



Collaborative Investigation with internationally recognized diatom experts

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- **Dr. Rex Lowe**, U of M-Biological Res. Station
- **Dr. Pat Kociolek**, U of M-Biological Res. Station
- **Three Lakes Association grant funds and volunteers** to collect samples of groundwater and benthic algae; some funds from TLPA

**What is it? What's causing it?
What can be done to prevent it?**



Patterns of golden brown benthic algae, changing the aesthetic appearance of the lake from beautiful turquoise to plain brown!

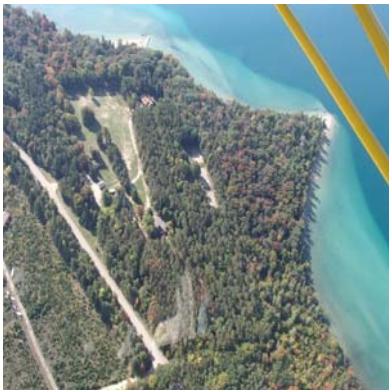
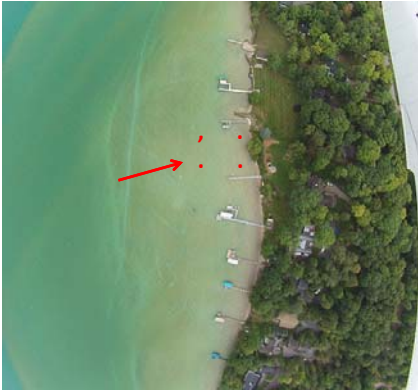


Patterns of areas with and without golden brown benthic algae, west side of Torch Lake

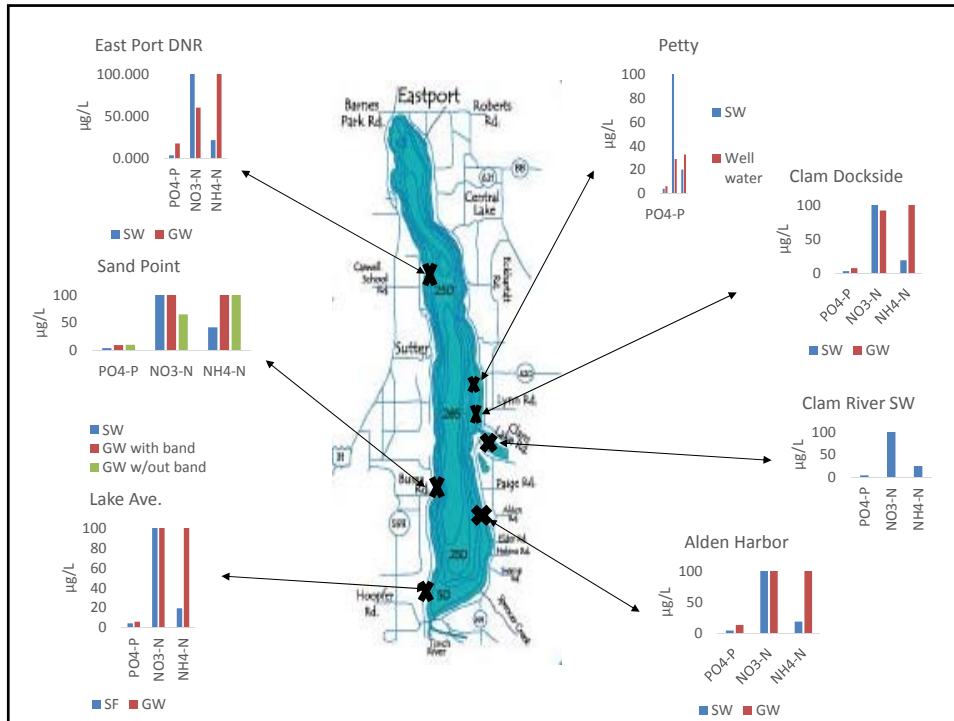


Initial Research Strategy

Compare two sites:

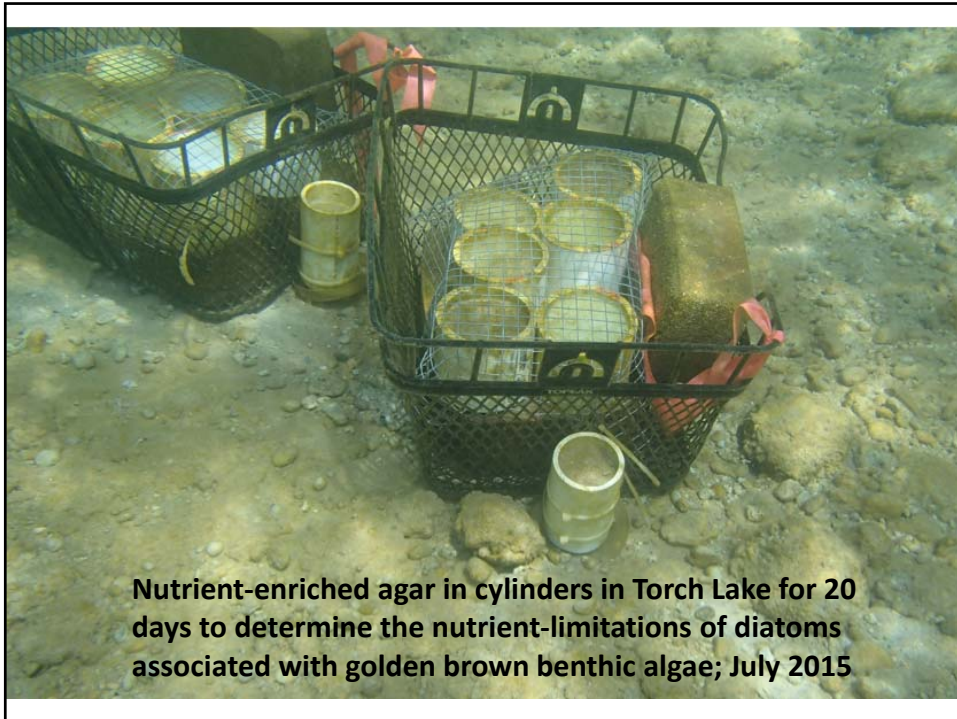
Low density land use	High density land use
	
Camp Hayo-Went-Ha	Petty property, August 2015

The complex block contains a title, a subtitle, and two columns of images. The title is 'Initial Research Strategy' and the subtitle is 'Compare two sites:'. The first column is titled 'Low density land use' and shows an aerial view of Camp Hayo-Went-Ha, which is a wooded area with a few buildings and a road. The second column is titled 'High density land use' and shows an aerial view of the Petty property, which is a residential area with many buildings, a dock, and a red arrow pointing to a specific area in the water. Below each image is a caption: 'Camp Hayo-Went-Ha' and 'Petty property, August 2015'.



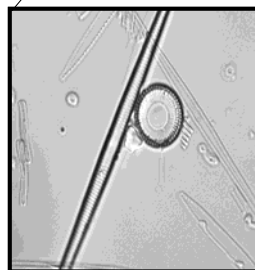
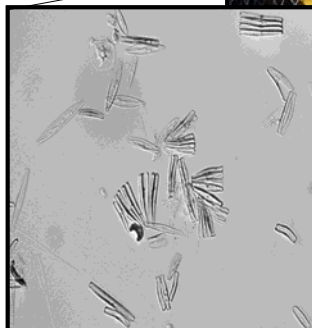
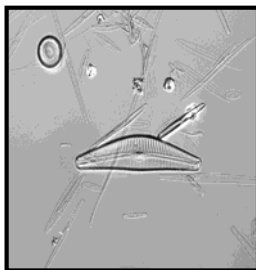
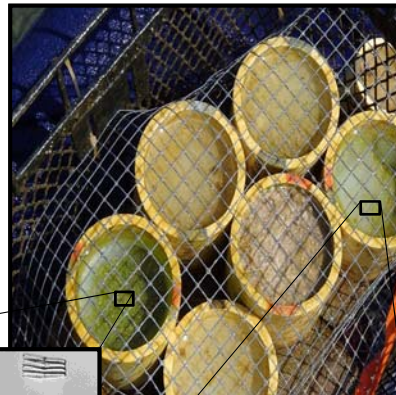
Concentrations of phosphorus Surface water vs Interstitial water

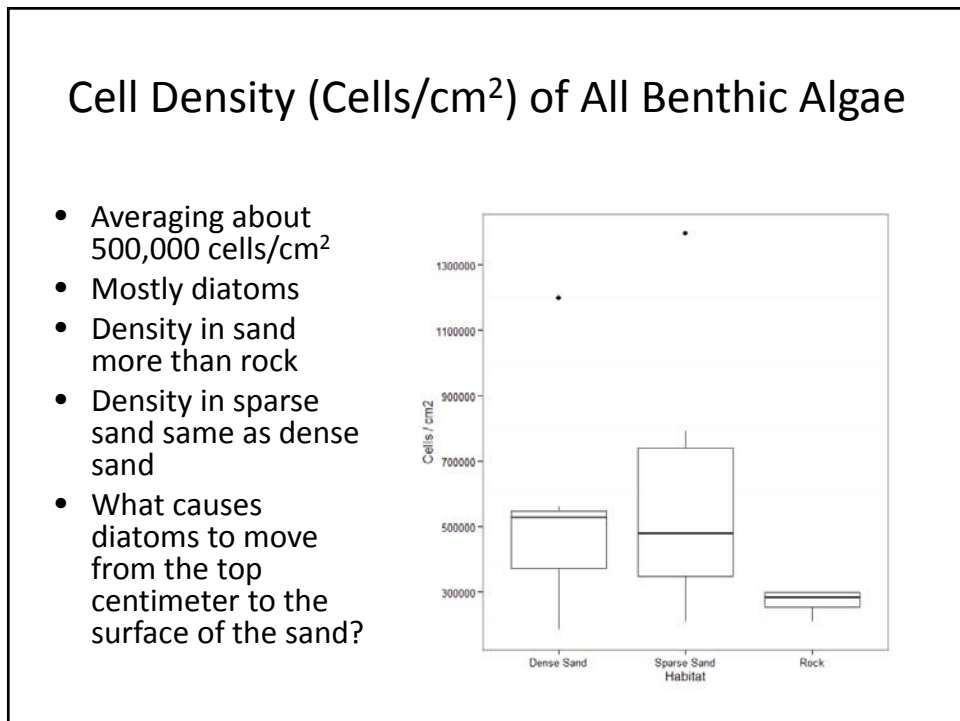
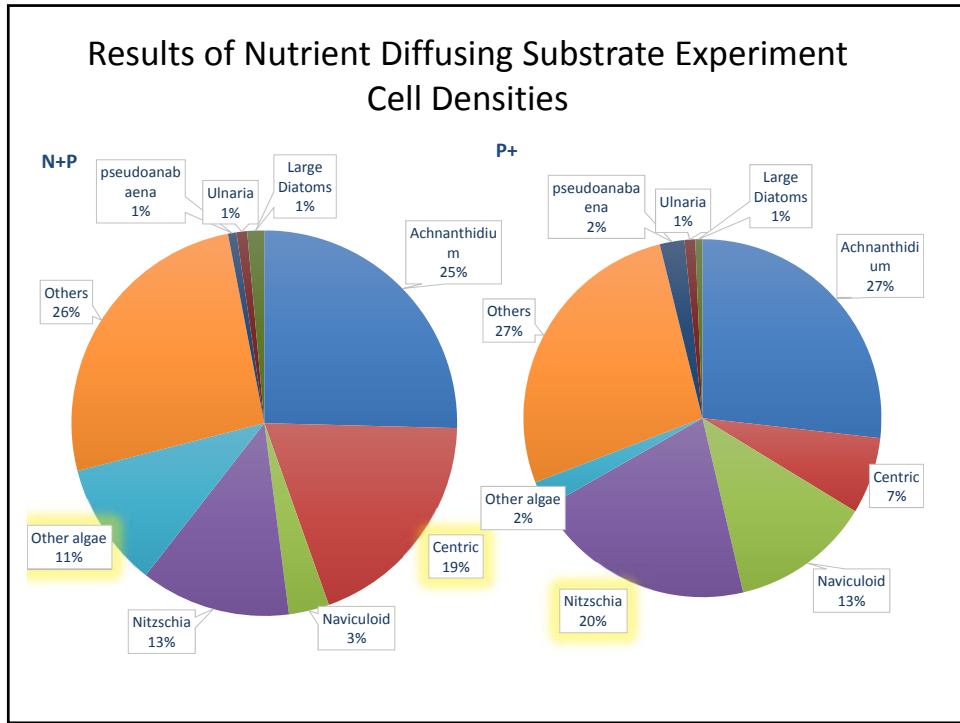
Water Sample Location	Phosphate (PO ₄ -P) ug/L Surface Water	Phosphate (PO ₄ -P) ug/L Interstitial Water
Clam River Dockside	3.28	7.79
Alden Harbor	4.26	13.48
Lake Ave	4.28	5.76
Sand Point	4.35	9.98
Eastport DNR	3.37	17.52
Average	3.91	10.91

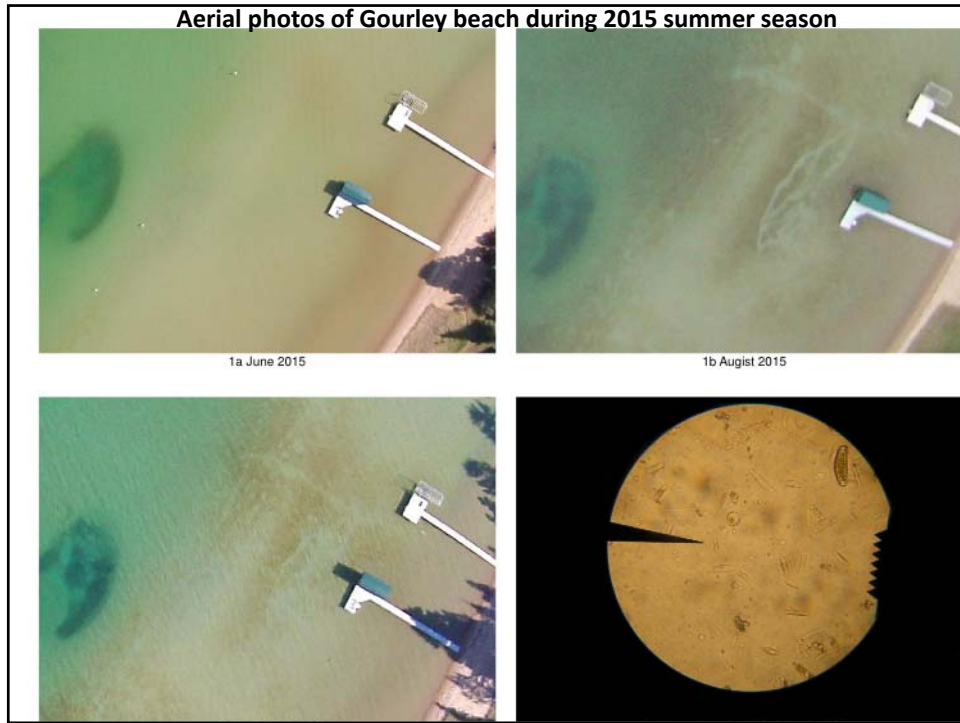


.... In summary

- Torch Lake P+ limited
- Blooms most likely caused by P input
- P source from ground water influx
- Different communities on treatments







Driving a piezometer into the lake bottom



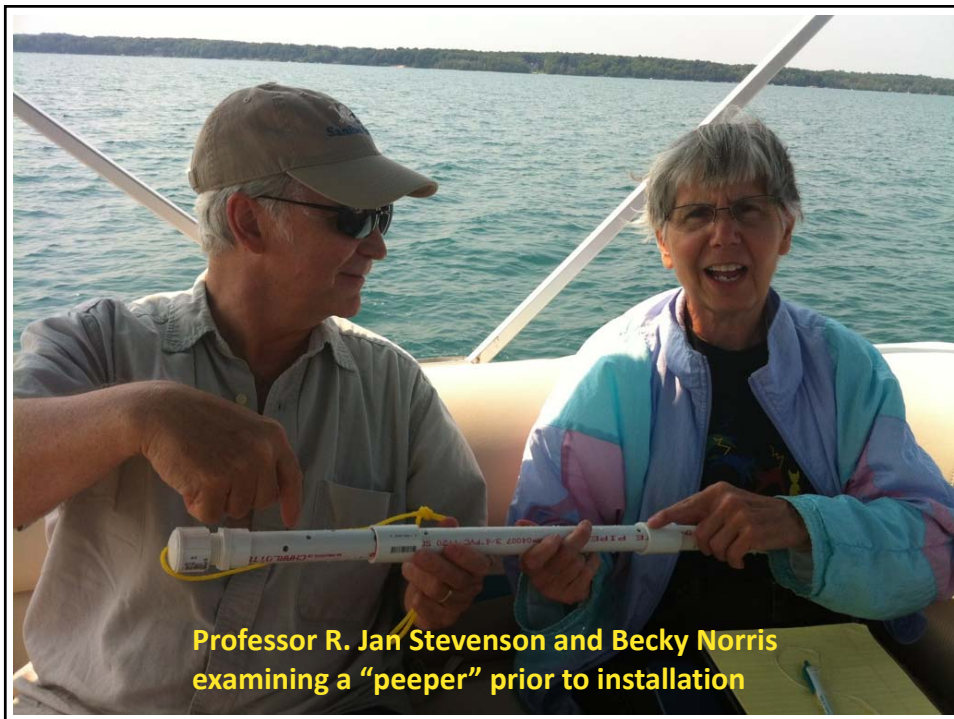
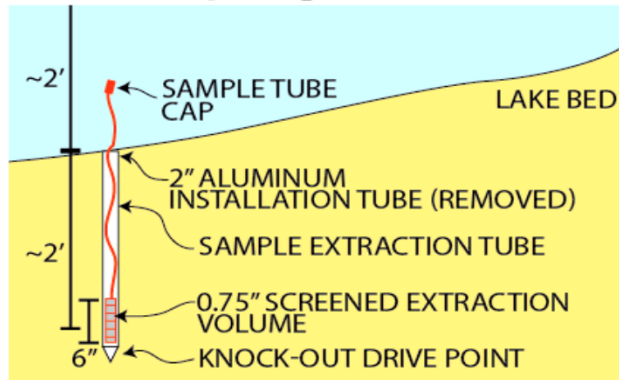
Shayna, Grandpa Dean, & Becky collecting a groundwater sample from a piezometer using a Topsider multipurpose vacuum pump connected to a sample-collection jug.



Piezometers

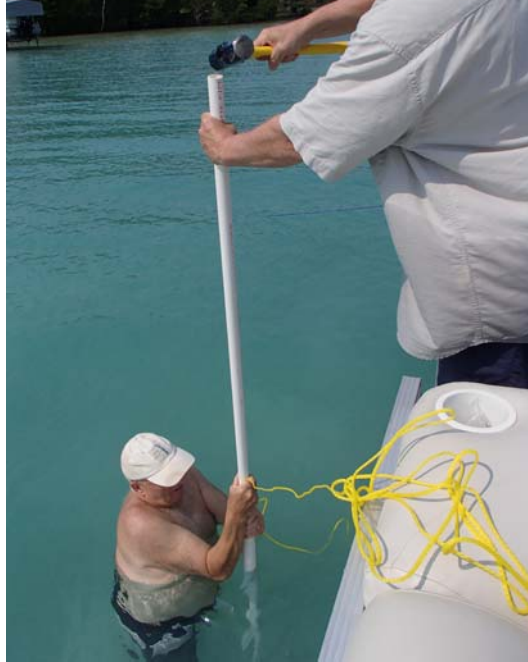
Near-shore groundwater wells

Sampling Methods

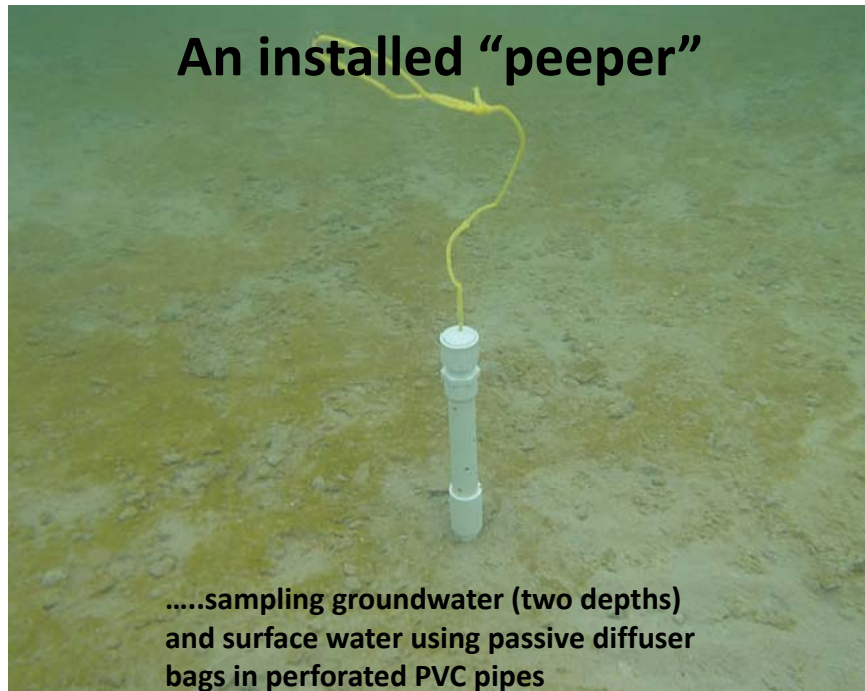


Professor R. Jan Stevenson and Becky Norris examining a "peeper" prior to installation

Driving a "peeper" into the lake bottom



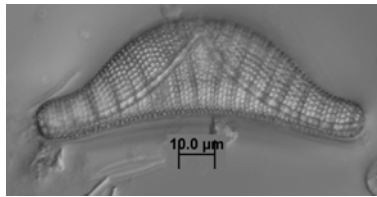
An installed "peeper"



.....sampling groundwater (two depths)
and surface water using passive diffuser
bags in perforated PVC pipes

Diatom Findings

- 140 Diatom species associated with golden brown benthic algae assemblages; 8 species new to science
- Naturally occurring in most lakes, rather than invasive species
- Epithemia, most abundant diatom taxa, capable of housing blue-green algae, and endosymbiotic nitrogen fixation



Microscopic image of *Epithemia smithii* identified in a sample collected at Camp Hayo-Went-Ha.

Intriguing research questions, not yet investigated

- Are groundwater nutrients inducing golden brown algae?
- Are the patterns of groundwater entering the lake similar to the patterns of golden brown algae, infrared images of surface water temp ~40 deg F with rising warmer groundwater ~50 deg F ?
- Do other lakes have similar diatom assemblages and groundwater profiles as the golden brown benthic algae assemblages in Torch Lake?

Questions ?

