Community and scientific monitoring of Great Slave Lake water quality

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Abstract

Great Slave Lake (GSL) is in a region experiencing a general warming trend. Mercury concentrations are increasing in lake trout and burbot, potentially due to increasing aquatic productivity, mercury methylation rates and/or watershed inputs. Slave River (SR) inputs are particularly important with concerns that increased development in Alberta may result in increased nutrient, metal and other loadings to the lake. Currently there are no programs investigating aquatic productivity and water quality in GSL although water quality programs exist for the SR. This study addresses these concerns by beginning a water quality study of Resolution Bay using the domestic water intake at Fort Resolution (FR). The primary objectives are to provide for 1) an enhanced understanding of the seasonal and annual cycles in lake productivity and water quality, 2) a community-run water quality monitoring program to provide training in sampling, data handling and analyses and 3) the necessary data base for the community and researchers to assess and investigate changes in water quality and productivity in the Resolution Bay area, particularly under SR and climate influences.

Rationale

- The influences of warming trends and increasing development in the SR watershed on the GSL ecosystem are poorly understood.
- Logistical costs with water quality sampling are expensive; GSL and the SR is accessible for sampling during limited times of the year.
- Sampling at water intakes has been used extensively in the Laurentian Great Lakes to provide year-round water quality data at a relatively low cost (Fig. 1).

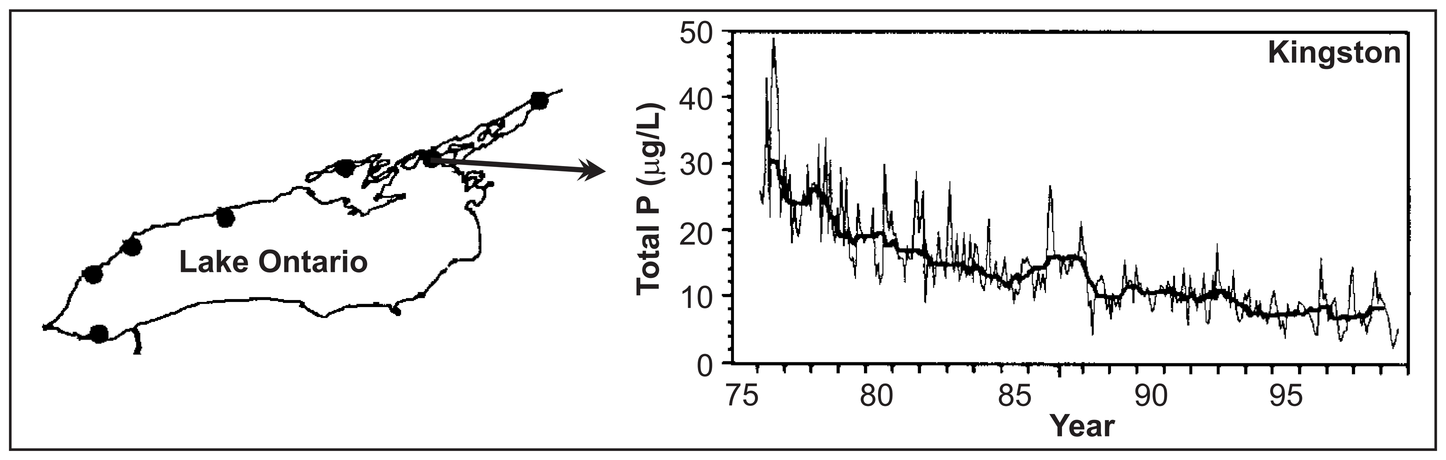

Figure 1. Long-term trends in total phosphorus concentrations measured at the water intake at Kingston on Lake Ontario (from Nicholls et al. 2001).

- The FR water treatment plant measures turbidity, temperature, colour, manganese, etc. of intake water on a regular basis (Fig. 2d).
- Analysis can be extended through additional community-collected water samples.
- Community sampling develops expertise in sample collection, data entry, graphing, interpretation, and other skill sets.
- Enhanced monitoring will allow for assessment of annual productivity and, on the long-term, productivity trends which will complement NCP and other studies assessing contaminant trends in GSL fish and SR upstream influences.

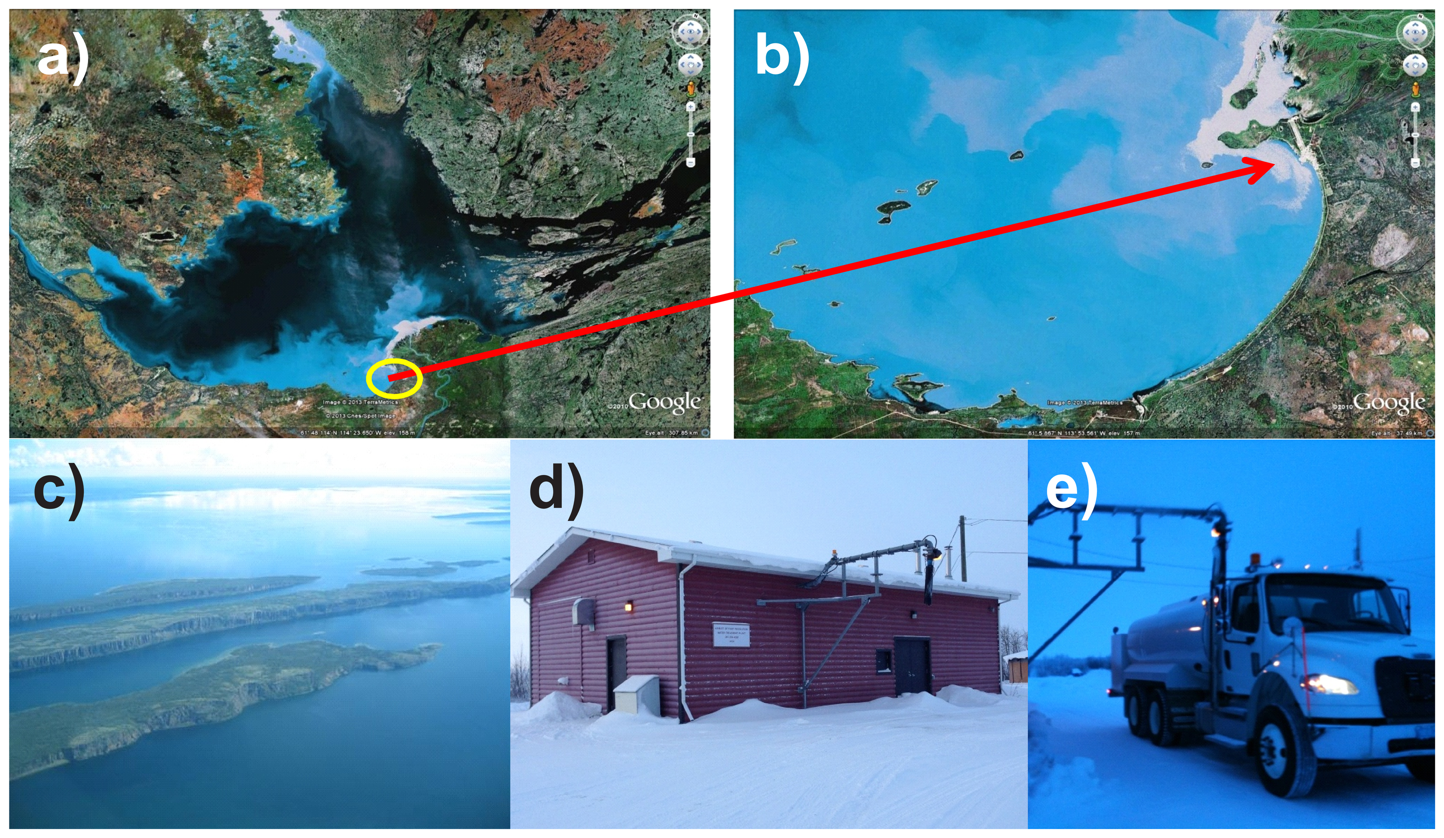

Figure 2. Upper panels: a) GSL and b) Resolution Bay where the intake is located. Light blue areas show SR influence and sediment resuspension. Lower panels: c) eastern GSL, d) FR water treatment plant and e) water truck.

First Steps

- Elizabeth Giroux transcribed 2008-2013 intake water quality data into Excel .
- Graphs were prepared to explore seasonal patterns in the physical and chemical features of the water.
- In Aug 2012, following training, Elizabeth began weekly and monthly sampling with expanded chemical parameter list; sampling continues.
- Elizabeth along with Linda Carpenter (plant operator) visited Saskatoon for more training in data entry, graphing and interpretation; toured Saskatoon water treatment plant and SIAST (Fig. 3).
- In Jan 2013, Elizabeth attended the CIMP workshop, where the study was presented.

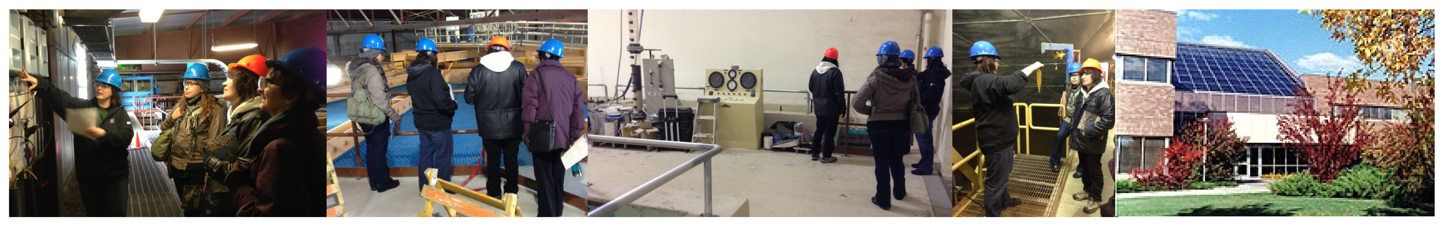

Figure 3. Saskatoon visit: water treatment plant and National Hydrology Research Centre,Environment Canada.

Results and Discussion

Historic water intake data

- Heating and cooling cycles were evident with subtle differences observed between years (Fig. 4).
- Turbidity was low during ice cover and periodically high during the ice-free period due to SR inflow, wind activity and possibly upwellings.
- Generally there was a good relationship between turbidity and iron in the untreated intake water (Fig. 5).

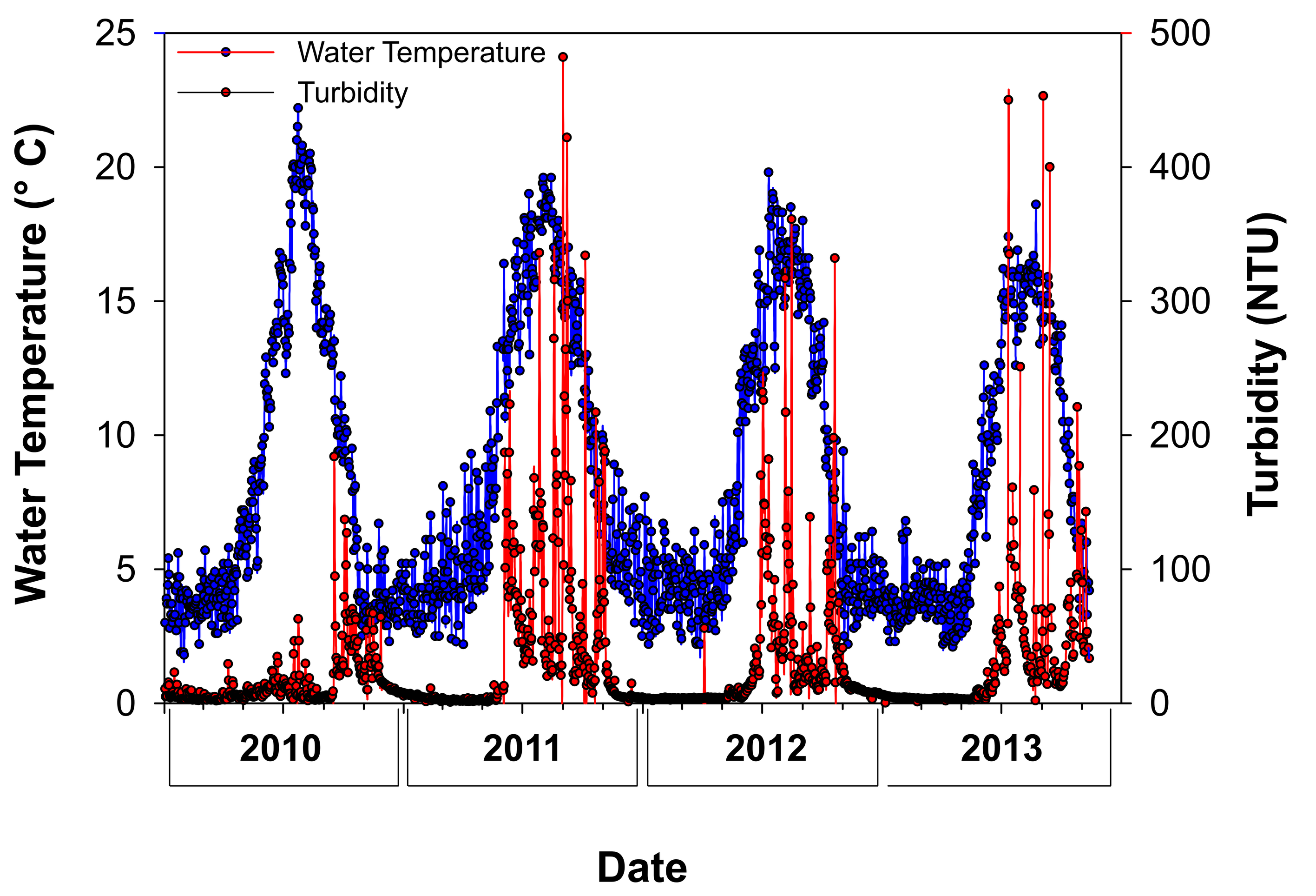

Figure 4. Water temperature and turbidity records for the intake water, 2010-2013.

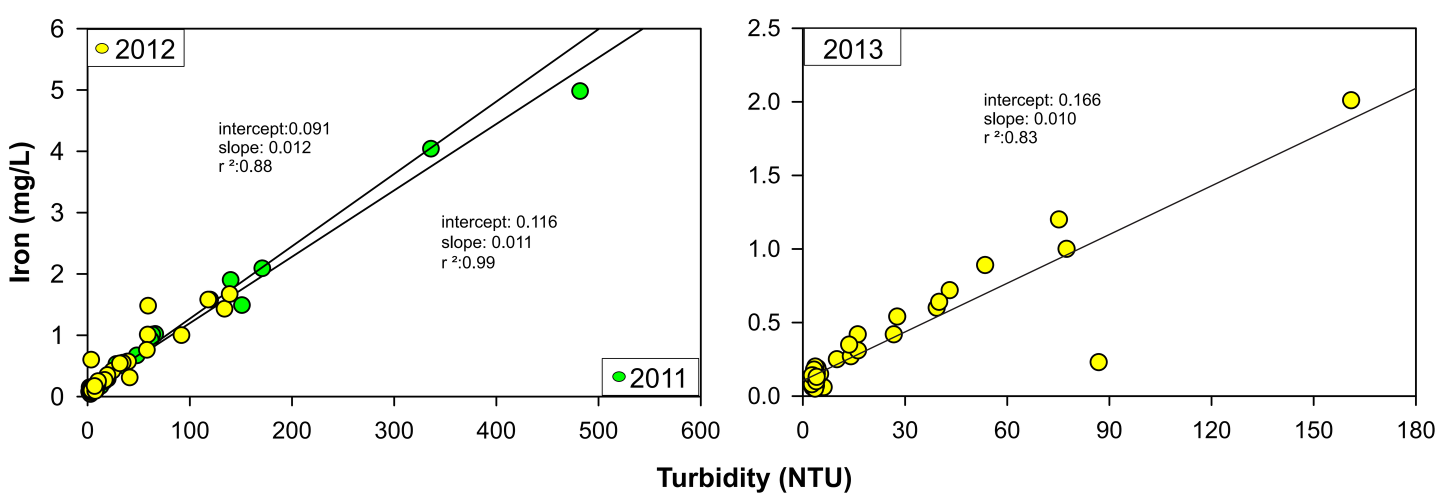

Figure 5. Relationship between iron and turbidity in intake water, 2011, 2012 and 2013. Also shown are the linear regressions which could be used to predict iron concentrations based on turbidity alone.

New measurements

- New sampling (Fig. 6) at the intake began in August 2012 with samples collected at approximately weekly (total phosphorus, chlorophyll) and monthly (plant nutrients, dissolved organic carbon, metals, major ions, chlorophyll, and algal assemblages) intervals.

Figure 6. Elizabeth collecting, measuring, and filtering water for chlorophyll analyses in the water treatment plant laboratory.

Metals

- Data examined for relationship to turbidity and water quality guidelines. Arsenic was below water quality guidelines (Fig. 7).

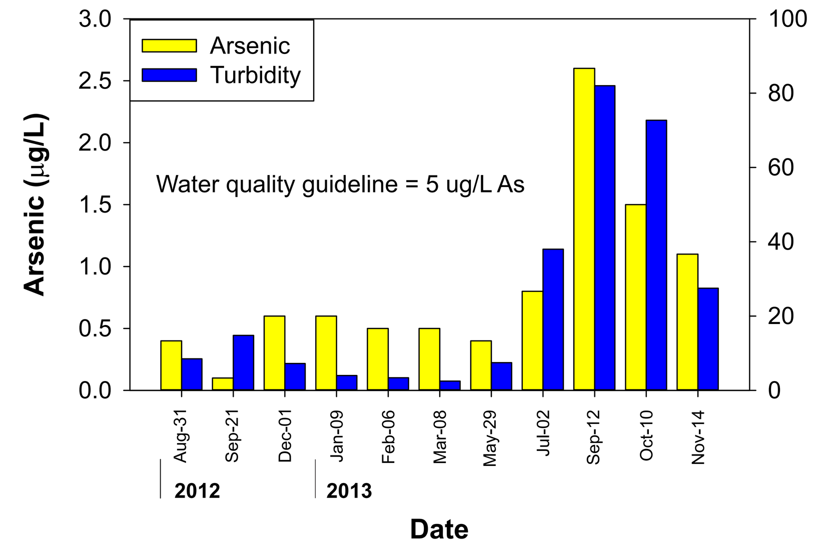

Figure 7. Arsenic concentrations and turbidity in intake water, Aug 2012 - Oct 2013.

Plant nutrients

- Nutrient data investigated for seasonal cycles.
- Total phosphorus concentrations were moderately high through autumn and winter and declined in May, possibly because of algal uptake. Concentrations increased in June and July with loss of ice-cover and increased SR flow.
- Dissolved phosphorus concentrations were moderately low, particulary during the growing season.

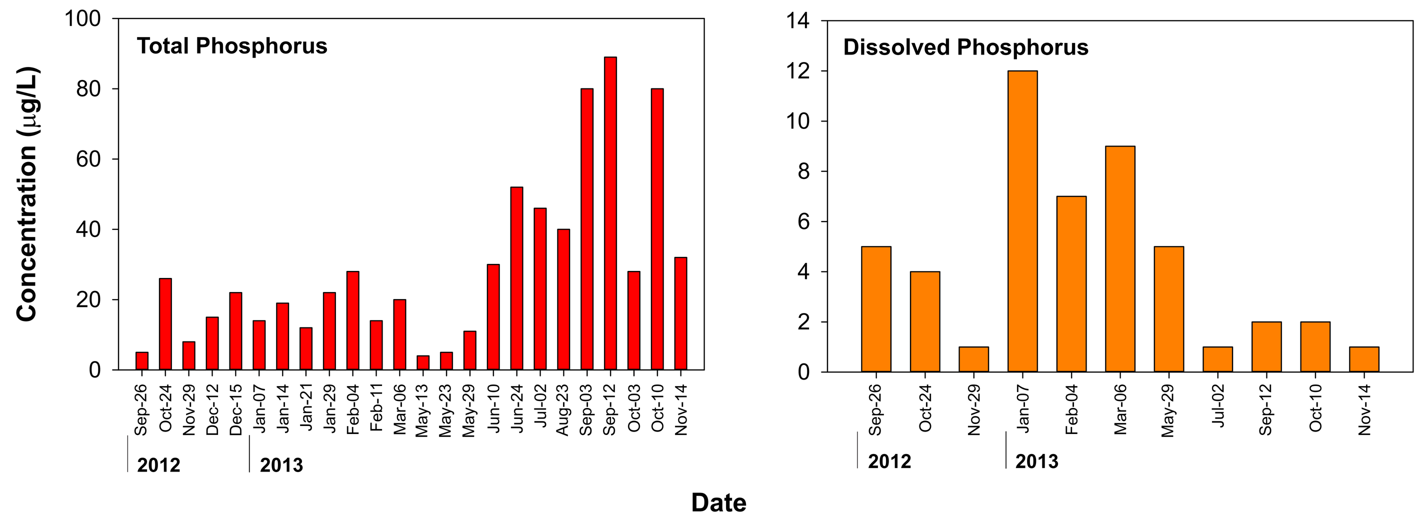

Figure 8. Total and dissolved phosphorus concentrations in intake water, Sept 2012- Oct 2013 based on ca. weekly and ca. monthly sampling, respectively.

Phytoplankton communities

- Chlorophyll concentrations declined markedly through autumn and winter, but began to increase under the ice in late winter with the lengthening of daylight hours.

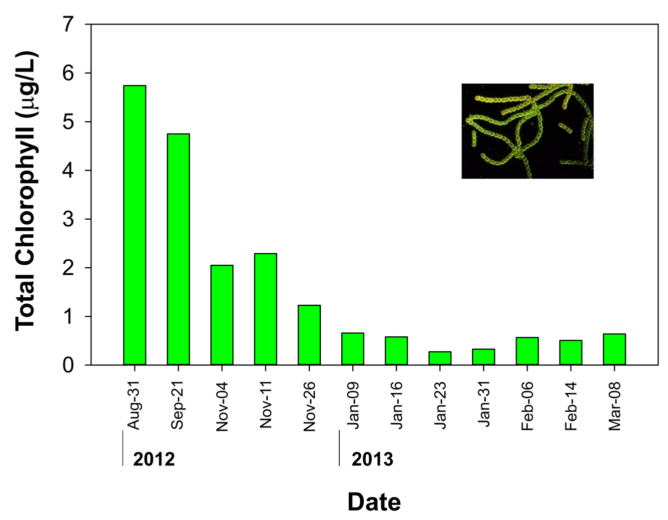

Figure 9. Seasonality in chlorophyll concentrations in intake water over Aug 2012 to Mar 2013.

Conclusions

The intake study is off to a promising start and water quality monitoring continues to this date. New partnerships are being developed.

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