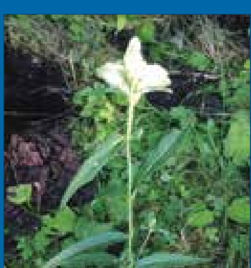

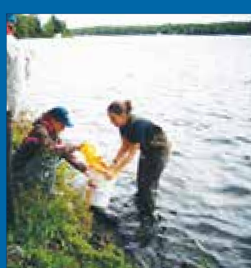

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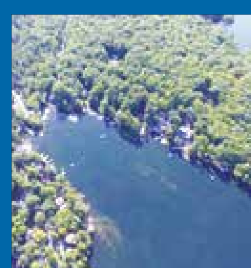

Study the Past, Plan for the Future

Kawartha Lake Stewards Association
2016 Annual Lake Water Quality Report

May 2017

KLSA

Kawartha Lake Stewards Association
Lake Water Quality Report 2016

This report was prepared exclusively for the members of the KLSA, its funders, interested academics and researchers, and other non-profit associations and individuals engaged in similar water quality testing in Ontario. The accuracy of the information and the conclusions in this report are subject to risks and uncertainties including but not limited to errors in sampling methodology, testing, reporting and statistics. KLSA does not guarantee the reliability or completeness of the data published in this report. Nothing in this report should be taken as an assurance that any part of any particular body of water has any particular water quality characteristics, or is (or is not) safe for swimming or drinking. There can be no assurance that conditions that prevailed at the time and place that any given testing result was obtained will continue into the future, or that trends suggested in this report will continue. The use of this report for commercial, promotional or transactional purposes of any kind whatsoever, including but not limited to the valuation, leasing or sale of real estate, is inappropriate and is expressly prohibited. This report may be reproduced in whole or in part by members of KLSA or KLSA's funders or research partners, for their own internal purposes. Others require the prior permission of KLSA.

Photo on cover by Janet Duval

Study the past, plan for the future. Before the construction of the Trent-Severn Waterway, these submerged cedar stumps stood on dry land in a wilderness area of Lower Buckhorn. During 130 years of sediment build-up since then, the waters around them have hosted many plants in succession: tapegrass, wild rice, milfoil, and algae clouds. A testament to the past, they are surrounded by traditional Indigenous hunting areas, loon and osprey nests, and 21st century houseboat visitors all summer.

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 KLSA website:

klsa.wordpress.com

Table of Contents

Executive Summary 4

Chair's Message 6

Archaeological and Environmental History in the Kawartha Lakes 8

Paleolimnology Study
- Paleolimnology: What is it and why is it useful? 11
- Kawartha Lakes Paleolimnological Study 15

Boyd (Big/Chiminis) Island Shoreline Species Inventory and Disturbed Versus Reference Biodiversity Study 19

The Next Invader: Water Soldier 22

Mats and Mountains of Tapegrass 26

Eurasian Water Milfoil Control: The Big Cedar Lake Experience 27

Kawartha Land Trust – Protecting the Land You Love!
– Big (Boyd/Chiminis) Island: The First Year 29

Kawarthas, Naturally Connected 31

Lessons from our Shoreline 33

2015 Kawartha Lakes Sewage Treatment Plants Report 36

E. coli Bacteria Testing 40

Phosphorus Testing 2016 41

Appendix A:
- Mission Statement, Board of Directors, Scientific Advisors 47
- Volunteer Testers 48

Appendix B: Financial Partners 49

Appendix C:
- Treasurer's Report 50
- Financial Statements 51

Appendix D: Privacy Statement 54

Appendix E: Rationale for *E.coli* Testing and 2016 Lake-by-Lake Results 55

Appendix F: 2016 Phosphorus and Secchi Data
- Total Phosphorus Measurements 61
- Secchi Depth Measurements 67

Support the Kawartha Lake Stewards Association 69

Map of Testing Area 71

Executive Summary

Kawartha Lake Stewards Association
Executive Summary - 2016 Report
Study the Past, Plan for the Future

The Kawartha Lake Stewards Association (KLSA) is a volunteer-driven, non-profit organization of cottagers, year-round residents and local business owners in the Kawartha Lakes region. The Association's programs include the testing of lake water for phosphorus, clarity and *E. coli* bacteria and research and public education about water quality issues. KLSA has formed valuable partnerships with universities, colleges and governmental agencies to conduct research studies and produce publications. The theme of this year's report, *Study the Past, Plan for the Future* reflects the importance of learning from our history as we develop policies and programs to protect our precious natural resources. KLSA is led by a 12-member Board of Directors. A list of the members of the Board is provided in Appendix A. A summary of articles contained in the 2016 KLSA Annual Water Quality Report follows.

Archaeological and Environmental History in the Kawartha Lakes

Dr. James Conolly, Professor of Archaeology at Trent University, describes the evolution of the Kawartha Lakes region from its earliest post-glacial origins 13,000 years ago through eras of European exploration and settlement to the present. Archaeologists have found evidence of Indigenous settlement, farming, fishing and hunting as well as burial sites throughout the region. European incursions disrupted Indigenous cultural systems, leading to power struggles and regional warfare related to the fur trade. European settlement began in the early 1800s and accelerated in the mid-19th century. Cottage ownership and tourism developed in the 20th century.

KLSA Paleolimnology and Shoreline Species Research Projects

KLSA has continued to support research pertaining to the ecology of the lakes and shorelines in the Kawartha region. Two articles by KLSA Chair William Napier and Dr. Brian Cumming describe a paleolimnological study being conducted at Queen's University, age-dating and analyzing the sediments in core samples collected in three lakes: Cameron, Pigeon and Stony. Paleolimnology is a science that uses the physical, chemical and biological information preserved in sediment cores to reconstruct past ecological and environmental conditions. The study will show how the nutrient status of the lakes has changed over time. This information can be used to help identify contaminant sources resulting from past and present human activity and suggest remedial measures to promote the sustainable use of our lakes.

For several years, KLSA has partnered with Fleming College to conduct research through the College's Credit for Product program. Teams of students, supported by mentors, undertake projects identified by sponsors. In 2016, three students conducted an inventory of macroinvertebrates, aquatic plants and terrestrial plants in the water and along the shoreline of Boyd Island in Pigeon Lake. They also compared species found in sites with evidence of human activity versus undisturbed sites. Their article summarizes their findings.

Aquatic Plants in the Kawartha Lakes

Aquatic plants (weeds) continue to adversely affect enjoyment of the Kawartha Lakes. In the first of two articles, Dr. Eric Sager describes a new invasive plant, water soldier, which has been found in the Trent River and has begun to spread. In a second article, he provides a possible explanation of the masses of tapegrass that many cottagers found floating in to their shorelines in the summer of 2016. A third article by KLSA Director Doug Colmer describes efforts by the Big Cedar Lake Stewardship Association to control Eurasian watermilfoil using methods such as weevils and biodegradable regrowth mats.

Kawartha Land Trust and Kawarthas, Naturally Connected

In late 2015, Big (Boyd/Chiminis) Island was donated to the Kawartha Land Trust. The Island will be preserved in its natural state. An article by KLT staff member Tara King describes the progress made in the first year of KLT ownership to clean up the island and prepare it for uses such as hiking that are compatible with protecting the natural environment. A second article by Amanda Warren describes the role of an organization, Kawarthas, Naturally Connected, a collaboration of governmental and environmental organizations to promote stewardship activities, develop, map and promote a Natural Heritage System that will protect and enhance the natural environmental features of the region.

Lessons from our Shoreline

KLSA Director Colleen Dempster provides an example of stewardship in action. Following a major storm that uprooted trees on her cottage shoreline in 2011, she and her sister undertook a project to create a four-metre buffer zone of native shrubs and flowers, removing non-native species. Some of the native plants grew naturally and others were purchased from local native plant nurseries. Helpful tips are included for those interested in restoring a natural shoreline.

2015 Kawartha Lakes Sewage Treatment Plants Report

Each year, KLSA monitors output from local sewage treatment plants that discharge effluent either directly into the Kawartha Lakes or their watershed, or to water bodies that flow into the Kawartha Lakes. Data for 2015, the latest year available, is analyzed by KLSA Director Mike Dolbey. Phosphorus (P) output is a key indicator and a primary cause of increased plant and algae growth in our lakes. KLSA would like all STPs that discharge directly into the lakes to achieve a 99% P removal rate. The report includes results for Minden, Coboconk, Fenelon Falls, Lindsay, Bobcaygeon, Omemee, King's Bay and Port Perry. The total amount of phosphorus discharged from all these plants in 2015 was 408 kg, a decrease of 55% from 2014, a substantial improvement but still below the 99% P removal goal. Continued monitoring of all STPs is vital.

E. coli Bacteria Testing

In 2016, KLSA volunteers tested 63 sites in 11 lakes 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* cfu/100 mL of water. The KLSA believes that counts in the Kawartha Lakes should not exceed 50 *E. coli* cfu/100 mL, given their high recreational use. In general, *E. coli* levels were low throughout the summer of 2016, consistent with other years, reflecting excellent recreational water quality. Of the total 370 tests conducted, 351 were in the 0 - 20 *E. coli* cfu/100 mL range, 12 were in the 20 - 50 *E. coli* cfu/100mL range, four were in the 50 - 100 range and only three tests were over 100 *E. coli* cfu/100 mL. The sites with elevated counts were usually in places where wildfowl congregated or in bays with low water circulation and all returned to normal when retests were conducted. The lakes west of Pigeon Lake, which used the Centre for Alternative Wastewater Treatment (CAWT) laboratory at Fleming College in Lindsay, did not participate in 2016 since there was no one to coordinate sample drop-off. KLSA hopes to resume the program in 2017. Lake-by-lake 2016 results can be found in Appendix E.

Phosphorus Testing

In 2016, as part of the Ministry of the Environment and Climate Change's Lake Partner Program (LPP), KLSA volunteers collected water samples four to six times (monthly from May to October) at 45 sites on 15 lakes for phosphorus testing. Samples were analyzed by the Ministry laboratory. Volunteers also measured water clarity, using a Secchi disk. The Ministry's Provincial Water Quality Objectives consider average total phosphorus levels exceeding 20 parts per billion (ppb) to be of concern since at that point algae and aquatic plant growth accelerate, increasing the risk of toxic blue-green algae (cyanobacteria). Overall in the summer of 2016, average total phosphorus levels were slightly higher than usual but followed a typical pattern of starting at 10 ppb in the spring, rising to about 20 ppb midsummer and dropping slightly in September. Detailed results of the 2016 Lake Partner Program are provided in Appendix F.

KLSA Membership and Public Meetings

In 2014, KLSA introduced a new system of paid membership. In 2016, the Board of Directors decided to discontinue the paid membership and to revert to relying on donations from individuals, businesses, municipalities and other government agencies. Please consider making a donation to support our work. KLSA holds two general meetings per year in the spring and fall. The fall meeting includes the Association's Annual General Meeting. In 2017, the spring meeting will be held at the Bobcaygeon Community Centre on Saturday, May 6 at 10 a.m.

Thank you

KLSA could not achieve its goals without the extraordinary support of the many volunteers who participate in our monitoring programs and the individuals and organizations that provide financial support. Thank you also to Dr. Brian Cumming, Dr. Paul Frost, Dr. Eric Sager and Sara Kelly for their scientific advice and staff at the Ministry of the Environment and Climate Change Lake Partner Program and SGS Lakefield Research who assist with the water testing programs. Thank you also to George Gillespie of McColl Turner LLP for reviewing our financial records. We are also very grateful to Joyce Volpe of the Lakefield Herald for her assistance with the publication of this report. For further details, visit our website: http://klsa.wordpress.com.

KLSA Editorial Committee: Sheila Gordon-Dillane (Chair), Janet Duval, Ruth Kuchinad, Kathleen Mackenzie and Pat Moffat

Chair's Message

William A. Napier
Chair, Kawartha Lake Stewards Association

During the last 12 months, the Kawartha Lake Stewards Association (KLSA) and its partners have continued to provide surveillance and monitoring of the Kawartha Lake system.

Citizen science: invaluable!

We are beginning to see the merits of maintaining and sustaining a long term phosphorus monitoring program for the Kawartha Lakes. The ability to predict environmental changes and potential adverse effects and to gain an understanding of the existing environment depends on good quality data. Long term planning and data collection are fundamental components of prudent environmental planning.

For example, the New Horizons trip to Pluto (our favourite planet–non-planet) and the Kuiper Belt took 9 years of space travel (http://pluto.jhuapl.edu/Mission/index.php). Climate models use 30 years of meteorological data as source values to predict future climatic conditions. Long term soil studies managed by the University of Michigan are entering their fifth decade with successive professors and managers inheriting the responsibility of maintaining the program.

One of the oldest examples of citizen science is the Christmas Bird Count sponsored by the National Audubon Society. Since 1900, the organization has sponsored a bird count that runs from December 14 through January 5 each year. The first bird count, organized by Frank Chapman, was proposed as an alternative to hunting birds on Christmas Day. During that day, 27 people counted about 90 species. Today, about 2,400 species are identified during the count. Closer to home, the Peterborough Christmas Bird Count (http://peterboroughnature.org/) just completed its 66th year and is the longest running wildlife survey in Peterborough County.

Long term or generational monitoring programs garner a robust database allowing for inferential statistical interpretation with greater degrees of confidence. We can predict, with clarity, what the future holds. In this report, Mike Dolbey reports on the surveillance of phosphorus concentrations in our lakes. Without the generous and continued support of the dedicated volunteer monitors, we would not be able to compile and review this emerging generational database.

Sediment study

As well as our current monitoring initiatives, KLSA is interested in the Kawartha Lakes' biology some decades and centuries ago. We have embarked on a retroactive study in collaboration with Kawartha Conservation, The Stony Lake Heritage Foundation, City of Kawartha Lakes, private donors and Queen's University's Paleoecological Environmental Assessment and Research Laboratory (PEARL - http://post.queensu.ca/~pearl/) to evaluate sediment cores along the Kawartha Lake continuum. The purpose of the study is to determine lake changes during the past two centuries by evaluating the lakes' trophic class trends and their rate of eutrophication. We are pleased to partner with PEARL, a recognized world class research facility for undertaking paleolimnological studies. Dr. Brian Cumming, Co-Director of PEARL is leading the team. PEARL is comprised of about 30 research scientists, post-doctoral fellows, graduate students, and other scientists dedicated to using paleolimnological and other techniques to provide historical perspectives on environmental change. Under the auspices of Dr. Cumming, Ms. Donna Paznar is working on this project as she undertakes her Master's program.

Other KLSA activities

This year KLSA continued its participation in the Credit for Product program at Fleming College. Colleen Dempster, with the assistance of Shari Paykarimah, coordinated a shoreline study and species inventory at Boyd Island. This work will add to the baseline data and help support the management of the Island's shoreline and near shore habitat (https://kawarthalandtrust.org/).

There are many people who contribute their time to various KLSA functions. A big thank you is extended to the speakers who brought their passion and expertise to the KLSA spring and fall public meetings. During our May 2016 meeting, Dr. Ron Porter provided a description of the history and status of the invasive Starry Stonewort aquatic alga as it populated Lake Scugog. Ms. Leora Berman, Chief Manager of The Land Between organization provided us with a description of the interactions of geology, biology and how we humans touch the land in this unique place where we live. During the October 2016 meeting, Ms. Lisa Solomon gave a presentation on the changes in fish communities in the region. The presentation described historical evolution of fish species and populations in the Kawartha Lakes and how physiological and chemical modifications to the lakes realigned fishery composition and populations. Mr. Don McLeod presented "Lakeshore Mammals: Who is Visiting You and When?". Don gave us a glimpse of how we can use tracks, scat and other indicators to detect which animals visit our shoreline. After each snowfall, I found myself wandering the neighbourhood trying to differentiate between coyote and fox tracks (Don – I need a refresher!).

There were changes to this year's KLSA Board of Directors. Ms. Erin McGauley did not stand for re-election. Erin provided valuable insight to the Board and will be missed. During the Fall 2016 meeting Mr. Doug Colmer was elected to the Board. We welcome Doug to our ranks.

KLSA relies on your support and interest. The effort of the folks at McColl Turner LLP and the Lakefield Herald is greatly appreciated and cannot be underestimated. We are guided by our Scientific Advisors at Queen's University, Trent University and Fleming College and all of you who provide us with comments and insight. I would also like to acknowledge and thank those in the business community, municipal and government agencies who continue to provide financial support for our work.

Throughout the year, take a peek at our website or Facebook page where we provide updates of our activities https://klsa.wordpress.com/.

Our Spring meeting is scheduled for 10 a.m. Saturday, May 6, 2017 at the Bobcaygeon Community Centre/ Arena. See you there.

KLSA Board of Directors (left to right): Front row: Colleen Dempster, Bill Napier, Lynn Woodcroft, Sheila Gordon-Dillane Back row: Doug Colmer, Mike Dolbey, Jeff Chalmers, Tracy Logan, Tom McAllister, Mike Stedman Absent: Kathleen Mackenzie, Shari Paykarimah. *Photo by D. Stedman*

Archaeological and Environmental History in the Kawartha Lakes

James Conolly
BA, MA, MSc, PhD,
Professor of Archaeology,
Trent University, Peterborough

The Kawartha Lakes are an ecocultural region with a long and dynamic history of interaction between people, lakes and wetlands that has unfolded over many thousands of years. As with all the Canadian landmass, the Kawarthas gradually reappeared from under a thick blanket of ice with the onset of warmer temperatures at the end of the Pleistocene Epoch. By 14,500 years ago the Laurentide Ice Sheet, which had extended far to the south across New York State, had receded northwards to southern Ontario and July temperature estimates rose to about 12 to 17 degrees C. By about 13,300 years ago the Peterborough landscape was wet but free of ice, and the early tundra and spruce parklands were transitioning to pine-dominated forests, suggesting further increases in temperature and humidity. However, the land was not yet wholly welcoming: massive glacial lakes had formed in the land and along the edges of the melting glacier and were discharging wide rivers of fast flowing frigid water towards the Atlantic. The Kawarthas are an important part of this history: from about 12,000 through 11,200 years ago, the modern chain of lakes was the route of the ancient glacial meltwater discharge with a flow estimated to have been roughly that of the modern St. Lawrence. The energy of the postglacial rivers was sufficient to create the great spillways visible on the landscape today. The Otonabee, Warsaw and Indian River valleys were each scoured and formed by glacial meltwater flowing towards the St. Lawrence.

The first Kawarthans

First Peoples arrived in the Kawarthas around this time, migrating into the region soon after the ice receded from more southern lands, where numerous earlier sites have been documented. Several so-called Paleoindian sites dating from approximately 12,800 years ago have been documented near Rice Lake by Lawrence Jackson. Late Paleoindian artifacts dating to approximately 11,000 years ago were recorded from the north shore of Stony Lake at Burleigh Falls by Susan Jamieson. Such sites are as rare as they are small, having been generated by highly mobile peoples with temporary shelters, who hunted caribou and caught rabbits, waterfowl and fish. These are some of the earliest sites in Ontario and are consistent with an interpretation of this region’s colonization by highly mobile groups following game through the cool pine forests and along the shores of ancient lakes.

A warming, changing environment

The warming of the climate occurred even more rapidly after the onset of the Holocene Epoch: after about 10,000 years ago there was a rapid shift to environments we would recognize today. Mixed boreal and deciduous forests emerged, characterized by maple, ashes, beech, oaks, birch and walnuts in warmer well-drained niches, alongside hemlock, pines, balsam fir and cedars across the thin and more poorly drained soils. This increased the density of animals, and Indigenous peoples adapted by reducing their migratory range, building community places, and focusing their subsistence practices on fishing and the hunting of deer. There are many more documented archaeological sites of this period throughout the Kawarthas, including along the north shore of Stony Lake, Pigeon Lake and Balsam Lake, as well as further south on Rice Lake and along Lake Ontario. Quite typically these sites consist of large accumulations of habitation debris mainly from stone tool manufacture and the bones of animals caught, cooked and consumed at camps along lake shores.

Fishing was clearly a major source of food - we know this from both the quantity of fish bones, and the appearance of a suite of technological innovations - including the use of fish weirs (as found in Lovesick Lake), fish net sinkers, harpoons and bone fish hooks. These artifacts have been documented at many ancient sites throughout the Kawarthas and are testimony to the shifting focus of Indigenous communities towards the lakes and their numerous and abundant resources. The relationships between the people and the land are deep and are demonstrated in many ancient places across this landscape. Some locations became important burying and ceremonial centres, in which ancestors were interred, commemorated and remembered over many hundreds of years. One of these is the ancient burying place at Jacob Island in Pigeon Lake, which has evidence of use from about 4500 to 1000 years ago. Other ceremonial centres, such as the Teaching Rocks, or Petroglyphs, were probably created during this period.

The Woodland period

Archaeologists define the succeeding Woodland period based on a relatively minor technological change, which was the introduction of ceramic vessels. The earliest vessels in these areas occur perhaps around 2500 years ago - some tentative early evidence comes from Chiminis (Big or Boyd Island) on Pigeon Lake, although the early Woodland is otherwise a continuation of the fishing, hunting and gathering practices, with lakeside settlements common. Animals such as deer, bear, beaver, turtle and muskrat are found in the bone assemblages and show the importance of hunting and trapping alongside fishing and wetland resource use. There is some evidence suggesting that people in the Kawarthas used plants that preferred to grow in open areas or forest margins, which points to controlled burning to create meadows to attract deer and encourage the growth of valuable plants such as those used for medicines.

Later, from about 2000 years ago, some of these places emerged as more ritually complex centres complete with pronounced mortuary ceremonialism at strategic points on lakes and rivers. The Serpent Mounds on Rice Lake is the best known, but this is only one of many places in the Kawartha Lakes in which new types of ritual and ceremonial items such as marine shells, silver jewelry and musical instruments were integrated with much older traditions of burial.

Indigenous agriculture

Lakeside settlements continued but from about AD 1300 there appear a few longhouse villages which were set away from the lake edges and were based on maize-focused horticultural practices. Some of these were fortified, suggesting a shift in the relationship between communities. This may indicate the appearance of newcomers - possibly Iroquoian speakers from the St. Lawrence region - settling amongst established societies that had been here for many thousands of years prior to the building of longhouses. The appearance of maize also marked a shift in human-landscape relationships, in that field clearances and cultivation of the soil became a new marker of human activity.

However, Indigenous cultivation was not focused only on maize fields: early European explorers noted how many places in the lower Great Lakes had managed landscapes consisting of fields, fruit trees, prairies and mature open forests, carefully tended by Indigenous populations. These landscapes were not pristine in the sense of untouched, but were, in fact, carefully managed systems created and maintained for many thousands of years by the communities who had continuously inhabited them since the ice had receded.

Struggles for dominance

As with most of North America, the beginning of European incursions into the Kawartha Lakes coincided with significant disruption to Indigenous health, population and cultural systems. The first documented European through the Kawarthas was Samuel de Champlain, who traversed the lakes in July 1615, accompanying Wendat and Anishinaabe warriors en route to attack the Onondaga in what is now Syracuse in New York State. This one, ultimately unsuccessful, skirmish was part of a larger power struggle and shifting alliances between competing First Nations, in part to secure trading relations with the French, Dutch and British.

Archaeological excavation on Jacob Island, Pigeon Lake, 2013. *Photo by J. Conolly*

Over the following three decades, escalating regional warfare culminated in a series of battles between the northern Ojibwa and southern Iroquois for control of the north shore of the lower Great Lakes and the lucrative fur trade. Battles were fought along the Otonabee and Rice Lake region, and oral traditions also place Fox Island at Buckhorn Lake as the site of an important skirmish. A musket ball found on Jacob Island may be related to these episodes of conflict. However, by the late seventeenth century, the Michi Saagiig (Ojibwa) had pushed back the Iroquois and colonial powers and controlled most of southern Ontario, including the Kawartha Lakes region, and thus became the power brokers for the next century of European colonial activities.

European settlement

Given the Kawarthas' location well north of the primary settlement and trading activities along the north shore of Lake Ontario, there was very limited permanent European presence in the region until the end of the eighteenth century. However, beginning in the 1800s, immigration from both overseas and post-Revolutionary War loyalists leaving the United States created significant pressures for new land to be opened for colonization. The Kawartha Lakes region was included within Treaty Number 20, signed in 1818 between the Crown and the "Principal Men of the Chippewa [Ojibwa] Nation of Indians". The first legal settlers arrived in the autumn of 1818. Treaty 20 involved the surrender of land to the British to enable European settlement of the region. It also protected subsistence rights of the First Nation members of the treaty area, which included the extraction of lake and wetland resources, particularly manomin (wild rice), fish, muskrat and beaver. Manomin harvesting remains an important right amongst Indigenous communities, and traditional harvesting methods include propagation, which is an ancient skill.

European settlement accelerated through the nineteenth century and had a profound effect on the ecology of the Kawarthas. As the landscapes in this area are generally poorly suited to farming, the principal economic activity was logging and the construction of mills by damming watercourses. There was considerable demand for wood for construction, and for pine trees to supply the Royal Navy during the Napoleonic Wars. Although First Nations groups had been manufacturing wooden weirs to capture fish for millennia, the first European dam to control water levels was constructed by John Hall between Buckhorn Lake and Lower Buckhorn Lake in the 1830s.

Further modifications to facilitate navigation occurred soon afterwards, with a lock installed linking Sturgeon and Pigeon Lakes at Bobcaygeon in 1835. During the second half of the eighteenth century, water control dams were in place at most of the lakes and by the 1880s further locks were constructed between Buckhorn Lake, Lovesick Lake and Stony Lake to open navigation. As well as opening the lakes to tourism, the locks facilitated transport of forestry products to such an extent that by a 1913 survey, most of the Kawarthas' watershed was recorded as either open cultivation or 'barrens' left from clear cutting. The resultant frequent widespread bush fires led to pronounced soil erosion.

Remedial action and replanting corrected this ecological tragedy through the 1920s and 1930s, at which time tourism and private cottage ownership started to increase and the forests again took hold. However, the 'rewilded' landscape today enjoyed by the many visitors and cottage owners, as well as the residents of the major towns such as Bobcaygeon and Buckhorn, is a pale shadow of its former self. A short walking tour along one of the trails on Chiminis (Big/Boyd Island) on Pigeon Lake into the Island's centre will take you through a former white pine forest in which the enormous centuries-old stumps still bear the deep cuts of the iron axes of the nineteenth century foresters.

Archaeological field school on Big Island, Pigeon Lake, 2014 *Photo by J. Conolly*

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Editorial Note

Imagine one day sitting at your dock when a very old bearded merman emerged close by. Imagine finding that he had lived for three hundred years in the Kawartha Lakes. Imagine that he was very observant and had a fabulous memory! Imagine all the things you could ask him such as, has the water become clearer or cloudier? Are the same plants growing in the lake? What about the type and number of fish and amphibians - have they changed? Are the forests the same now as they were three hundred years ago? One hundred years ago? How did the lakes change when the area was logged? When the canal was built? When towns and shorelines were populated? Can we tell where and when Indigenous people lived and roamed?

Such an informative 'denizen of the deep' exists! -- in the sediments at the bottom of our lakes. They tell us stories of the past through pollen fragments, algal pigments, trace metals and other materials that have gently drifted to the bottom of the lake hour after hour, year after year. In collaboration with Kawartha Conservation, The Stony Lake Heritage Foundation, The City of Kawartha Lakes, private donors and Queen's University, the KLSA hopes that analyzing the lake sediments will show us how our lakes have changed, and perhaps give us clues to why. For example, are our lakes being overrun with a certain 'weed'? Are certain algae starting to predominate, indicating an undesirable change in water quality? We believe understanding our past will help us plan our future.

Paleolimnology: What is it, and why is it useful?

William Napier
Chair, Kawartha Lake Stewards Association (KLSA)

Brian Cumming
Professor and Head, Department of Biology, Queen's University

``One of the best ways to determine where you are going is to determine where you have been.``

In 2016 KLSA and its funding and research partners began a paleolimnology study in three of the lakes within the Kawartha Lakes system. This study is described elsewhere in this report. The purpose of this article is to describe what paleolimnology is and why this technique is important and relevant to those of us who use the Kawartha Lakes.

Paleolimnology is a science that uses the physical. chemical and biological information preserved in sediment cores to reconstruct past ecological and environmental conditions. This includes techniques to date the sediment cores.

One of the many uses of the paleolimnological approach is to provide information on changes in water quality, a process that occurs over decades, and consequently normally predates high quality lake-water monitoring programs. Paleolimnological techniques became well developed in the 1980s, when they were used to track the magnitude and extent of lake acidification in North America and Europe. Many of these methods are suitable for other issues including the long-term nutrient enrichment of lakes from human activities, a process called lake eutrophication. We learn how the nutrient status of a lake has changed over time, and the corresponding increases in algal biomass.

Were our lakes different in the past?

In order to assess how nutrients in lakes have changed over time, and if the changes now exceed the range of natural variation, a long-term perspective is required. Modern data collection (i.e., monitoring) provides a snapshot of trends since the onset of monitoring programs. The use of proxy data[1] in dated sediment cores can provide a longer-term perspective of natural variation and the ability to discover if a lake system has changed beyond the range of natural variation and by how much (Fig. 1).

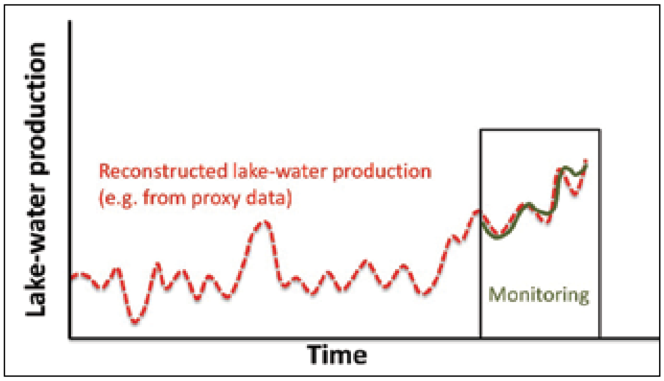

Fig. 1. Conceptual diagram showing possible changes in lake production over time. Only some of the long term increase in lake-water production is captured during the monitoring period.

[1] Proxy data are preserved physical characteristics of the environment that can stand in for direct measurements. For example, paleoclimatologists gather proxy data from tree rings, ice cores, fossil pollen, ocean sediments, corals and historical data.

Paleolimnology Study

The use of both recent monitoring and paleoecological techniques can provide insights on the dynamics of vegetation growth within the Kawartha Lakes, and can show if our lakes have become more productive by an increase in the type and amount of vegetation and algal growth in comparison with the variation that these lakes experienced in the past. Paleolimnological studies can also be used to help set realistic restoration targets.

Lessons from the lake bed

Lake sediments contain the remains of material from the atmosphere and from the catchment of a lake. Pollen and charcoal can be used to reconstruct terrestrial vegetation and fire history. Organisms that once lived within the lake such as algae, invertebrates and occasionally fish scales give us more information (Fig. 2). These sediments start accumulating when a lake forms which was around ten thousand years ago in the Kawartha region. The sediment is composed of organic and inorganic matter that can act as a time capsule of past ecological and environmental conditions based on interpreting the physical, chemical and biological information in the sediment record.

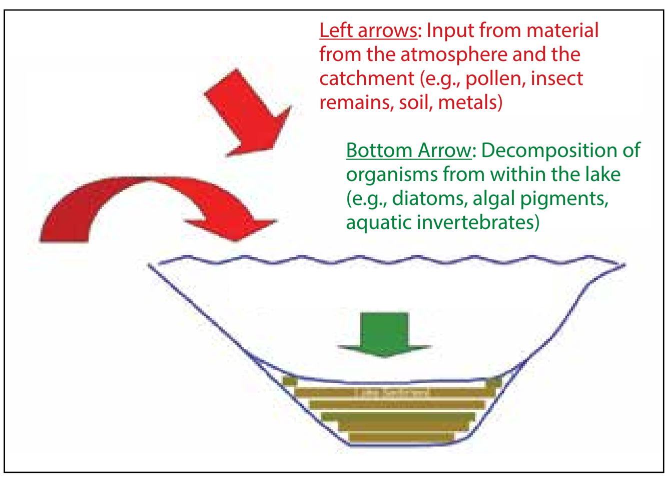

Fig. 2. Cross section of lake basin showing contributions of physical, chemical and biological remains from both outside and within the lake.

Collecting core samples

The results of all paleolimnological studies rest on obtaining high-quality sediment cores that have been recovered without disturbing the sediment record. Lake sediment cores that represent the past few hundred years of lake sedimentation can be removed with the aid of a simple gravity corer, whereas records representing thousands of years require much more specialized equipment. A sediment core representing the last few hundred years of sediment accumulation can be collected by using a cylinder tube. The corer uses its weight to penetrate the sediment (Fig. 3).

Fig. 3. A simple Glew gravity corer is shown on the left. The amount of weight used on a gravity corer largely depends on the water content of the sediments and the nature of the organic and inorganic matter. The close-up of a core on the right (taken from northwest Ontario, Arpin Lake), shows the sediment structure that can be recovered with this simple coring device. In this case the alternating light and dark layers represent an annual deposition of sediment (termed a varve).

Dating the core samples

There are a number of approaches that can be used to date sediment cores, with the most commonly used approach called ^{210}Pb dating, which is possible because ^{210}Pb (a lead isotope) has a known half-life of about 22 years (i.e., it loses half of its activity every 22 years). By age-dating the core, scientists can determine when the sediment was deposited and how much was deposited within a certain time period. Cores can be analyzed for a number of characteristics:

- Various radioisotopes in addition to lead that can be used for dating the core
- Metals, which can represent natural and human input
- Pollen, the male microgametophytes of seed plants, which can represent the vegetation
- Subfossil pigments, which can be used to reconstruct the predominant types and quantities of major algal groups
- Diatom assemblages, which can be used to track change in a wide range of environmental conditions, including changes in lake-water nutrients.

Thus, we can reconstruct what happened in the past.

Since the 1950s, surficial (of or relating to the earth's surface) sediment samples were collected primarily to evaluate the result of aerial deposition of certain chemicals such as mercury and sulphur and its derivatives. By the 1970s researchers noticed that if cores of the lake sediment were dated using radioactive decay products, they could provide an historical annotation of changes to the lake. Over the past 30 years both data collection methods and analytical techniques have improved in accuracy and precision, leading to better confidence in data collection and data interpretation.

Choosing an area to sample

Sediment cores representing the last 200 years are easily collected from the bottom of most lakes (Fig. 3). The core sampling location must be carefully selected, especially in large lakes with large fetches that are relatively shallow, including many lakes in the Kawarthas. It is important that the layers in the sediment core reflect the historical chronology and sequential layering of the material deposited. The best location to collect sediment cores is in a deep area where the lake bottom forms a gentle bowl with a relatively flat bottom where the sediment is deposited in an undisturbed manner. The lake bottom deposition zone must be of sufficient depth and calmness so that nearshore wave action, weather (periodic exposure during low-water periods), erosion, currents, sediment upwelling, dredging and propeller action don't mix the sediments. If the slopes of the bowl are too close to the sample collection site, sediment could have sloughed and disrupted the natural depositional time sequence of the core.

The integrity of sediment deposition patterns can be confirmed before sampling by the use of a subbottom profiler. This equipment allows visualization of the depth of sediment in various locations of the lake, and sedimentary structures if the density of sediment layers change. From productive lakes, cores that are 50 cm in length will typically represent a couple of hundred years of sediment accumulation. In some cases longer cores reflecting thousands of years of sediment layering are collected (Fig. 4).

Collecting samples

The collection of the core must be undertaken carefully. The water content of the sediment particularly at the upper layers can infiltrate downwards into the lower layer compromising the latter interpretation of the core. Once the cores are taken, they are sectioned into bags, normally in 0.5 cm intervals, but this can vary depending on the goal of the study. The sediments are transported back to the lab, typically in a cooler on ice. Once back at the lab, the sediment cores are stored in our cold room, which is kept at about 4°C. Normally the first analysis of the sediment is to determine age-depth relationship in the sediment core.

Age-dating

Determining the age of the various intervals of the core is completed by age-dating. The most common technique to date cores is through the measurement ^{210}Pb,. Another useful isotope can be ^{137}Cs, a caesium isotope, which can peak in sediment cores with sufficient inorganic matter. The peak can correspond to the peak of atmospheric testing of atomic bombs, before this practice was banned in the 1960s. Models are then used to estimate sediment deposition based on changes in the ^{210}Pb activities, which can be cross-checked with other approaches including the peak in ^{137}Cs, or the decline of stable lead since it was banned in gasoline in the 1970s in most parts of North America.

Nutrient loading

Once the core has been age-dated, another analysis shows how the lake ecosystem has changed over time. This can be done by looking at changes in sedimentation

Fig. 4. A 10.5 m core taken from a lake in British Columbia, showing changes in the composition of the sediment since this lake formed over 10,000 years ago.

rates in cores, as well as by examining changes in the relative abundance, concentrations and accumulations of proxies of past production, such as changes in diatom assemblages, pigment concentrations in sediment, and composition and abundance of secondary producers such as the remains of cladocera, or water flea. (Fig. 5). Diatoms have been useful bioindicators of environmental conditions since the early 1900s, with quantitative methods gaining wide acceptance over the past 30 years. Diatoms are unicellular algae found in most aquatic systems, and are estimated to be responsible for over one-third of the primary production on our planet.

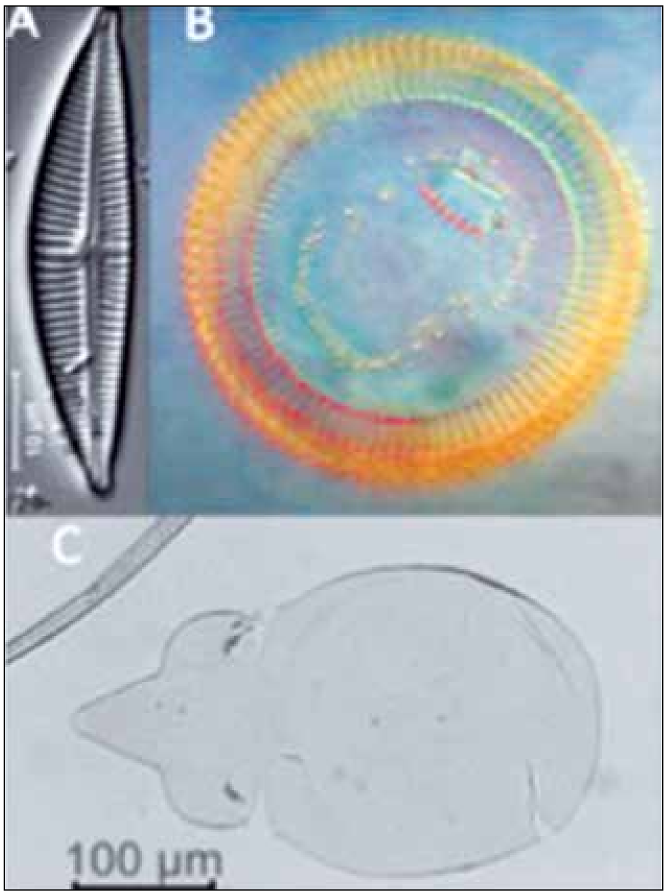

Fig. 5. Aquatic organisms commonly used in paleolimnological studies. A. Pennate benthic diatom from the genus Cymbella B. Centric planktonic diatom from the genus Cyclotella. This particular taxon is only found in saline lakes. C. The headshield of a cladocera. The remains of cladocera that are found in sediment include headshields, carapaces and post abdomens.

What diatoms tell us

Diatom assemblages are one of the most widely used techniques to reconstruct changes in production in lakes because they are abundant and present in most aquatic environments; they are normally well preserved since their cell walls are made of glass; their cell walls are taxonomically distinguishable and used to identify the thousands of common diatom species; and most importantly, the distributions of diatom taxa are highly related to environmental conditions of interest, including nutrients, acidity and levels of conductivity. Because diatom cell walls are made of silica (hydrated silicon dioxide) they are well preserved over long periods of time. Diatom communities are a popular tool for monitoring environmental conditions, past and present, because they are well preserved in lake sediments, and remain stable in sedimentary sequences.

Diatoms represent only one major group of algae. Other major groups do not leave microfossils, but they do leave pigments that represent the major groups (green algae, chrysophytes, diatoms, blue-green cyanobacteria, and cryptophytes). Chlorophyll *a* is abundant in most photosynthetic organisms, and can be measured using visible-near infrared reflectance (VNIR) spectroscopy. However ß-carotene and pigments specific to the other algal groups can be quantified in sediment layers using high pressure liquid chromatography. Cladoceran remains can also be quantified from lake sediments as a proxy for changes in secondary producers, as well as changes in food webs.

Conclusion

Sediments cored from the lake's bottom serve as a timeline of events: each year's sediments are stacked on top of the ones from the year before. The deeper the sediment, the older it is.

The Kawartha Lakes have been subjected to anthropogenic influences, namely the diversion of water flows, agricultural land use and recreational pursuits for the past two hundred years. New development projects in the Kawartha lake system are occurring and former seasonal residences are transforming to permanent homes as the Kawartha lake watershed 'urbanizes'. Water quality as an ecological service and health indicator is important to the Kawartha lake system. Determining a long-term database is essential for understanding environmental and ecological issues and concerns.

Sediment core samples provide a unique opportunity to determine historical influences from the past two centuries and provide insight on indices which could affect future quality trends. In the absence of long-term monitoring data, paleolimnological approaches can be used to reconstruct how nutrients and lake production have changed over time. This knowledge is essential to lake managers and cottage associations as it provides the only way to answer certain questions. What is the range of variability in primary production over the last 200 years? Is primary production increasing in these lakes with watershed development, and by how much? This information is crucial for lake managers in setting realistic mitigation targets for aquatic systems. In addition, the other chemical and metal analyses taken during the study will be able to show if there has been an upward trend in a particular substance over anticipated baseline conditions. If a trend is detected, a tailored monitoring and mitigation plan could be formulated to ensure a lake's well-being. This information can be used to help identify major contaminant sources correlated to past and present human activity and then propose measures to promote the sustainable use of our lakes.

Kawartha Lakes Paleolimnological Study: Collection, Analysis and Age-dating of Sediment Cores

"Understanding the past to plan for the future"

Brian Cumming
Professor and Head, Department of Biology,
Queen's University

William Napier
Chair, Kawartha Lake Stewards Association

Cultural eutrophication is one of the most pervasive environmental issues impacting freshwater ecosystems, and is the result of increases in nutrient loading to aquatic systems as the result of human activities. The ramifications of cultural eutrophication include increases in algal biomass, including potentially toxic cyanobacteria. The Kawartha Lake Stewards Association (KLSA) has long been concerned with changes in lake nutrients that could result in enhanced amounts of algal production that could lead to undesirable algal blooms.

Many stresses on lake water quality

In the Kawartha region, lakewater phosphorus concentrations generally increase from west to east, as water flows from Balsam Lake to Lovesick Lake, except when nutrient-poor water enters from Upper Stoney Lake. Besides changes in phosphorus loading from the watershed due to changing land-use practices, algae production and species composition can also be influenced by changes in climate due to warmer conditions, longer growing seasons, and higher precipitation, as well as exotic species and changes in fish populations (e.g., Karmakar et al 2015). In the Kawartha Tri-Lakes (Buckhorn, Chemong and Pigeon) fishing pressure on largemouth bass is high, typically exceeding the sustainable levels (Hornsby 2016). The interaction among these possible stressors is complex and difficult to predict, as all of these changes are now occurring in the Kawartha region.

Were our lakes always like they are now?

Long-term water quality monitoring of total phosphorus shows a decrease in total phosphorus between the early 1970s and the late 1980s, with little recorded change since that time (White 2006; KLSA 2012). Given the limited temporal perspective available from lakewater records, and the importance of other factors such as decreases in precipitation that could have decreased production (White 2006), a longer temporal perspective using consistent techniques will increase our understanding of the cumulative impact of potential stressors on the production in aquatic ecosystems. Previous work on sediment cores from Sturgeon and Rice Lakes provided some evidence of greater accumulation rates of algal pigments from 1930 to 1980. However, the isotopes that were used to date the cores may also suggest an interpretation that the cores were mixed due to the shallow nature of the core locations. Since this time, sediment-based techniques to assess production in a lake including ways to evaluate sediment stratigraphy[1] before coring have changed and improved. Also, there are multiple ways to assess changes in lake production (e.g., Davidson and Jeppesen 2013), using techniques that were not widely developed in the 1980s.

Three lakes in our study

Our current project, The Kawartha Lakes Paleolimnology Study was initiated in early 2016 by KLSA in conjunction with Dr. Brian Cumming at Queen's University and Dr. Paul Frost at Trent University. The science of paleolimnology uses the physical, chemical and biological characteristics that are preserved in the sedimentary record to reconstruct past ecological and/or environmental conditions. The goal of this study is to analyze indicators preserved in lake sediment cores, to infer how lake production has changed over the past 100 to 150 years in three lakes that were selected across the Kawartha region: Cameron Lake (A), upper Pigeon Lake (B) and Stony Lake (C) (Fig. 1). For each lake, a preferred site and alternate site were identified. Cameron Lake is considered an upstream lake with values of total phosphorus (TP) typically < 10 μg/L, whereas Pigeon

[1] Stratigraphy is a branch of geology that studies rock layers and layering (stratification).

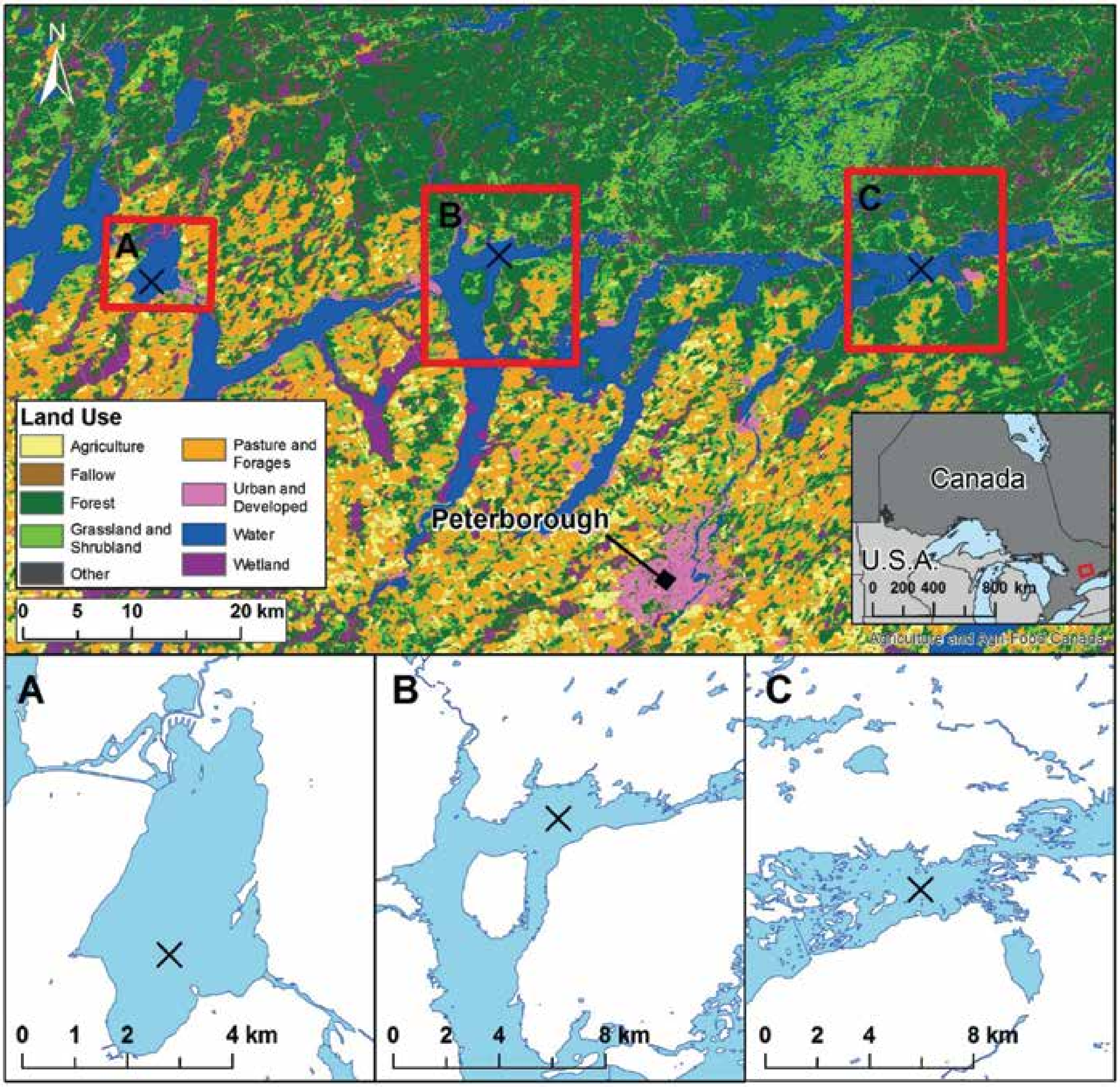

Fig. 1. Map showing the location of the three Kawartha study lakes used in this study (A. Cameron, B. Pigeon, C. Stony). Cores were removed from each lake between May 10th and 13th, 2016. The coring location in each of the lakes is marked by an 'X'.

Lake and Stony Lake have seasonal TP values typically between 10 and 20 µg/L (KLSA, 2013). These lakes were selected so that a gradient in production was covered by the study lakes, and because the lakes of interest would have characteristics from which relatively undisturbed lake sediments could be retrieved, based on bathymetric maps (i.e., contours of the lake bottom) that enabled the identification of coring locations where relatively undisturbed sediments may be present.

Our equipment

Prior to coring, we investigated the sedimentary environments of the proposed coring locations with a Knudsen subbottom profiler equipped with 200 and 14.1 KHz transducers. The 200 KHz transducer is similar to a normal depth sounder, but the 14.1 KHz transducer and receiver allow penetration of the soft sediment and visualization of the depth of sediment contained at the bottom of a lake. Chirp transmission and a large aperture receiver allows high resolution profiles from the sediments. In Pigeon Lake the preferred site west of Boyd Island was rejected following subbottom profiling, as there was little evidence of continuous sediment deposition, and highly variable depths to the bedrock at the bottom of the lake. Consequently, we used the alternative site located in the northeast region of the lake, where there were several metres of sediment present in the lake bottom.

Sediment cores from each of the three study lakes were successfully removed with the aid of a simple gravity corer using the coring platform from Queen's University (Fig. 3). The cores measured approximately 50 cm in length, and contain organic-rich sediments.

Fig. 3. Coring platform used in this project. The platform is mounted across two structurally-reinforced canoes. The Glew gravity corer was equipped with an 80-cm core tube, and weighs approximately 28 kg. The chocolate Lab Sasha is wearing a Ruffwear life jacket. The sediment core from Stony Lake is shown on the right.

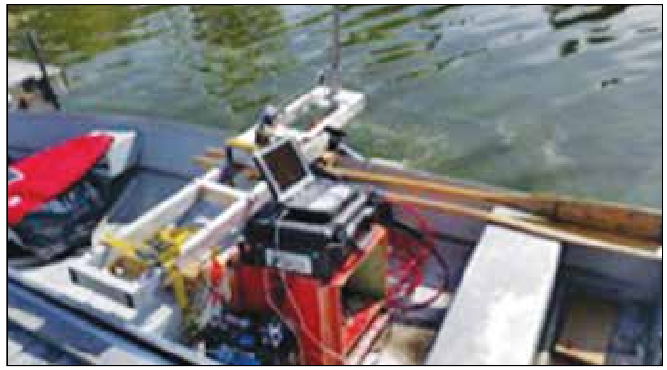

Fig. 2. Setup of the Knudsen subbottom profiler used in the Kawartha lakes from which the cores were taken. The transducer mount is attached to our centre seat, supporting the transducer and receiver which weigh approximately 20 kg.

Laboratory analysis

Professor Cumming's lab at Queen's will be undertaking the majority of the analyses on the cores from the study lakes, with Research Associate Dr. Kathleen Laird and M.Sc. student Donna Paznar focusing on analyses of proxies of lake production. The dating of the cores will be established by the analysis of approximately 20 intervals from each of the sediment cores by gamma spectroscopy at the Paleoecological Environmental Assessment and Research Laboratory (PEARL), which Dr. Cumming co-directs.

Atomic bombs and leaded gas create markers

Briefly, this analysis will be used to determine how the concentrations of two isotopes (^{210}Pb and ^{137}Cs) vary along the depth of the sediment cores. The concentration of ^{210}Pb (lead) is highest in the uppermost sediments and decays with a known half-life of about 22 years, thereby allowing the age of sediment intervals to be modelled. The ^{137}Cs (caesium) isotope is used as a check on the ^{210}Pb-derived dates, as ^{137}Cs is the result of atmospheric bomb tests, which peaked in the early 1960s, and consequently normally peak in sediment cores at approximately this time. Concentrations of metals in the sediment cores will also be assessed by Inductively Coupled Plasma-Optical Emission Spectrometer (ICP OES) techniques at the Analytical Services Laboratory (ASU) at Queen's University to provide information on changes in metals over time from both atmospheric and terrestrial sources. Changes in stable Pb will also be used to provide a check of the integrity of our cores, since stable Pb was banned from gasoline in the early 1970s.

Paleolimnology Study

Indicators of changes in lake production of primary producers since the mid-1850s will be reconstructed from analysis of algal indicators in the sediment cores. We will be looking at:

- Changes in the species composition and abundance of diatom assemblages, one of the most widely accepted techniques for tracking changes in lake-water nutrients (Cumming *et al.*, 2015)
- Spectrally-inferred chlorophyll *a* (Michelutti et al. 2005), a pigment present in the majority of primary producers
- Changes in algal pigments present in the sediments using High Pressure Liquid Chromatography (HPLC)
- Similarly, changes in secondary producers will be inferred by analysing how the abundance and composition of cladoceran zooplankton have changed since the mid-1850s, which may represent a top-down impact from changes in fish populations. Together, this multiproxy study will provide important information on changes in primary and secondary producers that have occurred in Cameron, Pigeon and Stony Lakes over the past 150 years.

Sediment study still in progress

The majority of the analyses are expected to be completed by the end of 2017, with the exception of the sub-fossil cladoceran analyses. The final report will be ready following the completion of Donna Paznar's M.Sc. thesis.

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KLSA Director Lynn Woodcroft at Rock the Locks, Buckhorn, summer 2016 *Photo by W. A. Napier*

Boyd (Big/Chiminis) Island Shoreline Species Inventory and Disturbed Versus Reference Biodiversity Study

Credit for Product Project,
Ecosystem Management Technology Program,
Fleming College
November 29, 2016
Faculty: Sara Kelly, Fleming College;
Mentor: Colleen Dempster, KLSA

The Boyd Island Team: Colleen Dempster (Mentor), Nadine Elmehriki, Nadine Roy and Tessa Arsenault

Introduction

Every so often the Kawartha Lake Stewards Association (KLSA) proposes a joint Credit for Product project with Professor Sara Kelly and students in the Ecosystem Management Program at Fleming College. From September to December of 2016, three students from Fleming College and a KLSA mentor undertook a shoreline biodiversity study on Boyd (Big/Chiminis) Island in Pigeon Lake.

Boyd Island, a 1,100 acre undeveloped island with 33 km of shoreline near Bobcaygeon in Pigeon Lake, was donated to the Kawartha Land Trust (KLT) in late 2015 and will be preserved in its natural state. The Island has a rich history of human settlement and activity, yet it remains relatively undisturbed despite its large size and setting in an ever more populated and impacted landscape.

This scenario provided a unique opportunity for a shoreline study, and the team set out with two main objectives:

1. To create a baseline study of shoreline species that were present in the first year of ownership by the Kawartha Land Trust (KLT)

2. To determine if the biodiversity of shoreline species was significantly affected by human activity at certain sites (a 'Disturbed Versus Reference' study). In this study we specifically looked at benthic macroinvertebrates, aquatic plants in the littoral zone and terrestrial plants along the shoreline. It was hypothesized that shoreline species' diversity would be negatively impacted by human disturbance. Interestingly, this was not the case.

The shoreline species inventory was shared with the KLT, to add to their database of what is currently present on the island. Baseline inventories help land managers and stewards understand how species composition might change over time, as well as comparing it to historical data to determine how it has already changed. Information from species inventories can also be used to educate visitors about the natural features that are there and to help garner a curiosity and respect for the land. The Disturbed Versus Reference study can be used to further enhance our understanding of development and human disturbance on the Kawartha Lakes.

This project was completed by Fleming College students: Tessa Arsenault, Nadine Elmehriki and Nadine Roy, in the Ecosystem Management Technology program as part of their Credit for Product course and was mentored by Colleen Dempster of the KLSA.

Methodology

The team went out to the island a total of four days. The first visit was to complete a basic site assessment to determine if there were areas we could sample and to get an idea of how many sites we could feasibly sample. Only the east side could be used for sampling as the other sides of the island have a limestone cliff and were therefore unable to be studied. A total of eight sites were sampled with two subsites each. The two subsites are identified as reference, an area of limited to no human disturbance and disturbed, an area of significant human activity (including a disallowed fire pit and campsite). By identifying samples of terrestrial plants, aquatic plants and benthic macroinvertebrates, we were able to determine the species diversity for each subsite and overall subsite types. When we were in the water collecting benthics and identifying aquatic plants, we did not go deeper than 0.75 m due to the quick drop-off of the lake bed. This led to a small sample size for aquatic plants because at many of the sites the aquatic plants were at a farther depth.

Results

Terrestrial plant species such as bottle gentian (*Gentiana andrewsii*), poison ivy (*Toxicodendron radicans*), spotted jewelweed (*Impatiens capensis*), bracken fern (*Pteridium sp.*) and turtlehead (*Chelone glabra*), among others, were found throughout the study area. Aquatic vegetation found included tapegrass (*Vallisneria americana*), Eurasian water-milfoil (*Myriophyllum spicatum*), pickerelweed (*Pontederia cordata*), coontail (*Ceratophyllum demersum*), cattails (*Typha sp.*), and white water lilies (*Nymphaea odorata*).

Boyd (Big/Chiminis) Island Shoreline Species Inventory and Disturbed Versus Reference Biodiversity Study

Figure 1: The eight randomly chosen study sites on Boyd Island (each comprised of a reference and disturbed subsite) *Google Maps 2016*

Benthic macroinvertebrates are bugs that live in the sediment of water bodies and are often used to indicate water quality for streams, wetlands and lakes. We did not look into water quality for this project but there were some interesting finds in terms of organisms found. When identifying 'good' water quality with benthos, we look for pollution sensitive taxa. We found some of these taxa at some subsites in our study: mayflies (*Ephemeroptera spp.*), stoneflies (*Plecoptera spp.*), and caddisflies (*Trichoptera spp.*). Water quality was outside the scope of our project but it would be interesting to analyze the benthic macroinvertebrates found at Boyd Island for such purposes in the future. Some invasive species were also found when completing the invertebrate identification: zebra mussels, rusty crayfish and spiny waterflea.

Using the Shannon's Diversity Index we were able to calculate the differences in biodiversity between the referenced and disturbed sites. Shannon's Diversity Index is a measure of a site's diversity determined by examining species' richness and abundance. We expected to see more diversity in the reference sites because at disturbed sites sensitive species can be damaged and/or removed. Disturbance will often introduce invasive species that out-compete native species and, in so doing, decrease diversity.

However, we could also expect disturbed sites to have a greater diversity of invasive species, thereby increasing overall biodiversity but not in a positive way. Aquatic vegetation, we found, was on average more diverse in the reference subsites than in the disturbed ones. The noticeable difference in shoreline slope between disturbed and reference sites might have been a stronger factor in determining aquatic plant diversity. For terrestrial vegetation, reference sites were also more diverse than the disturbed sites. Benthic macroinvertebrates had very slightly more diversity in the disturbed subsites than the reference subsites.

Despite slight differences in diversity between disturbed and reference sites, the statistical test 'Student's T-test' showed that there was no significant difference in diversity between reference and disturbed sites. This means that we were unable to prove that human disturbance had an effect on shoreline species' diversity on Boyd Island. It is important to note that species composition was different between sites, which might warrant greater consideration when managing the property for invasive versus native species.

Figure 2: N. Roy holding the D-net used for benthic collection. In the foreground are the quadrat and metre tape used for terrestrial plants analysis. (Elmehriki 2016)

Conclusion

Overall, this study found a good array of shoreline plants on Boyd Island (approximately 144 different species of plant and benthic macroinvertebrates). It set up baseline data that will be useful if someone (e.g., the KLT) wants to know about some of the species that can be found on the island. Our 'disturbed versus reference' study did not show any significant difference in diversity between reference and disturbed sites for terrestrial plants and benthics. This could be because our sample size was too small or there actually is no difference. If time and resources had allowed, a larger sample would have been able to provide us with more accurate data.

Figure 3: C. Dempster and T. Arsenault collecting benthic samples (Roy 2016)

Figure 4: Student team from Fleming College (Dempster 2016)

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The Next Invader: Water Soldier

Robert Canning
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Dr. Eric Sager
Ecological Restoration Program,
Fleming College and Trent University

Stratiotes aloides *Photo by Robert Canning*

Stratiotes aloides, also known as water soldier, is a submergent/emergent, aquatic plant. It grows in a rosette formation characterized by long, thin, spiny leaves of vibrant green. *S.aloides* is a highly gregarious species and often grows into vast clonal colonies. It is able to reproduce through both sexual and asexual processes, although vegetative propagation is its primary form of multiplication. (See Figure 1.)

Although native to parts of Europe and Asia, *S.aloides* was discovered growing in a section of the Trent River in Ontario in 2008. This was the first occurrence of this plant growing in a native ecosystem in North America. Shortly after its appearance in Ontario, *S.aloides* began to spread and colonize other sections of the river. At present, there are established populations of *S.aloides* in the Trent River more than 20 kilometres from where the plant was first observed. Two new populations were discovered in Ontario in 2015, the first in the Black River, which connects to the south shore of Lake Simcoe, and the second in a private pond near Bayfield.

How bad is water soldier?

S.aloides has demonstrated its ability to outcompete the existing macrophyte communities within the Trent River through its tendency to form dense, monoculture stands of plants. Desirable native species such as *Vallisineria americana* (tapegrass) and *Ceratophyllum demersum* (coontail) and known invasive species like *Myriophyllum spicatum* (Eurasian watermilfoil) and *Potamogeton crispus* (curly-leaved pondweed) have declined in abundance in areas of the Trent River where *S.aloides* is present.

The impact this plant will have on other parts of the ecosystem, e.g., fish, macroinvertebrate and phytoplankton communities, is unclear. The robust and spiny structure of the plant, coupled with its ability to convert small, diverse bodies of water entirely into single-species *S.aloides* colonies could pose additional risks to important natural, social and economic functions of the river.

Figure 1: Illustration of *S.aloides* showing two forms of reproduction (flower and clonal offset production), rosette growth formation, spiny leaves and plant roots (IFAS, 1991)

What does it look like?

Leaves: The leaves of *S.aloides* are long and thin, grow in a rosette formation and range in colour from light to dark green. The mature, outer leaves of the plant can reach lengths over 50 cm, yielding plants with diameters greater than 100 cm. Leaf shape varies depending on plant growth type, with emergent plants having straight leaves and submerged plants spirate leaves. All plants have spines on the edges of the leaf blades on both new and mature leaves. The spines are 2-5.5 mm in length and occur about 4 per cm on the leaf.

Roots: The roots of *S.aloides* are long, white and thin, averaging between 60-80 cm in length on full-grown plants. The root ends are covered in fine hairs, which are buried in the sediment. The roots are used primarily as a support structure (as opposed to nutrient uptake), but only loosely hold the rosette in the sediment, resulting in plants that can be easily dislodged from the bottom. This means that plants within the population could be rooted, free floating with no or limited roots or free floating with hanging root structures.

Offsets: Offsets are exact replicates of their parent plant and use connecting stolons (ranging from eight to 15 cm in length) to support their early stages of development. (See Figure 2.) Offset production from *S.aloides* plants begins in the late spring/early summer (May-June) and continues until the plant descends to the sediment in late fall/early winter (November/December). Mature plants can support one to six clonal offsets at any given time during the growing season, but plants with more than 20 offsets have been recorded.

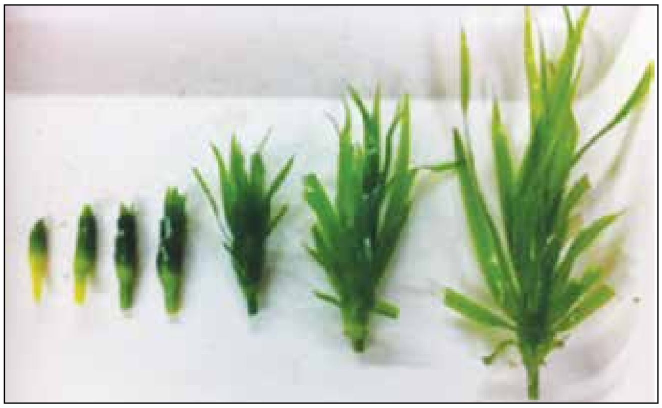


Figure 2: Progression of offset development from initial 'bud' to juvenile rosette (Canning, 2013)

Turions: Turions are teardrop shaped and either flat or rounded. A turion is a small bud capable of growing into a complete plant. The average length of mature turions is 2.25 cm and the average fresh weight is 0.46 g. (See Fig.3) *S.aloides* plants initiate turion production at the end of their growing season and continue producing these propagules until the plants descend to the sediment to overwinter. *S.aloides* plants, on average, can support between one and three turions at any given time during their production period, but the presence of eight at one time has been observed.

Figure 3: Grouping of turions (left) and single offset (right). Note the layered bud scales on the outside of the turions, which open as the propagule develops into a juvenile rosette (right) (Canning, 2013).

Flowers: Generally considered a dioecious plant, which has separate male and female plants, both male and female flowers have three white petals and a vibrant yellow centre. (See Fig. 4) Compared to offset and turion creation, flowers are produced for a much shorter period of time and are only present during mid- to late summer. Although within its native range the presence of flowers is relatively common, in Ontario, flowering *S.aloides* plants have only been observed in limited numbers on female plants in the Trent River population.

Figure 4: *S.aloides* flower from Ontario plant showing petal arrangement (Canning, 2013)

Where is it found?

The discovery of *S.aloides* in Ontario marks the first time this plant has successfully established itself within a native ecosystem in North America. Although purportedly native throughout its entire distribution in Eurasia, records showing the popularity of *S.aloides* as an ornamental plant date back to before the 18th century. It is uncertain which populations are actually native or have been introduced and subsequently naturalized. The following account of the distribution of *S.aloides* in the Eastern Hemisphere combines both native and 'introduced' populations.

North America: There are currently only two populations of *S.aloides* growing within natural ecosystems in North America, both of which are in Ontario. The largest and first to be discovered was on a section of the Trent-Severn Waterway in the Municipality of Trent Hills. The estimated size of this population exceeds 150 hectares (ha). The second population is located on a section of the Black River adjoining the south shore of Lake Simcoe in Georgina Township. This population is estimated to be less than 1 ha. There have also been incidental reports of water soldier in private ponds located in the Village of Bayfield (Huron County) and Blackstock (Regional Municipality of Durham).

Europe: Species are present throughout Sweden, Norway, Finland, Denmark, Ireland, Scotland, England, France, Switzerland, Belgium, Holland, Germany, Poland, Italy, Spain, Austria, Czechoslovakia, Hungary, Yugoslavia, Romania, Bulgaria and Turkey.

Asia: Species are present in parts of Russia and Siberia.

How does it grow?

Submerged vs. Emergent Populations: *S.aloides* is classified in the literature as both a submerged and emergent species. There are two reasons for this.

1) As a life history/competitive strategy, the majority of *S.aloides* plants undergo a seasonal transition within the water column. In the late spring/early summer, *S.aloides* rises to the top of the water column to form dense floating mats of emergent plants. In the late fall, these same plants then descend to the bottom sediment, where they overwinter as rosettes. This is due to the rise and fall of the plant's specific gravity, which allows it to either float or sink in water. This seasonal transition (especially to the top of the water column) is likely a competitive mechanism to enable *S.aloides* uncontested access to light and carbon resources, while effectively shading out competing macrophyte species.

2) Studies on natural populations of *S.aloides* have shown that in areas of deep or turbid water where the light intensity is too low to allow sufficient growth of new leaves, the specific gravity of these plants remains relatively high and they spend their entire life cycle as submerged plants. This, in turn, changes the morphological attributes of these plants compared to the emergent populations. Permanently submerged colonies of *S.aloides* produce fewer roots, offsets, flowers and turions, and have more twisted and spirate leaves than emergent stands.

Life Cycle: Starting in the spring, adult *S.aloides* plants begin their rise in the water column and start to produce roots that grow from the bottom of the rosette down into the sediment. At this time of the year, the plants are predominantly comprised of old, senescent leaves that eventually drop down and are replaced by new, healthy growth as the season progresses.

The production of offsets begins in the spring as soon as the parent plant can accumulate enough resources, and this continues until the plant returns once again to the bottom of the water body for the winter. Offsets are connected to their parent plant through stolons and can remain joined for varying degrees of time depending on growth form and habitat conditions. Emergent plants remain attached to their offsets for a shorter period of time (~ three weeks) compared to the submergent plants, which were found to retain offsets on their stolon for up to three months, subsequently leading to a more advanced stage of development (based upon leaf length) when they were released.

Flower and seed production (when possible) begins in mid-summer and lasts for only about four to five weeks of the growing season. Flowering has been documented in Ontario, specifically in the Trent River population, but no seed development was observed because no mixed stands containing both male and female plants are present on the river. Studies have shown that once released, up to 96% of the seeds become buoyant and could contribute to the further success of the plant as a hydrochoric (spread though water, i.e., current and wave action) or endozoochoric (spread by animals) dispersal mechanism. Seeds can remain dormant for long periods, but if they do not germinate shortly after seed-set, they run the risk of losing buoyancy and being covered with a thick sediment layer that can inhibit germination.

Turion production begins in late summer/early fall and is the last life cycle stage during the growing season. This continues alongside offset production until mid-winter. Turions dispersed at this time germinate and appear in the following spring as miniature rosettes.

Towards the end of the turion production period, *S.aloides* plants complete their seasonal transition as their decaying roots and leaves increase their specific gravity above that of the water and pull the plant back down to the sediment for the winter.

Can we control water soldier?

In Ontario, the only treatment measures that have been tested are the physical control of the plant through manual raking, shade cloths and mechanical harvesting, and chemical control through herbicide application.

Others types of control measures (e.g., biological, suction dredging and hydrological drawdown) either are not available or have not been tried for the management of *S.aloides* in Ontario. Since *S.aloides* had never been present in Canada when it was first discovered in 2008, no herbicides were registered for use on it. The herbicide diquat, which is a contact defoliator, was initially given a temporary use permit for emergency treatment, and still remains the only herbicide available for treating *S.aloides*. A greenhouse trial measuring the impacts of frequency of use, water temperature, plant size, turbidity and exposure time on the efficacy of diquat application for eradication of *S.aloides* found that this species was sensitive to herbicide treatment and that diquat could be effective as a control measure on the Trent River.

The efficacy of both physical and chemical treatments has been assessed on populations of *S.aloides* in the Trent-Severn Waterway. A post-treatment assessment of managed *S.aloides* stands conducted in 2012 showed that although both control methods were equally effective at eradicating the plant from those areas, chemical control allowed for a more diverse recovery of the native vegetation community than physical control. Based upon these early trials, in October 2015 and October 2016, a consultant was retained by the Ministry of Natural Resources and Forestry (MNRF) and Parks Canada to carry out the largest application of chemical herbicide in Canada for aquatic plant control in an inland lake. In both years, approximately 150 ha of water soldier were treated with diquat. Results from the 2015 application were generally favourable (see Figure 5) and managers are hopeful that the follow-up application in 2016 will further reduce the existing colonies when we reassess in summer 2017.

Report new water soldier sightings to the OFAH/MNRF Invading Species Hotline,

1-800-563-7711

Figure 5. Example of herbicide efficacy on a large patch of water soldier at Lake Seymour. Herbicide was applied in October, 2015.

Above: Before (September 2015) Below: After (July 2016) *Photos by Vicki McCulloch*

Mats and Mountains of Tapegrass

Dr. Eric Sager
Ecological Restoration Program,
Fleming College and Trent University

Many loud groans were heard throughout the Kawarthas last summer as shoreline residents reluctantly walked to their docks to once again remove the vast amounts of tapegrass that had accumulated. Many are asking, "Where did it all come from and why does it keep floating into/onto my dock?!"

Result of a morning's work raking up tapegrass
Photo by Ann Ambler

The plant: *Vallisneria americana* is a native aquatic macrophyte found throughout the Kawarthas. It is an important species ecologically in that it provides forage for waterfowl, habitat for fish and macroinvertebrates, and reduces the resuspension of sediments (and therefore nutrients for phytoplankton, including algae). It is also a species that effectively co-exists with Eurasian milfoil and its hybrids (*Myriophyllum spicatum* and *M. spicatum x sibiricum*), whereas many of our other native species tend to be outcompeted by the milfoils. In terms of habitat requirements, tapegrass favours rich organic sediments and warm temperatures, and handles a range of light conditions and hence water depths. This means that a good proportion of our lakes can support the growth of this plant.

The problem: Why we saw so much of this rooted plant floating on the surface of our lakes last year and whether it will be a phenomenon again this year are not entirely known. We do know that conditions in the Kawarthas are always good for growing tapegrass, with warm water temperatures and lots of sunlight. We also saw a significant collapse in hybrid milfoil patches (Lovesick Lake, Deer Bay, Pigeon Lake) in 2015-2016 and much of this area was recolonized by tapegrass. For example, the plant formed monodominant patches from depths of 1m-3.5m in areas we've monitored around the Oliver Centre on the north end of Pigeon Lake since the late 1990s. Previously it would have co-occurred with large patches of hybrid milfoil and four or five other native species.

What is causing this abundant tapegrass to become uprooted and accumulate on our shorelines?
I'm going to postulate that it is related to wave activity generated by recreational boating and wind. The boating impact comes from both the waves that are generated from the wake, but also from the direct impact of propeller wash. Previous studies have noted boating impacts to lake sediments at water depths greater than 3m (Apslund 2000) and as deep as 4.6m (Beachler and Hill 2003). The Beachler and Hill study also noted that sediments at depths less than 2.2m were most susceptible to waves generated by recreational boat traffic. For the Kawarthas, that represents a significant proportion of our lake bottoms and coincides quite nicely with the areas of the lake bottom that are colonized with plants. Add the fact that the very same organic sediment that provides an optimal mix of nutrients for tapegrass to grow is loosely consolidated. Thus, the sediment is very susceptible to physical disturbance, which makes it difficult for the plant roots to remain anchored to the bottom of the lake.

Floating mass of tapegrass in Pigeon Lake,
August 2016, *Photo by Tim Moore*

Eurasian Water Milfoil Control: The Big Cedar Lake Experience

Doug Colmer
Big Cedar Lake Stewardship Association
KLSA Director

Preface

In 2011, the Big Cedar Lake Stewardship Association was formed to preserve and improve the environmental health of Big Cedar Lake, serve as a focal point for stewardship projects, provide public education and provide a forum for lake users to get to know each other. Of particular concern was the rapid spread of Eurasian water milfoil (EWM) throughout the lake, interfering with swimming, boating and fishing. Beginning in 2011, the Association began a five-year project of stocking milfoil weevils in EWM beds and monitoring the results. Some success was realized but EWM continues to be a problem so other control techniques are now being tested.

For more information, see J. Graham, Big Cedar Lake Stewardship Association Milfoil Project, KLSA 2012 Water Quality Report, 2013 at klsa.wordpress.com or visit bclsa.ca/weevil.

The 2016 experience

In the summer of 2016, one of the cottage owners converted a raft into a milfoil extractor tool. It was a pump with a vacuum head that would reach down into the Eurasian water milfoil to extract the top of the plant and then try to extract the roots. It came with its own filter system to collect the residue for disposal.

This worked in a couple of locations under ideal conditions but trying to use it in other locations was problematic because it had trouble going deep enough to extract the roots, and in hard bottom areas the roots could not be pulled out of the rocks.

Aerial photo of part of Big Cedar Lake. *Photo by D. Colmer*

Eurasian Water Milfoil Control: The Big Cedar Lake Experience

Trent University scientists worked in the area that cottagers tried to clear with the extractor. They did some additional extracting of weeds and then put down a biodegradable regrowth weed mat that covered the area that had been cleared. We will have to wait until the summer of 2017 to see what grow-back occurs in those areas and whether this might be a practical way to use it in other areas of the lake where the depth is between 2 metres and 3.2 metres (6 feet and 10 feet) and where bottom conditions permit.

More weevils were introduced in some new areas and in other areas it was noticed that the weed population was less and some areas had been cleared and a new bottom weed had taken over the spot. This occurred in a place behind the island near the Julian Lake Road boat launch. Other areas are still struggling with dense weed populations and may require harvesting methods followed by matting.

In areas where only harvesting had been practised some annual grooming was required.

Three large patches were cleared successfully in 2016 but one cleared late in the season had a significant grow-back because of rushed clearing. It will have to be redone next year and a biodegradable regrowth mat may need to be put over it for one season.

For more information on weed harvesting and temporary matting, contact the author at: dougcolmer@gmail.com.

Bryozoan colony composed of microscopic invertebrates

Eurasian water milfoil interlaced with filamentous algae

Biodegradable regrowth weed mat

Kawartha Land Trust - Protecting the Land You Love!
Big (Boyd/Chiminis) Island: the First Year

Tara King
Development Coordinator,
Kawartha Land Trust (KLT)
On behalf of KLT Staff and Volunteers

To anyone who has heard the stories, looked at the pictures, visited, read about or just looked out across Pigeon Lake, it is clear this is a special place. Big (Boyd/Chiminis) Island is a unique, remarkable and historic spot where there is so much nature to enjoy, appreciate and more importantly, protect for future generations.

As we approach the one-year anniversary of the date the Island was officially gifted to Kawartha Land Trust (KLT) by Mike and Terry Wilson in March 2016, we can proudly look back at the significant strides made during our first year managing this 1,100 acre property.

In early 2016, KLT created a volunteer-based Boyd Island Management Advisory Team that consists of individuals from the local community, with different expertise and skill sets. This team helps to guide our management and stewardship plans for the long term. Here are a few recent accomplishments of our volunteers and staff:

- Removed more than 30 loads of debris, garbage and hazards
- Developed the beginnings of a formal trail network
- Communicated to local residents and businesses plans for care of, and access to the Island (e.g., provided volunteers and staff on site during the week and on weekends from May to October, and held an open house in May)
- Worked with local fire and police
- Received survey responses from the community
- Conducted an ecological land classification
- Started evaluating the shoreline for restoration
- Conducted inventories of plants, animals, geology and historical uses

During the short window of opportunity to receive the gift of this land, the Save Boyd Island Campaign was focused on funding the costs to secure the island and to support basic stewardship obligations over the long term. We would like to take this opportunity to thank all volunteers and donors who contributed gifts of time and money to the Save Boyd Island Campaign. Your generosity and commitment have been second to none!

What's next

The Boyd Island management plan includes expanded trails, outreach, signage and land stewardship making it a more accessible, safe and enjoyable place for residents and visitors to the Kawarthas to experience. We have applied for a project grant that would allow us to enhance access to Boyd Island and Pigeon Lake by creating three formal, well-organized access points. They will be clearly communicated and signed, and will have canoe and kayak launching ramps. There will be two locations on Boyd Island and one on the mainland in the Municipality of Trent Lakes.

Garbage, hazards and debris removed from Big Island (BoydChiminis) *Photo by KLT*

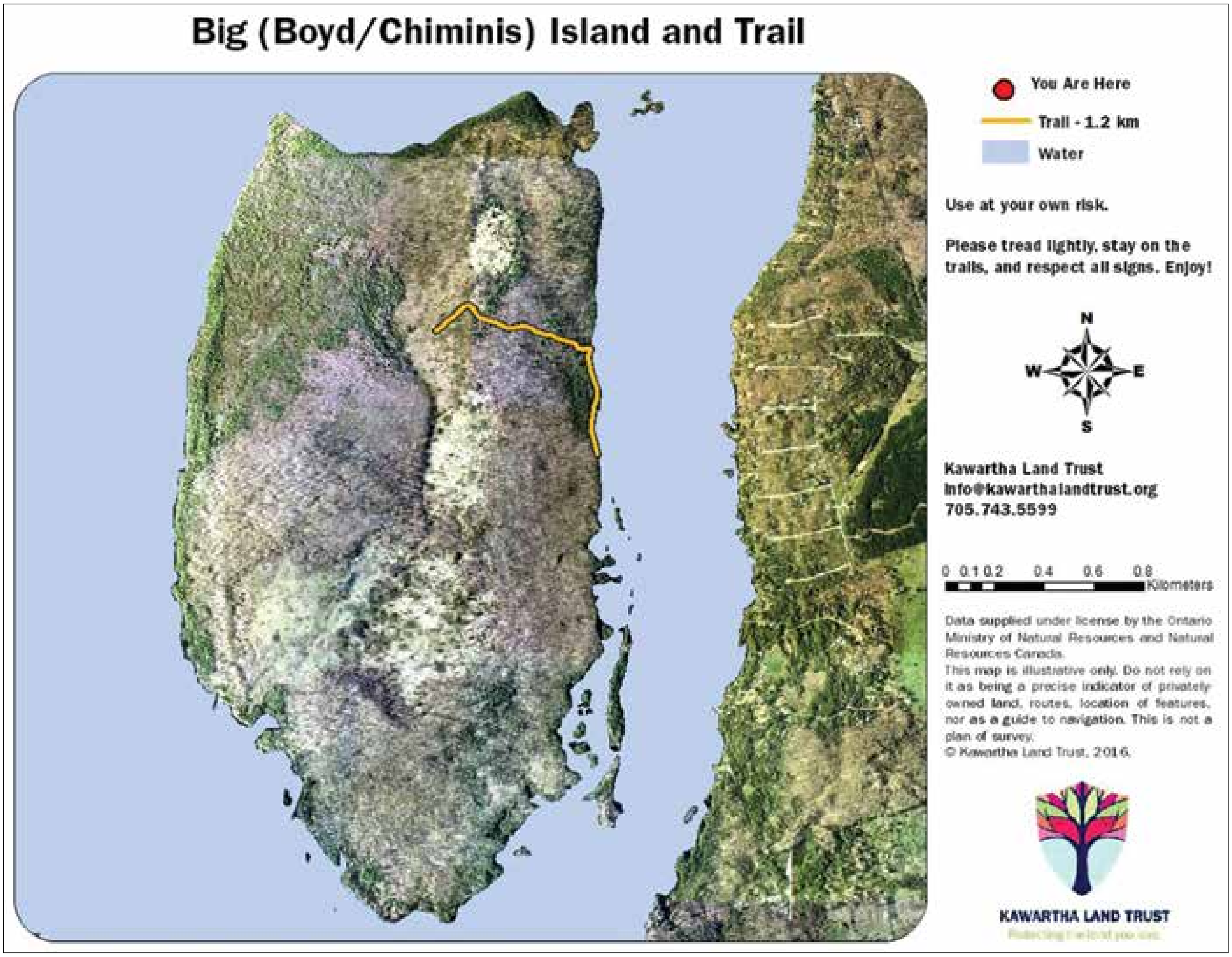
In other KLT news…

In addition to our efforts on Big (Boyd/Chiminis) Island throughout 2016, we also opened the Stony Lake trails network. This 10 km winding, woodland trail is not only a lovely walk, but it creates a connection between our Ingleton-Wells property and other private properties providing a larger natural corridor for wildlife. This area has unique and significant ecological features, flora and fauna. Please join us Saturday, July 8th to celebrate a new property gifted to Kawartha Land Trust within the trail network (event details will be posted at www.kawarthalandtrust.org in the spring).

As our impact continues to grow, so does our need for volunteers to help with our many projects!

Last year, over 90 volunteers gifted approximately 6,000 hours of their time to help care for and protect important natural places in the Kawarthas. When

Big (Boyd/Chiminis) Island: the First Year



you share your time and talents as a volunteer, you make it possible to achieve amazing things! We are seeking volunteers to help with ongoing clean-up, trail maintenance, boater and community outreach not only for Boyd Island but for other protected properties in the Kawarthas.

About KLT

Kawartha Land Trust is a registered charity dedicated to conserving the natural environment and enhancing quality of life in the Kawarthas. We do this by accepting donations of ecologically-significant lands and/or interests in lands and the connections between them, and engaging the community in support of this work to ensure these lands are cared for, in perpetuity.

Conservation in the Kawarthas is becoming increasingly important in light of trends already in progress and on the horizon. Land in the Kawarthas region will be increasing. KLT is a critical part of the solution, and the only non-government land conservation entity in the region.

Our volunteers, staff and partners help deliver on our mission "caring for lands entrusted to us and helping others protect the land they love in the Kawarthas". Together we work toward a future where the Kawartha Region is characterized by natural spaces and connections that support healthy and representative ecosystems and landscapes – a deeply-connected landscape founded on a mix of privately and publicly-protected lands, private land stewardship and a supportive policy framework.

We currently protect eleven properties totaling 3,040 acres and have assisted our partners to protect a dozen properties totaling 2,477 acres.

We hope that you will join our efforts in Protecting The Land You Love!

Kawartha Land Trust - Protecting the Land You Love!
Big (Boyd/Chiminis) Island: the First Year

Volunteers help clean up Big (Boyd/Chiminis) Island. *Photo by KLT*

To become a volunteer, sign up for our newsletter and stay informed on KLT news and events, make a donation or for more information, visit our website at: www.kawarthalandtrust.org or call us at 705-743-5599

Kawarthas, Naturally Connected: Collaborating Towards a More Sustainable Future for Peterborough and the Kawarthas

Amanda Warren
KNC Steering Committee;
Planning Technician, Municipality of Trent Lakes

Kawarthas, Naturally Connected (KNC) is a community-driven initiative launched to develop, map and promote a Natural Heritage System (NHS) that serves to protect and enhance the natural environmental features of our region.

"*Vision Statement*: A landscape that supports the needs of people and nature in a way that preserves the unique character of the Kawarthas."

What is a natural heritage system? The Provincial Policy Statement (2014) states that a Natural Heritage System "means a system made up of natural heritage features and areas, and linkages intended to provide connectivity and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species, and ecosystems. These systems can include natural heritage features and areas, federal and provincial parks and conservation reserves, other natural heritage features, lands that have been restored or have the potential to be restored to a natural state, areas that support hydrologic functions, and working landscapes that enable ecologic functions to continue." (Provincial Policy Statement, 2014).

The KNC Natural Heritage System is implemented through a number of collaborating partners, including municipalities, land trusts, conservation authorities and other organizations, providing a wealth of benefits to the entire region. From maintaining good air and water quality, providing habitat for native species, preventing soil erosion and reducing flooding, providing recreational opportunities and helping to mitigate the impacts of climate change, the NHS is proving to be a valuable tool for all partners and stakeholders.

Since the project's initiation in 2011, partners and stakeholders have worked together to design and map a system of natural heritage features to help maintain the region's unique ecological, social and economic values. This process involved collaborating to gather information, establish project goals, and set targets and priorities for the system. The team identified a number of NHS scenarios using a data modelling tool called Marxan. We then chose a preferred scenario that reflected the shared targets and priorities for each of the landscape features. Using various tools and government guidelines, we developed criteria to allocate the areas identified under the preferred scenario into a connected system that included aquatic and terrestrial cores, corridors, riparian linkages, barriers (i.e., existing man-made development), and adjacent lands that have the potential to be restored.

Over the past two years, the partners have been developing a range of publicly-available mapping tools intended to be used for the implementation of the Natural Heritage System. These tools can support additional spatial analysis, mapping and reporting needs of any organization and facilitate decision making regarding the identification of:

- Strategic restoration and stewardship opportunities
- Land use planning and policy development
- Priorities for conservation land acquisition
- Development proposal impact assessments
- Climate change adaptation strategies

Interested organizations, municipalities and individuals can visit our website at www.kawarthasnaturally.ca/resources to access the mapping tools such as PDF maps, ArcGIS Online, Google Earth, or to view the raw data layers through Land Information Ontario. Over the coming months, the website will also provide regular updates and reports on how some of our partner organizations are using the mapping tools to implement the Natural Heritage System.

Kawartha Conservation – Volunteer stewardship activity planting native grasses. *Photo by Kawartha Conservation*

A note from Mike Hendren
Executive Director, Kawartha Land Trust

"*Kawartha Land Trust has benefitted immensely from the Kawarthas, Naturally Connected collaborative. Information sharing and relationship building has been paramount and made our work at the land trust more efficient. We have also used the collaborative to strategically approach and respond to potential properties that may be secured for protection by Kawartha Land Trust. These include properties that we would consider acquiring, conservation easement agreements on private land or stewardship or trail agreements with private land owners. The natural values, species and habitats of the region matter deeply to visitors and residents of this area and we now have far more prospects than we can adequately respond to. This process has helped us identify the most appropriate priorities for Kawartha Land Trust and where we might share these opportunities with our partners in the region.*"

Left: View of fall colours, rolling hills in Kawartha Lakes *Photo by: Ian Walker*

Below: View of wetland in Peterborough County *Photo by Amanda Warren*

Lessons from our Shoreline

Colleen Dempster
KLSA Director

Our cottage shoreline after the windstorm of 2011. *Photo by C. Dempster*

Sometimes it takes an event to shake things up and make you try something different. I'll never forget the 2011 windstorm that hit us hard on the north end of Pigeon Lake. It took down many trees, including a giant silver maple at our cottage shoreline. Coincidentally, I was admiring the full-grown white pines on the island, with the sun setting behind them, and the thought occurred to me that those trees might be at the end of their lives. That was just before the winds tipped them over, exposing their shallow roots over bedrock. Indeed, change is part of nature.

I could go on about plant succession – the process where different plants recolonize an area at different times according to their growth strategies – but for this article I will focus on those little, wonderful, colourful wildflowers and shrubs that moved in to my cottage shoreline when the maple blew down. Being biologists and active environmental stewards (proudly puffing chest), my sister and I persuaded our father to let us create a 'no mow' zone on the newly exposed shoreline to see what might come up naturally. Having less to mow, he let us go ahead with our little experiment. We were just beginning to understand the true value of native plants, and we wanted to do our part in protecting our lake by restoring our shoreline with a diversity of native plants.

"Why native plants?" you may ask. Because native plants evolve in an area for a long period of time, they are not only suited for that environment, thereby requiring minimal maintenance, but they also offer habitat and food for other native species that evolved to use those plants. Non-native plants usually require extra care, such as excessive watering, and might provide inedible fruit for wildlife. Often, non-native plants have shallower roots than native ones,

Wildflowers at the shoreline – Scarlet beebalm (*Monarda didyma*)

Turtlehead flower (*Chelone glabra*)

Cardinal flower (*Lobelia cardinalis*)

Lessons from our Shoreline

which could lead to soil erosion. Furthermore, non-native plants can become invasive, thereby displacing beneficial native plants.

A recent report by Kawartha Conservation states that the number of buildings within 100 metres of the shoreline on Pigeon Lake increased from 300 in 1952 to 600 in 1968, and then boomed to 1800 by 1994. As of 2013, approximately 29 percent of the shoreline on Pigeon Lake had been developed within a 30-metre distance from shore, which involved the clearing of natural vegetation. Adding to shoreline impact, many of the traditionally three-season cottages are now being converted to permanent four-season homes. One of the primary objectives of Kawartha Conservation's Lake Management Plans is to enhance and maintain the natural integrity of the shorelines. To achieve this, they suggest that within the next five years 50 percent of residences should have more than 25 percent of their shorelines naturalized to a minimum of three metres (10 feet) from the water's edge, among other suggestions (See Kawartha Conservation's Pigeon Lake Management Plan Draft, March 2016.)

Fast forward to 2016: Our shoreline now has a four-metre buffer zone of plants of varying shapes, colours, and purposes! It looks more like a garden than an unkempt mess, much to the delight of our family and neighbours. We have orange flowered milkweed that feeds the butterflies, crimson-red cardinal flower, scarlet beebalm that pops artistically against green leaves and the amazing turtlehead whose flower really looks like a turtle's head. We enjoy the full, violet-rose Joe Pye weed and glowing goldenrod, which project themselves high above the other plants, the delightfully delicate and fun-to-pop spotted jewelweed (also known as 'touch-me-not') and the red-osier dogwood, which displays its red stems strikingly against the winter snow, and also stabilizes the shoreline from erosion, slows run-off and deters geese. There are sweet-smelling myrica gale, whose leaves can be used for making tea, edible wild raspberries, and many more native plants. We even have a young silver maple, but this time it is set a little further back from the shoreline where its roots can penetrate soil instead of sitting on rock.

As ideal as this sounds, it wasn't all easy to accomplish, and the native garden will continue to evolve and change every year. These plants didn't all pop up naturally. We purchased many of them from local native plant nurseries such as Grow Wild and Gamiing Nature Centre. Some of these plants aren't thriving, either because of transplant shock, or simply growing them in the wrong conditions. (Hours of sunlight, moisture, soil type, competition with other plants, and many more factors need to be considered when planting native plants, just like any other plants.) The red-osier dogwood was grown from clippings taken ethically from wild plants, and the Joe Pye weed and goldenrod came up naturally. We also have had to combat a few invasive species, mainly coltsfoot and daylilies. It's an ongoing struggle.

One environmentally friendly technique we used to remove unwanted plants and their seeds is known as soil solarizing. This method involves laying a cover – usually clear plastic but in our case black – to trap solar energy, which heats up the soil and essentially cooks and kills everything in it, thereby sterilizing the soil. We have

Soil solarizing using black garbage bags. *Photo by C. Dempster* had some success with preventing daylilies from re-sprouting but we will continue to combine this technique with hand removal in the unlevel areas.

The family lends a hand- Jess plants

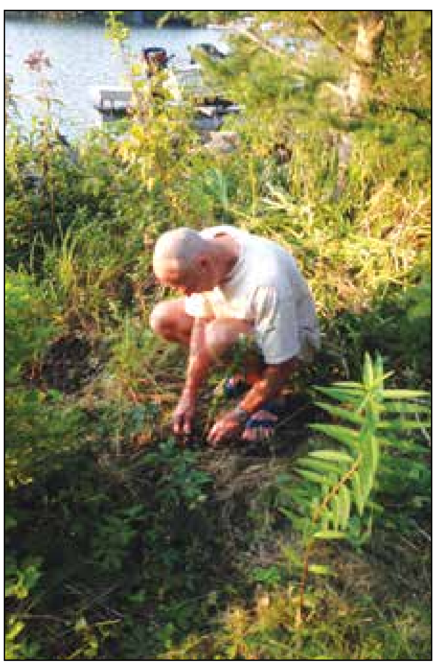
Even the naturally growing native plants needed some management. For example goldenrod can spread its roots aggressively, robbing smaller plants of space, sun and other resources they need. Indeed, monocultures do occur in nature, but if you have a particular vision for your shoreline that involves diversity, you'll want to cut or pull out those pushy plants once or twice a year.

Over the course of six years since our father let us start our native plant garden at the shoreline, I have learned a thing or two about managing and letting go. Our experiment has taught me to invest time in the planning process, especially to deeply consider a plant's natural habitat before planting it. It has shown me the fruits of our labour, as shapes, colours, and winged and footed visitors come and go. It has allowed me to slow down and enjoy the simpler things the cottage has to offer, and it has helped me bring people together, to discuss and consider all the gifts a healthy shoreline has to offer. Best of all, I feel good knowing I'm doing my part for the beautiful lake I love.

To see more photos and read an earlier article about our shoreline, visit Ontario Nature's website: https://www.ontarionature.org/connect/blog/bringing-back-nature-to-the-cottage/

Shoreline consulting advice and native plants may also be obtained from Kawartha Conservation by contacting their Stewardship Coordinator at Stewardship@KawarthaConservation.com or at 705.328.2271 ext 240.

References: Sturgeon Lake Management Plan, Pigeon Lake Management Plan Draft (March 2016), see: http://kawarthaconservation.com/lake-management-planning-development



The family lends a hand- Erwin plants

Scott and Colleen Dempster standing proudly in front of their cottage shoreline, holding 'naturalized shoreline' signs during a Blue Canoe presentation.

2015 Kawartha Lakes Sewage Treatment Plants Report

Mike Dolbey, Ph.D., P.Eng.,
KLSA Director

Each year, KLSA monitors the performance of Sewage Treatment Plants (STPs) that discharge effluent either directly to the Kawartha Lakes or their watershed, or to waterbodies that flow into the Kawartha Lakes. The purpose of STPs is to protect public health by minimizing the discharge of pathogens and to protect the environment by minimizing the discharge of phosphorus (P) to our lakes. Of primary interest to KLSA is the quantity of phosphorus that is discharged by these plants to our lakes because phosphorus is known to be the limiting nutrient that controls the growth of aquatic plants and algae.

Lake management studies have shown that the amount of phosphorus now discharged from STPs is only a small percentage of the phosphorus entering our lakes from all sources. This was not always the case. Prior to the 1970s STPs discharged between 50 and 100 times more phosphorus than modern STPs. Unlike most other phosphorus sources that are widely distributed, STPs are localized sources that can be controlled and municipalities spend considerable taxpayers' dollars to build and operate these plants to protect our health and environment.

KLSA monitors the performance of STPs to determine if they are being operated to their fullest potential. Ideally KLSA would like all STPs that discharge directly to our lakes to achieve a 99% phosphorus removal rate. This means that only one part in 100 of the phosphorus entering the plant leaves in the effluent. A drop of removal efficiency to 95% means five parts in 100 leave the plant, a 500% increase in phosphorus release compared to 99% removal efficiency. What might seem like small changes in removal efficiency can have very large consequences!

As we have indicated in past years, our STP data is always one year behind, because the reports for the previous year are not available to us before going to press. All of these reports are now online on the websites of their respective municipalities.

Again this year we have included three sewage treatment plants (STPs), Minden, Port Perry and King's Bay, that do not discharge directly into the Kawartha Lakes. These plants are upstream of our Kawartha Lakes and have at least one body of water in between to attenuate the effects of their effluent discharge.

Minden

Minden's STP discharges to the Gull River just above Gull Lake, which is two lakes away from our most upstream Kawartha lake, Shadow Lake. In 2015 this plant had a Total Phosphorus (TP) removal rate of 96.4%, resulting in a P discharge to the river of 17.9 kg for the year. There was one minor bypass of the tertiary filters in 2015, which was too small to have significantly increased the TP load.

Average *E. coli* discharges were generally low during the year but on several occasions readings as high as 68 colony forming units per 100 ml (cfu/100ml) were recorded. No spills or overflows and no complaints were reported.

Coboconk

This lagoon system continued to function well in 2015, with discharges to the Gull River just above town occurring in May and November. The average phosphorus content of all effluent discharges was stated to be <0.03 mg/L, the minimum reporting resolution, which is excellent. With lagoon systems such as Coboconk's, the volume of effluent released from the lagoons each year may be considerably more or less than the volume of raw input to the plant during the year. This may be due to operational considerations and variable amounts of precipitation and evaporation. Hence, determining the phosphorus removal rate is problematic. Considering all inputs and outputs over the past four years, the overall phosphorus removal rate was greater than 98.0% during that period and the 2015 total annual discharge of phosphorus was less than 2.23 kg.

Average *E. coli* in the discharges in May and November were a low 2.52 and 2.0 cfu/100 ml respectively. No spills, bypasses or overflows were reported. Only one odour complaint was received in September but it was not sustained.

Fenelon Falls

The 2015 Fenelon Falls STP report again incorrectly claimed excellent performance by reporting the maximum monthly phosphorus removal rate instead of the annual average phosphorus removal rate. For

2015, the actual removal rate was 96.3%, down from 96.6% in 2014 and well below our target of 99%. This resulted in a P discharge to Sturgeon Lake of 26.32 kg for the year.

The good news in 2015 was that there were no bypasses due to cross-connections (storm sewer connections into sanitary sewer systems and vice versa) as have occurred in past years. Work is under way to install a holding tank at the Ellice Street pumping station to solve the problem. It should have been completed by the end of 2016.

Again this year *E. coli* levels in the effluent were generally low at about 2 cfu/100ml. No spills or overflows were reported and only one odour complaint was received.

Lindsay

The Lindsay Waste Water Treatment Plant (WWTP) is the largest on the lakes. The City of Kawartha Lakes (CKL) operated the Lindsay WWTP until July 31, 2015, after which its operation was contracted to the Ontario Clean Water Agency (OCWA) which operates all the other sewage treatment plants owned by CKL. Perhaps because of this change in operator, the annual report for the Lindsay plant lacked key information that is required and usually provided in OCWA reports. Specifically, Appendix 1 was not provided. It normally contains information about the quantity and quality, including TP content, of both raw influent and treated effluent. The report did provide monthly average effluent TP concentrations, which indicate that the plant operated well in 2015. Assuming the quantity and TP concentrations of raw sewage treated in 2015 were similar to those of the past two years, it is estimated that the 2015 phosphorus removal rate was greater than 98.2%. This would result in a P discharge to Sturgeon Lake of less than 239.4 kg for the year.

On July 14, 2015, heavy rain caused a bypass at the Colbourne Street pumping station. Approximately 110 m^3 of overflow were removed by truck. It is not stated whether any sewage escaped to the environment. Two other minor spills occurred at the plant during the year but they resulted in no releases. Average *E. coli* in the discharge was 2.5 cfu/100 ml. No complaints were reported in 2015.

Bobcaygeon

This town has two side-by-side sewage treatment plants. In the past, one of the plants was problematic, with operational problems and high phosphorus discharges as documented in the separate reports for each plant. Since 2011, only one performance report has been produced, giving results for the combined output of the two plants. In 2015 the average removal rate was 98.0%, similar to last year's 97.9% but still below our desired target of 99%. The reported annual phosphorus load was 51.8 kg, down from last year's 61.7 kg.

E. coli discharges were relatively high at 21 cfu/100 ml on an annual basis. No spills or bypasses occurred during the year. Two odour complaints were received, both on April 27. Various odour abatement technologies continue to be studied. Meanwhile, operational strategies are being employed to minimize the impact of odour on local residents.

Omemee

This facility consists of two large settling lagoons. Until 2014 all of the effluent was spray-irrigated onto nearby fields during the summer months. A subsurface effluent disposal system began commissioning trials at the site in March, 2014 and operated simultaneously with the spray-irrigation system for parts of the year. Both the spray irrigation and subsurface disposal systems were used in 2015. There have been recurring problems with water breaking through the mantel (surface) of the subsurface disposal system. Because this system is higher than the lagoons, the released water flowed back to the lagoons and not away from the site. Repairs have been made but no modifications to the system had been initiated by early 2016.

We are pleased to see that more detailed information about the quantity and quality of raw influent and treated effluent was provided for this facility in 2015. The average effluent phosphorus concentration in 2015 was a high 1.6 mg/L, above the allowable 1.0 mg/L but this was a result of a single monthly sample in February that was inexplicably about 30 times higher than usual. Weekly effluent TP sampling was instituted. Lagoon systems can have considerable volume buffering capacity but based on the information provided, the volume of raw influent and treated effluent were similar in 2015. Based on the numbers provided, phosphorus removal was only ~60% with ~200 kg being distributed to the irrigation fields and subsurface system. This seems high and might suggest that the capacity of the lagoons is unable to allow sufficient settling before the effluent is distributed. However, because the effluent is applied to land far from Pigeon Lake, removal is probably almost 100% with respect to our lakes.

Annual average *E. coli* levels in the effluent were a relatively high 143 cfu/100 ml this year. This lagoon facility did not require any emergency discharges to the Pigeon River in 2015 and no complaints were noted.

King's Bay

The King's Bay STP serves a golf course community situated on a peninsula between Lake Scugog and the Nonquon River. Houses down the centre of the peninsula are surrounded by the golf course. Treated effluent from the STP at the apex of the peninsula is discharged into two large disposal beds under the golf course on each side of the peninsula. One up-gradient and three down-gradient wells are located around each disposal bed to monitor groundwater for phosphorus migration.

This plant functioned adequately in 2015, despite a few mechanical breakdowns, and the effluent targets continued to be met. Phosphorus discharge to the underground disposal beds averaged 0.29 mg/L, down from 0.38 mg/L in 2014, out of an allowable 1.0 mg/L. The annual daily loading for 2015 was 0.013 kg per day, less than 10% of the allowable discharge volume of 0.17 kg per day. Phosphorus annual average removal efficiency within the plant was 98.1% this year. However, one spill of about 70 m^3 of raw sewage occurred through an "engineered emergency overflow" that discharges to a marshy area on the edge of Lake Scugog. It is estimated that this resulted in a release of ~1.14 kg of phosphorus to the environment.

Monitoring wells located both up and down gradient from the disposal sites continue to have sporadic high TP readings as in past years. Upgrades to the wells and changes in sampling methods since 2011 have not significantly changed the situation. The Tier 1 "Alert" monitoring (4 times a year) that has been in place since 2011 has been replaced for 2016 by measuring TP twice a year using a field filtered grab sample. The purpose of the monitoring wells is to detect phosphorus migration towards the lake or the Nonquon River. Since these wells average 100 m from the lake or the Nonquon River, it is probable that, at least for the time being, we still have effectively 100% removal.

Port Perry

This plant consists of lagoons that discharge seasonally into the Nonquon River northwest of Port Perry, which, in turn, empties into Lake Scugog at Seagrave, where the King's Bay facility is located. In 2015, phosphorus was reduced to a monthly average of 0.08 mg/L for a total loading of 69.7 kg, a significant reduction from last year's 144.2 kg. This reflects a good removal rate of 98.2%. No information was provided about *E. coli* levels this year. There were no reported bypasses or spills and no odour complaints during 2015.

The Port Perry lagoons are to be replaced by a new tertiary treatment plant to allow for the expansion of Port Perry. Construction began in May 2015 with completion scheduled for the end of 2016. This new plant will have a much larger capacity than the old lagoon system and should result in reduced phosphorus discharge amounts and, we hope, a 99+% removal rate that we would like to see attained by all STPs in our area.

Summary

The total volume of phosphorus discharged to the mainstream Kawartha Lakes from the three aquatic discharge plants in 2015 was an excellent 318 kg, less than half last year's 737 kg. If we include all the plants that we now monitor, we had total phosphorus loading to the lakes of 408 kg in 2015 compared to 902 kg in 2014, a decrease of 55%. If all plants were to achieve the 99% removal rate that we would like, the total phosphorus discharge for the year would have been about 210 kg or about 52% of the 2015 total.

KLSA Annual Review of Area Sewage Treatment Plant Performance

Plant Location - Discharges to & Type	Year	Phosphorus Removal Rate % (1)	Total Annual TP Load Out kg (2)	Annual TP Load if 99% kg (3)	*E. coli* (cfu/100 ml)	Bypasses, Spills, Comments
Minden - **Gull River**	2012	98.0%	12.8	6.4	2.7	None reported
Extended aeration activated sludge	2013	90.1%	53.9	5.4	7.2	Bypass resulted in ~40 kg extra P load
process with tertiary treatment	2014	96.7%	19.4	5.8	9.0	None reported
	2015	96.4%	17.9	4.9	68.0	None reported
Coboconk - Gull River Mill Pond	2012	99.4%	1.2	1.2	5.5	None reported
Dual lagoons	2013	97.4%	3.2	1.0	12.4	None reported
semi annual discharge to river	2014	>97.6%	< 3.1	1.7	3.7	None reported
	2015	>98.0%	< 2.2	1.1	2.5	None reported
Fenelon Falls - Sturgeon Lake	2012	97.3%	27.5	8.7	2.0	Bypass resulted in ~ 8.1 kg extra P load.
Extended aeration activated sludge	2013	95.2%	45.6	9.1	2.0	Bypass resulted in ~ 19.1 kg extra P load.
process with tertiary treatment	2014	94.5%	51.8	9.1	2.0	Bypass resulted in ~ 21 kg extra P load.
	2015	96.3%	26.3	7.2	2.0	None reported
Lindsay - Sturgeon Lake	2012	98.1%	193	101.6	2.4	None reported
Flow equalization lagoons;	2013	98.0%	220	112.2	4.0	None reported
extended aeration activated sludge	2014	96.0%	622	149.7	2.6	Bypass resulted in ~ 402 kg extra P load.
process with Actiflo tertiary treatment	2015	>98.2%	<239.4	131.7	2.5	None reported
Bobcaygeon - Pigeon Lake	2012	97.8%	43.2	19.6	2.5	None reported
Extended aeration activated sludge	2013	96.9%	85.4	27.5	3.4	None reported
process with tertiary treatment	2014	97.9%	61.7	29.4	7.4	None reported
	2015	98.0%	51.8	26.9	21.0	None reported
Omemee - Fields/Underground	2012	100.0%	0	0.0	309.0	None reported
Dual lagoons with spray irrigation;	2013	100.0%	0	0.0	-	None reported
pumped into underground disposal	2014	100.0%	0	0.0	-	None reported
beds beginning 2015	2015	100.0%	0	0.0	143.0	None reported
King's Bay - Underground	2012	100.0%	0	0.0	-	None reported
Pumped into underground disposal	2013	100.0%	0	0.0	-	None reported
beds.	2014	100.0%	0	0.0	-	None reported
	2015	100.0%	0	1.1	-	Spill resulted in ~1.14 kg release to lake
Port Perry - Lake Scugog	2012	96.7%	148.9	45.1	-	None reported
6 lagoons, 2 extended aeration cells	2013	97.0%	121.3	40.4	-	None reported
effluent discharge to Nonquon River.	2014	96.6%	144.2	42.4	-	None reported
	2015	98.2%	69.7	37.8	-	None reported

(1) 'Phosphorus Removal Rate %' is the percentage of the phosphorus in the plant inffluent that is removed before effluent is discharged.
(2) 'Total Annual TP Load Out kg' is the total weight of phosphorus, in kilograms, that is discharged from the plant during the year.
(3) 'Annual TP Load if 99% kg' is the total weight of phosphorus, in kilograms, that would be discharged from the plant during the year if the plant achieved a 99 % Phosphorus Removal Rate.

E. coli Bacteria Testing

Kathleen Mackenzie
KLSA Vice-Chair

Many thanks go to our *E. coli* sampling volunteers, who sampled 63 sites on eleven Kawartha Lakes six times over the endlessly hot and dry summer. Thanks for your time and your expertise. Here's what we found:

1. Similar to other years, the huge majority of test results were very low, below 20 *E. coli* cfu/100 mL (see table below). This indicates excellent recreational water quality.

Number of readings	0 – 20 *E. coli* cfu/100 mL	21 – 50 *E. coli* cfu/100 mL	50 – 100 *E. coli* cfu/100 mL	Over 100 *E. coli* cfu/100 mL
2016	351	12	4	3
2015	296	17	16	5
2014	333	23	13	1
2013	335	14	7	3

2. In the few cases where there were elevated counts, they returned to normal by the time they were tested a few days later. These higher counts occurred:

- In areas where waterfowl congregated
- In bays with low circulation and high human use

KLSA would like to encourage volunteers to start *E. coli* testing again in the more western Kawartha Lakes (the west side of Pigeon Lake and lakes further west). This group uses a laboratory at Fleming College, and so requires someone to coordinate sample drop-offs. If you would be interested in this coordinator position, please let us know.

If you would like to test a location on your lake, please contact us. KLSA receives a very reasonable rate from our laboratories. Also, KLSA will pay for up to three sites for an association or one site for an individual for the first year of testing. Try it out for free! You can see what is involved by viewing our new *E. coli* testing video, found on the KLSA website.

Mike Dolbey
PhD, P.Eng, KLSA Director

Thank you KLSA volunteers for another successful season of collecting Total Phosphorus (TP) water samples and Secchi depth measurements as part of the Ontario Ministry of the Environment and Climate Change's Lake Partner Program (LPP). In 2016 data was collected at 45 sites in 15 lakes. Thanks also to Shari Paykarimah, our phosphorus test coordinator.

Many of our volunteers have been collecting this valuable data since KLSA's inception 15 years ago providing information from which long term trends can be determined. Continuous data is very important so if, for any reason, you will not be able to test in future we encourage you to try to recruit someone to replace you. If you are unable to do so, please contact KLSA and we will try to help. We currently need testers for Cameron Lake and for south Pigeon Lake. The program is free and kits are mailed directly to you. If you would like to begin testing, please contact Shari Paykarimah or any KLSA Director at kawarthalakestewards@yahoo.ca

For a complete listing of the 2016 Total Phosphorus and Secchi Depth results please see Appendix F. A summary and graphs of the TP data are presented below.

Why measure phosphorus levels in lake water?

Phosphorus is generally considered the nutrient in lake water that limits the growth of algae and aquatic plants. It enters our lakes from many sources including shoreline erosion, septic systems, domestic fertilizers and pets to name a few that we, as waterfront residents, have some control over. We encourage everyone to do your part to reduce such inputs.

The Ontario Ministry of the Environment & Climate Change has issued the following guidelines for Total Phosphorus in our lakes:

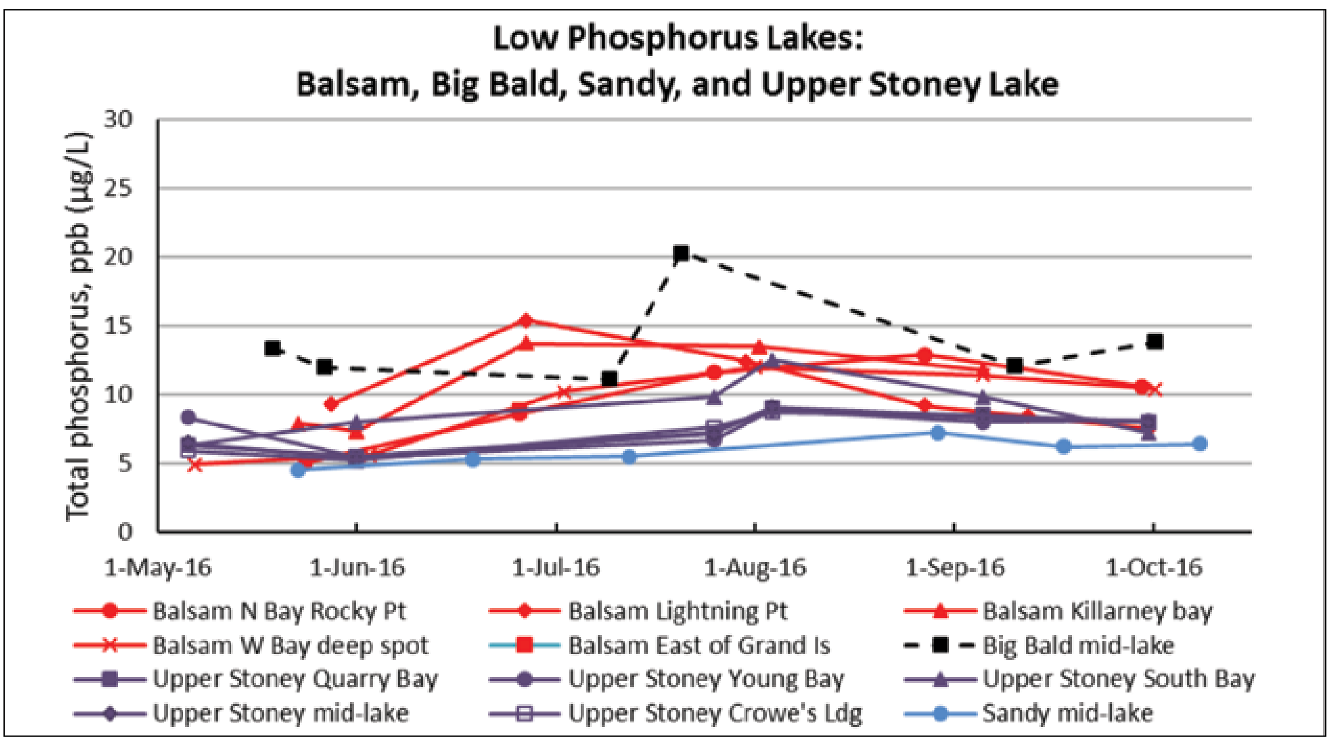
- To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 20 µg/L;

- A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10 µg/L or less.

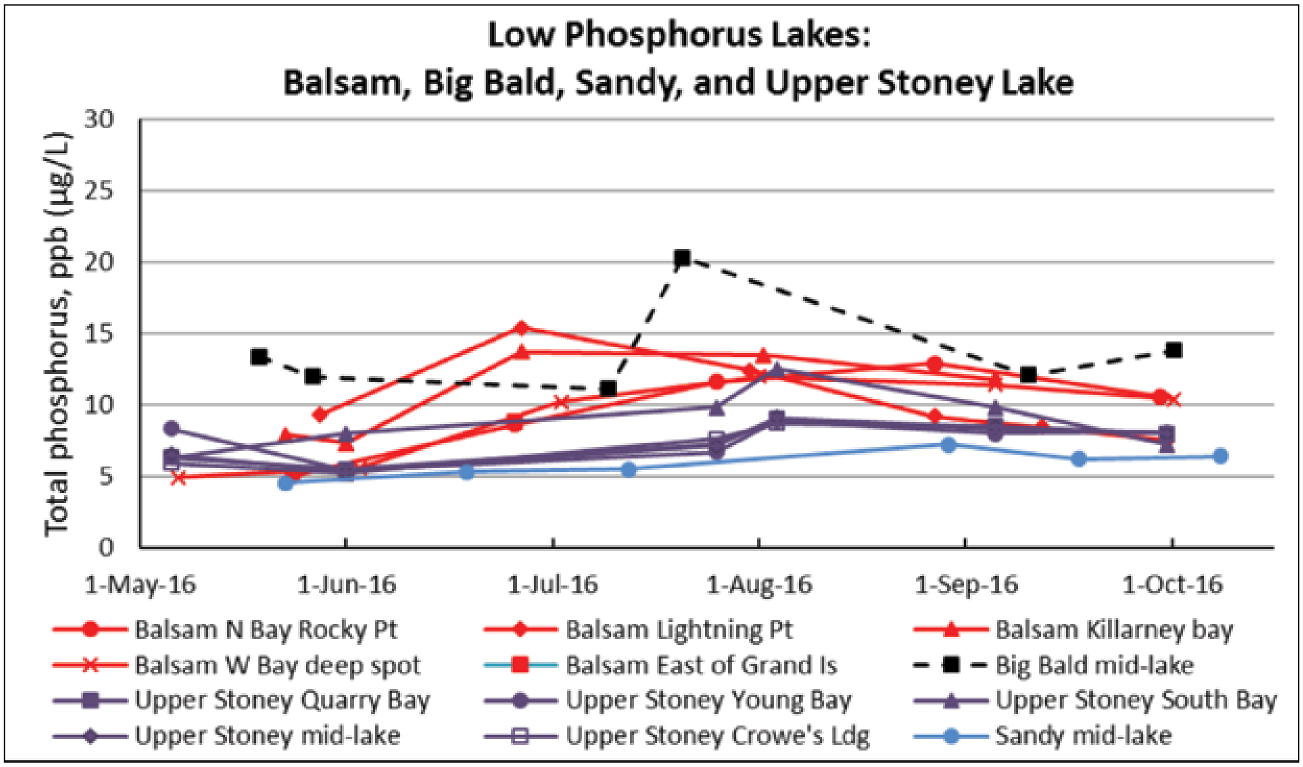
The following graphs illustrate 2016 phosphorus levels in the Kawartha Lakes, along with a discussion of why they vary from lake to lake and from month to month.

Phosphorus results summary

For ease of comparison we divide our lakes into four categories: Low Phosphorus, Upstream, Midstream and Downstream Lakes.



Phosphorus Testing 2016

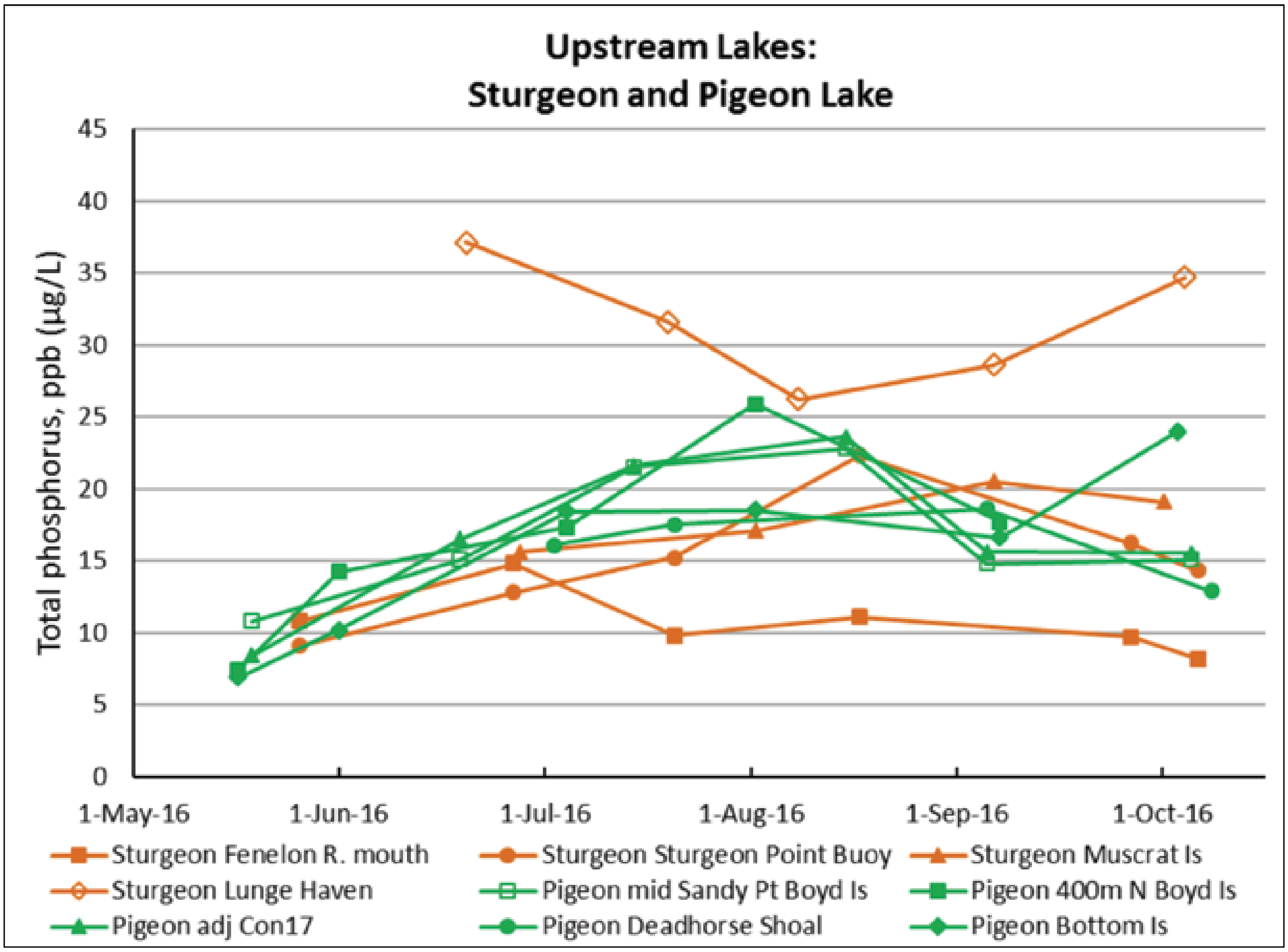


Low phosphorus lakes

The consistently low phosphorus levels throughout the year in Upper Stoney Lake and Balsam Lake result from their receiving most of their water directly from northern rivers. These rivers contribute low-phosphorus water because they come from areas of granitic rock, little soil, and sparse human population.

The very low phosphorus levels in Sandy Lake are due to a very different mechanism. Sandy is a spring-fed marl lake that receives water high in calcium carbonate from the surrounding limestone bedrock. During warm weather, photosynthesis by aquatic plants and algae removes carbon dioxide from the lake water and causes calcium carbonate to precipitate, giving the lake a milky, turquoise appearance. The phosphorus in the water is co-precipitated, transporting it out of the water and into the sediments. For more information on marl lakes, see: http://culturalecology.info/wetland_combi/Marllakes.html.

Big Bald Lake is possibly a hybrid of the two above types. It is set within granite bedrock but receives some of its water from limestone formations to both north and south. The higher than usual TP level near the end of July based on two similar sample results is unexplained.

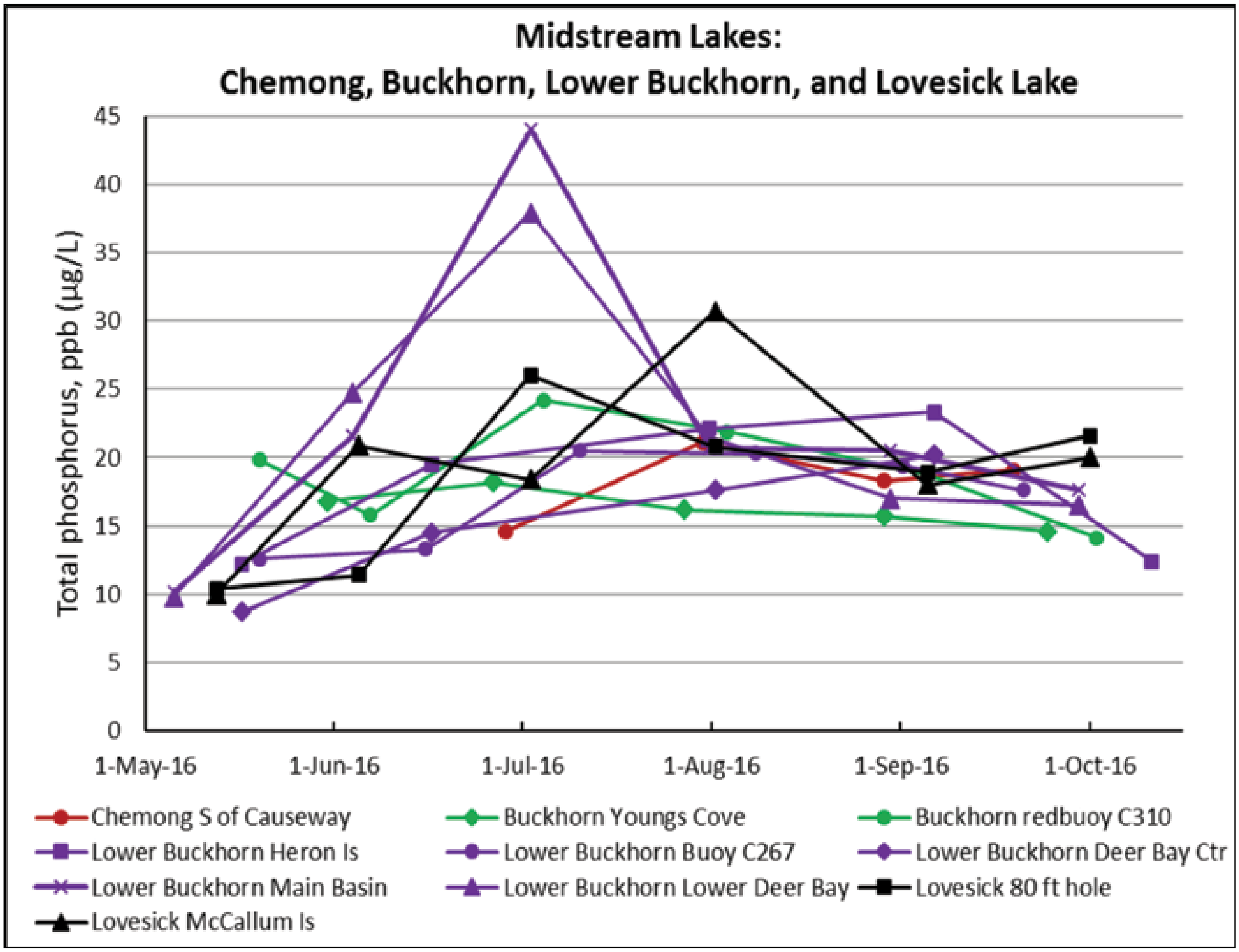


Upstream lakes

As in past years we see high TP levels in spring at the Sturgeon Lunge Haven site that is influenced by inputs from the Scugog River and Lindsay sources. While falling somewhat during the summer, TP levels remain high at this site compared to others in Sturgeon Lake. Low phosphorus water entering from the Fenelon River mixes with the high TP water from the Lindsay arm of the lake to produce modest rises in TP during the summer at the Sturgeon Point and Muskrat Island sites. In fall TP levels drop as Scugog River flow declines and additional low phosphorus water flows from the northern feeder lakes to maintain TSW water levels.

In 2016 the summer TP levels at a number of the Pigeon Lake sites were higher than usual but the high TP levels were not correlated with respect to location. One might expect the two sites in north Pigeon to have similar levels. However, while the site 100m north of Bottom Island was a normal 18 ppb the site 400m north of Boyd Island was a high 26 ppb. Similarly, the Concession 17 and Sandy Point sites had higher than usual TP levels but the nearby Deadhorse shoal site had a normal summer TP level.

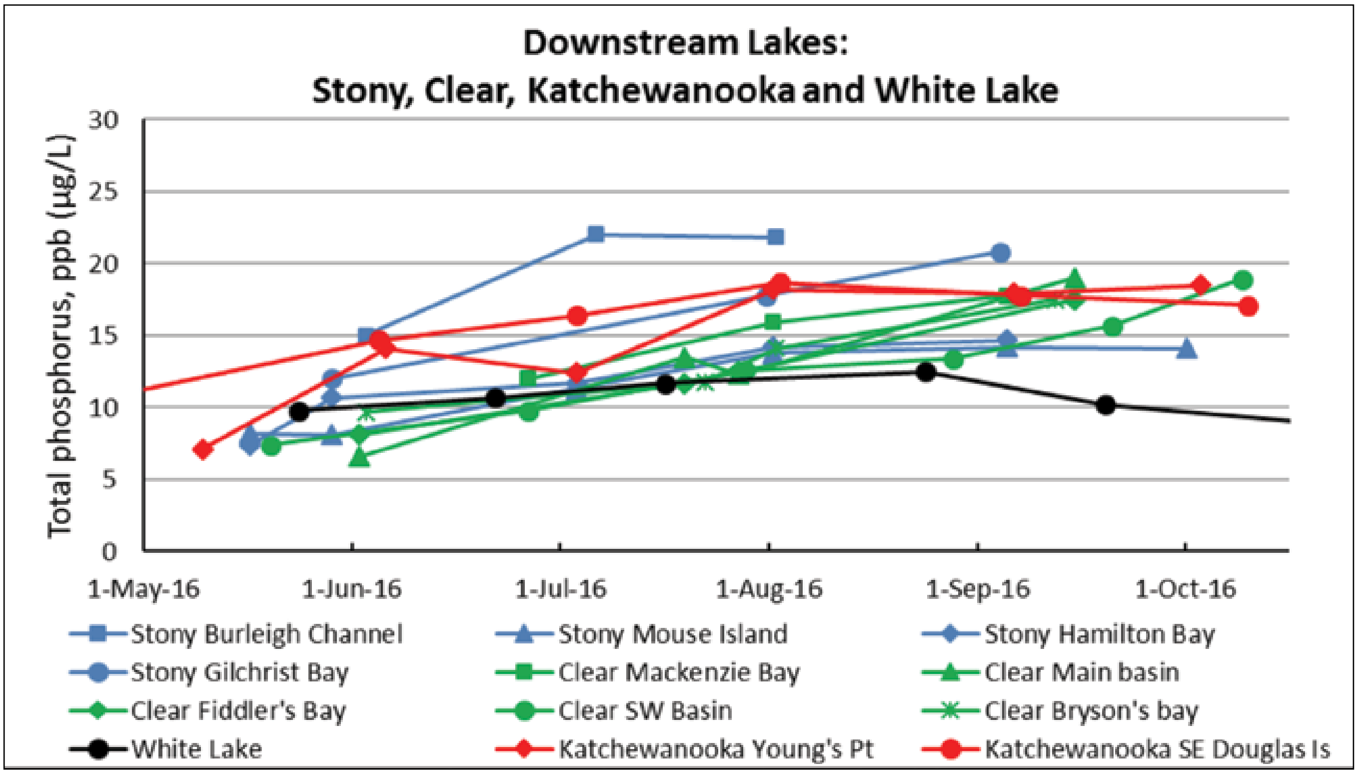
Residents on Buckhorn and Pigeon lakes have reported that water levels varied more than usual in 2016 possibly due to the dam and bridge reconstruction at Buckhorn. This could have affected conditions in upper Pigeon and the Bald Lakes which have very limited local stream inputs during summer and fall. Water leaves upper Pigeon Lake by evaporation and outflow when water levels drop. Sturgeon Lake water exiting the Bobcaygeon River is drawn into upper Pigeon Lake to replace evaporation loss and when water levels rise.



Midstream lakes

The general pattern and TP levels of the midstream lakes were again very similar to the upstream lakes. Phosphorus is low in the spring, rising until mid-summer and then gradually declining in fall.

The large spike in TP at the beginning of July at two sites in Lower Buckhorn is unusual. Both were sampled on the same day, July 3rd. Three other sites in the same lake had normal TP levels but were sampled more than a week before or after this event. Both sites in Lovesick Lake were also sampled on July 3rd with the “80’ hole” site having a somewhat elevated TP (26 ppb) whereas the “McCallum Island” site had a normal TP level. It is not clear whether these high readings are valid measurements or outliers.



Downstream lakes

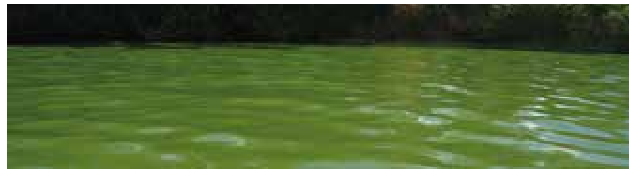
As seen in past years, water entering Stony Lake through the Burleigh Channel had similar TP levels as measured in the lakes just upstream (the midstream lakes). Other sites in Stony Lake had TP levels between 5 and 10 ppb lower probably due to mixing with the low phosphorus water from Upper Stoney Lake. Similar levels are seen at all sites in Clear Lake but they all seem to continue to rise in the fall. As usual, TP levels appear to be slightly higher by the time the flow reaches Lake Katchewanooka.

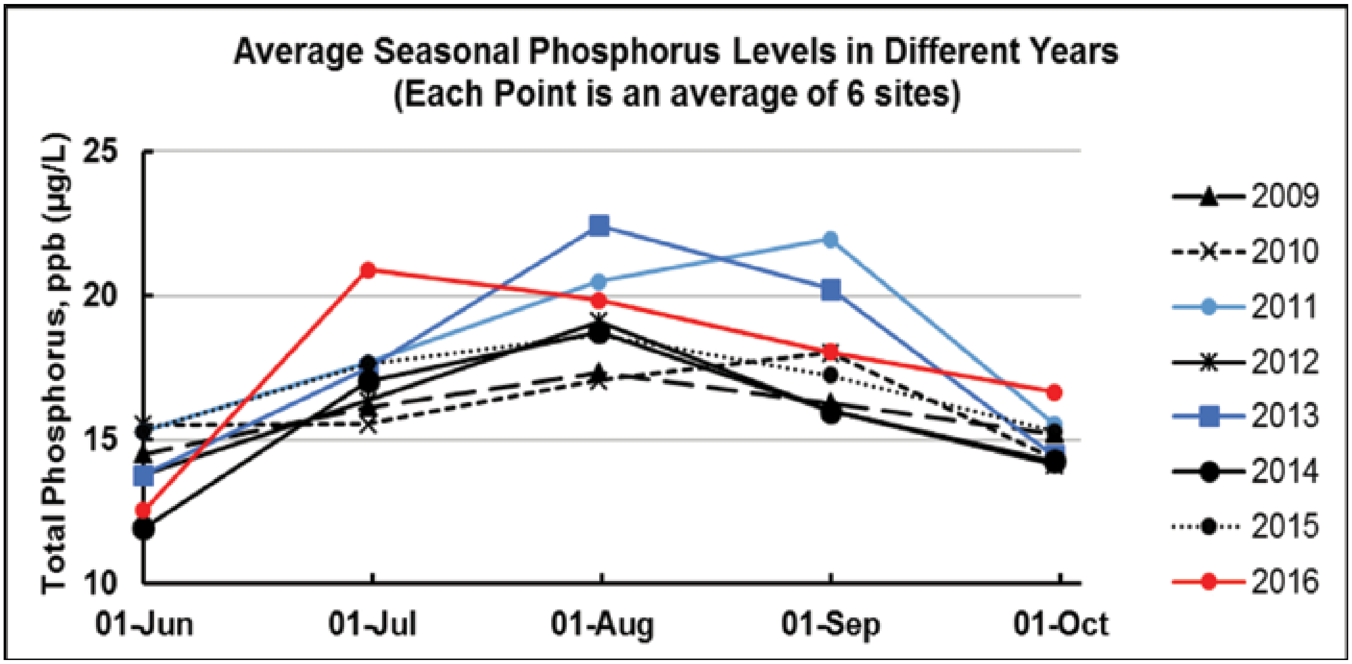
Was 2016 different from other years?

The winter of 2016 was milder with less snow than in the past few years. A warm spring resulted in a very early snowmelt with lake water levels peaking during the first week of April. The following spring and summer were among the driest and hottest on record. Do weather conditions such as these affect the seasonal levels in phosphorus in our lakes? We are not yet sure.

For some time, we have been computing an average annual seasonal TP curve for the lakes by averaging the monthly readings of six sites, one from each of the six lowest lakes on the TSW system; Pigeon – N end Con 17, Buckhorn – Narrows Buoy C310, Lower Buckhorn – Buoy C267, Lovesick – 80' hole, Stony – Mouse Island and Katchewanooka – Douglas Island. The following graph compares the 2016 average seasonal TP curve to those of the previous seven years. The five years shown in black have similar curves that are considered to be typical of a normal year. The two blue curves for 2011 & 2013 showed higher than typical seasonal variation peaking at the beginning of September and August respectively. The red curve for 2016 also shows higher than typical variation peaking at the beginning of July.

Above it was noted that two sites on Lower Buckhorn had very high TP levels measured on July 3, 2016 but neither of these were used in calculating the data for the 2016 curve in this graph. An examination of the values used to calculate the July, 2016 point showed that TP levels in all the upper 4 lakes were approximately 5 ppb higher than typical at the beginning of July. TP levels at the beginning of July in Stony and Katchewanooka Lakes, that are reduced by mixing with Upper Stoney Lake water, were typical. It appears that the elevated TP levels at the beginning of July may be valid measurements (rather than outliers) but at present we have no good explanation for how they occurred.





Conclusion

In 2016 Total Phosphorus levels throughout the Kawartha lakes were slightly higher than typical but displayed a similar pattern to those in past years. We believe the seasonal variation of TP levels in our lakes is primarily due to the following mechanism but other factors such as internal loading and weather may also be influences.

- Early in the year as snow melts the feeder lakes are filled to capacity and the excess low phosphorus water floods through our lakes resulting in low phosphorus levels.

- As inflows from local watersheds dry up in summer, the TSW releases only enough water from the feeder lakes to replace water lost to evaporation and lockage and to maintain the minimum required flow in the Otonabee River. As flow is reduced, phosphorus levels rise in most lakes probably due primarily to local and southern (Scugog River and Lindsay) inputs. Lakes not directly affected by TSW flow, such as the Bald Lakes, Sandy Lake, Chemong, Upper Stony and White Lake, show much less phosphorus increase in summer due to local geographic conditions (Low P water input or P precipitation with marl).

- In late summer the TSW increases the release of water from the feeder lakes in order to ensure they are at a low level before freeze-up. This increased flow of low-phosphorus water results in dilution and the leveling off or drop in phosphorus levels in late summer and fall.

- A number of our Kawartha lakes have mid-summer phosphorus levels that meet or exceed the provincial water quality objective of 20 ppb; the level at which nuisance concentrations of algae and aquatic plant growth might be expected. It is important that we all support lake management plan activities aimed at reducing phosphorus inputs into our lakes.

KLSA 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.

2016 – 2017 Board of Directors

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Lower Buckhorn Lake

Erin McGauley, Director**
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Shari Paykarimah, Director
Peterborough

*effective October 1, 2016
**until October 1, 2016

Scientific Advisors

Dr. Brian Cumming
Professor and Head, Department of Biology;
Director, School of Environmental Studies;
Co-Director, Paleoecological Environmental Assessment and Research Laboratory (PEARL), Queen's University, Kingston

Dr. Paul Frost
David Schindler Professor of Aquatic Science,
Trent University, Peterborough

Sara Kelly
Faculty, Ecosystem Management Program and Sustainable Agriculture Co-op Coordinator,
Fleming College, Lindsay

Dr. Eric Sager
Ecological Restoration Program,
Fleming College and Trent University,
Peterborough

Volunteer Testers, 2016

Balsam Lake - Douglas and Peggy Erlandson, Jim and Kathy Armstrong, Jeff Taylor, Richard Braniff, Ross Bird, Leslie Joynt

Big Bald Lake - Big Bald Lake Cottagers Association: Bruce Barnes, Colin Hoag

Big Bald Lake - Big Bald Lake Road Association: Gord Rance

Big Cedar Lake - Big Cedar Lake Stewardship Association: Rudi Harner

Cameron Lake – Lisa Martin, Stu Kinsinger

Chemong Lake – Brian and Linda Neck

Clear Lake – Birchcliff Property Owners Association: Jeff Chalmers

Clear Lake - Kawartha Park Cottagers Association: Vivian Walsworth

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

Lovesick Lake – Lovesick Lake Association: Ron Brown, John Ambler

Lower Buckhorn Lake – Lower Buckhorn Lake Owners Association: Brian Brady, Jeff Lang, Mark and Diane Potter, Dave Thompson, Janet and Paul Duval

Mill Pond – Paul South

Pigeon Lake – Concession 17 Pigeon Lake Cottagers Association: Donald Morrison

Pigeon Lake – North Pigeon Lake Ratepayers Association: Tom McCarron, Francis Currer

Pigeon Lake – Victoria Place: Brenda Oundjian, Bob Johnson

Sandy Lake – Sandy Lake Cottagers Association: Mike and Diane Boysen, Kim Letto, Rich Corbin

Stony Lake – Association of Stony Lake Cottagers: Bev and Don Foster, Ralph and Barb Reed, Kathleen Mackenzie, Bob Woosnam, Gail Szego

Sturgeon Lake – Bruce Hadfield, Sherry and Dave Young, Rod Martin, Kelly Tatchell

Upper Buckhorn Lake - Buckhorn Sands Property Owners Association: Craig, Anastasia, Henry and Lawrence Charlton

Upper Buckhorn Lake - Darrell Darling

Upper Stoney Lake - Upper Stoney Lake Association: Karl Macarthur

White Lake – White Lake Association: Wayne Horner

Thank you Volunteers!

Thank You to our 2016 Supporters

Municipal Government Contributions

Gold ($4,000+)
City of Kawartha Lakes

Silver ($1,000 – $3,999)
Municipality of Trent Lakes
Township of Douro-Dummer

Bronze (<$1,000)
Township of Selwyn

Associations, Businesses and Individual Supporters

Gold ($200+)

Mike Dolbey
Janet Duval
Jim Keyser
Lovesick Lake Association
Tom McAllister
Pinewood Cottages and Trailer Park Ltd
Rosedale Marina
Stony Lake Heritage Foundation

Silver ($100 - $199)

Birch Bend Cottage Resort
Birchcliff Property Owners
Big Cedar Lake Stewardship Association
Clearview Cottage Resort
Curve Lake First Nations Cultural Centre
Egan Houseboat Rentals
FR44 Cottagers Association
Sheila Gordon-Dillane
Lakefield Foodland
Nestle In Resort
Sandy Lake Cottagers Association
White Lake Association

Bronze (<$100)

Mary Auld
Big Bald Lake Cottage Association
Big Cedar Lake Road Committee
East Beehive Community Association
Peter Chappell
Robert Hogg
Lakeside Cottages
Keith Miller Electric
William A. Napier
Norma & Allan Walker
Water's Edge Cottage Resort
Jeff Webb
Wilson & Sons Home Improvements

Appendix C: KLSA Treasurer's Report

Mike Stedman, KLSA Treasurer

This Treasurer's Report refers to the 2016 calendar year and the McColl Turner LLP Chartered Accountants' Statement of Financial Position summarizing revenue, expenditure and assets for 2015 and 2016. Our thanks to Mr. George Gillespie for his continued support providing this community service.

2016 revenue of $13,421 is considerably more than 2015 and reflects increased municipal and community support for KLSA and our paleolimnology study.

Our continuing sources of income were:

- Water testing fees $3,060
- Municipal grants $6,200
- Private business/individual donations $2,816
- Association donations $1,240

2016 total expenses of $10,759 remained consistent with past years when you exclude major project activities like our Aquatic Plants Guide, the Milfoil Weevil Guide and the Algae of the Kawartha Lakes Study.

The most significant operating expenses included:

- *E. coli* test costs $3,259
- KLSA insurance $1,704
- KLSA Annual Report $4,969

The Lakefield Herald kept our annual report publishing cost at $2.06 a copy. Postage at over $3.00 a copy forces us to minimize distribution by mail. As a non-profit organization, we are not required to pay income tax.

In terms of total assets, we closed 2016 with a cash balance of $17,163 and an RBC GIC of $5,185 for total assets of $22,348. The Board considers we need approximately $8,000 for working capital to cover our early 2017 expenses for insurance and the annual report. This permits a KLSA contribution of approximately $14,000 towards ongoing sediment core sampling and analysis for our paleolimnology study with Queen's University. The entire paleo project, at over double this amount, is made possible by significant financial support from the Stony Lake Heritage Foundation, Kawartha Conservation Authority and the City of Kawartha Lakes Environmental Advisory Committee.

KLSA is pleased to pursue a role in 'citizen science' on the Kawartha Lakes, which is made possible by our community's generous support, both financial and in-kind.

Financial Statements of

KAWARTHA LAKE STEWARDS ASSOCIATION

December 31, 2016

Note to the Financial Statements

Notice to Reader Report

Statement of Financial Position

Statement of Operations

Note To The Financial Statements
December 31, 2016

BASIS OF PRESENTATION

The accompanying financial statements relate to the incorporated association registered by Letters Patent as Kawartha Lake 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.

Kawartha Lake 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 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 LLP
CHARTERED PROFESSIONAL ACCOUNTANTS

MCT

McCOLL TURNER LLP
CHARTERED PROFESSIONAL ACCOUNTANTS

362 Queen Street
Peterborough, ON
K9H 3J6

P: 705.743.5020
F: 705.743.5081
E: info@mccollturner.com
www.mccollturner.com

NOTICE TO READER

On the basis of information provided by management, we have compiled the statement of financial position of Kawartha Lake Stewards Association as at December 31, 2016 and the statement of operations for the year then ended.

We have not performed an audit or review engagement in respect of these financial statements and, accordingly, we express no assurance thereon.

Readers are cautioned that these statements may not be appropriate for their purposes.

McColl Turner LLP
Licensed Public Accountant

Peterborough, Ontario
February 8, 2017

KAWARTHA LAKE STEWARDS ASSOCIATION

Statement of Financial Position - December 31, 2016

	(Unaudited) 2016	2015
ASSETS		
Current Assets		
Cash	$ 17,163	14,527
Guaranteed Investment Certificate	5,185	5,159
	22,348	19,686
NET ASSETS	22,348	19,686
	$ 22,348	$ 19,686

Statement of Operations
Year ended December 31, 2016

	(Unaudited) 2016	2015
REVENUE		
Municipal grants	6,200	-
Associations	1,240	2,031
Private contributions and donations	2,816	2,175
Water testing fees	3,060	4,682
Membership fees	79	804
Interest	26	41
	13,421	9,733
EXPENDITURES		
Water testing fees	3,259	3,402
Special projects	151	1,553
Annual report costs	4,969	4,922
Insurance	1,704	1,709
Telephone, copies and other administrative costs	634	427
Bank charges	42	51
	10,759	12,064
EXCESS OF REVENUE OVER EXPENDITURES (EXPENDITURES OVER REVENUE) FOR THE YEAR	2,662	(2,331)
NET ASSETS - beginning of year	19,686	22,017
NET ASSETS - end of year	$ 22,348	$ 19,686

McCOLL TURNER LLP
CHARTERED PROFESSIONAL ACCOUNTANTS

Appendix D: Privacy Statement

Jeffrey Chalmers, KLSA Privacy Officer

As a result of 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 to:

KLSA
24 Charles Court
Lakefield, ON K0L 2H0

Appendix E: Rationale for *E. coli* Testing and 2016 Lake-by-Lake Results

Kathleen Mackenzie, KLSA Vice-Chair
Tom McAllister, KLSA Director

Providing context for these results

- In Ontario, a public beach is 'posted' when the level of *E. coli* in the water exceeds 100 *E. coli* cfu/100mL (colony-forming units/100ml) of water. This means that the water is unsafe for recreational use, including human bathing (swimming).
- KLSA considers counts over 50 cfu/100mL as somewhat high for the Kawartha Lakes, and cause for re-testing where possible.
- Counts of 20 and below, with an occasional reading between 20 and 50, are normal for the Kawartha Lakes.

Choosing sites for the KLSA *E. coli* testing program

The goals of this testing are threefold:

- To see how safe the water is 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.
- Only sites consistent with provincial sampling protocol have been reported.

The protocol for *E. coli* testing is found in the Ontario Ministry of Health's "Beach Management Guidance Document, 2014", in the section, "Water Sample Collection". This document can be found at http://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/docs/guidance/guide_beach.pdf

How and 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 or illness, as occurs in occasional ground beef 'scares' that can lead to food poisoning. The basic analysis done by the laboratories 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.

Results are expressed as *E. coli* cfu/100 mL. When sample water is plated on growth medium in the laboratory, each live bacterium will grow to form a visible colony. 'Cfu' signifies 'colony forming units'. 'Cfu' generally represents numbers of live bacteria as opposed to a microscopic count, which would count both live and dead bacteria.

What do this year's results tell us?

All lakes and sites were, for the most part, safe to swim in (i.e., with readings <100). Any readings over 100 tended to be isolated and generally returned to low or more moderate readings shortly thereafter.

Big Bald Lake – Big Bald Lake Cottagers Association							
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL							
Site	July 4	July 18	July 25	August 2	August 4	August 22	September 6
1	4	6	6	14	--	10	0
2	1	4	3	0	--	6	5
3	1	1	2	8	--	3	1
9	2	1	0	0	--	3	0
10	1	5	32	151	0	18	0
10 clear	--	--	--	--	1	--	--
10 problem	--	--	--	--	17	--	--

Counts were generally low on Big Bald Lake.

The only high count occurred on Aug. 2 on Site 10. This site is in a shallow bay with low circulation, particularly during this dry summer. Waterfowl often congregate here. There had been a high level of human activity in the bay just before the sampling date. There were many active bubblers* nearby, which might have been stirring up sediments. There have been occasional high counts at this site during the previous two summers. Site 10 had returned to a low count by August 4.

*A bubbler is a pipe with holes that you leave submerged. It pipes out bubbles of air, reducing algal growth in stagnant areas.

Big Cedar Lake - Big Cedar Lake Road Association						
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL						
Site	July 4	July 18	July 25	August 2	August 8	September 6
640	3	0	1	0	1	0

Counts were consistently low at this location on Big Cedar Lake.

Buckhorn Lake - Buckhorn Sands Property Owners Association						
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL						
Site	July 4	July 18	July 25	August 2	August 8	September 6
7	0	1	1	2	0	1
8	4	107	6	3	3	0
9	0	5	2	1	0	1
10	2	1	7	0	0	0

Counts were very low at the four locations, with the exception of Site 8's high reading on July 18. Site 8 was not a swimming area at that time of the year.

Clear Lake – Birchcliff Property Owners Association						
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL						
Site	July 20	July 28	August 3	August 8	August 18	September 15
2	0	1	0	1	0	1
3	0	0	0	0	0	2
4	1	2	2	3	5	2
5	1	7	1	1	2	0
6	0	1	1	1	0	0
7	0	0	0	0	2	0
8	0	18	36	42	2	2
B-B	0	0	5	0	1	0

E. coli readings were consistently low at all eight sites tested by the Birchcliff POA.

Clear Lake – Kawartha Park Cottagers Association							
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL							
Site	June 27	July 11	July 17	July 25	August 2	August 15	September 5
A	0	6	1	0	0	19	0
B	2	1	3	0	1	2	3
C	0	0	10	0	5	0	2
D	1	1	0	0	1	1	10
P	1	0	0	0	2	0	2
W	1	3	1	6	0	2	1

E. coli counts were consistently low at all six Kawartha Park sites.

Katchewanooka Lake – Site 7							
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL							
Site	July 4	July 19	July 25	July 27	August 2	August 8	September 6
7	1	3	380	9	6	6	0
7 down	-	-	-	4	-	-	-
7 up	-	-	-	34	-	-	-

All counts were low at Site 7 except on July 25th. This sample was taken near a raft that was covered in goose droppings. It had rained hard in the early morning just before sampling. Counts returned to normal very quickly.

Katchewanooka Lake - Lake Edge Cottages					
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL					
Site	July 4	July 18	July 25	August 3	September 6
3	2	2	3	14	3

Counts were consistently low at Site 3 on Katchewanooka Lake.

Lovesick Lake – Lovesick Lake Association					
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL					
Site	July 13	July 24	August 1	August 7	September 5
16	0	0	0	0	0
18	0	0	0	0	1
19	0	2	6	0	0

Counts were extremely low at these three locations on Lovesick Lake.

Lower Buckhorn Lake - Site 13A, 13B						
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL						
Site	July 4	July 25	August 11	August 30	September 6	September 12
13A	2	11	6	10	18	2
13B	--	--	4	--	--	--

Counts were all low at Lower Buckhorn Sites 13A and 13B.

Lower Buckhorn Lake - Lower Buckhorn Lake Owners Association						
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL						
Site	July 5	July 17	July 28	August 2	August 8	September 6
1	7	7	-	-	-	-
2	1	21	1	2	0	1
5	2	23	0	2	1	0
8	7	6	16	0	6	0
20	0	2	0	0	1	0

Counts were consistently quite low at all five sites on Lower Buckhorn Lake.

Pigeon Lake – Concession 17 Pigeon Lake Cottagers Association					
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL					
Site	July 4	July 15	August 2	August 15	September 5
3	1	4	0	2	1
A	0	13	1	1	0
B	0	2	1	0	0

Counts were consistently low at all three sites in the Pigeon Lake Concession 17 area.

Pigeon Lake – North Pigeon Lake Ratepayers Association				
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL				
Site	July 4	July 20	August 2	September 7
1A	0*	0	4	13
5A	3*	6	4	6
6	19*	25	33	14
8	2*	0	0	0
13	5*	5	1	10

*Samples were past standard holding time of 48 hours upon receipt.
Counts were very low at sites 1A, 5A, 8 and 13. Counts were somewhat higher at Site 6, but still exhibiting good recreational quality.

Pigeon Lake – Victoria Place						
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL						
Site	July 4	July 18	July 25	August 2	August 8	September 6
1	3	0	0	5	0	1
2	1	1	0	0	0	2
3	2	1	2	0	0	0
4	0	0	2	1	1	0
5	0	0	6	0	3	0

Counts were extremely low at all five Victoria Place sites.

Sandy Lake – Sandy Lake Cottagers Association						
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL						
Site	July 4	July 18	July 25	August 2	August 9	September 6
1	2	0	1	1	0	0
2	2	0	1	0	0	1
3	1	4	1	0	1	1

Counts were extremely low at all three Sandy Lake sites.

Stony Lake – Association of Stony Lake Cottagers						
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL						
Site	July 4	July 18	July 25	August 2	August 8	September 6
E	11	6	3	6	4	2
F	1	0	0	0	0	0
I	1	16	43	46	12	0
L	5	3	0	1	0	0
P	0	0	0	0	0	0
PRV28	12	29	6	8	50	0

Compared to the readings on all the lakes this year, Site I and PRV28 had somewhat elevated counts.

It is interesting that the sampler recorded steady rain for several hours before sampling on July 25, but counts were not elevated; perhaps the land wasn't saturated, resulting in minimal runoff.

At Site PRV28 on August 8, the sampler noticed that a neighbour was raking and pulling aquatic plants. Perhaps this disturbance of the sediment caused the reading of 50 *E. coli* cfu/100 mL.

Upper Stoney Lake – Upper Stoney Lake Association						
2016 *E. coli* Lake Water Testing – *E. coli* cfu/100mL						
Site	July 4	July 18	July 25	August 2	August 8	September 6
6	18	28	21	8	58	28
20	8	10	6	4	1	0
21	1	0	0	0	0	4
52	2	5	3	2	23	5
65	0	0	5	0	0	1
70	0	2	0	0	1	4
78A	0	1	0	0	1	0

Upper Stoney Lake counts were standard for a Kawartha Lake – many below 20, several between 20 and 50. There was no obvious reason for the somewhat elevated reading of 58 at Site 6 on Aug. 28.

A beaver in a boathouse finds a use for tapegrass: as bedding material.
Photo by Pat Moffat

Total Phosphorus (TP) Measurements

In 2016 volunteers tested 45 sites in 15 Kawartha lakes. Results are listed below.Twelve TP measurements are in bold type. These were considered outliers, and were not used to calculate the TP average.

STN	Site ID	Lake Name	Site Description	Date	TP1 (µg/L)	TP2 (µg/L)	Avg.TP (µg/L)
6902	2	BALSAM LAKE	N Bay Rocky Pt.	24-May-16	5.0	5.0	5.0
6902	2	BALSAM LAKE	N Bay Rocky Pt.	26-Jun-16	9.2	8.0	8.6
6902	2	BALSAM LAKE	N Bay Rocky Pt.	26-Jul-16	11.6	11.6	11.6
6902	2	BALSAM LAKE	N Bay Rocky Pt.	27-Aug-16	13.2	12.6	12.9
6902	2	BALSAM LAKE	N Bay Rocky Pt.	30-Sep-16	10.0	11.2	10.6
6902	5	BALSAM LAKE	NE end-Lightning Pt	28-May-16	9.4	9.2	9.3
6902	5	BALSAM LAKE	NE end-Lightning Pt	27-Jun-16	16.8	14.0	15.4
6902	5	BALSAM LAKE	NE end-Lightning Pt	31-Jul-16	12.2	12.6	12.4
6902	5	BALSAM LAKE	NE end-Lightning Pt	27-Aug-16	9.0	9.4	9.2
6902	5	BALSAM LAKE	NE end-Lightning Pt	12-Sep-16	8.0	8.8	8.4
6902	5	BALSAM LAKE	NE end-Lightning Pt	1-Oct-16	7.4	7.6	7.5
6902	7	BALSAM LAKE	South B-Killarney B	23-May-16	7.4	8.4	7.9
6902	7	BALSAM LAKE	South B-Killarney B	1-Jun-16	7.6	7.0	7.3
6902	7	BALSAM LAKE	South B-Killarney B	27-Jun-16	14.2	13.2	13.7
6902	7	BALSAM LAKE	South B-Killarney B	2-Aug-16	13.6	13.4	13.5
6902	7	BALSAM LAKE	South B-Killarney B	5-Sep-16	11.4	12.2	11.8
6902	8	BALSAM LAKE	W Bay2, deep spot	7-May-16	5.0	4.8	4.9
6902	8	BALSAM LAKE	W Bay2, deep spot	3-Jun-16	5.6	5.6	5.6
6902	8	BALSAM LAKE	W Bay2, deep spot	3-Jul-16	10.0	10.4	10.2
6902	8	BALSAM LAKE	W Bay2, deep spot	1-Aug-16	11.8	12.2	12.0
6902	8	BALSAM LAKE	W Bay2, deep spot	5-Sep-16	11.4	11.4	11.4
6902	8	BALSAM LAKE	W Bay2, deep spot	2-Oct-16	10.4	10.4	10.4
6902	9	BALSAM LAKE	E of Grand Is	26-Jun-16	8.0	9.6	8.8
6941	1	BIG BALD LAKE	Mid Lake, deep spot	19-May-16	15.8	11.0	13.4
6941	1	BIG BALD LAKE	Mid Lake, deep spot	27-May-16	12.0	**43.6**	12.0
6941	1	BIG BALD LAKE	Mid Lake, deep spot	10-Jul-16	11.2	11.0	11.1
6941	1	BIG BALD LAKE	Mid Lake, deep spot	21-Jul-16	20.8	19.8	20.3
6941	1	BIG BALD LAKE	Mid Lake, deep spot	10-Sep-16	12.6	11.6	12.1
6941	1	BIG BALD LAKE	Mid Lake, deep spot	2-Oct-16	14.4	13.2	13.8
363	1	BIG CEDAR LAKE	Mid Lake, deep spot	22-May-16	7.0	7.8	7.4
7131	1	BUCKHORN LAKE (U)	Narrows-redbuoy C310	20-May-16	19.6	20.0	19.8
7131	1	BUCKHORN LAKE (U)	Narrows-redbuoy C310	7-Jun-16	16.0	15.6	15.8
7131	1	BUCKHORN LAKE (U)	Narrows-redbuoy C310	5-Jul-16	23.8	24.6	24.2
7131	1	BUCKHORN LAKE (U)	Narrows-redbuoy C310	4-Aug-16	21.6	22.2	21.9

Appendix F:
2016 Phosphorus and Secchi Data

STN	Site ID	Lake Name	Site Description	Date	TP1 (µg/L)	TP2 (µg/L)	Avg.TP (µg/L)
7131	1	BUCKHORN LAKE (U)	Narrows-redbuoy C310	5-Sep-16	18.6	18.8	18.7
7131	1	BUCKHORN LAKE (U)	Narrows-redbuoy C310	3-Oct-16	14.4	13.8	14.1
7131	9	BUCKHORN LAKE (U)	Young's Cove, Deep Spot	31-May-16	16.4	17.2	16.8
7131	9	BUCKHORN LAKE (U)	Young's Cove, Deep Spot	27-Jun-16	19.0	17.4	18.2
7131	9	BUCKHORN LAKE (U)	Young's Cove, Deep Spot	28-Jul-16	16.2	16.2	16.2
7131	9	BUCKHORN LAKE (U)	Young's Cove, Deep Spot	29-Aug-16	15.8	15.6	15.7
7131	9	BUCKHORN LAKE (U)	Young's Cove, Deep Spot	25-Sep-16	14.2	15.0	14.6
6951	9	CHEMONG LAKE	S. of Causeway	29-Jun-16	14.4	14.8	14.6
6951	9	CHEMONG LAKE	S. of Causeway	31-Jul-16	21.0	21.2	21.1
6951	9	CHEMONG LAKE	S. of Causeway	29-Aug-16	18.6	18.0	18.3
6951	9	CHEMONG LAKE	S. of Causeway	19-Sep-16	19.4	18.8	19.1
6951	10	CHEMONG LAKE	Deep Spot, N. of Bridge North	10-May-16	10.6	11.2	10.9
6955	1	CLEAR LAKE	MacKenzie Bay	27-Jun-16	12.0	12.0	12.0
6955	1	CLEAR LAKE	MacKenzie Bay	2-Aug-16	16.0	15.8	15.9
6955	1	CLEAR LAKE	MacKenzie Bay	5-Sep-16	18.0	17.6	17.8
6955	2	CLEAR LAKE	Main Basin-deep spot	2-Jun-16	6.6	6.6	6.6
6955	2	CLEAR LAKE	Main Basin-deep spot	20-Jul-16	13.2	13.8	13.5
6955	2	CLEAR LAKE	Main Basin-deep spot	28-Jul-16	12.2	12.4	12.3
6955	2	CLEAR LAKE	Main Basin-deep spot	15-Sep-16	19.2	18.8	19.0
6955	3	CLEAR LAKE	Fiddlers Bay	2-Jun-16	7.6	8.6	8.1
6955	3	CLEAR LAKE	Fiddlers Bay	20-Jul-16	11.4	12.0	11.7
6955	3	CLEAR LAKE	Fiddlers Bay	28-Jul-16	12.8	12.2	12.5
6955	3	CLEAR LAKE	Fiddlers Bay	15-Sep-16	17.4	17.6	17.5
6955	4	CLEAR LAKE	Brysons Bay	3-Jun-16	10.6	8.8	9.7
6955	4	CLEAR LAKE	Brysons Bay	23-Jul-16	11.4	12.2	11.8
6955	4	CLEAR LAKE	Brysons Bay	2-Aug-16	14.4	13.8	14.1
6955	4	CLEAR LAKE	Brysons Bay	12-Sep-16	17.6	17.4	17.5
6955	5	CLEAR LAKE	Southwest Basin, Deep Spot	20-May-16	7.2	7.6	7.4
6955	5	CLEAR LAKE	Southwest Basin, Deep Spot	27-Jun-16	9.6	10.0	9.8
6955	5	CLEAR LAKE	Southwest Basin, Deep Spot	29-Jul-16	12.6	12.6	12.6
6955	5	CLEAR LAKE	Southwest Basin, Deep Spot	28-Aug-16	13.8	13.0	13.4
6955	5	CLEAR LAKE	Southwest Basin, Deep Spot	21-Sep-16	16.4	15.0	15.7
6955	5	CLEAR LAKE	Southwest Basin, Deep Spot	10-Oct-16	18.4	19.4	18.9
7076	1	KATCHEWANOOKA LAKE	S/E Douglas Island	1-May-16	11.6	10.8	11.2
7076	1	KATCHEWANOOKA LAKE	S/E Douglas Island	5-Jun-16	15.8	13.6	14.7
7076	1	KATCHEWANOOKA LAKE	S/E Douglas Island	4-Jul-16	16.4	16.4	16.4
7076	1	KATCHEWANOOKA LAKE	S/E Douglas Island	3-Aug-16	18.6	18.8	18.7
7076	1	KATCHEWANOOKA LAKE	S/E Douglas Island	7-Sep-16	17.6	18.0	17.8

STN	Site ID	Lake Name	Site Description	Date	TP1 (µg/L)	TP2 (µg/L)	Avg.TP (µg/L)
7076	1	KATCHEWANOOKA LAKE	S/E Douglas Island	11-Oct-16	17.6	16.6	17.1
7076	2	KATCHEWANOOKA LAKE	Young Pt near locks	10-May-16	7.0	7.2	7.1
7076	2	KATCHEWANOOKA LAKE	Young Pt near locks	6-Jun-16	13.6	14.6	14.1
7076	2	KATCHEWANOOKA LAKE	Young Pt near locks	4-Jul-16	12.4	12.4	12.4
7076	2	KATCHEWANOOKA LAKE	Young Pt near locks	2-Aug-16	18.0	18.4	18.2
7076	2	KATCHEWANOOKA LAKE	Young Pt near locks	6-Sep-16	18.2	17.6	17.9
7076	2	KATCHEWANOOKA LAKE	Young Pt near locks	4-Oct-16	18.4	18.6	18.5
7087	1	LOVESICK LAKE	80’ hole at N. end	13-May-16	9.6	11.2	10.4
7087	1	LOVESICK LAKE	80’ hole at N. end	5-Jun-16	11.0	11.8	11.4
7087	1	LOVESICK LAKE	80’ hole at N. end	3-Jul-16	23.2	28.8	26.0
7087	1	LOVESICK LAKE	80’ hole at N. end	2-Aug-16	21.2	20.4	20.8
7087	1	LOVESICK LAKE	80’ hole at N. end	5-Sep-16	19.2	18.6	18.9
7087	1	LOVESICK LAKE	80’ hole at N. end	2-Oct-16	22.6	20.6	21.6
7087	3	LOVESICK LAKE	McCallum Island	13-May-16	9.8	10.2	10.0
7087	3	LOVESICK LAKE	McCallum Island	5-Jun-16	21.8	20.0	20.9
7087	3	LOVESICK LAKE	McCallum Island	3-Jul-16	20.8	16.0	18.4
7087	3	LOVESICK LAKE	McCallum Island	2-Aug-16	30.2	31.2	30.7
7087	3	LOVESICK LAKE	McCallum Island	5-Sep-16	17.2	18.8	18.0
7087	3	LOVESICK LAKE	McCallum Island	2-Oct-16	20.0	20.0	20.0
6990	1	LOWER BUCKHORN LAKE	Heron Island	17-May-16	12.4	12.0	12.2
6990	1	LOWER BUCKHORN LAKE	Heron Island	17-Jun-16	17.4	21.6	19.5
6990	1	LOWER BUCKHORN LAKE	Heron Island	1-Aug-16	21.6	22.6	22.1
6990	1	LOWER BUCKHORN LAKE	Heron Island	6-Sep-16	23.0	23.6	23.3
6990	1	LOWER BUCKHORN LAKE	Heron Island	12-Oct-16	**62.8**	12.4	12.4
6990	1	LOWER BUCKHORN LAKE	Heron Island	12-Oct-16	14.4	14.4	14.4
6990	4	LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	20-May-16	13.0	12.2	12.6
6990	4	LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	16-Jun-16	13.6	13.0	13.3
6990	4	LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	11-Jul-16	20.4	20.6	20.5
6990	4	LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	8-Aug-16	20.2	20.4	20.3
6990	4	LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	1-Sep-16	26.8	19.4	19.4
6990	4	LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	21-Sep-16	17.4	17.8	17.6
6990	6	LOWER BUCKHORN LAKE	Deer Bay-centre	17-May-16	8.2	9.2	8.7
6990	6	LOWER BUCKHORN LAKE	Deer Bay-centre	17-Jun-16	15.0	14.0	14.5
6990	6	LOWER BUCKHORN LAKE	Deer Bay-centre	2-Aug-16	17.2	18.0	17.6
6990	6	LOWER BUCKHORN LAKE	Deer Bay-centre	6-Sep-16	19.0	21.4	20.2
6990	7	LOWER BUCKHORN LAKE	Lower Deer Bay, Mid-deep	6-May-16	**9.8**	15.6	9.8
6990	7	LOWER BUCKHORN LAKE	Lower Deer Bay, Mid-deep	4-Jun-16	22.2	27.2	24.7
6990	7	LOWER BUCKHORN LAKE	Lower Deer Bay, Mid-deep	3-Jul-16	40.2	35.6	37.9

STN	Site ID	Lake Name	Site Description	Date	TP1 (µg/L)	TP2 (µg/L)	Avg.TP (µg/L)
6990	7	LOWER BUCKHORN LAKE	Lower Deer Bay, Mid-deep	1-Aug-16	20.8	22.2	21.5
6990	7	LOWER BUCKHORN LAKE	Lower Deer Bay, Mid-deep	30-Aug-16	**25.4**	17.0	17.0
6990	7	LOWER BUCKHORN LAKE	Lower Deer Bay, Mid-deep	30-Sep-16	17.4	15.6	16.5
6990	8	LOWER BUCKHORN LAKE	Main basin, deep- spot	6-May-16	10.0	10.4	10.2
6990	8	LOWER BUCKHORN LAKE	Main basin, deep- spot	4-Jun-16	**29.6**	21.6	21.6
6990	8	LOWER BUCKHORN LAKE	Main basin, deep- spot	3-Jul-16	**66.0**	44.0	44.0
6990	8	LOWER BUCKHORN LAKE	Main basin, deep- spot	1-Aug-16	20.8	20.6	20.7
6990	8	LOWER BUCKHORN LAKE	Main basin, deep- spot	30-Aug-16	22.6	18.4	20.5
6990	8	LOWER BUCKHORN LAKE	Main basin, deep- spot	30-Sep-16	**26.8**	17.6	17.6
6919	3	PIGEON LAKE	Middle-SandyPtBoyd I	19-May-16	9.8	11.8	10.8
6919	3	PIGEON LAKE	Middle-SandyPtBoyd I	19-Jun-16	14.0	16.2	15.1
6919	3	PIGEON LAKE	Middle-SandyPtBoyd I	15-Jul-16	20.6	22.4	21.5
6919	3	PIGEON LAKE	Middle-SandyPtBoyd I	15-Aug-16	20.4	25.2	22.8
6919	3	PIGEON LAKE	Middle-SandyPtBoyd I	5-Sep-16	14.8	14.8	14.8
6919	3	PIGEON LAKE	Middle-SandyPtBoyd I	6-Oct-16	14.8	15.4	15.1
6919	12	PIGEON LAKE	N-400m N of Boyd Is.	17-May-16	7.6	7.2	7.4
6919	12	PIGEON LAKE	N-400m N of Boyd Is.	1-Jun-16	15.6	12.8	14.2
6919	12	PIGEON LAKE	N-400m N of Boyd Is.	5-Jul-16	16.0	18.6	17.3
6919	12	PIGEON LAKE	N-400m N of Boyd Is.	2-Aug-16	23.2	28.6	25.9
6919	12	PIGEON LAKE	N-400m N of Boyd Is.	7-Sep-16	18.2	17.2	17.7
6919	13	PIGEON LAKE	N end-Adjacent Con17	19-May-16	8.6	8.2	8.4
6919	13	PIGEON LAKE	N end-Adjacent Con17	19-Jun-16	16.0	17.0	16.5
6919	13	PIGEON LAKE	N end-Adjacent Con17	15-Jul-16	21.6	**32.4**	21.6
6919	13	PIGEON LAKE	N end-Adjacent Con17	15-Aug-16	23.4	23.8	23.6
6919	13	PIGEON LAKE	N end-Adjacent Con17	5-Sep-16	15.8	15.4	15.6
6919	13	PIGEON LAKE	N end-Adjacent Con17	6-Oct-16	15.4	15.6	15.5
6919	15	PIGEON LAKE	C340-DeadHorseSho	3-Jul-16	16.2	16.0	16.1
6919	15	PIGEON LAKE	C340-DeadHorseSho	21-Jul-16	**17.8**	17.2	17.5
6919	15	PIGEON LAKE	C340-DeadHorseSho	5-Sep-16	20.2	17.0	18.6
6919	15	PIGEON LAKE	C340-DeadHorseSho	9-Oct-16	13.2	12.6	12.9
6919	16	PIGEON LAKE	N300yds off Bottom I	17-May-16	7.2	6.6	6.9
6919	16	PIGEON LAKE	N300yds off Bottom I	1-Jun-16	9.0	11.4	10.2
6919	16	PIGEON LAKE	N300yds off Bottom I	5-Jul-16	18.0	18.8	18.4
6919	16	PIGEON LAKE	N300yds off Bottom I	2-Aug-16	18.2	18.8	18.5
6919	16	PIGEON LAKE	N300yds off Bottom I	7-Sep-16	17.2	16.0	16.6
6919	16	PIGEON LAKE	N300yds off Bottom I	4-Oct-16	23.6	24.4	24.0
6919	16	PIGEON LAKE	N300yds off Bottom I	4-Oct-16	45.8	46.8	46.3
7241	2	SANDY LAKE	Mid Lake, deep spot	23-May-16	4.4	4.6	4.5
7241	2	SANDY LAKE	Mid Lake, deep spot	19-Jun-16	5.4	5.2	5.3

STN	Site ID	Lake Name	Site Description	Date	TP1 (µg/L)	TP2 (µg/L)	Avg.TP (µg/L)
7241	2	SANDY LAKE	Mid Lake, deep spot	13-Jul-16	6.2	4.8	5.5
7241	2	SANDY LAKE	Mid Lake, deep spot	29-Aug-16	8.0	6.4	7.2
7241	2	SANDY LAKE	Mid Lake, deep spot	18-Sep-16	**17.8**	6.2	6.2
7241	2	SANDY LAKE	Mid Lake, deep spot	9-Oct-16	5.8	7.0	6.4
7133	4	STONY LAKE	Burleigh locks chan.	3-Jun-16	15.0	15.0	15.0
7133	4	STONY LAKE	Burleigh locks chan.	7-Jul-16	21.2	22.8	22.0
7133	4	STONY LAKE	Burleigh locks chan.	2-Aug-16	21.8	**30.8**	21.8
7133	6	STONY LAKE	Gilchrist Bay	29-May-16	11.8	12.2	12.0
7133	6	STONY LAKE	Gilchrist Bay	1-Aug-16	15.4	20.2	17.8
7133	6	STONY LAKE	Gilchrist Bay	4-Sep-16	22.2	19.4	20.8
7133	7	STONY LAKE	Mouse Is.	17-May-16	7.8	8.6	8.2
7133	7	STONY LAKE	Mouse Is.	29-May-16	7.8	8.4	8.1
7133	7	STONY LAKE	Mouse Is.	4-Jul-16	11.4	11.2	11.3
7133	7	STONY LAKE	Mouse Is.	2-Aug-16	13.8	13.8	13.8
7133	7	STONY LAKE	Mouse Is.	5-Sep-16	13.4	15.0	14.2
7133	7	STONY LAKE	Mouse Is.	2-Oct-16	14.2	14.0	14.1
7133	8	STONY LAKE	Hamilton Bay	17-May-16	7.4	7.4	7.4
7133	8	STONY LAKE	Hamilton Bay	29-May-16	10.4	11.0	10.7
7133	8	STONY LAKE	Hamilton Bay	4-Jul-16	11.8	11.6	11.7
7133	8	STONY LAKE	Hamilton Bay	2-Aug-16	14.4	14.0	14.2
7133	8	STONY LAKE	Hamilton Bay	5-Sep-16	15.4	14.0	14.7
6924	4	STURGEON LAKE	Muskrat I-Buoy C388	28-Jun-16	14.8	16.4	15.6
6924	4	STURGEON LAKE	Muskrat I-Buoy C388	2-Aug-16	18.0	16.2	17.1
6924	4	STURGEON LAKE	Muskrat I-Buoy C388	6-Sep-16	19.8	21.2	20.5
6924	4	STURGEON LAKE	Muskrat I-Buoy C388	2-Oct-16	19.6	18.6	19.1
6924	5	STURGEON LAKE	Sturgeon Point Buoy	26-May-16	8.8	9.4	9.1
6924	5	STURGEON LAKE	Sturgeon Point Buoy	27-Jun-16	12.6	13.0	12.8
6924	5	STURGEON LAKE	Sturgeon Point Buoy	21-Jul-16	14.8	15.6	15.2
6924	5	STURGEON LAKE	Sturgeon Point Buoy	17-Aug-16	23.8	20.8	22.3
6924	5	STURGEON LAKE	Sturgeon Point Buoy	27-Sep-16	16.0	16.4	16.2
6924	5	STURGEON LAKE	Sturgeon Point Buoy	7-Oct-16	14.6	14.0	14.3
6924	9	STURGEON LAKE	Fenelon R. mouth	26-May-16	9.8	11.8	10.8
6924	9	STURGEON LAKE	Fenelon R. mouth	27-Jun-16	13.6	16.0	14.8
6924	9	STURGEON LAKE	Fenelon R. mouth	21-Jul-16	10.0	9.6	9.8
6924	9	STURGEON LAKE	Fenelon R. mouth	17-Aug-16	11.0	11.2	11.1
6924	9	STURGEON LAKE	Fenelon R. mouth	27-Sep-16	9.8	9.6	9.7
6924	9	STURGEON LAKE	Fenelon R. mouth	7-Oct-16	8.4	8.0	8.2
6924	10	STURGEON LAKE	Lunge Haven	24-May-16	33.8	40.4	37.1
6924	10	STURGEON LAKE	Lunge Haven	20-Jun-16	33.2	30.0	31.6

Appendix F:
2016 Phosphorus and Secchi Data

STN	Site ID	Lake Name	Site Description	Date	TP1 (µg/L)	TP2 (µg/L)	Avg.TP (µg/L)
6924	10	STURGEON LAKE	Lunge Haven	20-Jul-16	27.2	25.2	26.2
6924	10	STURGEON LAKE	Lunge Haven	8-Aug-16	28.4	28.8	28.6
6924	10	STURGEON LAKE	Lunge Haven	6-Sep-16	33.8	35.6	34.7
6924	10	STURGEON LAKE	Lunge Haven	5-Oct-16	20.6	21.2	20.9
5178	1	UPPER STONEY LAKE	Quarry Bay	6-May-16	6.6	6.0	6.3
5178	1	UPPER STONEY LAKE	Quarry Bay	1-Jun-16	5.4	5.6	5.5
5178	1	UPPER STONEY LAKE	Quarry Bay	26-Jul-16	**15.8**	7.2	7.2
5178	1	UPPER STONEY LAKE	Quarry Bay	4-Aug-16	8.6	9.4	9.0
5178	1	UPPER STONEY LAKE	Quarry Bay	5-Sep-16	8.2	8.4	8.3
5178	1	UPPER STONEY LAKE	Quarry Bay	1-Oct-16	7.6	8.4	8.0
5178	3	UPPER STONEY LAKE	Young Bay	6-May-16	10.4	6.2	8.3
5178	3	UPPER STONEY LAKE	Young Bay	1-Jun-16	5.4	5.4	5.4
5178	3	UPPER STONEY LAKE	Young Bay	26-Jul-16	6.8	6.6	6.7
5178	3	UPPER STONEY LAKE	Young Bay	4-Aug-16	8.6	9.2	8.9
5178	3	UPPER STONEY LAKE	Young Bay	5-Sep-16	7.8	8.2	8.0
5178	3	UPPER STONEY LAKE	Young Bay	1-Oct-16	8.6	7.6	8.1
5178	4	UPPER STONEY LAKE	S Bay, deep spot	6-May-16	6.4	6.2	6.3
5178	4	UPPER STONEY LAKE	S Bay, deep spot	1-Jun-16	8.0	8.0	8.0
5178	4	UPPER STONEY LAKE	S Bay, deep spot	26-Jul-16	9.8	9.8	9.8
5178	4	UPPER STONEY LAKE	S Bay, deep spot	4-Aug-16	12.4	12.6	12.5
5178	4	UPPER STONEY LAKE	S Bay, deep spot	5-Sep-16	10.0	9.6	9.8
5178	4	UPPER STONEY LAKE	S Bay, deep spot	1-Oct-16	7.2	7.2	7.2
5178	5	UPPER STONEY LAKE	Crowes Landing	6-May-16	5.6	6.2	5.9
5178	5	UPPER STONEY LAKE	Crowes Landing	1-Jun-16	5.2	5.2	5.2
5178	5	UPPER STONEY LAKE	Crowes Landing	26-Jul-16	7.2	8.0	7.6
5178	5	UPPER STONEY LAKE	Crowes Landing	4-Aug-16	8.6	8.8	8.7
5178	5	UPPER STONEY LAKE	Crowes Landing	5-Sep-16	8.8	8.2	8.5
5178	5	UPPER STONEY LAKE	Crowes Landing	1-Oct-16	8.4	7.6	8.0
5178	6	UPPER STONEY LAKE	Mid Lake, deep spot	6-May-16	6.4	6.6	6.5
5178	6	UPPER STONEY LAKE	Mid Lake, deep spot	1-Jun-16	5.2	5.4	5.3
5178	6	UPPER STONEY LAKE	Mid Lake, deep spot	26-Jul-16	7.0	7.2	7.1
5178	6	UPPER STONEY LAKE	Mid Lake, deep spot	4-Aug-16	9.6	8.6	9.1
5178	6	UPPER STONEY LAKE	Mid Lake, deep spot	5-Sep-16	8.0	8.8	8.4
5178	6	UPPER STONEY LAKE	Mid Lake, deep spot	1-Oct-16	8.0		8.0
6963	1	WHITE LAKE (DUMMER)	S end, deep spot	24-May-16	9.2	10.4	9.8
6963	1	WHITE LAKE (DUMMER)	S end, deep spot	22-Jun-16	10.4	11.0	10.7
6963	1	WHITE LAKE (DUMMER)	S end, deep spot	17-Jul-16	12.0	11.4	11.7
6963	1	WHITE LAKE (DUMMER)	S end, deep spot	24-Aug-16	12.2	12.8	12.5
6963	1	WHITE LAKE (DUMMER)	S end, deep spot	20-Sep-16	10.2	10.2	10.2
6963	1	WHITE LAKE (DUMMER)	S end, deep spot	30-Oct-16	8.4	8.8	8.6

2016 Secchi Depth Measurements

Named after its inventor, Angelo Secchi, a Secchi disk is a device for measuring water clarity. It is a weighted disc 20cm in diameter with alternate black and white quadrants. When lowered into a lake, the depth at which the disc can no longer be seen is called the Secchi depth. The deeper the Secchi depth, the clearer the water. Basic water clarity can be affected by the amount of sediments or Dissolved Organic Matter (DOM) that the water contains. Seasonal variation of water clarity is usually related to the amount of algae it contains resulting in spring and fall Secchi Depths being greater than mid-summer values.

The Lake Partner Program (LPP) asks volunteers to measure the Secchi Depth every two weeks between early May to early October but for practical reasons many sites can only be measured in conjunction with phosphorus sample collection, about six times a year. Until 2015, LPP published all the Secchi readings for each site but in 2016 they have published only the annual average Secchi Depth and the number of measurements averaged. At the time of publication, we have not received an explanation of the change from the LPP.

STN	Site ID	Lake Name	Site Description	Secchi Avg (m)	# of Secchi mmts
6902	2	BALSAM LAKE	N Bay Rocky Pt.	5.4	10
6902	5	BALSAM LAKE	NE end-Lightning Pt	3.9	6
6902	7	BALSAM LAKE	South B-Killarney B	4.3	5
6902	8	BALSAM LAKE	W Bay2, deep spot	4.7	38
6902	9	BALSAM LAKE	E of Grand Is	3.5	1
6941	1	BIG BALD LAKE	Mid Lake, deep spot	4.6	6
7131	1	BUCKHORN LAKE (U)	Narrows-redbuoy C310	3.1	6
6951	10	CHEMONG LAKE	Deep Spot, N. of Bridge North	2.8	12
6955	2	CLEAR LAKE	Main Basin-deep spot	4.8	8
6955	3	CLEAR LAKE	Fiddlers Bay	3.6	8
6955	4	CLEAR LAKE	Brysons Bay	3.6	3
6955	5	CLEAR LAKE	Southwest Basin, Deep Spot	4.0	8
7076	1	KATCHEWANOOKA LAKE	S/E Douglas Island	4.9	8
7076	2	KATCHEWANOOKA LAKE	Young Pt near locks	5.7	11
7087	1	LOVESICK LAKE	80' hole at N. end	5.0	6
7087	3	LOVESICK LAKE	McCallum Island	4.9	6
6990	1	LOWER BUCKHORN LAKE	Heron Island	4.1	5
6990	4	LOWER BUCKHORN LAKE	Deer Bay W-Buoy C267	3.9	8
6990	6	LOWER BUCKHORN LAKE	Deer Bay-centre	3.4	5
6990	7	LOWER BUCKHORN LAKE	Lower Deer Bay, Mid-deep	1.9	9
6990	8	LOWER BUCKHORN LAKE	Main basin, deep- spot	2.8	9
6919	3	PIGEON LAKE	Middle-SandyPtBoyd I	3.0	6
6919	12	PIGEON LAKE	N-400m N of Boyd Is.	3.3	5
6919	13	PIGEON LAKE	N end-Adjacent Con17	3.0	6
6919	15	PIGEON LAKE	C340-DeadHorseSho	3.0	4

Appendix F:
2016 Phosphorus and Secchi Data

STN	Site ID	Lake Name	Site Description	Secchi Avg (m)	# of Secchi mmts
6919	16	PIGEON LAKE	N300 yds off Bottom I	3.5	6
7133	4	STONY LAKE	Burleigh locks chan.	3.1	4
7133	6	STONY LAKE	Gilchrist Bay	3.3	3
7133	7	STONY LAKE	Mouse Is.	4.8	6
7133	8	STONY LAKE	Hamilton Bay	4.1	6
6924	4	STURGEON LAKE	Muskrat I-Buoy C388	2.5	4
6924	5	STURGEON LAKE	Sturgeon Point Buoy	3.3	7
6924	9	STURGEON LAKE	Fenelon R. mouth	3.2	7
5178	1	UPPER STONEY LAKE	Quarry Bay	6.7	6
5178	3	UPPER STONEY LAKE	Young Bay	6.8	6
5178	5	UPPER STONEY LAKE	Crowes Landing	6.8	6
5178	6	UPPER STONEY LAKE	Mid Lake, deep spot	6.6	6

Herons feed their young high atop a white pine on Lower Buckhorn Lake.
Photo by Robin Blake

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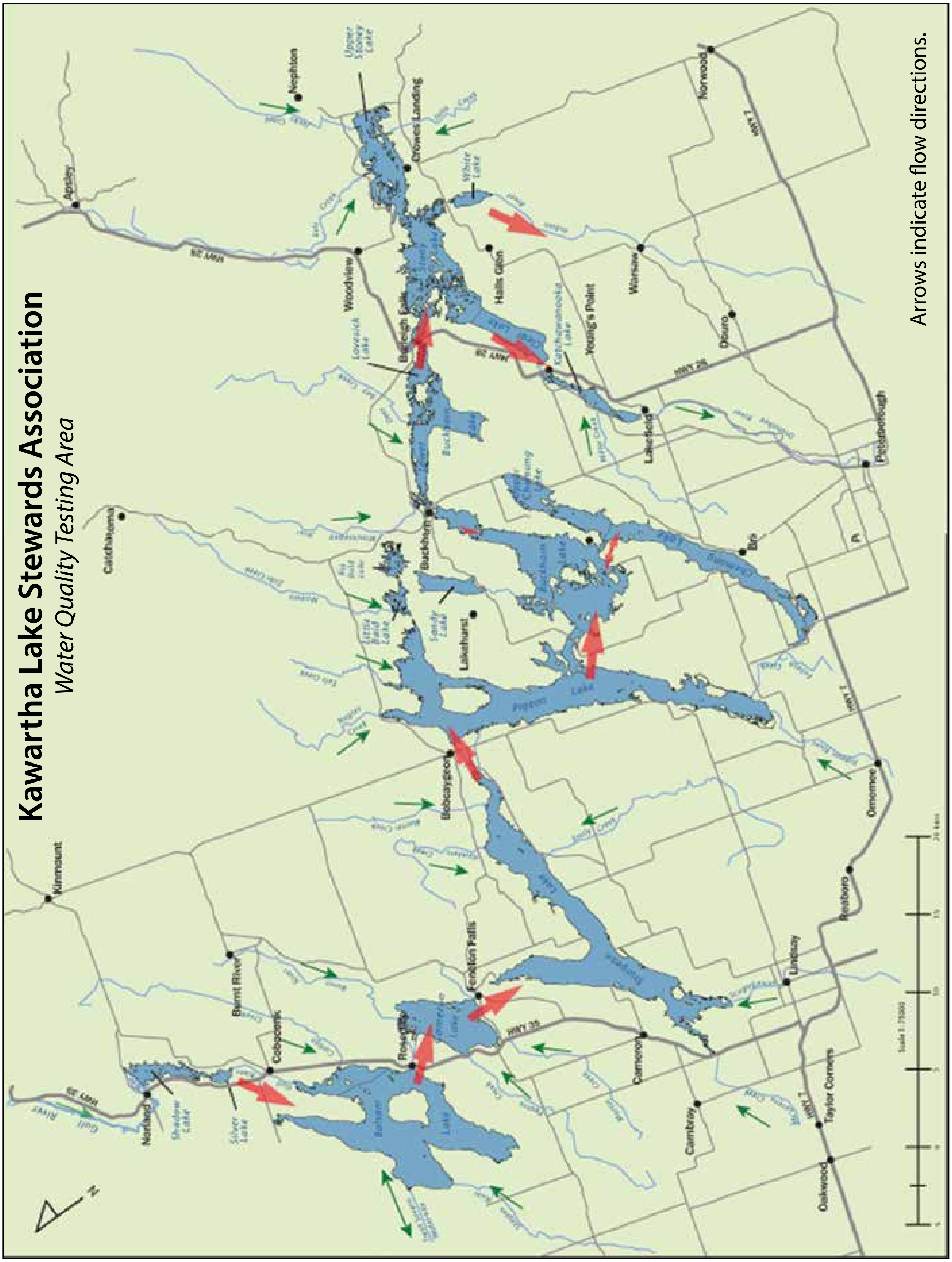
Kawartha Lake Stewards Association
Water Quality Testing Area
Arrows indicate flow directions.
Apsley
Nephton
Upper Stoney Lake
Crowes Landing
Woodview
White Lake
Halls Glen
Burleigh Falls
Lovesick Lake
Katchewanooka Lake
Young's Point
Warsaw
Norwood
Lakefield
Douro
Peterborough
Buckhorn
Catchacoma
Lakehurst
Sandy Lake
Little Bald Lake
Bald Lake
Pigeon Lake
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