**Update on the KLSA and Partners, sediment core - Paleolimnology Study**

***Kawartha Lakes Paleolimnological Study: Collection, Analysis and Age-dating of Sediment Cores “Understanding the past to plan for the future*".**

1. Background

Cultural eutrophication is one of the most pervasive environmental issues impacting freshwater ecosystems. Cultural eutrophication results in increases in algal biomass, including potentially toxic cyanobacteria. The Kawartha Lake Stewards Association (KLSA) is concerned about changes in algal production that could lead to enhanced algal production resulting in undesirable algal blooms, and potentially a state change to turbid waters. The leading cause of increases in phytoplankton biomass in lakes is lake-water phosphorus concentrations, although other factors can also be important. In the Kawartha region, lake-water phosphorus concentrations generally increase from west to east, as water flows from Balsam Lake to Lovesick, except when nutrient-poor water enters from Upper Stony Lake. The loadings of total phosphorus to lake systems in the Kawartha region have increased due to human activities on the landscape[[1]](#footnote-1) (White, 2006). However, lake production can also be enhanced due to changes in climate conditions that are favourable to algal growth including higher precipitation, warmer conditions and longer growing seasons. Changes in lake production can also be influenced by invasions of exotic species, and changes in the populations of piscivores and planktivores. In 2016 KLSA and its funding and research partners began a paleolimnology study in three of the lakes within the Kawartha Lake system. Paleolimnology is the use of age-dated sediment cores to reconstruct water quality histories and evaluate water quality trends. The purpose of the study is to determine historical nutrient accumulation rates in certain Kawartha Lake continuums and will answer the following questions: What is the range of variability in primary production and metals over the last 150 to 200 years (what is the trend)? and, Is primary production increasing (and by how much) with corresponding human activities? The study will provide lake managers with information to set realistic mitigation targets for aquatic systems (if required).

The partners in the study include the Queen’s University, Paleoecological Environmental Assessment and Research Laboratory (PEARL), Stony Lake Heritage Foundation; Kawartha Conservation; Municipality of Kawartha Lakes and Kawartha Lakes Stewards Association[[2]](#footnote-2).

1. Sample selection and Collection (April, May 2016)

Three sites[[3]](#footnote-3) were identified for sample collection:

* Upstream: West side of Cameron Lake;
* Mid-stream: Pigeon Lake, north east of Boyd Island; and
* Downstream: Stony Lake, north of Hamilton Bay.

The sampling sites were selected by the PEARL team and KLSA members, based on bathymetric maps and discussions with those familiar with the area.

The KLSA cores were collected early in the field season. The three sediment cores[[4]](#footnote-4) were collected during the week of May 12th 2016 by the PEARL Team.

1. Core sample collection (May 2016)

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. . The cores measured approximately 50 cm in length, and contain organic-rich sediments. The integrity of sediment deposition patterns was confirmed before sampling by the use of a sub-bottom 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. For each lake, a preferred site and alternate site were identified. In Pigeon Lake the preferred site west of Boyd Island was rejected because the sub-bottom profiling, showed limited 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.

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 later interpretation

of the core. Once the cores were taken, they were sectioned into bags at 0.5 cm intervals. The sediments were transported to the laboratory and stored in the cold room, which is kept at about 4°C. Dr. Cumming stated the collected cores were excellent samples with no cross contamination occurring. He especially liked the Stony Lake sample. During the summer the cores were stored at the PEARL facility.

1. Dating the core samples (October 2016)

The dating of the cores has been established by the analysis of approximately 20 intervals from each of the sediment cores by gamma spectroscopy at the PEARL. The sediment cores were dated using radio isotopes (210Pb, 137Cs). By age-dating the core, scientists can determine when the sediments were deposited and how much was deposited within a certain time period. The cores have been dated. The sediment deposition that will be analyzed of for the past 150 years. However the sediment core collected is for a longer period of time ranging from 250 to 500 years. However the core will be preserved to continue the analysis.

Table 1: Very Preliminary Age Dating Results of Sediment Core

|  |  |  |  |
| --- | --- | --- | --- |
|  | Core depth (cm) | 150 yr depth (cm) | Time period (yr) for complete core length |
| Cameron Core | 57 | 18 (200yr) | ~500 |
| Pigeon Core | 52 | 28 | ~300 |
| Stony | 50 | 35 | ~250 - 300 |

1. Sediment deposition rates and metal analyses (Q3, Q4 2017)

*Nutrient loadings*: Lake ecosystem changes over time are assessed by looking at changes in sedimentation rates, i.e., the amount of deposition over a period of time[[5]](#footnote-5). Diatom assemblages (algae) measure the lakes productivity and can be used as a surrogate to determine if total phosphorous concentrations have changed over time. Pigment analysis tell us what groups of algae have occupied the lake over time.

*Metal Loadings*: The core segments will be analyzed for metals including stable lead – this will help validate the age-dating analysis.

*Caleocerons*: PEARL will also be identifying the abundance of *cladocera* (water fleas etc.). This information will determine if zooplankton population and numbers have changed[[6]](#footnote-6). The analyses on subfossil zooplankton will occur in early 2018 of this project.   Analyses of *cladocerans* is important since changes in lake production it will assist in determining the viability of certain fish species (i.e. largemouth and smallmouth Bass) based on current fishery activity[[7]](#footnote-7).

1. Interim Q4 2017 Report and Final Report (Q4, 2018)

An interim report describing the results of the key analyses and data compilation will be completed by September 2017 in preparation for the KLSA October meeting. The final report including all the data and interpretations will be ready in 2018.

1. Administrative Changes and Budget

PEARL understands the funding challenge we face and offered to participate in the study at a reduced rate. The payment of the Master’s student will be shared by the university and KLSA.

The following table (“Table 2”) shows the estimated budget for the Project.

Table 2: Project Activity and Associated Costs

|  |  |
| --- | --- |
| **Cost Item** | **Project Cost:**  **2017 Estimate** |
| **Phase 1** |  |
| PEARL Laboratory (Queen’s University): sample site selection, sample collection and preservation, radioactive gamma logging (for age-dating), diatom analysis, LOI, *Chlorophyll* analysis, metal scan and *cladocera* identification. | $30,000 |
| Support for a Graduate Student | $10,000 |
| Sub-total | $40,000 |
| **Phase 2a** |  |
| Public education | $5,000 |
| Total | $45,000 |

Note:

a The public education activity and cost will be funded as a separate phase of the Study.

KLSA is still short of $9,500 to complete the study. We are still seeking additional funding to fulfill our commitment to PEARL.

Figure 1, shows the Project Schedule.

1. Summary
2. Core samples have been collected and analysis has begun.
3. A Masters student has been identified and is working on the Project.
4. PEARL is plays a prominent role in the Project
5. An interim report will be ready for the Fall, 2017 and a final report will be completed next year.
6. KLSA is continuing its funding effort to address the expected shortfall.

Figure 1: Project Schedule



1. See White, 3006 on the KLSA website: https://klsa.wordpress.com/ [↑](#footnote-ref-1)
2. KLSA is appreciative to its donors, including other municipalities, lake associations, businesses and the public who also contribute to the funding requirements of this Project. [↑](#footnote-ref-2)
3. Cameron Lake is considered an upstream lake with values of total phosphorus (TP) typically < 10 µg/L, whereas Pigeon Lake and Stony Lake have seasonal TP values typically between 10 and 20 µg/L. Stony Lake is recipient of an inflow from Lovesick Lake of about 20 µg/L which is reduced to 10 to 15 µg/L because of inflows from other sources. These lakes were selected so that a gradient in production was covered by the study lakes within the chain of lakes of interest to KLSA. [↑](#footnote-ref-3)
4. 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. [↑](#footnote-ref-4)
5. A MOE 2993 concluded sediment deposition rates have increased since the 1930s when compared to earlier time periods see: <https://klsa.wordpress.com/> for a copy of the Report. This study will confirm this hypothesis. [↑](#footnote-ref-5)
6. 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. [↑](#footnote-ref-6)
7. In the Kawartha Tri Lakes fishing pressure on Largemouth Bass is high, with anglers catching between 161-218% of this population annually.  Changes in the composition of piscivores can have a cascading influence planktivores which can influence zooplankton composition and algae.   Cladocerans are also influenced by bottom-up changes in their food source.   Analyses of the subfossil zooplankton will provide insights on the timing of any possible changes in cladoceran zooplankton abundance and community structure over the past 150 years [↑](#footnote-ref-7)