorus) in lake water in the Kawartha Lakes. The Kawartha Lake Stewards Association ensures that water quality test results, prepared according to professionally validated protocols with summary analysis, are made available to all interested parties. The Kawartha Lake Stewards Association has expanded into research activities that help to better understand lake water quality and may expand its program into other related issues in the future.

Directors

Pat Moffat, Chair Lovesick Lake Association	(519) 884-6549, (705) 654-4012 email: patmoffat@yahoo.com
Kevin Walters, Vice-Chair Lovesick and Harvey Lakeland Estates	(416) 778-5210 email: kwalters@dillon.ca
Ann Ambler, Secretary Lovesick Lake Association	(705) 654-4537 email: annieambler@yahoo.com
Mike Stedman, Treasurer White Lake Cottagers Association	(705) 877-1735 email: mike.stedman@sympatico.ca
Jeff Chalmers, Director Birchcliff Property Owners' Association (Clear Lake)	(705) 652-8992 email: jeffreychalmers@yahoo.ca
Janet Duval, Director Deer Bay Reach and Black Duck Bay, Lower Buckhorn	(905) 877-1994, (705) 657-8491 email: j_duval@sympatico.ca
Sheila Gordon-Dillane, Director Conc. 17 Pigeon Lake Cottagers Association	(416) 225-9236, (705) 657-1389 email: sgdillane@rogers.com
Kathleen Mackenzie, Director Association of Stony Lake Cottagers	(416) 283-7659, (705) 654-3051 email: k_mackenzie@sympatico.ca
Rod Martin, Director Sturgeon Lake Association	(705) 738-1450 email: rodlynn81@i-zoom.net

KLSA email: kawarthalakestewards@yahoo.ca
On the web: http://klsa.wordpress.com

Other Volunteers

Balsam Lake – Balsam Lake Association – Ross Bird, Leslie Joint, Dave Stamper, Richard Braniff

Killarney Bay-Cedar Pt. Cottage Assoc. – 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

Chemong Lake – Smith-Ennismore-Lakefield Ratepayers' Assoc. – Rosalind Macquarrie

Clear Lake – Birchcliff Property Owners' Assoc. – Jeff Chalmers
Kawartha Park Cottagers' Assoc. – Judith Platt
Sandy Point Road Assoc. – Derek Dotzko

Julian Lake – Julian Lake Cottagers – George Loyst

Katchewanooka Lake – Lake Edge Cottages – Peter Fischer, Mike Dolbey

Lovesick Lake – Lovesick Lake Assoc. – Ann Ambler, Ron Brown, Pat Moffat, Bev Richards

Lower Buckhorn Lake – Lower Buckhorn Lake Owners' Assoc. –
Wally Kralik, Jeff Lang, Peter Miller, Mike Piekny, Mark Potter, Harry Shulman, Dave Thomson, Bruce Ward
Gallery-on-the-Lake Assoc. – John and Kathy Burgess

Nogies Creek area – Steve Clarke

Pigeon Lake – Concession 17 Pigeon Lake Cottagers' Assoc. – Sheila Gordon-Dillane and Jim Dillane
North Pigeon Lake Ratepayers' Assoc. – Tom McCarron, Francis Kerr
Victoria Place – Ralph Erskine, Dennis Hearse, Glen Williamson

Sandy Lake – Harvey Lakeland Common Owners' Assoc. – Percy Payette, Mike and Diane Boysen

Stony Lake – Assoc. of Stony Lake Cottagers – Gail Szego, Ralph Reed, Bob Woosnam

Sturgeon Lake – Sturgeon Lake Assoc. –
Don Holloway, Ken LeMasurier, 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 occasion.
Many thanks to all for sharing your time, your energy, and your gas tanks!

Appendix B: Financial Partners 2008

Parks Canada, Trent-Severn Waterway

Big Cedar Road Committee
Birchcliff Property Owners Association (Clear Lake)
Buckhorn Sands Association
Carol McCanse
City of Kawartha Lakes
Concession 17 Pigeon Lake Cottagers' Association
Dr M Dolbey
East Beehive Community Association
Edmond Hill
Eganridge Inn & Country Club
Julian Lake Cottagers Association
Katch Fund-Katchewanooka Lake
Kawartha Park
Lake Edge Cottages (Katchewanooka Lake)
Lovesick Lake Association
Lower Buckhorn Association
Mattamy Homes
North Pigeon Lake Ratepayers Association
North Sturgeon Association
Peterborough County Stewardship Council
Sandy Point Road Association
Stinson's Bay Property Owners Association
Stony Lake Heritage Foundation
Township of Douro-Dummer
Township of Galway-Cavendish and Harvey
Township of Smith-Ennismore-Lakefield
Victoria Place Association Inc. Pigeon Lake
White Lake Association

Donors to our 2008 aquatic plant project are recognized in the Aquatic Plants Guide to be distributed in May of 2009.

Thanks to all our generous supporters.

Appendix C: Treasurer's Report 2008

KLSA has had a successful financial year. As you read the following statements you should know that our financial year is the calendar year, licensed public accountant McColl Turner has conducted a successful review, and this report will be presented at the Spring General Meeting. Our operations require a working capital of approximately $3,000 and our cash flow is well balanced over the financial/calendar year with revenues received by summer's end and cash expenditures spread evenly over the year with report publishing in the first quarter, insurance in the second and water testing in the third quarter.

We structure our finances along two channels, normal operations and special projects.

The first channel covers our Kawartha Lakes water quality monitoring and reporting with an annual operating budget of approximately $10,000.

- Close to 50% of these expenses go to SGS Lakefield Research for E.coli testing
- 22% for the KLSA Annual Water Quality Report and brochure printing and distribution
- 17% for insurance covering the volunteers and board members and
- 11% for group memberships and general administrative costs

The funding sources for these operating expenses fall into four categories:

- 40% from 25 cottage and property owner associations and testing groups
- 20% from surrounding township councils
- 15% from Parks Canada Trent-Severn Waterway
- 25% from small business, foundations and individuals

The second or special project channel covers the Aquatic Plants Guide undertaken in collaboration with Trent University and significantly supported by the Ontario Trillium Foundation. This is a project valued at over $125,000 if you included "in-kind" contributions; approximately half that in cash outlay. The extraordinary funds that allowed us to make this happen included:

• Ontario Trillium Foundation-Year 1 of 2	$44,900
• KLSA's Cottage Life Green Cottager Award	2,500
• City of Kawartha Lakes	4,000
• Stony Lake Heritage Foundation	1,000
• Peterborough County Stewardship	1,000
• KLSA's community outreach donor campaign	4,100
o Total	$57,500

In summary our success in 2008 fund raising has allowed KLSA to complete its normal water monitoring operations, complete year 1 of the Aquatic Plants project, and move into 2009 with the financial resources required to complete and distribute our Aquatic Plants Guide, and undertake further water quality studies given matching funds from community sources.

• 2008 revenue	$66,815
• Less 2008 expenses	59,950
• Equals revenue exceeding expenses	6,865
• Add 2008 opening cash balance	4,690
• Add GIC investments	3,187
• Equals 2008 year end assets	$14,742

At time of writing, we are projecting 2009 expenditures of over $20,000 and a reduction in this cash balance.

Kawartha Lake Stewards Association – Treasurer's Report – 2008 Revenue & Expenses

Date	Revenue		
	Balance Forward from December 31, 2007		**$4,690.35**
1-Feb-08	07 expense est. reversed (not paid out)	100.00	
1-Feb-08	Buckeye Marine (weed project)	250.00	
8-Feb-08	Scotsman Point Resort (weed project)	100.00	
20-Feb-08	Egan Marine (weed project)	50.00	
7-Mar-08	Red Eagle Trailer Park (weed project)	250.00	
20-Mar-08	Big Cedar Road Committee (weed project)	100.00	
1-Apr-08	Heather Campbell (weed project)	25.00	
10-Apr-08	Boljkovec Thomas & Eleanore (weed project)	25.00	
15-Apr-08	Cottage Life (Green Cottage Award to KLSA)	2,500.00	
15-Apr-08	Nesvabada, Marek (weed project)	50.00	
15-Apr-08	Kolvereid, Susan (weed project)	15.00	
15-Apr-08	Trillium Fund (for weed project)	44,900.00	
22-Apr-08	Deposit TSW 2007 funding	3,000.00	
9-May-08	North Pigeon Lake Rate Payers Assoc. (07 & 08 testing)	500.00	
14-May-08	Carol McCanse (Katchewanooka)	50.00	
14-May-08	Dr. Dolbey (weed project) (Katchewanooka Lake)	100.00	
14-May-08	Twsp. Of Douro-Dummer	750.00	
14-May-08	Twsp. Of Smith-Ennismore-Lakefield	245.00	
20-May-08	North Pigeon Lake Rate Payers Assoc. (weed project)	200.00	
30-May-08	Birchcliff Property Owners Association (Clear Lake)	500.00	
30-May-08	Dr. Dolbey (Katchewanooka Lake)	100.00	
30-May-08	Jullian Lake Association	150.00	
30-May-08	Katch Fund (Katchewanooka Lake)	50.00	
30-May-08	Lake Edge Cottages (Katchewanooka Lake)	50.00	
30-May-08	Twsp. of Galway-Cavendish & Harvey	1,000.00	
12-Jun-08	Edmond Hill	25.00	
19-Jun-08	Lovesick Lake Association	150.00	
19-Jun-08	Mattamy Homes	1,500.00	
20-Jun-08	Stinsons Bay Property Owners Association (N. Sturgeon)	50.00	
20-Jun-08	East Beehive Community Association (N. Sturgeon)	35.00	
23-Jun-08	GIC Interest	95.02	
	Matured GIC	3,194.16	
27-Jun-08	Gallagher	50.00	
11-Jul-08	North Sturgeon testing	100.00	
11-Jul-08	Route 45-Test	100.00	
	Big Cedar-Test	50.00	
	Clear Lake Southwest	50.00	
	Big Bald-Weed	300.00	
	Lovesick Assoc-Weed	250.00	
21-Jul-08	White Lake Assoc Weed	100.00	
	Pat Green-Weed	100.00	
21-Jul-08	Sandy Point Road-Test	100.00	
	Peterborough County Stewardship	1,000.00	
25-Jul-08	Nargaret Currie-Weed	30.00	
27-Jul-08	Pigeon Lake Assoc-Test	150.00	
30-Jul-08	Victoria Place Assoc. Test	250.00	
	Kawartha Park Test	300.00	
	East Beehive Community Association (N. Sturgeon)	15.00	
8-Aug-08	Rosedale Marina-Weed	100.00	
	Sally Jones-Weed	50.00	
	Boowalee-Test	10.00	
9-Sep-08	Buckhorn Sands Assoc Test	200.00	
19-Aug-08	Pinewood Cottages Marg Robinson-Weed	100.00	
3-Sep-08	Bain-Eetobicoke/Sturgeon Lake-Weed	100.00	
12-Sep-08	City of Kawartha Lakes -Weed Manual	4,000.00	
24-Sep-08	Lake Edge Cottages (Katchewanooka Lake)	150.00	
25-Sep-08	Stony Lake Heritage Foundation-Test	800.00	
	Stony Lake Heritage Foundation-Weed	1,000.00	
17-Sep-08	Reversed service fee	1.88	

17-Nov-08	Lower Buckhorn-Mike Pickney		475.00	
	Westwind Inn		25.00	
		Total Revenue	70,066.06	74,756.41
Date	**Expenses**			
2-Jan-08	Bank Fees			
1-Feb-08	Bank Fees		3.75	
3-Mar-08	Bank Fees		3.75	
2-Apr-08	Bank Fees		3.75	
3-Apr-08	LMS Prolink Insurance		1,749.60	
14-Apr-08	Canada Post (mailing 2006 reports)		577.72	
15-Apr-08	Borne Printing (printing 2006 reports)		1,134.54	
22-Apr-08	Trent University (weed project funding)		44,900.00	
1-May-08	Bank Fees		3.75	
9-May-08	Ann Ambler expenses		303.89	
9-May-08	Buckhorn Community Centre		100.00	
10-May-08	Pat Moffat expenses		109.27	
10-May-08	Ann Ambler expenses		85.10	
22-May-08	Borne Printing (printing 100 2006 reports)		302.00	
1-Jun-08	Bank Fees		3.75	
16-Jun-08	Janet Duval expenses -survey monkey		41.13	
23-Jun-08	GIC purchase		3,289.98	
25-Jun-08	Bourne Digital Printing`		93.23	
	Monthly Fee		3.75	
16-Jul-08	Ann Ambler Luncheon		150.00	
21-Jul-08	Pat Moffat expenses		77.43	
1-Aug-08	FOCA 2008 Membership		179.81	
	Bank Fees		8.75	
15-Aug-08	SGS Test Costs		1,519.87	
9-Sep-08	SGS Test Costs		2,585.78	
2-Sep-08	Bank Fees		3.75	
12-Sep-08	Ontario Environment Network		40.00	
1-Oct-08	Bank Fees		3.75	
6-Oct-08	Bistro Gift Certicate for Speakers		150.00	
15-Oct-08	SGS Lakefield Research		724.56	
22-Oct-08	MacKenzie General Meet Lunch		78.02	
28-Oct-08	Trent University (weed project funding)		4,800.00	
3-Nov-08	Bank Fees		3.75	
7-Nov-08	Borne Printing Brochures 200		93.23	
12-Nov-08	SGS Lakefield Research		15.75	
	Buckhorn Community Centre		50.00	
1-Dec-08	Bank Fees		3.75	
18-Dec-08	Ann Ambler Supplies, copying postage		140.65	
18-Dec-08	Correction for historic bank fee input error		3.27	
		Total Expenses	63,341.08	$63,341.08
			Net Balance	**$11,415.33**

2008 Investment Account

Date	Transaction	**Credit**	**Balance**	
1-Jan-08	Balance Forward		3,187.00	
21-Jun-08	GIC value $3,289.98	102.98	3,289.98	
	Reinvested at 2.1% maturity 23 Jun 2009		3,289.98	
			3,289.98	
			3,289.98	
			3,289.98	
			3,289.98	
			3,289.98	$3,289.98
			Grand Total	**$14,705.31**

Mike Stedman Treasurer
Kawartha Lake Stewards Association

Financial Statements of

KAWARTHA LAKES STEWARDS ASSOCIATION

December 31, 2008

Note To The Financial Statements
December 31, 2008

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.

In 2008, the Association was successful in deriving funding from Ontario Trillium Foundation to fund the Aquatic Plant Handbook project facilitated by Trent University. The 2008 funding from Ontario Trillium Foundation was for $44,900, while the Kawartha Lake Stewards Association added a further $4,800 to the study from internal resources.

Kawartha Lakes Stewards Association qualifies as a non-profit organization under section 149(1)(l) of the Income Tax Act, and, as such, is not responsible to pay any income tax. The distribution of any of its assets or profits to, or for the personal benefit, of its members, directors or affiliates is prohibited.

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.
Website www.mccollturner

REVIEW ENGAGEMENT REPORT

To Mr. Michael W. Stedman, Treasurer

KAWARTHA LAKES STEWARDS ASSOCIATION

We have reviewed the statement of financial position of Kawartha Lakes Stewards Association as at December 31, 2008 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
February 9, 2009

KAWARTHA LAKES STEWARDS ASSOCIATION

Statement of Financial Position - December 31, 2008

	(Unaudited) 2008	2007
ASSETS		
Current Assets		
Cash	$ 11,415	4,690
Guaranteed Investment Certificate	3,327	3,187
	14,742	7,877
NET ASSETS	14,742	7,877
	$ 14,742	$ 7,877

Statement of Operations
Year ended December 31, 2008

	(Unaudited) 2008	2007
REVENUE		
Parks Canada, Trent-Severn Waterway	$ 3,000	$ 3,000
Ontario Trillium funding for aquatic plant project	$ 44,900	$ -
Municipal grants	6,995	2,020
Associations	5,000	3,900
Private contributions	4,280	3,410
Cottage Life Award	2,500	-
Interest	140	195
	66,815	12,525
EXPENDITURES		
Water testing fees	4,846	5,204
Trent University aquatic plant project funding	49,700	-
Annual report costs	2,208	3,694
Registration fees, insurance and membership fee	1,969	1,906
Telephone, copies and other administrative costs	1,178	1,322
Bank charges	49	45
	59,950	12,171
EXCESS OF REVENUE OVER EXPENDITURES FOR THE YEAR	6,865	354
NET ASSETS - beginning of year	7,877	7,523
NET ASSETS - end of year	$ 14,742	$ 7,877

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, email 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.

Jeffrey Chalmers, KLSA Privacy Officer

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* usually indicates fecal contamination from warm-blooded animals such as birds or mammals, including humans. The presence of *E.coli* indicates the possible presence of other disease-causing organisms found in fecal material, such as those causing gastrointestinal and outer ear infections.

- *E.coli* is present in fecal material in very high numbers. Healthy humans excrete about 100 million *E.coli* per ¼ teaspoon of fecal matter! Therefore, it is easier to "find" than most other less plentiful bacteria.

- *E.coli* itself can be dangerous. Although most strains of *E.coli* are harmless, some strains cause serious disease, such as in the Walkerton tragedy, or occasionally in ground beef "scares." The basic analysis done by SGS Lakefield Research cannot distinguish the difference between the harmless and the deadly, so we always treat *E.coli* as if we were dealing with a harmful strain.

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 in Ontario;
- KLSA considers counts over 50 *E.coli*/100 mL as somewhat high fpr the Kawartha Lakes, and cause for re-testing;
- 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						
2008 *E.coli* Lake Water Testing *E.coli*/100 mL						
Site No.	**30-Jun-08**	**22-Jul-08**	**28-Jul-08**	**5-Aug-08**	**12-Aug-08**	**2-Sep-08**
1	30	3	**56**	6	1	9
2	2	5	19	14	11	4
3	4	13	16	15	4	9
5	0	0	2	0	1	1
7	0	3	2	1	1	0
8	0	4	2	0	3	3

As in previous years, counts were generally low on Big Bald Lake. Site 1 is an area of limited water circulation, and there was a large population of Canada Geese present on July 28, possibly causing an elevated count. It is interesting to note, though, that the geese were also present on August 5, when the count was very low.

Buckhorn L: Buckhorn Sands						
2008 *E.coli* Lake Water Testing *E.coli*/100 mL						
Site No.	**27-Jun-08**	**22-Jul-08**	**28-Jul-08**	**5-Aug-08**	**18-Aug-08**	**3-Sep-08**
A	0	0	0	0	1	0
B	2	0	0	1	45	1
C	0	1	0	0	0	0
D	14	2	2	0	0	37

As in previous years, counts were uniformly low in all locations in the Buckhorns Sands area.

Clear Lake: Birchcliff Property Owners					
2008 *E.coli* Lake Water Testing *E.coli*/100 mL					
Site No.	**4-Jul-08**	**1-Aug-08**	**5-Aug-08**	**21-Aug-08**	**10-Sep-08**
BB	20	**69**	2, 3, 13	3	16
1	0	0	2	0	1
2	0	0	0	0	0
3	0	15	11	1	0
4	2	3	3	0	0
5	2	0	0	0	0
6	14	0	11	0	0
7	2	1	0	0	3
8	0	1	0	45	0

Site BB is located at an inflow, which in the past has had elevated counts after a large rainfall. According to the nearest rain gauge (north shore Stony Lake, see Appendix H), 18 mm of rain fell on August 1. This may have been the reason for this elevated count.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming in Ontario;
- KLSA considers counts over 50 *E.coli*/100 mL as somewhat high fpr the Kawartha Lakes, and cause for re-testing;
- 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					
2008 *E.coli* Lake Water Testing *E.coli*/100 mL					
Site No.	**7-Jul-08**	**24-Jul-08**	**5-Aug-08**	**13-Aug-08**	**2-Sep-08**
AA	0	0	1	0	0
B	8	0	0	1	0
C	2	0	0	1	0
D	0	0	0	0	0
P	0	0	0	6	0
S	0	1	0	0	0

As in previous years, the Kawartha Park area exhibited very low counts.

Clear L: Sandy Point Road Assoc.						
2008 *E.coli* Lake Water Testing *E.coli*/100 mL						
Site No.	**10-Jul-08**	**22-Jul-08**	**28-Jul-08**	**5-Aug-08**	**19-Aug-08**	**2-Sep-08**
1A	4	0	0	2	1	9
2A	0	0	0	9	0	1

Results were uniformly low throughout the summer on the two Sandy Point RA sites.

Clear L: Southwest Shore						
2008 *E.coli* Lake Water Testing *E.coli*/100 mL						
Site No.	**2-Jul-08**	**21-Jul-08**	**28-Jul-08**	**5-Aug-08**	**11-Aug-08**	**2-Sep-08**
1	6	0	3	0	2	0
2	0	0	3	1	0	6

As in most previous years, counts were uniformly low.

Julian Lake						
2008 *E.coli* Lake Water Testing *E.coli*/100 mL						
Site No.	**4-Jul-08**	**22-Jul-08**	**28-Jul-08**	**5-Aug-08**	**12-Aug-08**	**2-Sep-08**
A	2	0	6	5	2	1
B	4	9	10	2	0	4
C	1	0	5	3	1	0

As in previous years, counts were uniformly low on Julian Lake.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming in Ontario;
- KLSA considers counts over 50 *E.coli*/100 mL as somewhat high fpr the Kawartha Lakes, and cause for re-testing;
- 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.

Katchewanooka Lake: Sites 1,7

2008 *E.coli* Lake Water Testing – *E.coli*/100 mL

Site No.	2-Jul-08	21-Jul-08	5-Aug-08	11-Aug-08	2-Sep-08
1	10	9	4	3	0
7	6	20	11	4	0

Katchewanooka Lake: Sites 2,3,4,5,6

2008 *E.coli* Lake Water Testing – *E.coli*/100 mL

Site No.	2-Jul-08	16-Jul-08	22-Jul-08	29-Jul-08	6-Aug-08	11-Aug-08	4-Sep-08
2	8	-	21	16	**59**	4,6,13	2
3	12	-	3	0	30	1	2
4	2	-	6	6	9	3	3
5	**62**	6,64,96,76,2	75,47,28	3	31	8	5
6	0	-	3	2	9	0	20

The count of 59 at Site 2/Aug 6 had no obvious explanation. Site 5, an area where a stream enters the lake, had several high counts in 2003 and 2004, but none in the next 3 summers. There had not been much rain in the 48 hours previous to the July 2 test, and no large population of waterfowl, so the reason for this elevated count is unknown.

Lovesick Lake

2008 *E.coli* Lake Water Testing – *E.coli*/100 mL

Site No.	1-Jul-08	22-Jul-08	29-Jul-08	5-Aug-08	11-Aug-08	2-Sep-08
15	2	6	2	1	1	2
16	4	1	2	0	1	1
17	2	1	0	0	0	1

Counts were uniformly low on these three new locations on Lovesick Lake.

Lower Buckhorn Lake

2008 *E.coli* Lake Water Testing – *E.coli*/100 mL

Site No.	30-Jun-08	21-Jul-08	28-Jul-08	5-Aug-08	10-Aug-08	2-Sep-08
1	7	19	17	3	7	5
2	5	1	3	0	0	1
3	2	25	28	31	23	25
4A	**65**	18	**55**	0	**60**	36
4B	-	**75**	**76**	**47**	**56**	46
5	1	1	6	1	3	0
8	1	0	3	36	1	0
9	0	1	0	0	0	1
10	0	0	2	1	0	2
11	1	**105**	8	2	10	3
12	7	10	33	18	11	24
13	1	2	-	-	11	-
14	1	-	5	3	2	1
11A	-	-	10	-	-	-
11B	-	-	6	-	-	-

Counts at Sites 4A and 4B were similar to previous years. Counts tend to be high at these locations due to an inflow from a large wetland area, whose streams have high *E.coli* counts (see KLSA Annual Report 2004 Appendix E).

The high count at Site 11/Jul21 was unusual for this site. There was no visible reason for the elevated count.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming in Ontario;
- KLSA considers counts over 50 *E.coli*/100 mL as somewhat high fpr the Kawartha Lakes, and cause for re-testing;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha Lakes;
- A "–" indicates no data available for that date.

Pigeon Lake: Concession 17 Pigeon Lake Cottagers' Assoc.						
2008 *E.coli* Lake Water Testing *E.coli*/100 mL						
Site No.	**29-Jun-08**	**21-Jul-08**	**28-Jul-08**	**5-Aug-08**	**10-Aug-08**	**1-Sep-08**
A	2	0	4	1	0	9
B	2	0	4	0	0	3
3	2	0	4	1	0	3

Counts were uniformly low on all the above sites.

Pigeon Lake: North Pigeon Lake Ratepayers' Assoc.						
2008 *E.coli* Lake Water Testing *E.coli*/100 mL						
Site No.	**3-Jul-08**	**21-Jul-08**	**28-Jul-08**	**5-Aug-08**	**11-Aug-08**	**3-Sep-08**
1A	20	48	12	2	1	1
5	**72**	30,35,31	29	**112**	32,29,21,17,14	2
6	**90**	29,19,38	**84**	**58,84,**36	19,8,17	19
8	4	2	0	2	5	0
13	8	2	6	0	0	9

Over the past few years, Sites 5 and 6 have exhibited counts between 50 and 100 quite regularly. This is probably because they are near an area that often has a large population of Canada Geese (for further discussion see KLSA Annual Report 2003 Appendix D and 2004 Appendix E).

Pigeon Lake: Victoria Place						
2008 *E.coli* Lake Water Testing *E.coli*/100 mL						
Site No.	**14-Jul-08**	**21-Jul-08**	**28-Jul-08**	**5-Aug-08**	**12-Aug-08**	**2-Sep-08**
1	3	0	3	1	0	0
2	0	0	4	0	2	0
3	0	0	5	0	0	2
4	0	0	9	0	1	0
5	2	0	6	1	4	0

Counts were uniformly low on all the Victoria Place sites.

Sandy Lake: Fire Route 48						
2008 *E.coli* Lake Water Testing *E.coli*/100 mL						
Site No.	**2-Jul-08**	**21-Jul-08**	**28-Jul-08**	**6-Aug-08**	**11-Aug-08**	**1-Sep-08**
MD1	0	0	0	1	0	1

Counts were uniformly very low at this Sandy Lake site.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming in Ontario;
- KLSA considers counts over 50 *E.coli*/100 mL as somewhat high fpr the Kawartha Lakes, and cause for re-testing;
- Counts 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha Lakes;
- A "–" indicates no data available for that date.

Sandy Lake: Harvey Lakeland				
2008 *E.coli* Lake Water Testing – *E.coli*/100 mL				
Site No.	**3-Jul-08**	**31-Jul-08**	**6-Aug-08**	**18-Aug-08**
SR	0	11	-	30
SS	8	**135**	1,7,**56**	**112**
PP	12	**319**	28,**75,83**	16
CW	11	5	-	3
PS	-	-	26	-

The high counts are thought to be caused by a large waterfowl population, which is attracted by small rock islets.

Stony Lake: Association of Stony Lake Cottagers							
2008 *E.coli* Lake Water Testing – *E.coli*/100 mL							
Site No.	**1-Jul-08**	**21-Jul-08**	**28-Jul-08**	**5-Aug-08**	**11-Aug-08**	**1-Sep-08**	**2-Sep-08**
E	8	2	2	1	5	4	-
I	26	1	17	0	2	1	-
J	8	5	13	0	6	-	4
K	2	0	7	1	0	-	3
L	24	2	**63**	25	0	6	-
P	8	0	4	2	1	0	-
26	4	7	11	1	3	4	-
27	6	7	7	0	9	3	-

Counts were typically low for this lake. The elevated count at Site L/Jul 28 had no discernible cause.

Sturgeon Lake: North Shore Combined Group							
2008 *E.coli* Lake Water Testing – *E.coli*/100 mL							
Site No.	**2-Jul-08**	**8-Jul-08**	**22-Jul-08**	**28-Jul-08**	**5-Aug-08**	**11-Aug-08**	**2-Sep-08**
2	4	-	22	19	10	**440**	40
2A	**190**	20,22,32	20	16	10	7	3
3	**70**	**128,64,162**	**76**	**64**	33,45,8	4	**73**
4	36	-	2	11	4	1	0
5	**514**	**100,96,104**	28	3	3	0	1
WS1	**732**	**180,118,142**	2	2	11	16	2
SB1	**220**	4,2,2	**300**	41,12,15	12	17	17
SB2	**160**	26,18,14	24	1	36	4	16

As in previous years, there were several counts exceeding 100 at several sites in Sturgeon Lake. This is unusual for a Kawartha lake. July 2 and July 8 were notably worse than other dates, as there were counts over 100 at several scattered locations. This suggests that the cause may have been lakewide, rather than a local problem.

The cause may have been weather related. Until mid-August, 2008 was truly a 'summer of storms' (see Appendix H). On a large, open, shallow lake like Sturgeon Lake, a storm can result in suspension of the sediments, turning the lake murky. On July 2, our experienced KLSA volunteer noticed that the lake was quite murky, and he noticed it several more times during the year. He actually noticed that the WS1 sample on July 2 'looked funny in the bottle' due to its murkiness. There were, however, no large storms for the three days before that testing date.

To put the results in perspective:

- 100 *E.coli*/100 mL is the level at which public beaches are posted unsafe for swimming in Ontario;
- KLSA considers counts over 50 *E.coli*/100 mL as somewhat high fpr the Kawartha Lakes, and cause for re-testing;
- 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.

In the past few years, researchers have been discovering that *E.coli* can survive and reproduce in lake and stream sediments. Thus, disturbance of the sediments can cause a rise in *E.coli* counts in the overlying water. Could this be the source of higher *E.coli* counts in Sturgeon Lake?

The answer is: quite possibly. All the Sturgeon Lake sites were in shallow areas with thick sediments. Many were exposed to wave action, and our volunteers remember the lake looking somewhat murky on several occasions over the summer.

There are numerous sources of *E.coli* that, over the years, may have inoculated the Sturgeon Lake sediments. These include local agriculture, cottage septic systems, waterfowl (geese, ducks, gulls), and (human) swimmers and boaters.

The only site which has had consistently low counts since 2004 is Site 4. This site differed from the others in that it was in deeper water (over 1 m as opposed to less than 0.5 m) and on an open shoreline (as opposed to in a more sheltered area).

It would be valuable to try to find the source of Sturgeon Lake's *E.coli* counts. If the source were found to be fresh human sewage (as in some city beaches after heavy rains), this would be cause for concern, because the high *E.coli* counts would indicate the presence of other human disease-causing bacteria and viruses (a.k.a. pathogens). However, if the high *E.coli* counts were found to be due to the resuspension of sediments, it would be less likely that other human pathogens (many of which do not survive in the sediments) would be present.

Upper Stoney Lake: Upper Stoney Lake Assn.						
2008 *E.coli* Lake Water Testing *E.coli*/100 mL						
Site No.	**2-Jul-08**	**21-Jul-08**	**28-Jul-08**	**5-Aug-08**	**11-Aug-08**	**1-Sep-08**
6	2	16	15	19	6	2
20	0	0	6	5	8	1
21	2	0	9	1	1	2
52	8	7	5	6	16	5
65	0	0	1	0	6	1
70	4	0	2	0	0	0
78A	2	0	1	0	1	0

As in previous years, *E.coli* counts were uniformly low in Upper Stoney Lake.

Appendix F: 2008 Phosphorus and Secchi Data

Why does KLSA test for phosphorus? We monitor phosphorus because it is the most powerful 'fertilizer' for a lake. Adding phosphorus to a lake causes an immediate increase in algal growth, and the eventual creation of rich sediments that support aquatic plant growth. The Ontario Ministry of the Environment's interim Provincial Water Quality Objective for Total Phosphorus is as follows:

> Current scientific evidence is insufficient to develop a firm Objective at this time. Accordingly, the following phosphorus concentrations should be considered as general guidelines which should be supplemented by site-specific studies:
>
> - To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 20µg/L;
> - A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10µg/L or less. This should apply to all lakes naturally below this value;

Natural sources of lake phosphorus include rock, soil and runoff from native vegetation. Human sources include sewage treatment plants, septic systems, fertilizers, and urban and agricultural runoff.

The graphs below show phosphorus levels at each testing site from June 1 to September 1. Do they help you understand why your lake looks the way it does? Do they make you curious as to why different lakes have different phosphorus levels? We hope so!

davidwoolverton

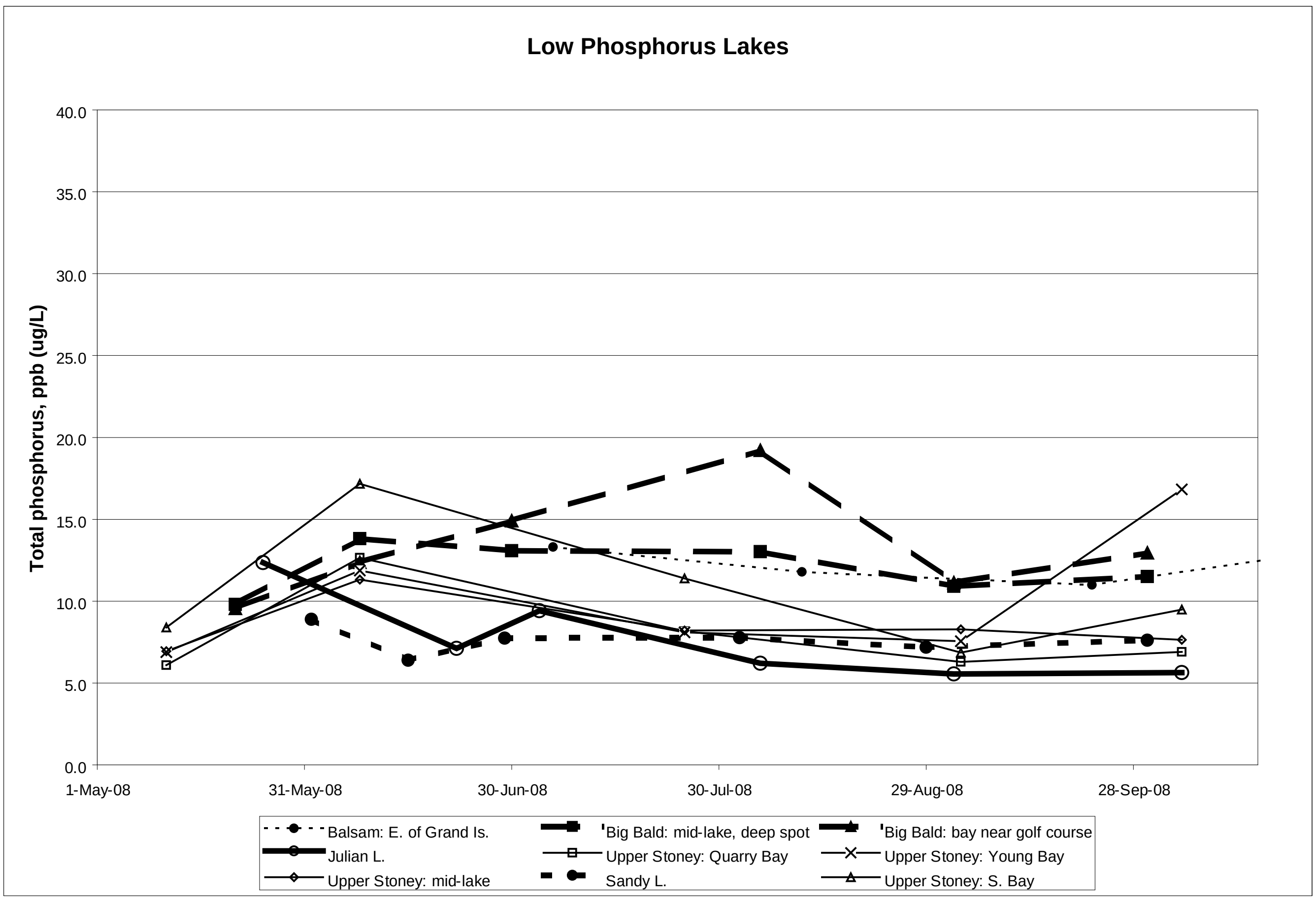
Low Phosphorus Lakes

As in previous years:

- All of these lakes have phosphorus levels below 15 ppb throughout the summer. Balsam and Upper Stoney are fed directly with water from the north, and their waters flow *into* the Trent-Severn Waterway. Sandy Lake and Big Bald Lake are off-line, with their water originating from small surrounding watersheds; as is Julian Lake, which furthermore, is not connected to the TSW by water. All three lakes have low to extremely low phosphorus levels because of low phosphorus inputs from their watershed, and marl precipitation during the summer (see KLSA report 2005).

New in 2008:

- The early August reading on "Big Bald: bay near golf course" was unusually high; this peak has not been seen in previous years.

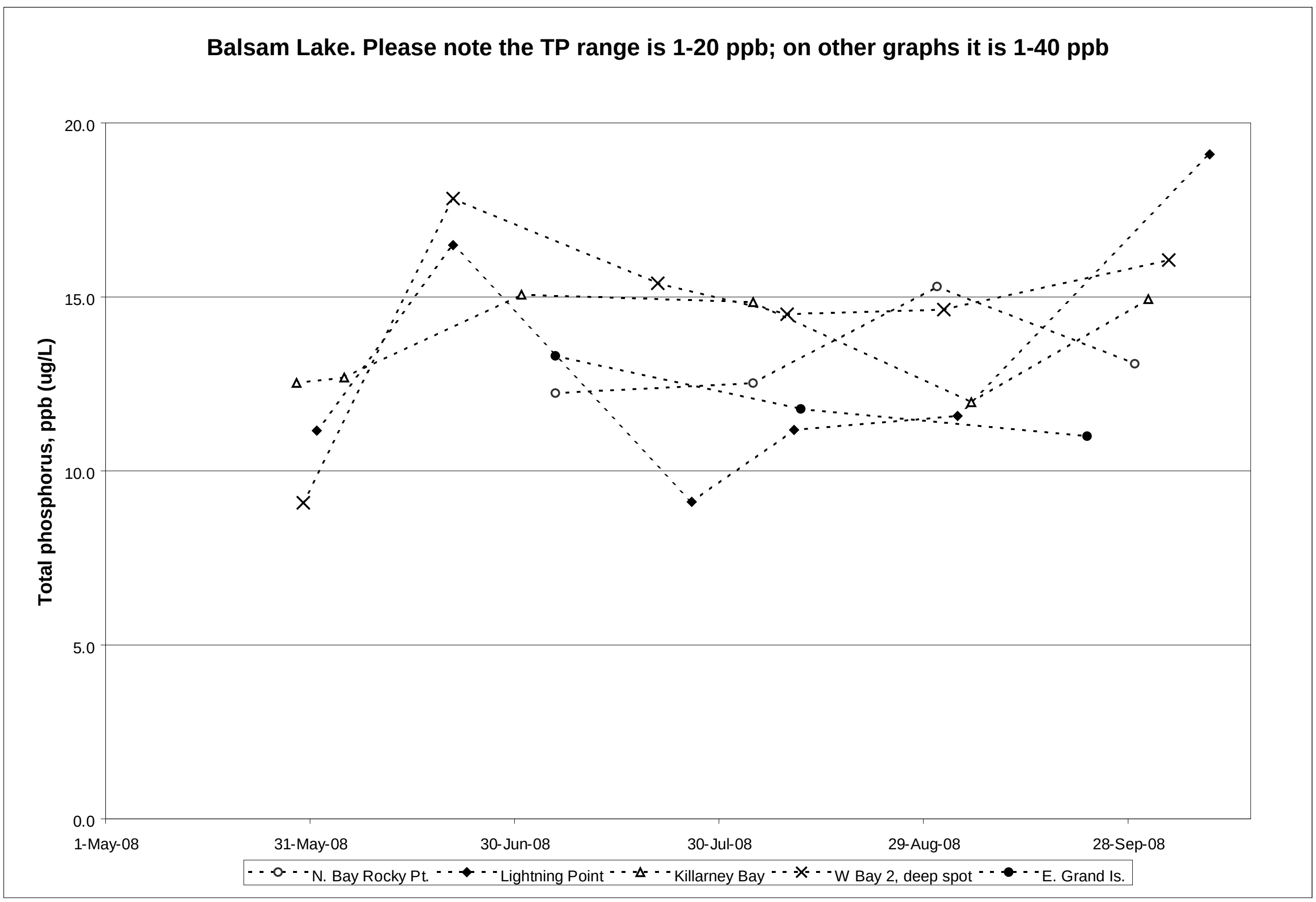


Balsam Lake: the "Top of the Trent"

From Balsam Lake, "it's all downhill" on the Trent-Severn Waterway. Balsam receives almost all its water from the north via the Gull River. Almost all of this water then flows east into Cameron Lake, then Sturgeon, and further downstream.

As in 2007:

- Lightning Point is slightly lower in phosphorus than the other sites, probably because it receives water directly from the north.
- Phosphorus levels are quite stable, remaining between 10 and 15 ppb throughout the summer.
- Often within one Kawartha Lake, the sites show very similar phosphorus levels, and they rise and fall together. This is not true on Balsam Lake. Perhaps this is because the flow is mainly through the northeast corner and water doesn't mix as quickly throughout the rest of the lake. Mixing in the south end is also hindered by the presence of Grand Island.



Upstream Lakes: Pigeon and Sturgeon Lake

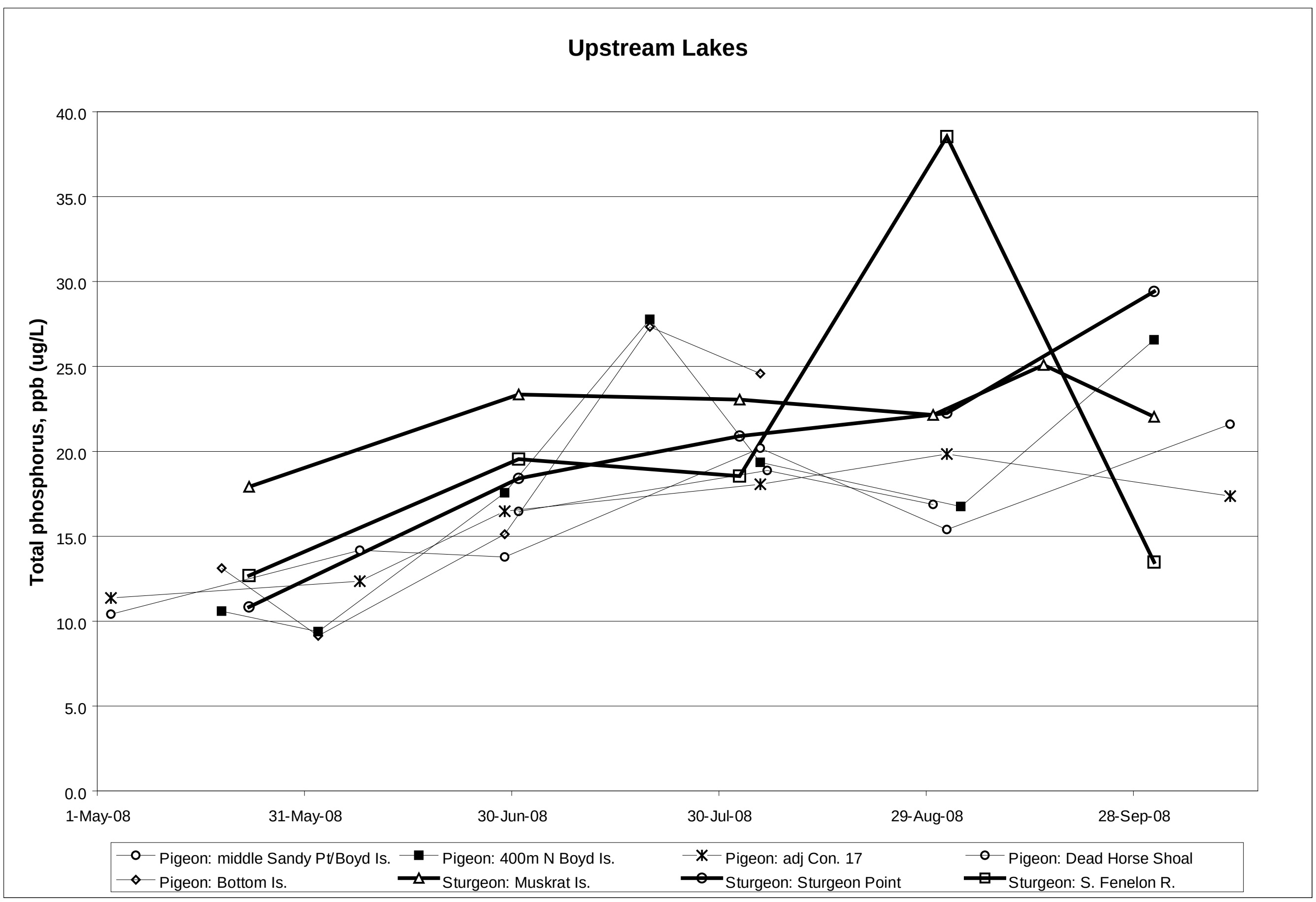
Between Balsam Lake and Sturgeon, there is a major input from the north via Burnt River and two much smaller inputs from the south, Pearns Creek and Martin Creek.

As in previous years:

- While Balsam Lake's phosphorus levels remain under 15 ppb throughout the summer, Sturgeon and Pigeon show phosphorus levels rising to near 20 ppb by August 1.

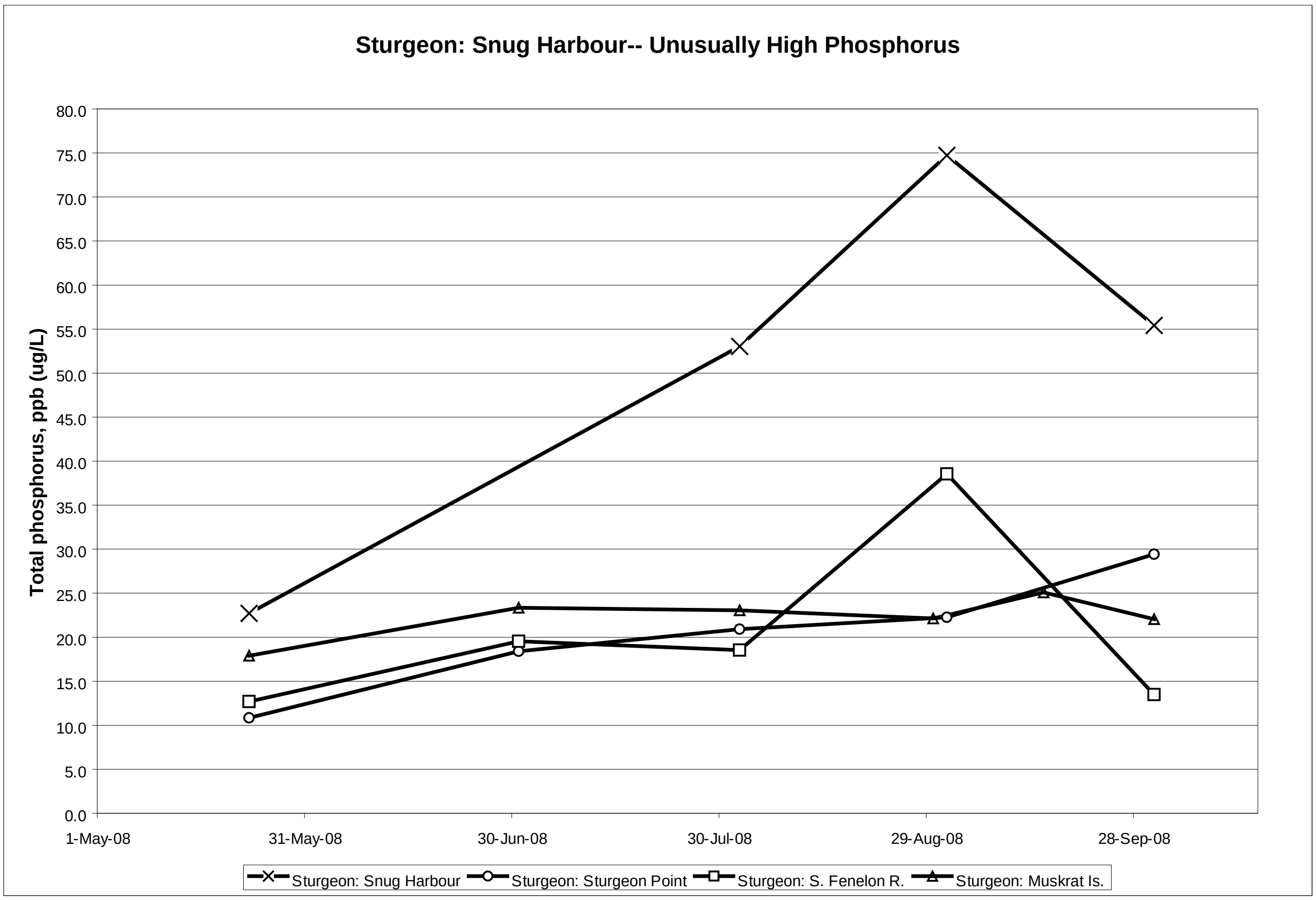
New in 2008:

- In 2008, Pigeon Lake's phosphorus levels were generally a bit lower than Sturgeon's; in other years Pigeon's were about the same or higher.
- There was a 'spike' of phosphorus in early September at the "S. Fenelon River" location. The sample may have been contaminated, but a similar spike of 40.7 ppb was seen at this site in October 4/07.
- On July 20, there was a phosphorus spike at two Pigeon Lake locations at the north end. The Oliver Centre rain data (Appendix H) shows that there was a major rainfall of 14.6 mm on July 18. Possibly this runoff may have raised phosphorus levels; both these sites are near the Nogies Creek inflow, a large source of runoff.



Sturgeon Lake/Snug Harbour: A special case

The Snug Harbour site had phosphorus levels that were several times higher than in the rest of Sturgeon Lake. Similar elevated levels were seen in 2005, but not in 2006 or 2007. This area receives inflow from the Scugog River, which is a high phosphorus source due to agricultural runoff, Lindsay's urban runoff, and the effluent from the Lindsay sewage treatment plant. During dry summers, the Scugog River hardly flows. In 2008, being a wet year, there would have been more water entering Snug Harbour from the Scugog River. This correlation can be seen in 2005: after a dry June and July, readings were quite low, but spiked up after heavy rain at the end of August and during September. It will be interesting to follow this correlation in the future.



Midstream Lakes: Chemong, Buckhorn, Lower Buckhorn and Lovesick Lake

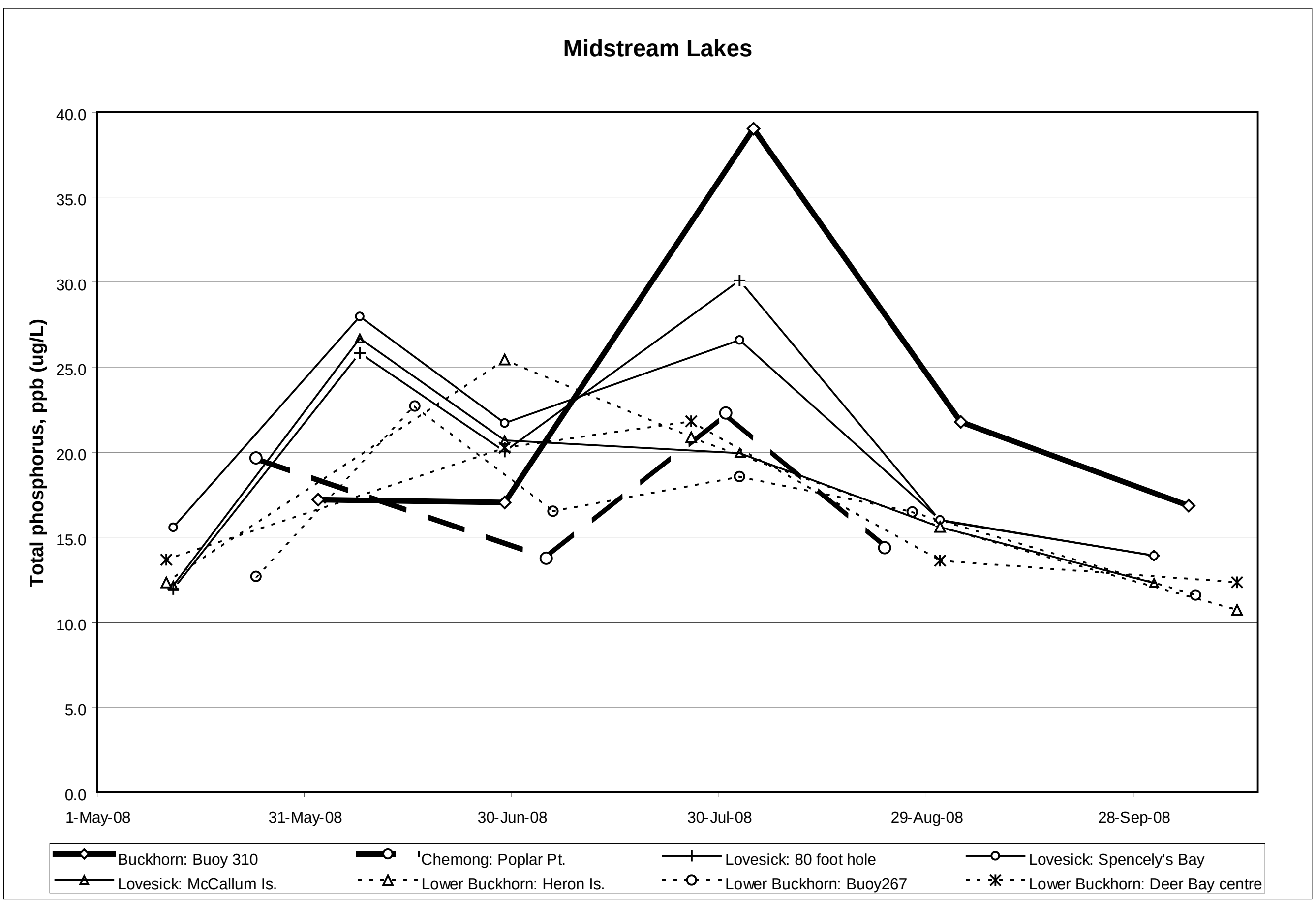
As in previous years:

- Chemong Lake's phosphorus levels were slightly less than Lower Buckhorn's, which were slightly less than Lovesick's.

New in 2008:

- The 'blip' on the three Lovesick sites on June 8 was also seen on Upper Stoney Lake sites which happened to have been tested on that particular day. This may be caused by growth cycles of various plants and small animals in the lakes. We would probably see many more of these 'blips' if we were testing every day.

- It is tempting to dismiss the very high reading at Buckhorn/Buoy 310 in early August as a contaminated sample. However, there are similar peaks around the same date at two Lovesick sites and at the Chemong site. Might this have been a result of an 18 mm local rainfall on August 1? (see Appendix H).



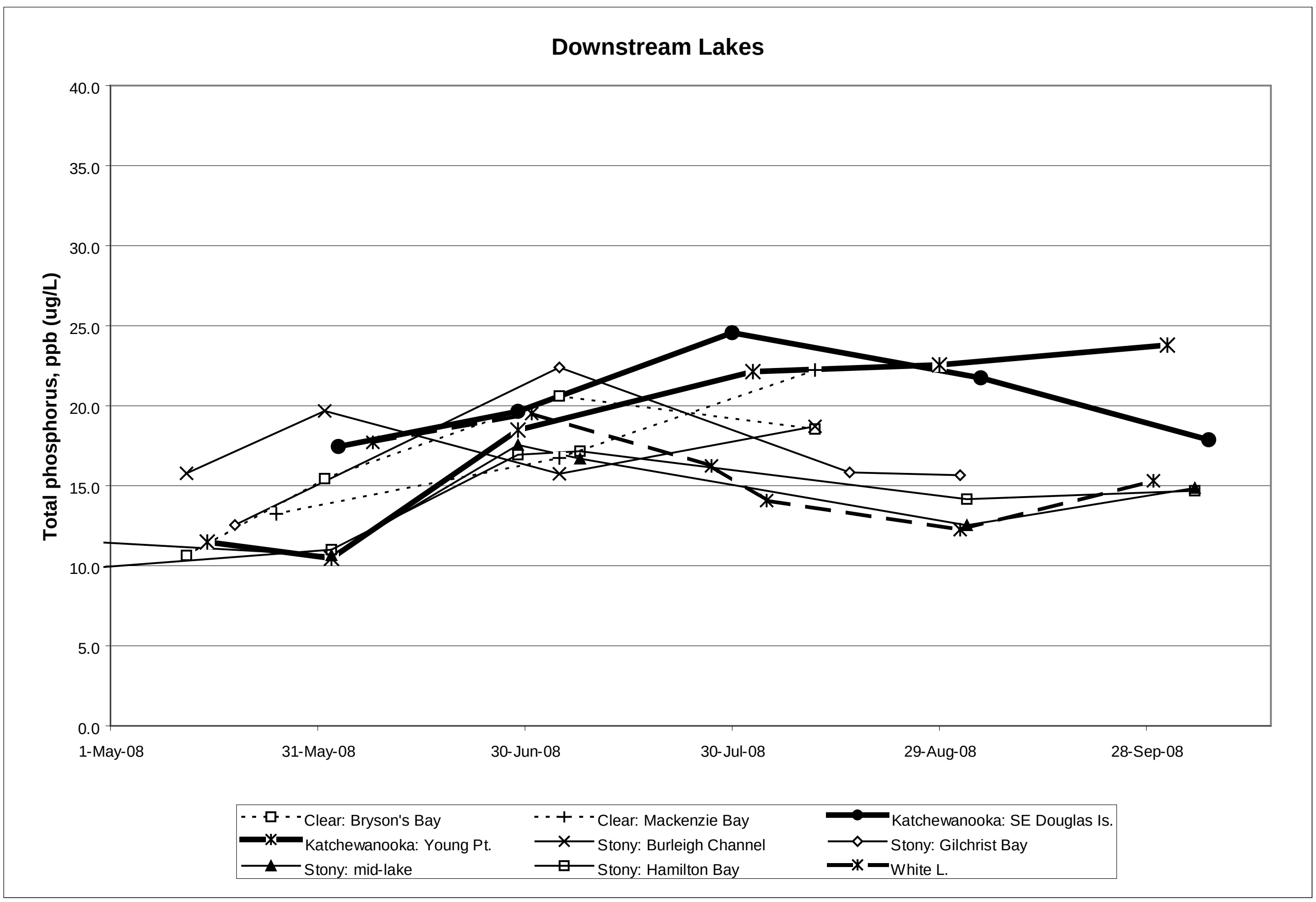
Downstream Lakes: Stony, Clear, Katchewanooka, and White Lake

As in previous years:

- Phosphorus levels are lower in Stony than in Lovesick, probably due to low-phosphorus water contributed by Upper Stoney Lake. As water flows downstream from Stony Lake, phosphorus levels rise slightly in Clear Lake, and again in Katchewanooka Lake.
- Stony Lake/Gilchrist Bay flows directly into White Lake, yet White Lake is 2 to 3 ppb lower in phosphorus than Gilchrist Bay. Why? Our guess at this point is that there are some low-phosphorus springs feeding White Lake.

New in 2008:

- In 2007, the Stony/Burleigh Channel site had higher readings than the rest of Stony Lake, which made sense as this site is upstream from the area that is diluted by Upper Stoney, and is actually very close to Lovesick Lake. This year, however, the Burleigh Channel site readings were closer to the other Stony Lake sites, for no apparent reason.



Following is the complete record of total phosphorus (TP) and Secchi disk measurements taken in 2008.

** indicates sample likely contaminated*

LAKE	LOCATION	DATE	SECCHI (m)	TP (ug/L)	TP (ug/L)	AveTP (ug/L)
BALSAM LAKE	N Bay Rocky Pt.	6-Jul-08		12.0	12.4	12.2
BALSAM LAKE	N Bay Rocky Pt.	6-Jul-08	5.0			
BALSAM LAKE	N Bay Rocky Pt.	16-Jul-08	5.0			
BALSAM LAKE	N Bay Rocky Pt.	4-Aug-08		14.9	10.2	12.5
BALSAM LAKE	N Bay Rocky Pt.	4-Aug-08	4.5			
BALSAM LAKE	N Bay Rocky Pt.	17-Aug-08	4.0			
BALSAM LAKE	N Bay Rocky Pt.	31-Aug-08		15.3		15.3
BALSAM LAKE	N Bay Rocky Pt.	28-Sep-08	4.0			
BALSAM LAKE	N Bay Rocky Pt.	29-Sep-08		13.2	13.0	13.1
BALSAM LAKE	N/E end-Lightning Point	1-Jun-08		10.3	12.0	11.2
BALSAM LAKE	N/E end-Lightning Point	21-Jun-08		19.1	13.9	16.5
BALSAM LAKE	N/E end-Lightning Point	26-Jul-08		8.9	9.3	9.1
BALSAM LAKE	N/E end-Lightning Point	10-Aug-08		12.2	10.2	11.2
BALSAM LAKE	N/E end-Lightning Point	10-Aug-08	4.4			
BALSAM LAKE	N/E end-Lightning Point	3-Sep-08		8.8	14.3	11.6
BALSAM LAKE	N/E end-Lightning Point	3-Sep-08	5.4			
BALSAM LAKE	N/E end-Lightning Point	10-Oct-08		19.1		19.1
BALSAM LAKE	N/E end-Lightning Point	10-Oct-08	4.0			
BALSAM LAKE	Killarney Bay	29-May-08		11.0	14.1	12.5
BALSAM LAKE	Killarney Bay	29-May-08	3.1			
BALSAM LAKE	Killarney Bay	5-Jun-08		14.5	10.9	12.7
BALSAM LAKE	Killarney Bay	5-Jun-08	3.1			
BALSAM LAKE	Killarney Bay	1-Jul-08		16.0	14.1	15.1
BALSAM LAKE	Killarney Bay	1-Jul-08	2.7			
BALSAM LAKE	Killarney Bay	4-Aug-08		15.9	13.8	14.9
BALSAM LAKE	Killarney Bay	4-Aug-08	2.7			
BALSAM LAKE	Killarney Bay	5-Sep-08		11.1	12.8	12.0
BALSAM LAKE	Killarney Bay	5-Sep-08	3.7			
BALSAM LAKE	Killarney Bay	1-Oct-08		10.9	19.0	14.9
BALSAM LAKE	Killarney Bay	4-Oct-08	4.2			
BALSAM LAKE	W Bay2, deep spot	30-May-08		8.9	9.3	9.1
BALSAM LAKE	W Bay2, deep spot	30-May-08	3.8			
BALSAM LAKE	W Bay2, deep spot	21-Jun-08		17.5	18.1	17.8
BALSAM LAKE	W Bay2, deep spot	21-Jun-08	3.5			
BALSAM LAKE	W Bay2, deep spot	21-Jul-08		14.3	16.5	15.4
BALSAM LAKE	W Bay2, deep spot	21-Jul-08	3.4			
BALSAM LAKE	W Bay2, deep spot	9-Aug-08		14.9	14.1	14.5
BALSAM LAKE	W Bay2, deep spot	15-Aug-08	3.7			
BALSAM LAKE	W Bay2, deep spot	1-Sep-08		14.7	14.6	14.6
BALSAM LAKE	W Bay2, deep spot	1-Sep-08	2.9			
BALSAM LAKE	W Bay2, deep spot	4-Oct-08		14.6	17.5	16.1
BALSAM LAKE	W Bay2, deep spot	4-Oct-08	4.5			
BALSAM LAKE	E of Grand Is	6-Jul-08		13.2	13.4	13.3
BALSAM LAKE	E of Grand Is	6-Jul-08	3.3			
BALSAM LAKE	E of Grand Is	11-Aug-08		11.0	12.6	11.8

BALSAM LAKE	E of Grand Is	11-Aug-08	3.0			
BALSAM LAKE	E of Grand Is	22-Sep-08		10.7	11.3	11.0
BALSAM LAKE	E of Grand Is	22-Sep-08	3.3			
BALSAM LAKE	E of Grand Is	17-Oct-08	3.8			
BALSAM LAKE	E of Grand Is	18-Oct-08		17.2	8.0	12.6
BIG BALD LAKE	Mid Lake, deep spot	21-May-08		9.6	10.0	9.8
BIG BALD LAKE	Mid Lake, deep spot	21-May-08	3.9			
BIG BALD LAKE	Mid Lake, deep spot	21-May-08	3.9			
BIG BALD LAKE	Mid Lake, deep spot	4-Jun-08	3.7			
BIG BALD LAKE	Mid Lake, deep spot	4-Jun-08	3.7			
BIG BALD LAKE	Mid Lake, deep spot	8-Jun-08		12.5	15.1	13.8
BIG BALD LAKE	Mid Lake, deep spot	30-Jun-08		13.6	12.6	13.1
BIG BALD LAKE	Mid Lake, deep spot	30-Jun-08	3.8			
BIG BALD LAKE	Mid Lake, deep spot	30-Jun-08	3.8			
BIG BALD LAKE	Mid Lake, deep spot	4-Jul-08	3.7			
BIG BALD LAKE	Mid Lake, deep spot	4-Jul-08	3.7			
BIG BALD LAKE	Mid Lake, deep spot	5-Aug-08		13.6	12.4	13.0
BIG BALD LAKE	Mid Lake, deep spot	5-Aug-08	4.0			
BIG BALD LAKE	Mid Lake, deep spot	5-Aug-08	4.0			
BIG BALD LAKE	Mid Lake, deep spot	2-Sep-08		12.9	8.9	10.9
BIG BALD LAKE	Mid Lake, deep spot	2-Sep-08	4.4			
BIG BALD LAKE	Mid Lake, deep spot	2-Sep-08	4.4			
BIG BALD LAKE	Mid Lake, deep spot	30-Sep-08		11.5	11.5	11.5
BIG BALD LAKE	Mid Lake, deep spot	1-Oct-08	4.7			
BIG BALD LAKE	Mid Lake, deep spot	1-Oct-08	4.7			
BIG BALD LAKE	Bay nr golf course	21-May-08		9.9	9.3	9.6
BIG BALD LAKE	Bay nr golf course	8-Jun-08		12.1	12.7	12.4
BIG BALD LAKE	Bay nr golf course	30-Jun-08		14.4	15.4	14.9
BIG BALD LAKE	Bay nr golf course	5-Aug-08		17.3	21.1	19.2
BIG BALD LAKE	Bay nr golf course	2-Sep-08		11.0	11.3	11.1
BIG BALD LAKE	Bay nr golf course	30-Sep-08		13.8	12.1	12.9
BUCKHORN LAKE (U)	Narrows, red buoy C310	2-Jun-08		17.9	16.5	17.2
BUCKHORN LAKE (U)	Narrows, red buoy C310	2-Jun-08	2.4			
BUCKHORN LAKE (U)	Narrows, red buoy C310	27-Jun-08	3.5			
BUCKHORN LAKE (U)	Narrows, red buoy C310	29-Jun-08		17.4	16.7	17.0
BUCKHORN LAKE (U)	Narrows, red buoy C310	4-Aug-08		39.3	38.8	39.0
BUCKHORN LAKE (U)	Narrows, red buoy C310	5-Aug-08	3.1			
BUCKHORN LAKE (U)	Narrows, red buoy C310	3-Sep-08		19.3	24.2	21.8
BUCKHORN LAKE (U)	Narrows, red buoy C310	3-Sep-08	4.2			
BUCKHORN LAKE (U)	Narrows, red buoy C310	6-Oct-08		14.8	18.9	16.8
BUCKHORN LAKE (U)	Narrows, red buoy C310	6-Oct-08	4.5			
CHEMONG LAKE	Poplar Pt.	27-May-08	1.0			
CHEMONG LAKE	Poplar Pt.	4-Jul-08	1.2			
CHEMONG LAKE	Poplar Pt.	5-Jul-08		12.3	15.3	13.8
CHEMONG LAKE	Poplar Pt.	31-Jul-08		18.0	26.6	22.3
CHEMONG LAKE	Poplar Pt.	31-Jul-08	1.0			
CHEMONG LAKE	Poplar Pt.	23-Aug-08		15.0	13.7	14.4
CHEMONG LAKE	Poplar Pt.	23-Aug-08	0.8			
CHEMONG LAKE	Poplar Pt.	10-Nov-08		43.3	66.3	54.8

CHEMONG LAKE	Poplar Pt.	11-Nov-08	1.0			
CLEAR LAKE	MacKenzie Bay	25-May-08		12.9	13.6	13.2
CLEAR LAKE	MacKenzie Bay	5-Jul-08		16.8	16.7	16.7
CLEAR LAKE	MacKenzie Bay	11-Aug-08		21.4	23.1	22.2
CLEAR LAKE	Main Basin, deep spot	21-Aug-08		20.7	19.7	20.2
CLEAR LAKE	Fiddlers Bay	21-Aug-08		20.3	19.9	20.1
CLEAR LAKE	Brysons Bay	12-May-08		11.9	9.4	10.6
CLEAR LAKE	Brysons Bay	1-Jun-08		15.0	15.9	15.4
CLEAR LAKE	Brysons Bay	5-Jul-08		21.4	19.8	20.6
CLEAR LAKE	Brysons Bay	11-Aug-08		19.4	17.6	18.5
JULIAN LAKE	Mid Lake, deep spot	25-May-08		13.6	11.1	12.4
JULIAN LAKE	Mid Lake, deep spot	25-May-08	4.8			
JULIAN LAKE	Mid Lake, deep spot	21-Jun-08	6.1			
JULIAN LAKE	Mid Lake, deep spot	22-Jun-08		7.3	6.9	7.1
JULIAN LAKE	Mid Lake, deep spot	4-Jul-08		7.9	11.0	9.4
JULIAN LAKE	Mid Lake, deep spot	22-Jul-08	2.5			
JULIAN LAKE	Mid Lake, deep spot	28-Jul-08	2.7			
JULIAN LAKE	Mid Lake, deep spot	5-Aug-08		5.3	7.1	6.2
JULIAN LAKE	Mid Lake, deep spot	5-Aug-08	3.1			
JULIAN LAKE	Mid Lake, deep spot	12-Aug-08	4.0			
JULIAN LAKE	Mid Lake, deep spot	2-Sep-08		5.1	6.0	5.6
JULIAN LAKE	Mid Lake, deep spot	2-Sep-08	4.2			
JULIAN LAKE	Mid Lake, deep spot	5-Oct-08		5.6	5.7	5.6
KATCHEWANOOKA LAKE	S/E Douglas Island	3-Jun-08		12.6	22.3	17.5
KATCHEWANOOKA LAKE	S/E Douglas Island	29-Jun-08		20.8	18.5	19.6
KATCHEWANOOKA LAKE	S/E Douglas Island	30-Jul-08		24.0	25.2	24.6
KATCHEWANOOKA LAKE	S/E Douglas Island	4-Sep-08		21.9	21.6	21.7
KATCHEWANOOKA LAKE	S/E Douglas Island	7-Oct-08		19.3	16.5	17.9
KATCHEWANOOKA LAKE	Young Pt near locks	15-May-08		11.2	11.8	11.5
KATCHEWANOOKA LAKE	Young Pt near locks	15-May-08	3.5			
KATCHEWANOOKA LAKE	Young Pt near locks	2-Jun-08		10.6	10.4	10.5
KATCHEWANOOKA LAKE	Young Pt near locks	2-Jun-08	5.4			
KATCHEWANOOKA LAKE	Young Pt near locks	24-Jun-08	4.4			
KATCHEWANOOKA LAKE	Young Pt near locks	29-Jun-08		17.7	19.3	18.5
KATCHEWANOOKA LAKE	Young Pt near locks	2-Jul-08	4.2			
KATCHEWANOOKA LAKE	Young Pt near locks	16-Jul-08	4.2			
KATCHEWANOOKA LAKE	Young Pt near locks	2-Aug-08		23.8	20.5	22.1
KATCHEWANOOKA LAKE	Young Pt near locks	5-Aug-08	3.9			
KATCHEWANOOKA LAKE	Young Pt near locks	21-Aug-08	4.6			
KATCHEWANOOKA LAKE	Young Pt near locks	29-Aug-08		18.8	26.3	22.5
KATCHEWANOOKA LAKE	Young Pt near locks	2-Sep-08	5.2			
KATCHEWANOOKA LAKE	Young Pt near locks	16-Sep-08	4.5			
KATCHEWANOOKA LAKE	Young Pt near locks	1-Oct-08		30.1	17.5	23.8
KATCHEWANOOKA LAKE	Young Pt near locks	1-Oct-08	5.0			
LOVESICK LAKE	80’ hole at N. end	6-May-08	3.5			
LOVESICK LAKE	80’ hole at N. end	12-May-08		11.8	12.1	11.9
LOVESICK LAKE	80’ hole at N. end	8-Jun-08		26.1	25.6	25.8
LOVESICK LAKE	80’ hole at N. end	8-Jun-08	3.0			
LOVESICK LAKE	80’ hole at N. end	29-Jun-08		20.6	19.5	20.0

LOVESICK LAKE	80' hole at N. end	1-Jul-08	4.0			
LOVESICK LAKE	80' hole at N. end	2-Aug-08		38.4	21.9	30.1
LOVESICK LAKE	80' hole at N. end	5-Aug-08	4.0			
LOVESICK LAKE	80' hole at N. end	31-Aug-08		14.9	17.0	16.0
LOVESICK LAKE	80' hole at N. end	2-Sep-08	4.0			
LOVESICK LAKE	80' hole at N. end	1-Oct-08		12.4	15.4	13.9
LOVESICK LAKE	80' hole at N. end	7-Oct-08	6.5			
LOVESICK LAKE	Spenceley's Bay	6-May-08	4.0			
LOVESICK LAKE	Spenceley's Bay	12-May-08		15.6	15.5	15.6
LOVESICK LAKE	Spenceley's Bay	8-Jun-08		25.7	30.2	28.0
LOVESICK LAKE	Spenceley's Bay	8-Jun-08	2.5			
LOVESICK LAKE	Spenceley's Bay	29-Jun-08		21.7		21.7
LOVESICK LAKE	Spenceley's Bay	1-Jul-08	4.0			
LOVESICK LAKE	Spenceley's Bay	2-Aug-08		23.2	30.0	26.6
LOVESICK LAKE	Spenceley's Bay	5-Aug-08	3.8			
LOVESICK LAKE	Spenceley's Bay	31-Aug-08		15.6	16.4	16.0
LOVESICK LAKE	Spenceley's Bay	2-Sep-08	4.5			
LOVESICK LAKE	Spenceley's Bay	1-Oct-08		15.0	12.8	13.9
LOVESICK LAKE	Spenceley's Bay	7-Oct-08	5.5			
LOVESICK LAKE	McCallum Island	6-May-08	4.0			
LOVESICK LAKE	McCallum Island	12-May-08		12.7	11.7	12.2
LOVESICK LAKE	McCallum Island	8-Jun-08		25.6	27.8	26.7
LOVESICK LAKE	McCallum Island	8-Jun-08	4.0			
LOVESICK LAKE	McCallum Island	29-Jun-08		21.0	20.4	20.7
LOVESICK LAKE	McCallum Island	1-Jul-08	4.0			
LOVESICK LAKE	McCallum Island	2-Aug-08		19.2	20.7	19.9
LOVESICK LAKE	McCallum Island	5-Aug-08	3.3			
LOVESICK LAKE	McCallum Island	31-Aug-08		15.6	15.6	15.6
LOVESICK LAKE	McCallum Island	2-Sep-08	4.0			
LOVESICK LAKE	McCallum Island	1-Oct-08		13.0	11.6	12.3
LOVESICK LAKE	McCallum Island	7-Oct-08	5.0			
LOWER BUCKHORN LAKE	Heron Island	9-May-08	3.5			
LOWER BUCKHORN LAKE	Heron Island	11-May-08		12.6	12.0	12.3
LOWER BUCKHORN LAKE	Heron Island	29-Jun-08		28.5	22.4	25.4
LOWER BUCKHORN LAKE	Heron Island	30-Jun-08	3.1			
LOWER BUCKHORN LAKE	Heron Island	26-Jul-08		21.5	20.3	20.9
LOWER BUCKHORN LAKE	Heron Island	28-Jul-08	3.5			
LOWER BUCKHORN LAKE	Heron Island	31-Aug-08		15.6	15.6	15.6
LOWER BUCKHORN LAKE	Heron Island	31-Aug-08	3.2			
LOWER BUCKHORN LAKE	Heron Island	13-Oct-08		10.8	10.6	10.7
LOWER BUCKHORN LAKE	Heron Island	19-Oct-08	4.4			
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	24-May-08		12.9	12.5	12.7
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	24-May-08	2.5			
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	27-May-08	3.0			
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	16-Jun-08		23.1	22.3	22.7
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	16-Jun-08	3.6			
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	6-Jul-08		15.7	17.3	16.5
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	8-Jul-08	3.6			
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	20-Jul-08	3.4			

LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	2-Aug-08		18.9	18.2	18.6
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	2-Aug-08	3.8			
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	15-Aug-08	4.5			
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	27-Aug-08		15.6	17.3	16.5
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	27-Aug-08	4.7			
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	7-Oct-08		11.8	11.4	11.6
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	7-Oct-08	7.5			
LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	18-Oct-08	7.5			
LOWER BUCKHORN LAKE	Deer Bay-centre	9-May-08	3.4			
LOWER BUCKHORN LAKE	Deer Bay-centre	11-May-08		12.0	15.4	13.7
LOWER BUCKHORN LAKE	Deer Bay-centre	20-Jun-08	2.8			
LOWER BUCKHORN LAKE	Deer Bay-centre	29-Jun-08		20.2	20.3	20.3
LOWER BUCKHORN LAKE	Deer Bay-centre	26-Jul-08		20.9	22.7	21.8
LOWER BUCKHORN LAKE	Deer Bay-centre	28-Jul-08	2.7			
LOWER BUCKHORN LAKE	Deer Bay-centre	31-Aug-08		13.6	13.7	13.6
LOWER BUCKHORN LAKE	Deer Bay-centre	31-Aug-08	2.7			
LOWER BUCKHORN LAKE	Deer Bay-centre	13-Oct-08		12.3	12.4	12.3
PIGEON LAKE	S end, deep spot	5-May-08		24.7	23.0	23.8
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	3-May-08		9.8	11.0	10.4
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	3-May-08	2.8			
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	8-Jun-08		14.1	14.3	14.2
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	8-Jun-08	3.1			
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	29-Jun-08		13.5	14.1	13.8
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	29-Jun-08	2.6			
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	5-Aug-08		19.9	20.5	20.2
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	5-Aug-08	3.0			
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	1-Sep-08		15.7	15.1	15.4
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	1-Sep-08	2.8			
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	12-Oct-08		20.4	22.8	21.6
PIGEON LAKE	Mid-Sandy Pt/Boyd Is.	12-Oct-08	3.9			
PIGEON LAKE	N-400m N of Boyd Is.	19-May-08		9.0	12.1	10.6
PIGEON LAKE	N-400m N of Boyd Is.	2-Jun-08		8.6	10.2	9.4
PIGEON LAKE	N-400m N of Boyd Is.	29-Jun-08		17.8	17.3	17.6
PIGEON LAKE	N-400m N of Boyd Is.	20-Jul-08		22.7	32.8	27.8
PIGEON LAKE	N-400m N of Boyd Is.	21-Jul-08	3.2			
PIGEON LAKE	N-400m N of Boyd Is.	5-Aug-08		19.0	19.7	19.4
PIGEON LAKE	N-400m N of Boyd Is.	5-Aug-08	3.2			
PIGEON LAKE	N-400m N of Boyd Is.	3-Sep-08		16.7	16.8	16.7
PIGEON LAKE	N-400m N of Boyd Is.	1-Oct-08		27.0	26.1	26.6
PIGEON LAKE	N end, Adjacent Con 17	3-May-08		11.1	11.7	11.4
PIGEON LAKE	N end, Adjacent Con 17	3-May-08	2.9			
PIGEON LAKE	N end, Adjacent Con 17	8-Jun-08		11.3	13.4	12.4
PIGEON LAKE	N end, Adjacent Con 17	8-Jun-08	2.9			
PIGEON LAKE	N end, Adjacent Con 17	29-Jun-08		18.7	14.3	16.5
PIGEON LAKE	N end, Adjacent Con 17	29-Jun-08	2.4			
PIGEON LAKE	N end, Adjacent Con 17	5-Aug-08		19.2	17.0	18.1
PIGEON LAKE	N end, Adjacent Con 17	5-Aug-08	3.2			
PIGEON LAKE	N end, Adjacent Con 17	1-Sep-08		20.9	18.8	19.8
PIGEON LAKE	N end, Adjacent Con 17	1-Sep-08	2.9			

PIGEON LAKE	N end, Adjacent Con 17	12-Oct-08		17.6	17.2	17.4
PIGEON LAKE	N end, Adjacent Con 17	12-Oct-08	3.8			
PIGEON LAKE	Dead Horse Shoal	1-Jul-08		16.3	16.6	16.5
PIGEON LAKE	Dead Horse Shoal	2-Jul-08	2.8			
PIGEON LAKE	Dead Horse Shoal	18-Jul-08	3.1			
PIGEON LAKE	Dead Horse Shoal	6-Aug-08		19.1	18.6	18.9
PIGEON LAKE	Dead Horse Shoal	6-Aug-08	3.2			
PIGEON LAKE	Dead Horse Shoal	30-Aug-08		15.9	17.8	16.9
PIGEON LAKE	Dead Horse Shoal	3-Sep-08	3.7			
PIGEON LAKE	N-300yds off Bottom Is.	19-May-08		14.2	12.1	13.1
PIGEON LAKE	N-300yds off Bottom Is.	2-Jun-08		8.3	10.0	9.1
PIGEON LAKE	N-300yds off Bottom Is.	29-Jun-08		15.4	14.8	15.1
PIGEON LAKE	N-300yds off Bottom Is.	20-Jul-08		29.2	25.5	27.3
PIGEON LAKE	N-300yds off Bottom Is.	21-Jul-08	3.2			
PIGEON LAKE	N-300yds off Bottom Is.	5-Aug-08		24.7	24.5	24.6
PIGEON LAKE	N-300yds off Bottom Is.	5-Aug-08	2.8			
SANDY LAKE	Mid Lake, deep spot	19-May-08	4.8			
SANDY LAKE	Mid Lake, deep spot	1-Jun-08		10.9	6.9	8.9
SANDY LAKE	Mid Lake, deep spot	1-Jun-08	4.8			
SANDY LAKE	Mid Lake, deep spot	15-Jun-08		5.4	7.4	6.4
SANDY LAKE	Mid Lake, deep spot	15-Jun-08	5.5			
SANDY LAKE	Mid Lake, deep spot	29-Jun-08		7.8	7.7	7.7
SANDY LAKE	Mid Lake, deep spot	1-Jul-08	5.0			
SANDY LAKE	Mid Lake, deep spot	2-Aug-08		8.1	7.4	7.8
SANDY LAKE	Mid Lake, deep spot	3-Aug-08	4.6			
SANDY LAKE	Mid Lake, deep spot	29-Aug-08		7.0	7.3	7.2
SANDY LAKE	Mid Lake, deep spot	31-Aug-08	4.1			
SANDY LAKE	Mid Lake, deep spot	28-Sep-08	5.7			
SANDY LAKE	Mid Lake, deep spot	30-Sep-08		8.5	6.8	7.6
SANDY LAKE	Mid Lake, deep spot	11-Oct-08	8.4			
STONY LAKE	Burleigh locks chan.	12-May-08		16.0	15.6	15.8
STONY LAKE	Burleigh locks chan.	1-Jun-08		21.5	17.9	19.7
STONY LAKE	Burleigh locks chan.	5-Jul-08		14.9	16.6	15.8
STONY LAKE	Burleigh locks chan.	11-Aug-08		18.8	18.6	18.7
STONY LAKE	Gilchrist Bay	19-May-08		13.3	11.8	12.6
STONY LAKE	Gilchrist Bay	19-May-08	2.8			
STONY LAKE	Gilchrist Bay	5-Jul-08		23.9	20.9	22.4
STONY LAKE	Gilchrist Bay	6-Jul-08	3.0			
STONY LAKE	Gilchrist Bay	16-Aug-08		15.8	15.8	15.8
STONY LAKE	Gilchrist Bay	18-Aug-08	3.3			
STONY LAKE	Gilchrist Bay	1-Sep-08		16.0	15.4	15.7
STONY LAKE	Gilchrist Bay	21-Sep-08	4.5			
STONY LAKE	mid-lake	28-Apr-08		12.1	10.9	11.5
STONY LAKE	mid-lake	28-Apr-08	3.9			
STONY LAKE	mid-lake	2-Jun-08		10.5	10.8	10.7
STONY LAKE	mid-lake	2-Jun-08	3.9			
STONY LAKE	mid-lake	29-Jun-08		17.8	17.3	17.5
STONY LAKE	mid-lake	2-Jul-08	3.0			
STONY LAKE	mid-lake	8-Jul-08		17.3	16.1	16.7

STONY LAKE	mid-lake	5-Aug-08	2.9			
STONY LAKE	mid-lake	2-Sep-08		13.3	11.8	12.5
STONY LAKE	mid-lake	2-Sep-08	4.8			
STONY LAKE	mid-lake	5-Oct-08		14.5	15.2	14.9
STONY LAKE	mid-lake	5-Oct-08	4.3			
STONY LAKE	Hamilton Bay	28-Apr-08		9.4	10.4	9.9
STONY LAKE	Hamilton Bay	28-Apr-08	4.0			
STONY LAKE	Hamilton Bay	2-Jun-08		11.1	10.9	11.0
STONY LAKE	Hamilton Bay	2-Jun-08	3.2			
STONY LAKE	Hamilton Bay	29-Jun-08		16.9	17.0	16.9
STONY LAKE	Hamilton Bay	2-Jul-08	3.9			
STONY LAKE	Hamilton Bay	8-Jul-08		16.3	18.0	17.2
STONY LAKE	Hamilton Bay	5-Aug-08	3.2			
STONY LAKE	Hamilton Bay	2-Sep-08		16.3	12.1	14.2
STONY LAKE	Hamilton Bay	2-Sep-08	4.0			
STONY LAKE	Hamilton Bay	5-Oct-08		14.6	14.7	14.7
STONY LAKE	Hamilton Bay	5-Oct-08	4.1			
STURGEON LAKE	Muskrat Is. at Buoy C388	23-May-08		18.0	17.8	17.9
STURGEON LAKE	Muskrat Is. at Buoy C388	23-May-08	4.5			
STURGEON LAKE	Muskrat Is. at Buoy C388	23-May-08	4.5			
STURGEON LAKE	Muskrat Is. at Buoy C388	1-Jul-08		22.4	24.3	23.4
STURGEON LAKE	Muskrat Is. at Buoy C388	1-Jul-08	3.4			
STURGEON LAKE	Muskrat Is. at Buoy C388	1-Jul-08	3.4			
STURGEON LAKE	Muskrat Is. at Buoy C388	2-Aug-08		22.7	23.4	23.1
STURGEON LAKE	Muskrat Is. at Buoy C388	5-Aug-08	3.1			
STURGEON LAKE	Muskrat Is. at Buoy C388	5-Aug-08	3.1			
STURGEON LAKE	Muskrat Is. at Buoy C388	30-Aug-08		22.1		22.1
STURGEON LAKE	Muskrat Is. at Buoy C388	2-Sep-08	4.2			
STURGEON LAKE	Muskrat Is. at Buoy C388	15-Sep-08		24.7	25.5	25.1
STURGEON LAKE	Muskrat Is. at Buoy C388	1-Oct-08		21.2	22.9	22.0
STURGEON LAKE	Muskrat Is. at Buoy C388	1-Oct-08	3.9			
STURGEON LAKE	Sturgeon Point Buoy	23-May-08		11.8	9.9	10.8
STURGEON LAKE	Sturgeon Point Buoy	23-May-08	3.2			
STURGEON LAKE	Sturgeon Point Buoy	23-May-08	3.2			
STURGEON LAKE	Sturgeon Point Buoy	1-Jul-08		17.8	19.0	18.4
STURGEON LAKE	Sturgeon Point Buoy	1-Jul-08	3.0			
STURGEON LAKE	Sturgeon Point Buoy	1-Jul-08	3.0			
STURGEON LAKE	Sturgeon Point Buoy	2-Aug-08		21.8	20.0	20.9
STURGEON LAKE	Sturgeon Point Buoy	5-Aug-08	2.6			
STURGEON LAKE	Sturgeon Point Buoy	5-Aug-08	2.6			
STURGEON LAKE	Sturgeon Point Buoy	1-Sep-08		19.9	24.6	22.3
STURGEON LAKE	Sturgeon Point Buoy	2-Sep-08	4.0			
STURGEON LAKE	Sturgeon Point Buoy	1-Oct-08		30.7	28.1	29.4
STURGEON LAKE	Sturgeon Point Buoy	1-Oct-08	3.0			
STURGEON LAKE	S of Fenelon R-Buoy N5	23-May-08		13.3	12.1	12.7
STURGEON LAKE	S of Fenelon R-Buoy N5	23-May-08	3.2			
STURGEON LAKE	S of Fenelon R-Buoy N5	23-May-08	3.2			
STURGEON LAKE	S of Fenelon R-Buoy N5	1-Jul-08		19.0	20.1	19.5
STURGEON LAKE	S of Fenelon R-Buoy N5	1-Jul-08	2.9			

STURGEON LAKE	S of Fenelon R-Buoy N5	1-Jul-08	2.9			
STURGEON LAKE	S of Fenelon R-Buoy N5	2-Aug-08		17.8	19.3	18.5
STURGEON LAKE	S of Fenelon R-Buoy N5	5-Aug-08	2.5			
STURGEON LAKE	S of Fenelon R-Buoy N5	5-Aug-08	2.5			
STURGEON LAKE	S of Fenelon R-Buoy N5	1-Sep-08		40.4	36.6	38.5
STURGEON LAKE	S of Fenelon R-Buoy N5	2-Sep-08	3.0			
STURGEON LAKE	S of Fenelon R-Buoy N5	1-Oct-08		13.2	13.8	13.5
STURGEON LAKE	S of Fenelon R-Buoy N5	1-Oct-08	3.2			
STURGEON LAKE	Snug Harbour	23-May-08		22.1	23.3	22.7
STURGEON LAKE	Snug Harbour	23-May-08	2.1			
STURGEON LAKE	Snug Harbour	23-May-08				
STURGEON LAKE	Snug Harbour	1-Jul-08		*251.5	*240.0	*245.7
STURGEON LAKE	Snug Harbour	1-Jul-08				
STURGEON LAKE	Snug Harbour	1-Jul-08	2.1			
STURGEON LAKE	Snug Harbour	2-Aug-08		49.8	56.3	53.0
STURGEON LAKE	Snug Harbour	5-Aug-08	2.0			
STURGEON LAKE	Snug Harbour	5-Aug-08				
STURGEON LAKE	Snug Harbour	1-Sep-08		82.9	66.6	74.7
STURGEON LAKE	Snug Harbour	2-Sep-08				
STURGEON LAKE	Snug Harbour	1-Oct-08		55.4		70.3
STURGEON LAKE	Snug Harbour	1-Oct-08				
UPPER STONEY LAKE	Quarry Bay	11-May-08		6.3	5.9	6.1
UPPER STONEY LAKE	Quarry Bay	11-May-08	6.0			
UPPER STONEY LAKE	Quarry Bay	8-Jun-08		12.3	13.0	12.7
UPPER STONEY LAKE	Quarry Bay	12-Jun-08	3.6			
UPPER STONEY LAKE	Quarry Bay	25-Jul-08		8.1	8.3	8.2
UPPER STONEY LAKE	Quarry Bay	28-Jul-08	5.6			
UPPER STONEY LAKE	Quarry Bay	1-Sep-08	6.3			
UPPER STONEY LAKE	Quarry Bay	3-Sep-08		6.1	6.5	6.3
UPPER STONEY LAKE	Quarry Bay	5-Oct-08		8.0	5.8	6.9
UPPER STONEY LAKE	Quarry Bay	5-Oct-08	6.7			
UPPER STONEY LAKE	Quarry Bay	24-Oct-08		5.6	6.8	6.2
UPPER STONEY LAKE	Quarry Bay	24-Oct-08	7.4			
UPPER STONEY LAKE	Young Bay	11-May-08		6.9	6.9	6.9
UPPER STONEY LAKE	Young Bay	11-May-08	6.1			
UPPER STONEY LAKE	Young Bay	8-Jun-08		13.0	10.8	11.9
UPPER STONEY LAKE	Young Bay	12-Jun-08	4.2			
UPPER STONEY LAKE	Young Bay	25-Jul-08		8.1	8.1	8.1
UPPER STONEY LAKE	Young Bay	28-Jul-08	6.3			
UPPER STONEY LAKE	Young Bay	1-Sep-08	6.0			
UPPER STONEY LAKE	Young Bay	3-Sep-08		8.0	7.1	7.6
UPPER STONEY LAKE	Young Bay	5-Oct-08		6.6	27.0	16.8
UPPER STONEY LAKE	Young Bay	5-Oct-08	6.7			
UPPER STONEY LAKE	Young Bay	24-Oct-08		5.7	5.7	5.7
UPPER STONEY LAKE	Young Bay	24-Oct-08	6.5			
UPPER STONEY LAKE	S Bay, deep spot	11-May-08		8.4	8.4	8.4
UPPER STONEY LAKE	S Bay, deep spot	11-May-08				
UPPER STONEY LAKE	S Bay, deep spot	8-Jun-08		18.5	15.8	17.2
UPPER STONEY LAKE	S Bay, deep spot	12-Jun-08				

UPPER STONEY LAKE	S Bay, deep spot	25-Jul-08		11.0	11.8	11.4
UPPER STONEY LAKE	S Bay, deep spot	28-Jul-08				
UPPER STONEY LAKE	S Bay, deep spot	1-Sep-08				
UPPER STONEY LAKE	S Bay, deep spot	3-Sep-08		7.0	6.7	6.9
UPPER STONEY LAKE	S Bay, deep spot	5-Oct-08		10.2	8.8	9.5
UPPER STONEY LAKE	S Bay, deep spot	5-Oct-08				
UPPER STONEY LAKE	S Bay, deep spot	24-Oct-08		8.9	9.2	9.0
UPPER STONEY LAKE	S Bay, deep spot	24-Oct-08				
UPPER STONEY LAKE	Crowes Landing	1-May-08	6.2			
UPPER STONEY LAKE	Crowes Landing	11-May-08		6.3	6.8	6.5
UPPER STONEY LAKE	Crowes Landing	8-Jun-08		14.0	10.2	12.1
UPPER STONEY LAKE	Crowes Landing	12-Jun-08	3.7			
UPPER STONEY LAKE	Crowes Landing	25-Jul-08		8.5	8.6	8.6
UPPER STONEY LAKE	Crowes Landing	28-Jul-08	5.6			
UPPER STONEY LAKE	Crowes Landing	1-Sep-08	6.2			
UPPER STONEY LAKE	Crowes Landing	3-Sep-08		9.6	10.0	9.8
UPPER STONEY LAKE	Crowes Landing	5-Oct-08		7.4	8.6	8.0
UPPER STONEY LAKE	Crowes Landing	5-Oct-08	7.3			
UPPER STONEY LAKE	Crowes Landing	24-Oct-08		6.3	7.3	6.8
UPPER STONEY LAKE	Crowes Landing	24-Oct-08	6.8			
UPPER STONEY LAKE	Mid Lake, deep spot	11-May-08		6.8	7.1	7.0
UPPER STONEY LAKE	Mid Lake, deep spot	11-May-08	6.2			
UPPER STONEY LAKE	Mid Lake, deep spot	8-Jun-08		10.2	12.5	11.3
UPPER STONEY LAKE	Mid Lake, deep spot	12-Jun-08	3.6			
UPPER STONEY LAKE	Mid Lake, deep spot	25-Jul-08		8.2	8.3	8.2
UPPER STONEY LAKE	Mid Lake, deep spot	28-Jul-08	5.6			
UPPER STONEY LAKE	Mid Lake, deep spot	1-Sep-08	6.5			
UPPER STONEY LAKE	Mid Lake, deep spot	3-Sep-08		7.1	9.5	8.3
UPPER STONEY LAKE	Mid Lake, deep spot	5-Oct-08		7.7	7.6	7.6
UPPER STONEY LAKE	Mid Lake, deep spot	5-Oct-08	6.4			
UPPER STONEY LAKE	Mid Lake, deep spot	24-Oct-08		6.5	6.2	6.4
UPPER STONEY LAKE	Mid Lake, deep spot	24-Oct-08	6.4			
WHITE LAKE (DUMMER)	S end, deep spot	8-Jun-08		17.4	18.0	17.7
WHITE LAKE (DUMMER)	S end, deep spot	8-Jun-08	2.3			
WHITE LAKE (DUMMER)	S end, deep spot	1-Jul-08		21.4	17.7	19.5
WHITE LAKE (DUMMER)	S end, deep spot	1-Jul-08	2.9			
WHITE LAKE (DUMMER)	S end, deep spot	27-Jul-08		16.3	16.2	16.2
WHITE LAKE (DUMMER)	S end, deep spot	27-Jul-08	2.7			
WHITE LAKE (DUMMER)	S end, deep spot	4-Aug-08		13.8	14.4	14.1
WHITE LAKE (DUMMER)	S end, deep spot	4-Aug-08	2.9			
WHITE LAKE (DUMMER)	S end, deep spot	1-Sep-08		12.5	12.0	12.3
WHITE LAKE (DUMMER)	S end, deep spot	1-Sep-08	3.3			
WHITE LAKE (DUMMER)	S end, deep spot	26-Sep-08	4.5			
WHITE LAKE (DUMMER)	S end, deep spot	29-Sep-08		17.4	13.2	15.3

Appendix G: Glossary

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

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

Algal blooms – Sudden proliferations of algae.

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

Benthic mat – A piece of heavy textile placed on the nearshore substrate as a physical barrier to smother weed growth.

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. The Shield 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 found in photosynthesizing organisms; the amount of chlorophyll a in surface water samples indicates the amount of free-floating algae.

Drumlin – An elongated "whale-shaped" hill formed by glacial action.

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

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

Esker – A long, narrow ridge of coarse gravel deposited by meltwater rivers flowing under glaciers or ice sheets.

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.

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

Gneiss – A common, widely distributed type of rock formed by high grade regional metamorphic processes from pre-existing formations that were originally igneous or sedimentary rock.

Isotope – Any of two or more forms of a chemical element having the same atomic number but different atomic weights.

Karst – An area of irregular limestone in which erosion has produced fissures, sinkholes, underground streams and caverns.

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

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

Marl and marl lake – Marl is limestone (calcium carbonate) that collects on the lake bottom. Marl lakes receive drainage from limestone dominated watersheds. Rainfall, which is slightly acidic, dissolves the limestone as it percolates through the rocks or soil. When the high-calcium water in the lake warms in the summer, chemical conditions cause the dissolved limestone to precipitate out.

Mesa – The Spanish word for table, a mesa is an elevated area of land with a flat top and sides that are usually steep cliffs.

Metaphyton – Large clumps of filamentous algae that are found in the shallow portions of lakes and will often be attached to aquatic plants.

Moraine – A glacially formed accumulation of unconsolidated glacial debris (soil and rocks). Moraines may be composed of silt or large boulders, generally somewhat angular or rounded in shape.

Ordovician period – A geologic period, the second of six of the Paleozoic era, covering the time from 488 to 443 million years ago.

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

Pathogen – A disease-causing microorganism.

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, often microscopic free-floating algae that can turn lake water greenish, and are fed upon by zooplankton, zebra mussels, baby fish, etc.

Primary productivity – Amount of biomass produced through photosynthesis per unit area of time by plants and algae.

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.

Scarp – The steeper side of an escarpment, sometimes forming a cliff.

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

Substrate – The earthy material that exists in the bottom of a marine habitat, like dirt, rocks, sand or gravel.

Tannic water –Brown-stained water containing astringent chemicals produced by the decay of vegetation.

Tufa – A calcium carbonate deposit that forms by chemical precipitation from bodies of water with a high dissolved calcium content.

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.

Wind set-up – The tendency for water levels to increase at the downwind shore, and to decrease at the upwind shore due to storm winds.

Appendix H: Rainfall in the Kawarthas – Summer 2008

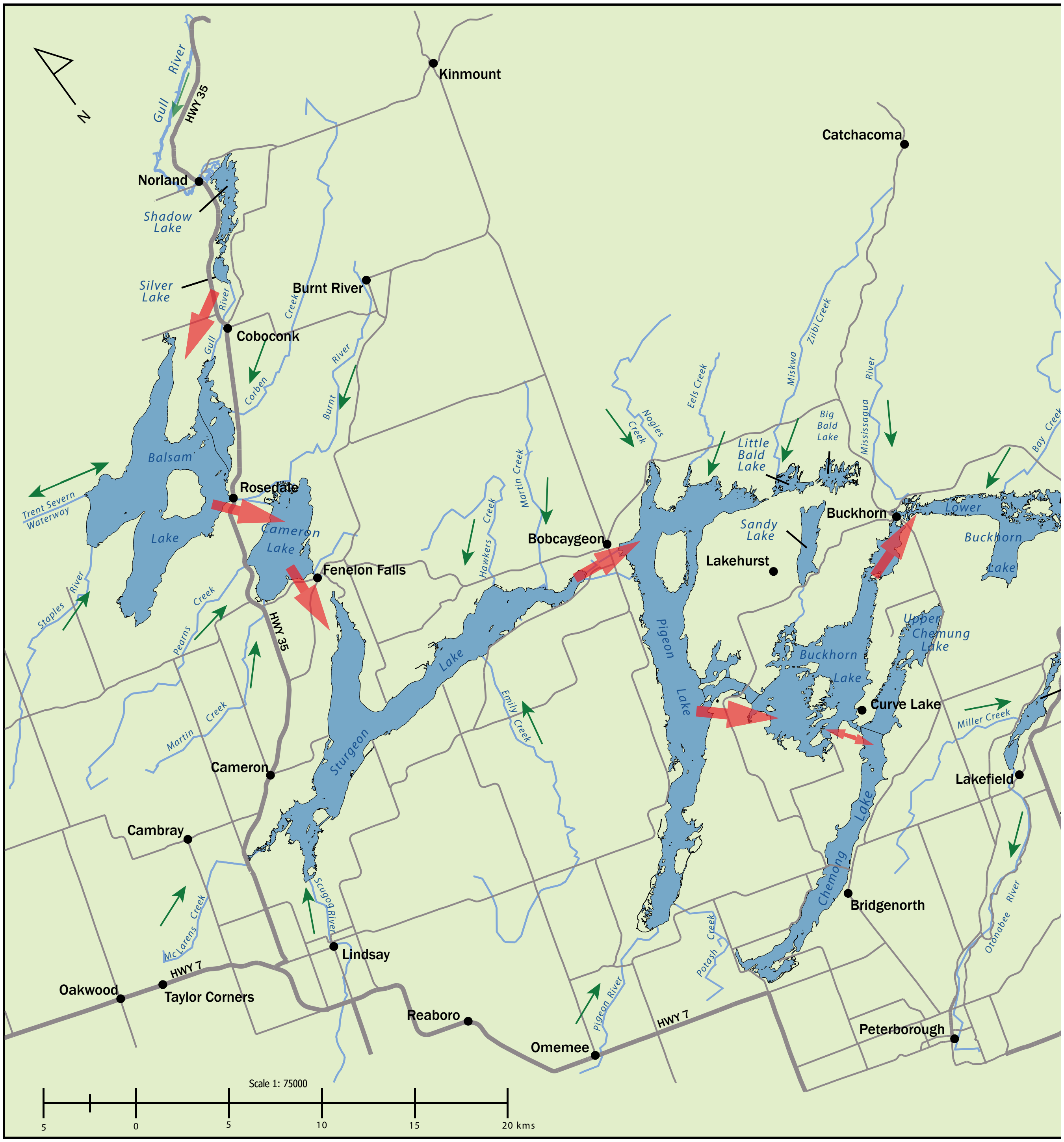
This chart shows rainfall (mm) at four sites in the Kawarthas during the summer of 2008. Please see map for locations. Rainfall over 10 mm is in **bold**.

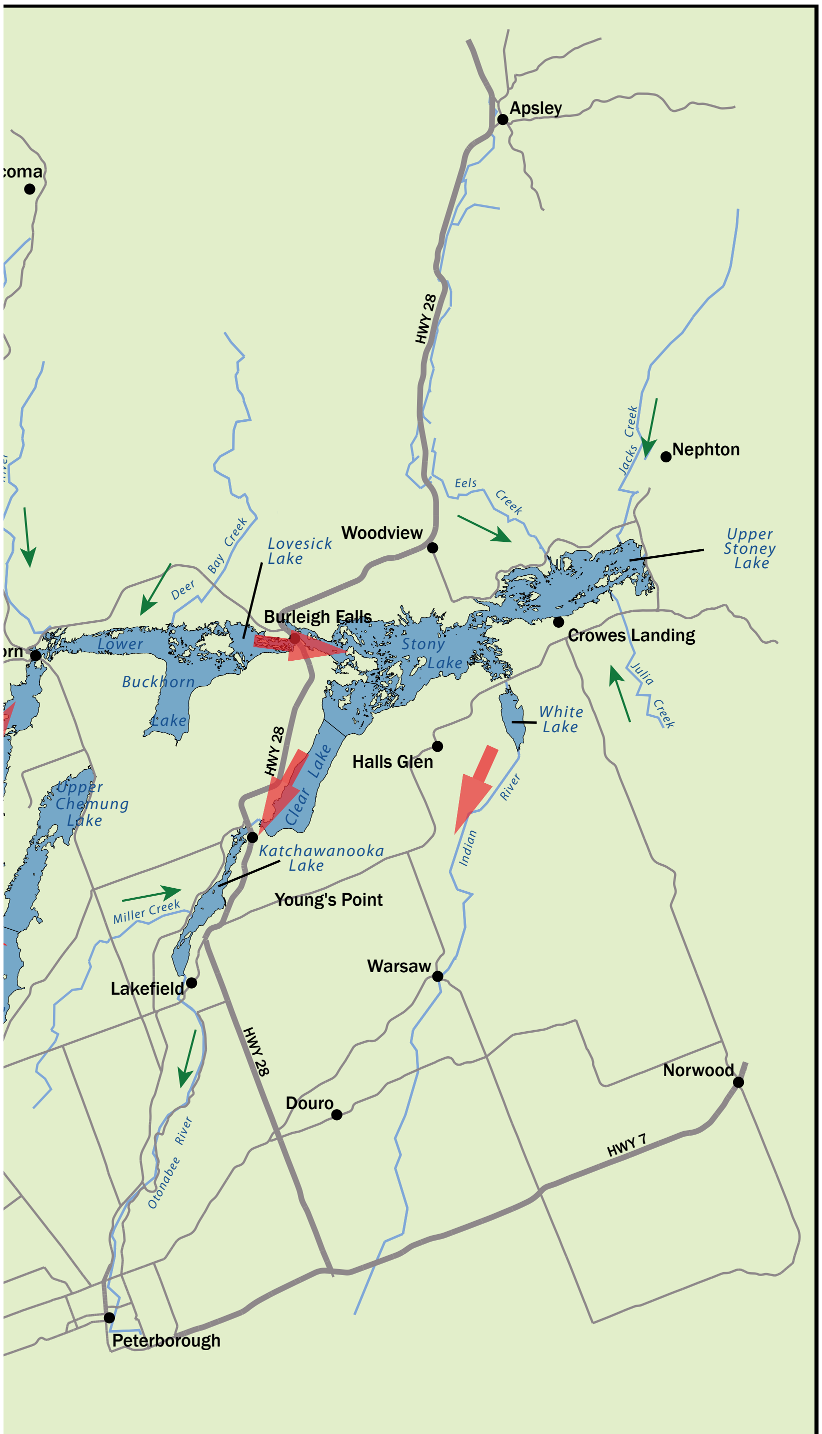
	Rainfall, mm					Rainfall, mm			
Date/08	**Oliver Centre**	**Stony Lake**	**Trent U.**	**Lindsay**	**Date/08**	**Oliver Centre**	**Stony Lake**	**Trent U.**	**Lindsay**
Jun25	0	0	0.0	0	Aug1	0	**18.2**	0	0
Jun26	0	0	1.4	0	Aug2	0.5	5.3	3.3	3.1
Jun27	0	0	0.0	0	Aug3	0	-	0.6	0.1
Jun28	**10.6**	7.4	9.8	9.6	Aug4	0	-	0	0
Jun29	1.4	8.8	6.0	2.2	Aug5	7.7	-	8.3	8.5
Jun30	0	0	0.0	0.4	Aug6	0.1	5.9	0	0
June Total	**-**	**-**	**120.8**	**-**	Aug7	0	4.5	1.8	3.1
June Avg.	**-**	**-**	**78.9**	**-**	Aug8	2.2	6.2	2.9	7.0
Jul1	0	0	0	0	Aug9	3.7	1.5	9.6	8.3
Jul2	0	0	0.7	0	Aug10	0.2	**25.0**	6.9	2.9
Jul3	4.3	3.2	3.7	5.5	Aug11	3.0	8.8	6.2	1.9
Jul4	0.1	0	0	0	Aug12	0.2	0	0	0.1
Jul5	0	0	0	0	Aug13	**14.5**	8.8	6.7	8.2
Jul6	0	0	0	0	Aug14	0.2	0	0.6	0.3
Jul7	0	8.2	0	0	Aug15	0.5	0.7	0.6	6.6
Jul8	6.0	0	0.8	**11.1**	Aug16	0	-	0	0
Jul9	0	0	1.6	0	Aug17	0	-	0	0
Jul10	0	0	0	0	Aug18	2.4	2.9	**31.8**	**23.1**
Jul11	7.2	4.4	3.6	3.9	Aug19	0	0	0	0.1
Jul12	8.9	-	6.7	1.5	Aug20	0	0	0	0
Jul13	0.3	**25.9**	0	0.3	Aug21	0	0	0	0
Jul14	0	0	0	0.2	Aug22	0	0	0	0
Jul15	0	0	0	0	Aug23	0	0	0	0
Jul16	3.0	3.2	5.1	7.0	Aug24	0	0	0	0.1
Jul17	**21.2**	0	2.8	0.3	Aug25	0	0	0	0.1
Jul18	1.9	**14.6**	0.6	4.0	Aug26	0	0	0	0
Jul19	0.3	0	0	0	Aug27	0	0	0	0
Jul20	1.7	0	5.9	4.9	Aug28	0.9	0	0	1.4
Jul21	**10.9**	**14.4**	5.4	**12.5**	Aug29	**11.5**	3.5	**23.8**	**20.2**
Jul22	4.1	0	2.1	2.1	Aug30	0	0.5	0	0.1
Jul23	7.5	**14.7**	**27.2**	9.7	Aug31	0	-	0	0
Jul24	1.7	**15.0**	5.6	0.3	**Aug Total**	**47.6**	**91.8**	**103.1**	**95.2**
Jul25	0.1	0	0	0	**Aug Avg.**	**-**	**-**	**91.6**	**-**
Jul26	**23.3**	0	3.4	8.3	Sep1	0.1	0	0	0
Jul27	0.3	2.4	3.6	1.2	Sep2	0	0	0	0
Jul28	0	0	0	0	Sep3	0.1	0	0	0
Jul29	0	0	0	0	Sep4	0	0	0	0
Jul30	3.4	6.5	3.1	**18.7**	Sep5	0.2	0	1.0	0.4
Jul31	0	0	0	0	Sep6	**10.4**	8.8	8.6	**11.8**
July Total	**106.2**	**112.5**	**81.9**	**91.5**	Sep7	3.1	4.4	4.4	4.4
July Avg.	**-**	**-**	**68.4**	**-**	Sep8	3.1	-	8.1	2.4
					Sep9	8.6	**12.4**	10.4	**12.3**

Appendix I: Maps

Kawartha Lake Stewards Association

Water Quality Testing Area





This map produced by: Ryan C. Barton, David M. Gostick & Kristopher K. Joseph, Winter 2009 Created using: ArcMap 9.2, Adobe Illustrator CS3 & Map Publisher 8. Projection: Lambert Conformal Conic Canada. Data provided by: Kawartha Lake Stewards Association, Trent Conservation Coalition, Land Information Ontario & Fleming College