Rapid decline of phytoplankton in the Les Cheneaux Islands during a five-year period.

R.A. Smith

2 April 2018

Introduction:

Estimates of phytoplankton (free-floating algae) density for this study were made by measuring photosynthetic chlorophyll which was chemically extracted from phytoplankton contained in water samples collected monthly throughout Les Cheneaux during a five month period each year. Resulting chlorophyll concentrations, in this case Chlorophyll-a, were used to estimate phytoplankton population densities throughout the study.

Effect of a decreased phytoplankton community within the Les Cheneaux Islands:

The balance between plankton and rooted aquatic plants is critical to a healthy aquatic ecosystem. Moreover, plankton species and population densities are important to the aquatic food web. These lower level organisms are integral members of the lower aquatic food web. Decreasing plankton density could be a contributing factor to explain lower mayfly hatches in recent years. Also, if the lower food web is weakened for an extended period, the quality of the Les Cheneaux Island (LCI) sport fishery could be adversely affected.

Summary:

Following a 2013 peak concentration in Chlorophyll-a (Chl-a) [(1)] recorded from twelve different sites throughout LCI, a steady, annual decline in Chl-a was observed through 2017 (Fig. 1). Aside from the one elevated data point from 2012 to 2013, the annual Chl-a decrease persisted from 2013-2017. Was this a trend that will be continued in 2018, or was it an observation that is a cyclic, or non-cyclic, event?

During the 2013-2017 era of Chl-a decline the Lake Huron water level increased annually a total of 45 1/2" (116cm). It is possible that phosphorus, a primary plankton nutrient, was diluted by the influx of lower nutrient water from the open waters of Lake Huron (Fig. 2). Many interior bays and channels had depths of four-to-eight feet in 2012. A four foot inflow of low-nutrient water would reduce the available nutrients by up to one half which could adversely impact plankton growth and be reflected by lower Chl-a concentrations as shown in Fig. 1.

In addition to primary nutrient dilution within LCI, the pelagic regions of Lake Huron are also low in micro-nutrients required by plankton. Iron (Fe) and Manganese (Mn) are two essential nutrients required by most common planktonic algae forms. Table 1 shows the concentration of these two elements in an interior LCI embayment, Mackinac Bay, as well as concentrations measured in the lower nutrient pelagic Lake Huron waters. Whereas Fe does not appear to be limiting in the sheltered Mackinac Bay, Mn does appear limiting vs the concentration recovered from open Lake Huron waters. If Mackinac Bay is representative of LCI channel waters prior to dilution by Lake Huron water, it is highly probable that nutrients and micronutrients within the LCI channels have decreased during the rapid rise in lake level to a point that the plankton community growth densities have declined.

1) Chl-a concentration is used as an indicator of phytoplankton (free-floating plankton) density in the water column at sites being tested. Therefore, higher Chl-a values reflect greater plankton density.

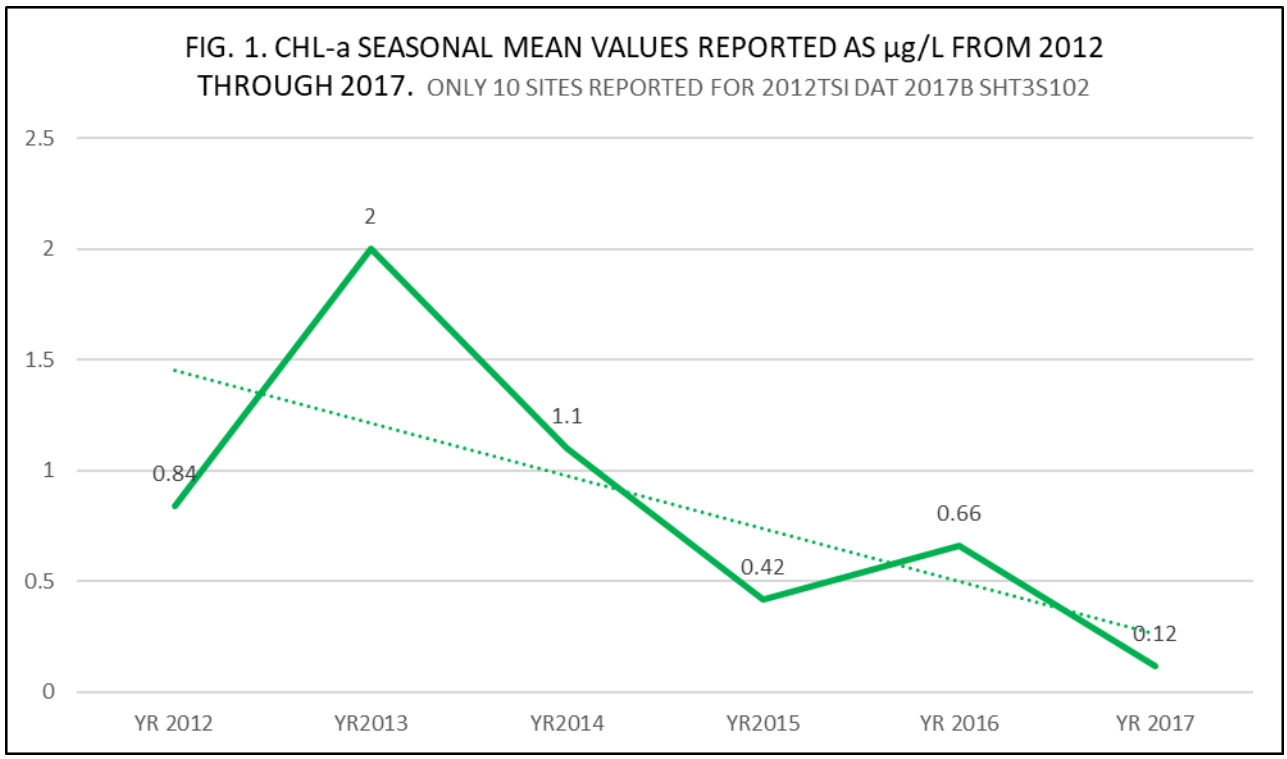

Fig. 2. Areas where low nutrient and micronutrient Lake Huron water flows into Les Cheneaux channels.

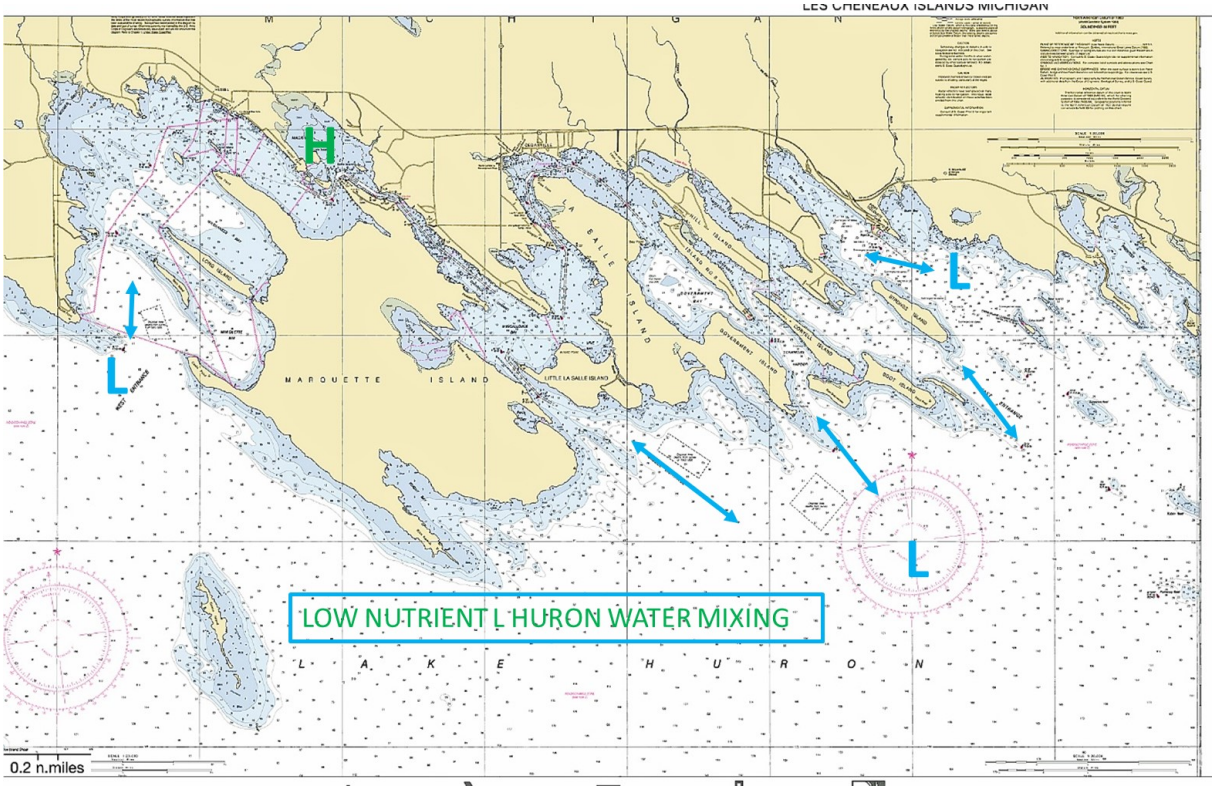

Table 1. Phytoplankton micronutrient availability in LCI waters.
<MICRONUTRIENTS 180218> L4

SITE	Zn++	Mn++
	µg/L	µg/L
MACKINAC BAY	0.620	2.552
NARNIA SITE	0.354	0.329
L HURON CHEBOYGAN	0.007	0.242
STRAITS OF MACKINAC	1.772	0.157

UMBS data per T. Vererica. 2 Apr 2018. Personal communication. Data generated by Global Change Biology course. Michela Arniboldi.

Common micronutrients required by plankton: Ca, Mn, Cu, Zn, Co, Mo

Interpretation of UMBS micronutrient data:
-Mn is low by a factor of 10 for waters at three sites that could dilute its concentration within LCI relative to Mackinac Bay
-Zn does not appear limiting
-No data on other elements

Background notes:

It is believed that the one-year rise from 2012 to 2013 was due to a significant die-off of Eurasian watermilfoil (EWM) during the fall of 2012. Decomposition of the dense EWM growth would have released significant quantities of phosphorus in the form of particulate and of soluble reactive phosphorus (SRP). SRP is a form of phosphorus that is readily metabolized by plankton. The excess SRP availability would have provided nutrients above the normal levels, which could have contributed to the higher Chl-a levels recorded for the summer of 2013. The particulate form of phosphorus must be converted to SRP to be biologically available for plankton or rooted plants. That conversion can be accomplished by either a chemical reaction or by microbial activity.

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