Discussions for Collaborative Investigation of Golden Brown Algae in Torch Lake, Michigan

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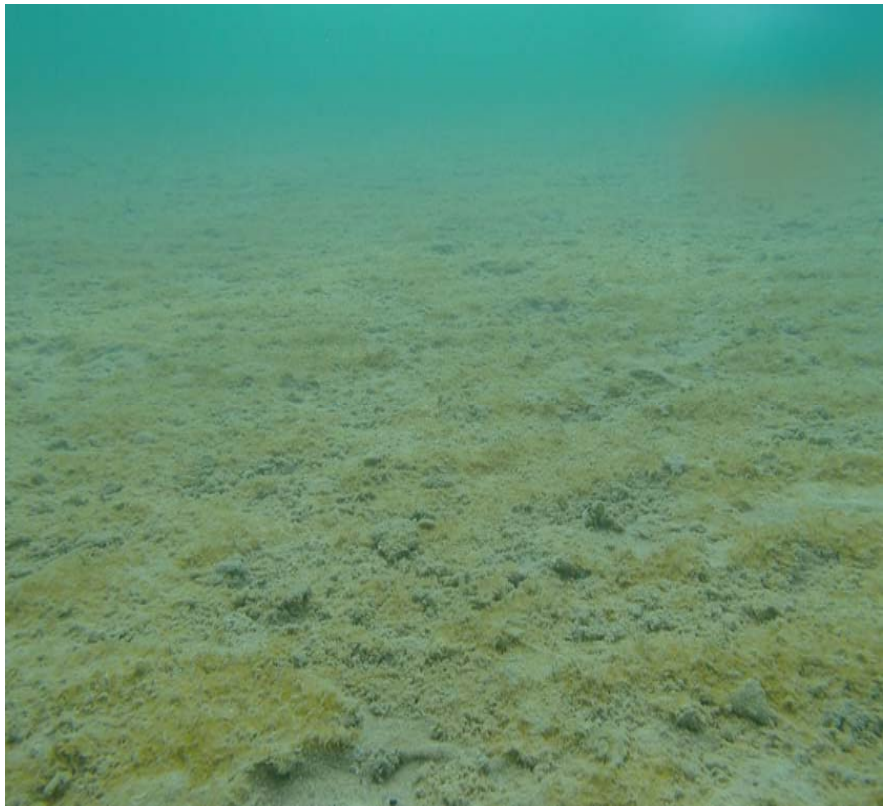
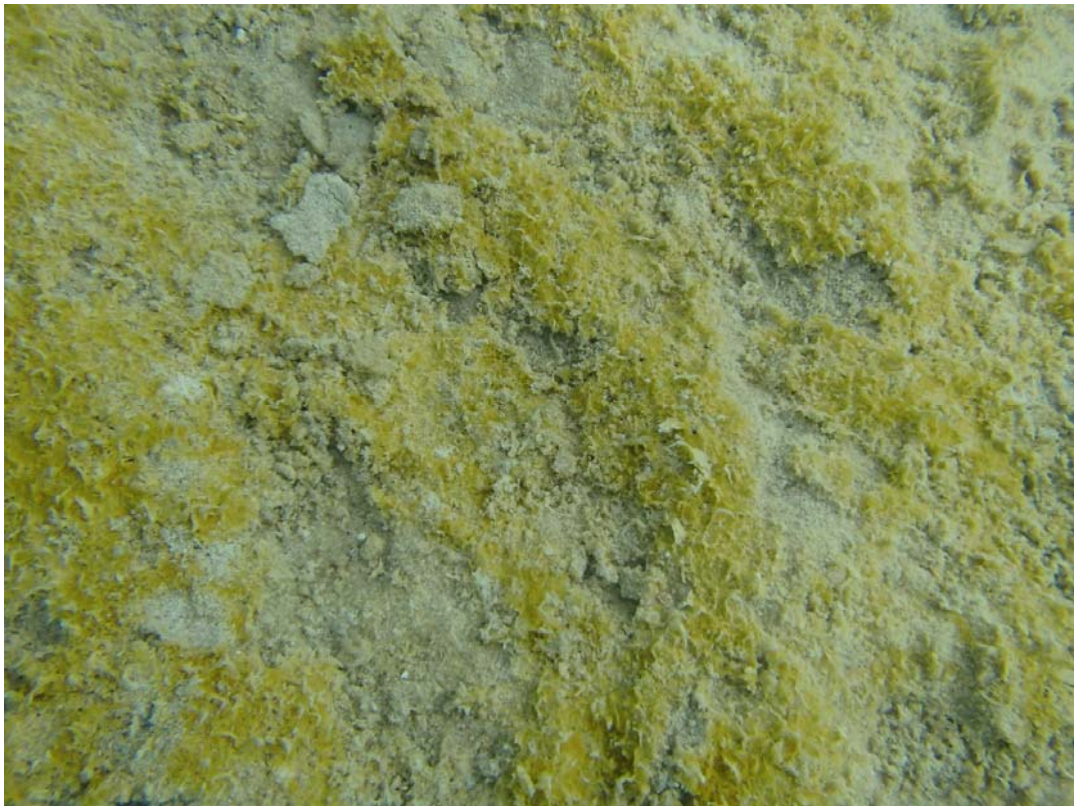
Torch Lake's
Golden Brown Algae
Summer 2014





Torch Lake

18 miles long (north to south)
Greatest width 2 miles (east to west)
Maximum depth 302 feet

Torch Lake is one of 14 lakes in the Elk River Chain of Lakes

South end of Torch Lake with Sand Bar
To the West Elk Lake and Grand Traverse Bay

Torch Lake Hydrologic Budget 2005

Inflow	
Clam River	72%
Spencer Creek (in Alden)	3%
Other tributaries (over 40)	1%
Precipitation	12%
Groundwater Seepage	13%
Outflow	
Torch River (near the Sandbar)	88%
Evaporation	12%

Clam River flowing into Torch Lake

Torch Lake Characteristics

Phosphorus: Low; Based on more than 200 samples lake-wide total Phosphorus concentration in 2005 was determined to be 2.6 ppb.*

Phytoplankton chlorophyll concentrations: Low; 0.5 to 0.7 ppb in 2005.*

Dissolved oxygen concentrations: High throughout the year; exceeded 11ppm in deep hypolimnion throughout the winter period in 2005.*

Water clarity: Excellent; Secchi disk depths from 2 sources in 2013 has it ranging from 14 m (45.9 ft) in early summer to 7 m (23 ft) in late summer.

*2006 GLEC Development of a Predictive Nutrient-Based Water Quality Model for Torch Lake submitted to Three Lakes Association Three Lakes Association http://3lakes.com/downloads/torchmodel06.pdf

Previous Studies on Torch Lake

- GLEC 2006 Development of a Predictive Nutrient-Based Water Quality Model for Torch Lake submitted to Three Lakes Association Three Lakes Association

  Groundwater phosphorus when measured from 13 shallow piezometer wells was 10x higher than lake levels, 21.7 ppb compared to 2.0 ppb.

  Phosphorus mass balance for Torch Lake

Phosphorus Input/Output	Annual Load/Loss in kg	% P load/loss
Tributary loading	+1590	+33%
Groundwater loading	+1480	+31%
Atmospheric loading	+1770	+37%
Settling loss	-4120	-83%
Torch River outflow	- 830	-17%

- Homa, E. S. and Chapra S.C. 2011 Modeling impacts of calcite precipitation on the epilimnion of an ultraoligotrophic, hard water lake.

  Alaklinity of Torch Lake is 2.7 mequiv./L

  The decline in water transparency observed every summer appears to be the result of calcium carbonate precipitation, a naturally-occurring phenomenon in many lakes.

- Yohn et al. 2003 Inland Lakes Sediment Trends: Sediment Analysis Results for Six Michigan Lakes, MDEQ, East Lansing

  Sedimentation rate for Torch Lake is 447 g/m^2/yr. Calcium makes up 31.2% by mass and phosphorus makes up 0.035% by mass.

What is it?

Sample site on East side of Torch Lake
Sample from 2 m depth. Benthic algae absent in first 1 m depth possibly due to wave action.

Dr. Lowe's findings

The samples were "dominated by diatoms with fine filaments of a blue green algae (*Geitlerinema*). The dominant diatom was *Epithemia* and more than one species of this genus. It is normally an indicator of a nitrogen limited situation which can occur with excess phosphorus.

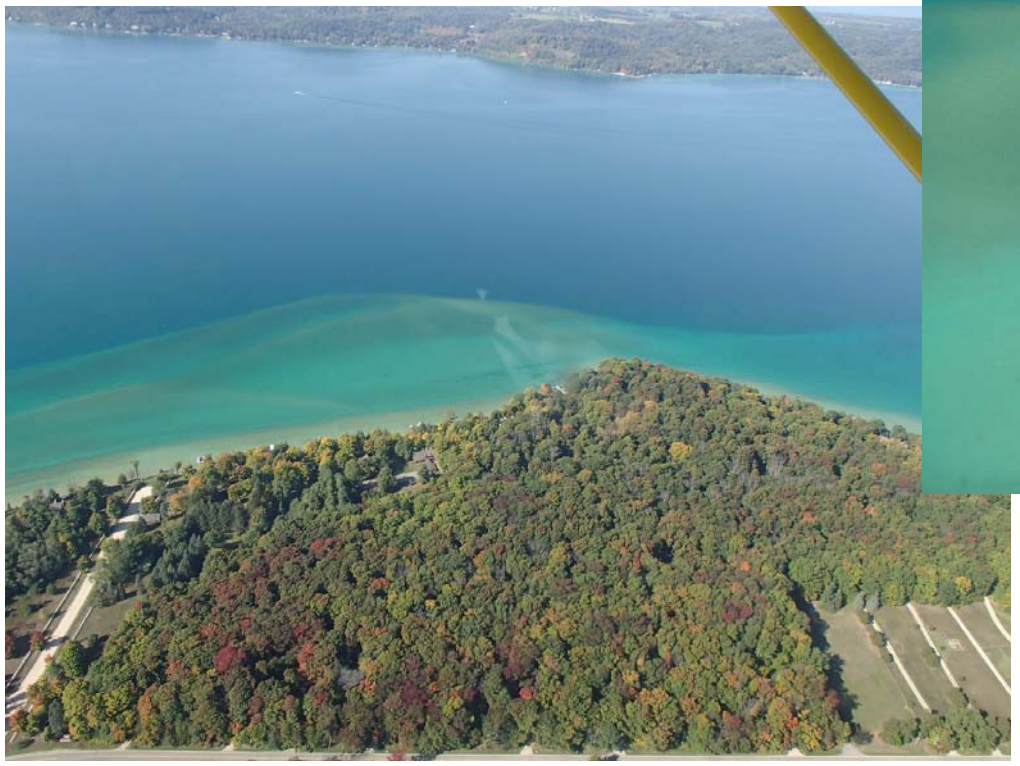
Additional benthic samples were submitted in 2012 by Elk-Skegemog Lake Association to Phyco Tech and determined to be a combination of cyanobacteria and diatoms. Report available.

North end of Torch Lake
September 2014

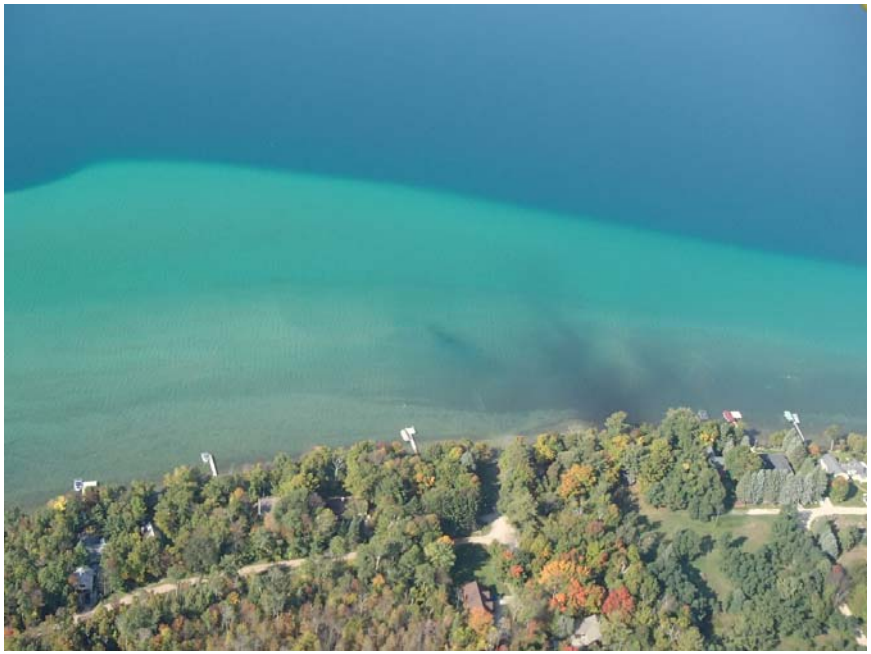
A courtesy flight with pilot **Dave Reck** allowed Trish Narwold to take these amateur aerial photos.

West side of Torch Lake
September 2014

East side of Torch Lake
September 2014



East side Torch Lake
stream outflows



Research Ideas previously discussed

1) Broad range sampling around Torch Lake including divers taking samples from sites along drop off that are not visible from water surface or from aerial views.

2) Land-sat study to determine historical presence of golden brown algae.

What's causing golden brown benthic algae mats to grow?

- Increasing nutrients in ground water
- Global warming
- Bioturbation of lake bottom by critters releasing phosphorus
- Increase nutrients in sediment pore water
- Decrease in grazers
- Zebra mussel population causing near-shore shunting
- Other ideas???

What can residents in the Torch Lake watershed do to discourage growth of golden brown benthic algae?

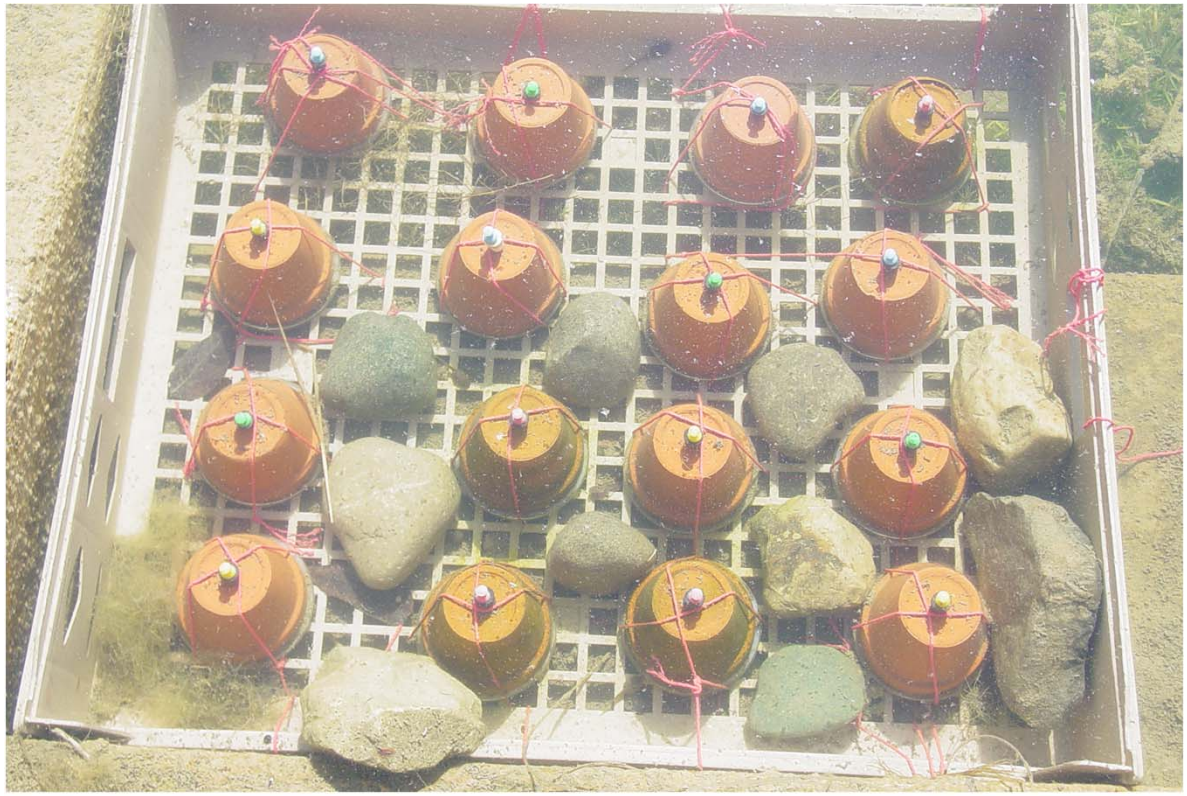
Additional Potential Research Plans

- Dr. Rex Lowe study with nutrient manipulation in flowerpots at 2 sites on East side of Torch Lake; low and high density land use

Camp Hay-o-went-ha

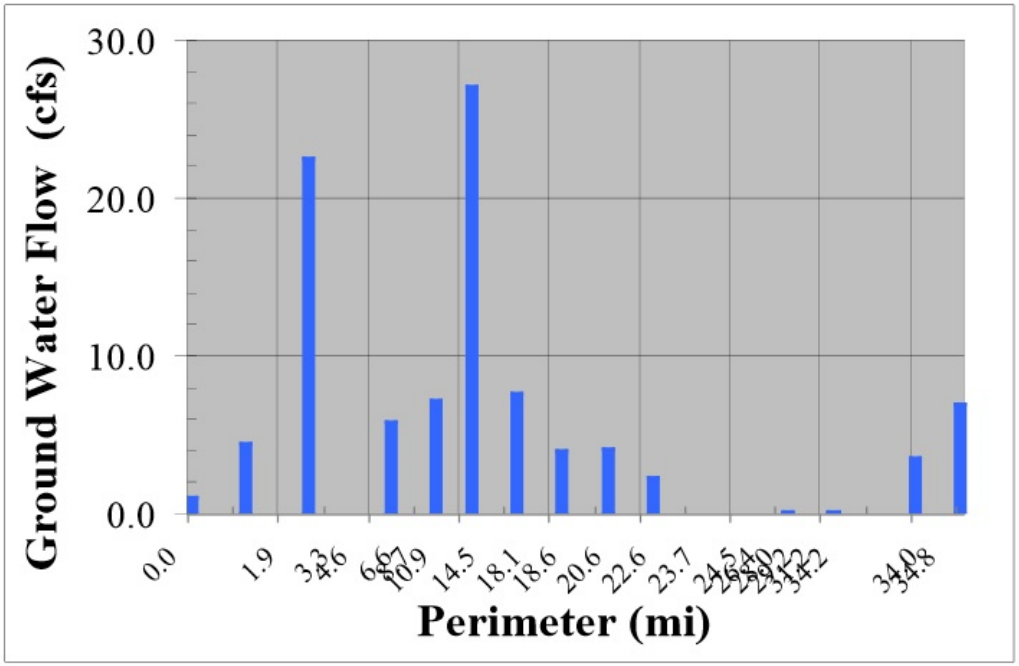
Sunset Torch Condominiums

Flower pot array

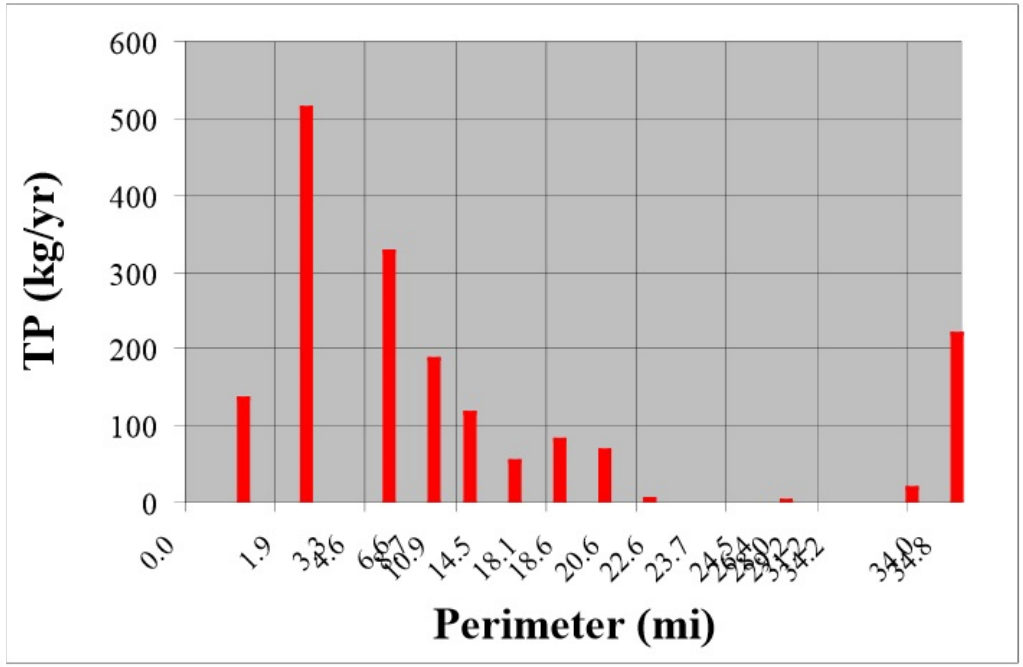


Groundwater Piezometer Sites 2005

Results from 2005 Piezometer Study



Groundwater flow (cfs) of Torch Lake piezometers beginning with North Station #1 and proceeding clockwise around perimeter of the lake.



Groundwater phosphorus flow (kg/yr) of Torch Lake piezometers beginning with North Station #1 and proceeding clockwise around perimeter of the lake.

Other research ideas ??

Thank you for all the time you have provided us in addressing our golden brown algae issue.