Visualizing and Quantifying Sources of Nutrients in the Agriculturally Dependent Muskrat River Watershed

Funding for the WAMQI project was provided through Growing Forward 2, a federal-provincial-territorial initiative. The program was administered by Farm & Food Care Ontario.

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Growing Forward 2
A federal-provincial-territorial initiative

Water Adaptation Management and Quality Initiative

FARM & FOOD Care ONTARIO

Ontario

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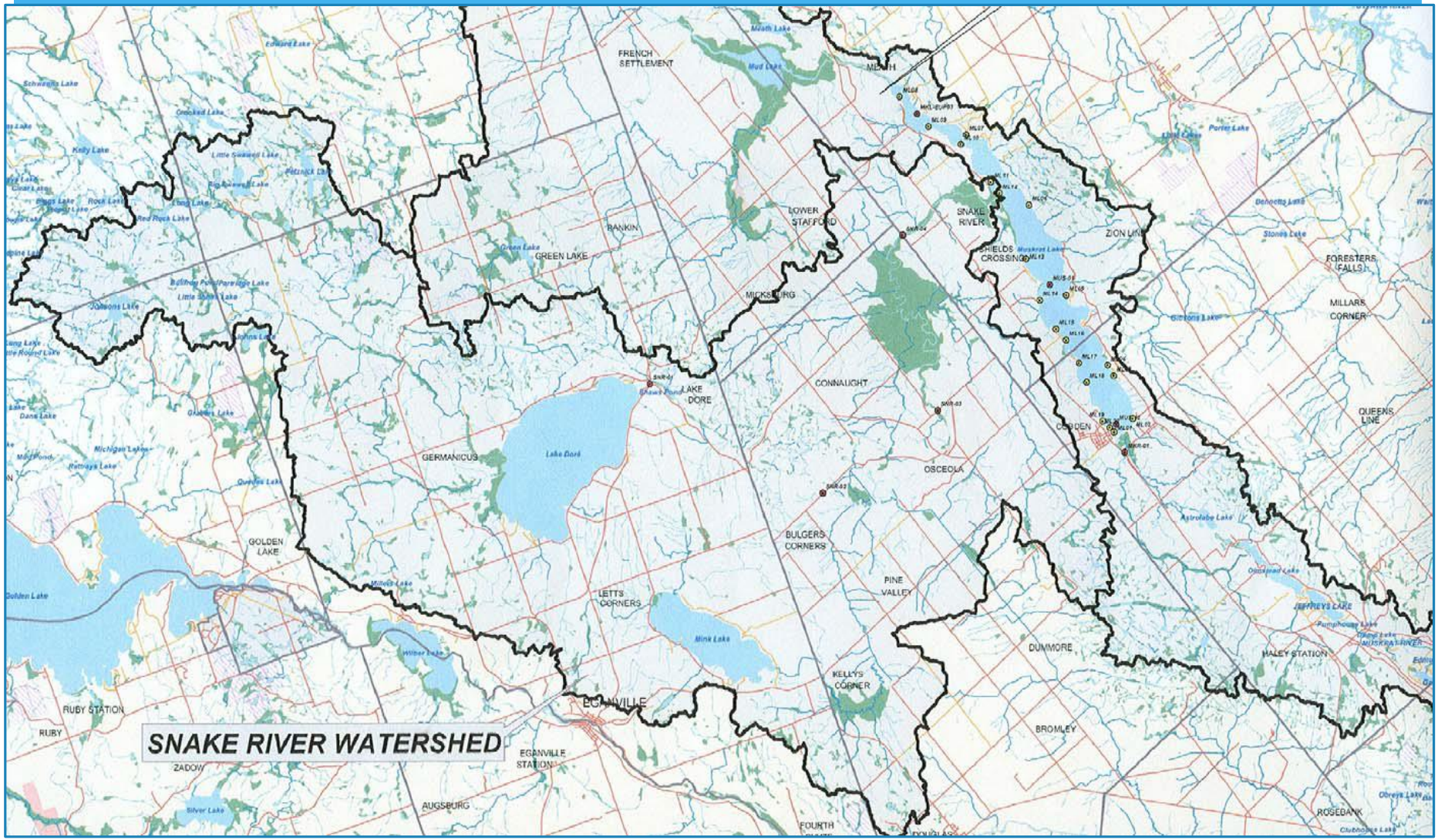
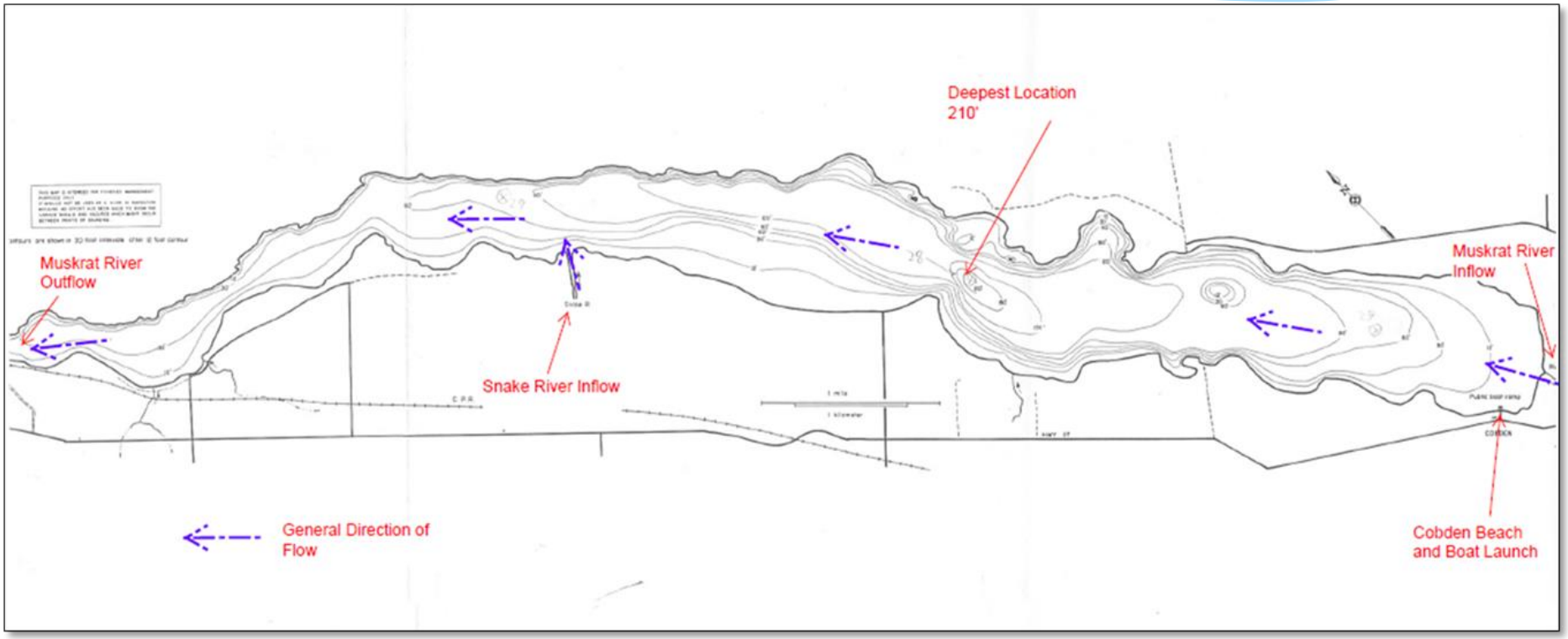
Presentation Overview

* About Muskrat Lake and its residents
* WAMQI purpose and hypothesis
* Causes and concerns
* Research and action
* Partnerships and collaboration
* Lessons learned
* Life after WAMQI
* Algal bloom detection and remote sensing

Muskrat Watershed



Muskrat Lake:
Physical Characteristics



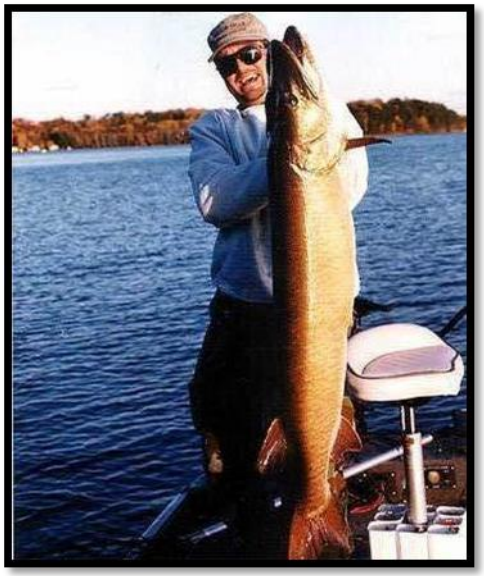
Muskrat Lake: Facts

Max depth: 64m, mean depth 17.7m
Lake volume 213,200,000 cu. m.
Perimeter of 34km
Hectares 1201 (ha)
Two main inflows: Snake R. and Muskrat R.
One main outflow: Muskrat R.
Lake residence time: approx. 1 year

One of only 23 lakes that sustain lake trout (designated as an "at capacity" lake")

Actively fished year round for lake trout, muskellunge, rainbow smelt, smallmouth and largemouth bass, longnose gar, pike, and walleye.

Also home to protected American Eel and Sturgeon



Muskrat Lake: Water Use

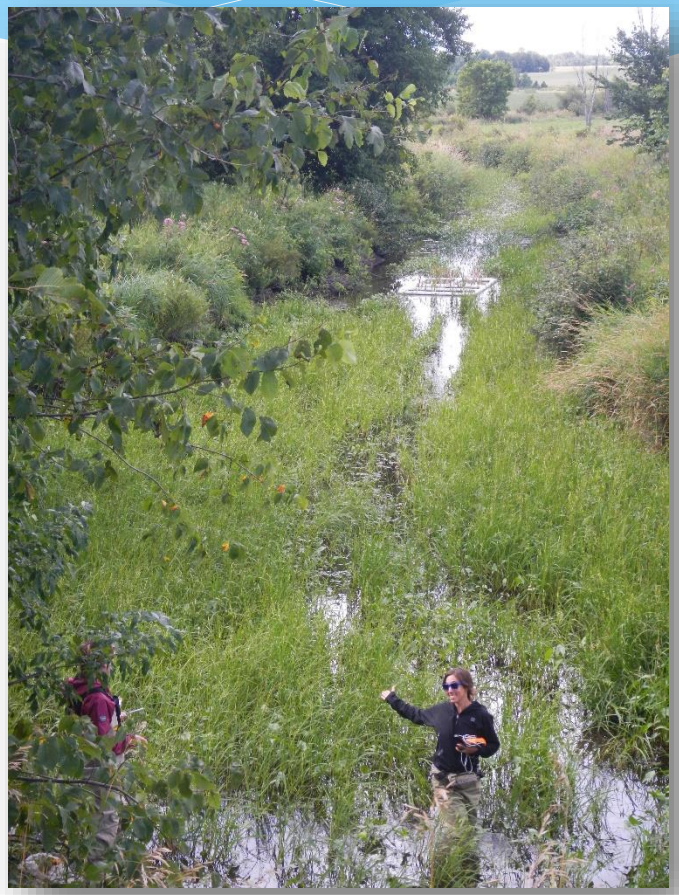
* Drinking water supply for the town of Cobden and for some lake residents
* Location of the Cobden sewage treatment plant
* Easily accessible and rewarding fishing; bass tourne and big ice fishing community
* Home to several campgrounds, important for recreation and tourism
* Upstream agricultural influences (Snake River)
* Area Supported by cities of Pembroke and CFB Petawawa

WAMQI Purpose & Hypothesis

* The overall purpose of the project was to document water quality issues in the MRW in relation to current land-use practices.

* It was hypothesized that nutrients and sediments from agriculturally dominated areas in the MRW could be contributing to the high phosphorus levels and blue-green algaal blooms in Muskrat Lake.

* Other potential causes and concerns include…



Other Potential Causes & Concerns

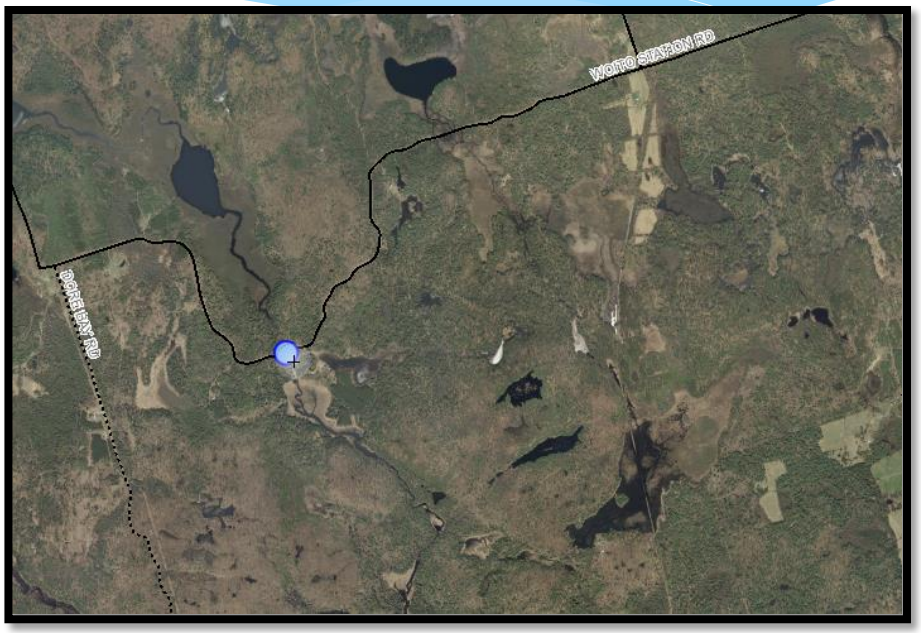
* Algal Blooms and bacterial contamination
* Outdated septic systems
* Zebra Mussels
* Failing sewage treatment plants, under capacity
* Diversity of opinions, development vs. non development
* Naturally eutrophic (or mesotrophic conditions)
* Lack of awareness of the benefits of BMPs
* Confusion among landowners
* A lack of any long-term scientifically defensible data
* “At capacity” lake (300m setback)

Phosphorous – The Limiting Culprit

* Intense agricultural activity
* Removal of natural wetlands & bio-filtration
* Shoreline development
* Outdated infrastructure
* Storm-water runoff
* Extensive municipal and private tile drains
* Dams added and removed
* Natural decomposition, sedimentation

Impacted vs. Non-impacted Areas

The Snake River Drainage downstream has been significantly altered and the landscape is heavily patterned by agriculture



…but there are remaining areas at the headwaters which are relatively un-impacted.

A Blue-Green Summer

Blue-green algae at Muskrat Lake's "Deep Site"

Blue-green algae at Snake River site

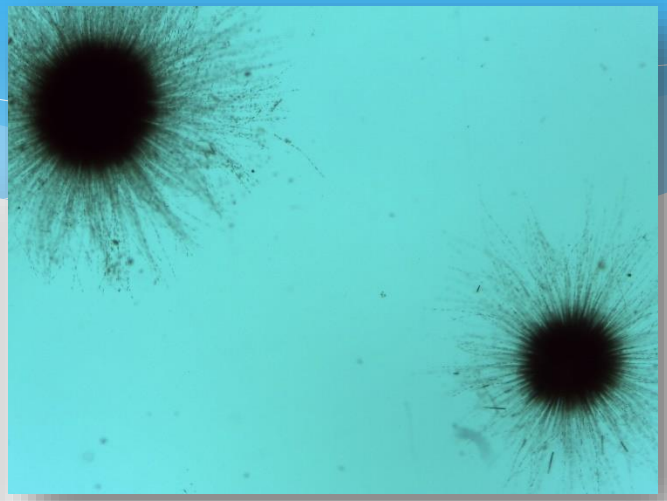
Blue-green Algal Blooms

Blue-green algae at the “Deep Site” on Muskrat Lake

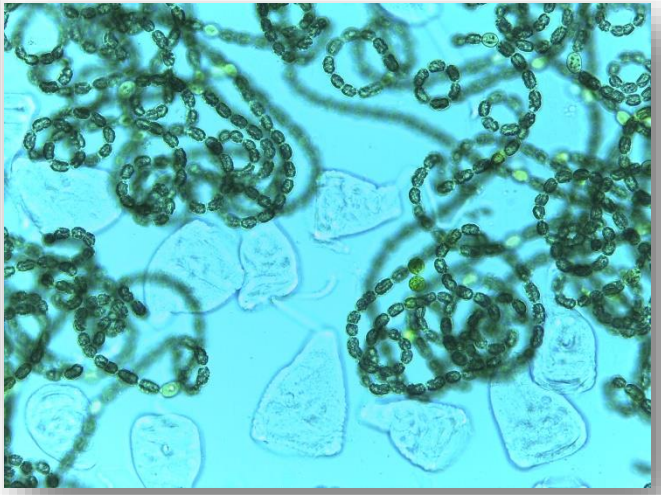
Blue-green algae on the shores of Muskrat Lake

Blue-green Algae: Snake River

Blue-green algae – Snake River site



Gloeotrichia



Anabaena and vorticellids

WAMQI – Research & Action

* Established the first-ever monitoring network for Muskrat River Watershed.
* Determined problem areas within the watershed that are a main cause for nutrient loading.
* Conducted a DO and temp lake profile to determine lake behavior/dynamics (e.g., insight into lake stratification, lake turnover and changes in oxygen profiling, which all influence timing of blue green algal blooms).
* Provided momentum for us and partners; other funds leveraged from the Cobden Civitan Club, NSERC, OMAFRA, MOECC, and municipalities.
* Forging new and important relationships with local farmers and the municipalities.
* Development of a scientific report for the 2014 data.

Partnerships & Collaboration

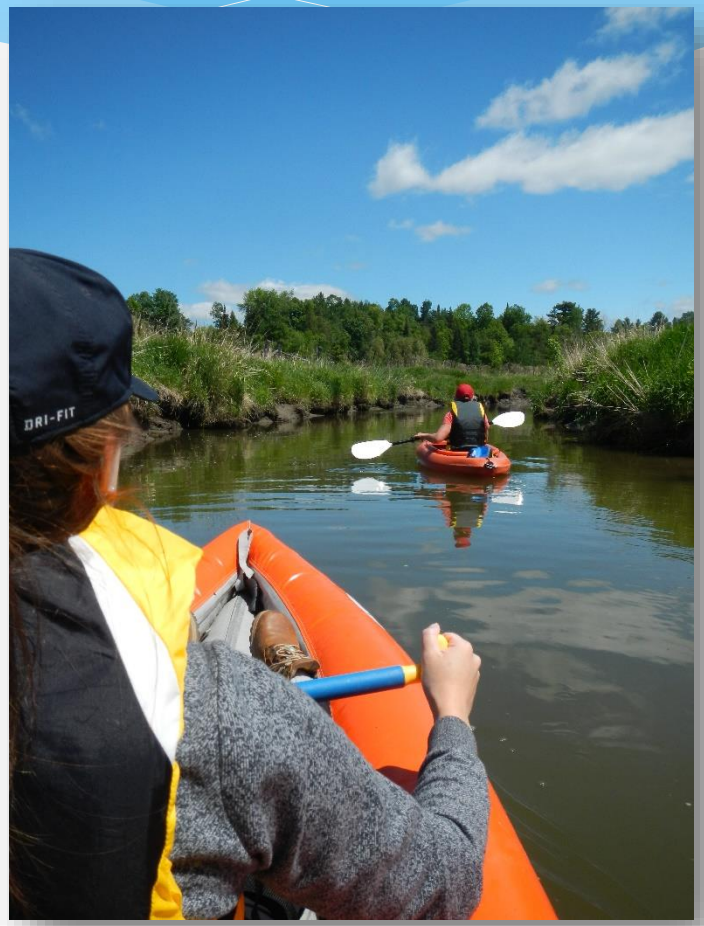
* **Diverse partnerships and multi-tiered collaboration:**
  * Algonquin College's Office of Applied Research and the Environmental Technician Diploma Program
  * The Muskrat Watershed Council and other community organizations
  * Municipal government (Township of Whitewater Region and Laurentian Valley Township)
  * Provincial government (MOECC, OMAFRA, MNRF)
  * Federal government (Agriculture & Agri-Food Canada)
  * Private sector (ORMG, Inc.)
  * Crown corporation (C.N.L., formerly A.E.C.L.)

Lessons Learned

* Nutrient loading from land-use practices are a real threat to the water quality of Muskrat Lake (MOECC, 2016; Dalton, 2015).
* Internal loading of the lake is also a significant area of concern (MOECC, 2016).
* Broad acknowledgment by participating organizations/agencies that a multi-pronged approach is required to tackle Muskrat Lake issues.
* At this point, options for remediating internal loading of the lake are complicated and not cost effective. Currently focusing on more cost effective measures.

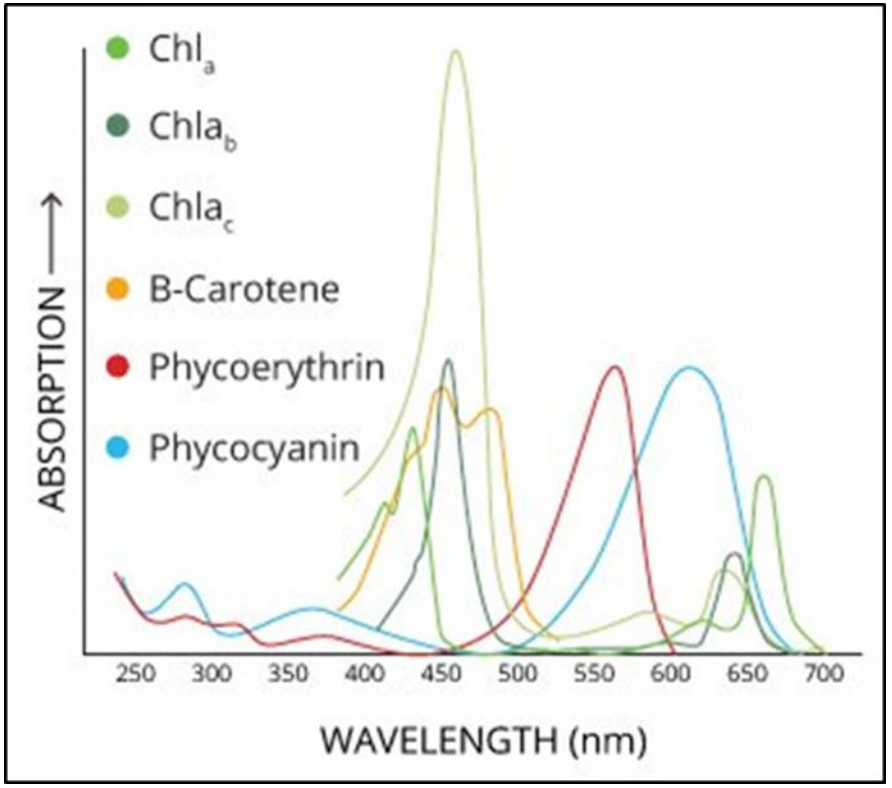
Life After WAMQI

* Upstream agricultural BMP implementations (e.g., CTD, shoreline buffers, cover crop, etc.).
* 2 years of data allows us to draw comparisons on water quality pre- and post-implementations of CTDs and other agricultural BMPs.
* Support the Muskrat Watershed Council on funding applications; joining forces to tackle the issues, improve relationships with farmers and discuss other potential options for lake remediation.
* Expanding our research: NSERC funding – better algal bloom detection using remote sensing.



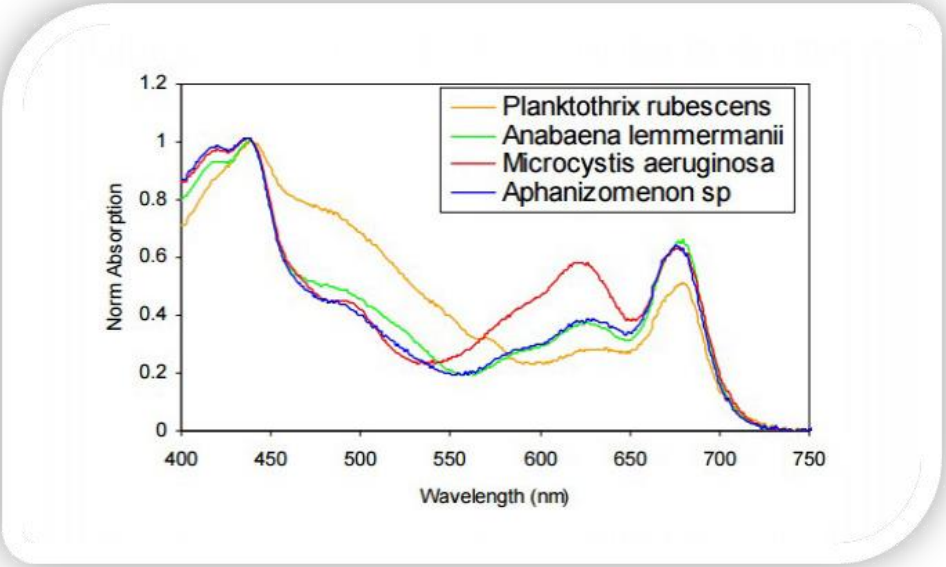
Algal Blooms – Remote Sensing

* Remote sensing could allow for earlier detection of blue green algal blooms and represent a more cost effective way to detect them.
* Plant pigments have unique absorption spectra that can be used for detection.
* Phycocyanin, a cyano pigment, has it's max absorption around 620 – 630 nm.



Algal Blooms – Remote Sensing

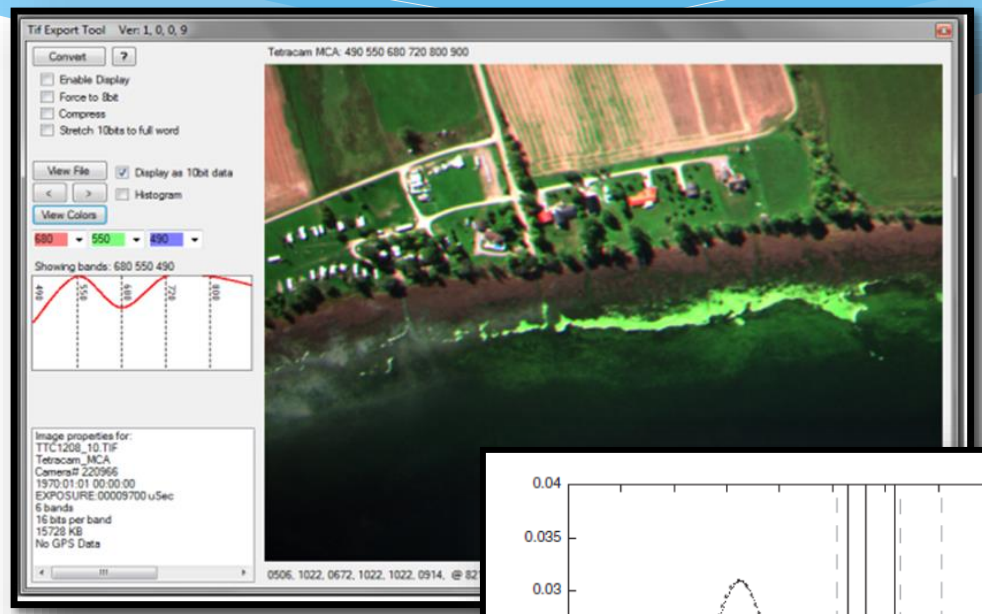
* Individual species also have unique absorption spectra. This diagram from C. Binding (2012) illustrates the interspecific differences

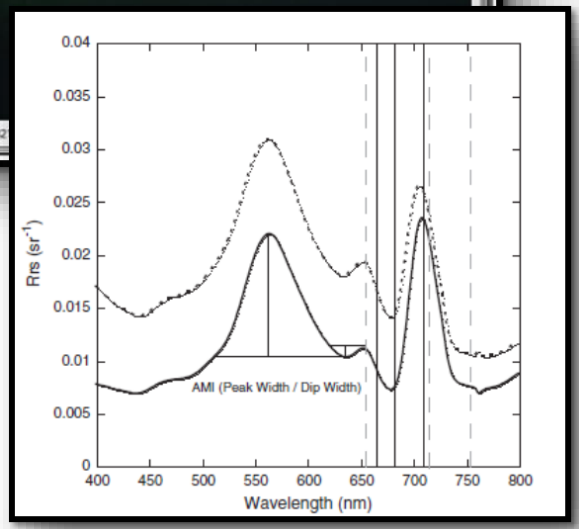


Suspected Algal Bloom

* A color composite image from the CU Tetracam (mounted on a fixed wing) collected last year during a suspected algal bloom.

* The camera filters were not specifically adjusted to detect cyanos but notice the absorption at 680nm and high reflection at 550nm and 720nm (somewhat consistent with Kudela shown to the right).





Thank you!