Notes:

Golden brown benthic algae (aka Brown Crud) has many other lakes in the region also taking notice as it might not just be limited to Torch Lake.

The Leelanau Clean Water Group is the sister organization to TLA's Elk River Chain of Lakes Watershed Plan Implementation Team (ERCOL –WPIT). Both work collaboratively with local organizations to protect water quality.

Collaborative Investigation with internationally recognized diatom experts

- **Dr. R. Jan Stevenson**, MSU-Zoology Dept.
- **Dr. Rex Lowe**, U of M-Biological Res. Station
- **Dr. Pat Kociolek**, U of M-Biological Res. Station
- **Three Lakes Association used grant funds and volunteers** to collect samples of groundwater and benthic algae; funds from TLPA

Notes:

Dr. Stevenson served as the principal investigator for 2015.
The grant funds came from the final gift of the Robert Hildorf Foundation, The Dole foundation and Torch Lake Protection Alliance.

Special thanks to the following volunteers for their time, expertise and/or their property:
Art Hoadley, Fred Sittel, Paul Roush, Steve Hoadley, Gary & Linda Petty, Camp Hayo-Went-Ha, Ed & Sandy Gourley, the Lambert Family, Becky Norris, Trish, Drew and Meg Narwold, Dean, Dennis and Shayna Branson.

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!

Notes:

Benthic algae just means it sits on the bottom and we know it doesn't hurt to walk on. It can be up to ½" thick. So far as we know at this time it is mostly an aesthetic nuisance.

Our research goal for 2015 was to determine whether changes in the concentrations of groundwater are contributing to the proliferation of these mats of golden brown benthic algae. While the word benthic is important to distinguish it from the nasty blue-green algae that have plagued Lake Erie, caused by fertilizer and urban runoff.

We commonly refer to this investigation simply as GBA (Golden Brown Algae). It makes things easier for discussion purposes.

Notes:

The benthic algae growth appears in a pattern of bands or lines; supporting our hypothesis that groundwater could be a factor.

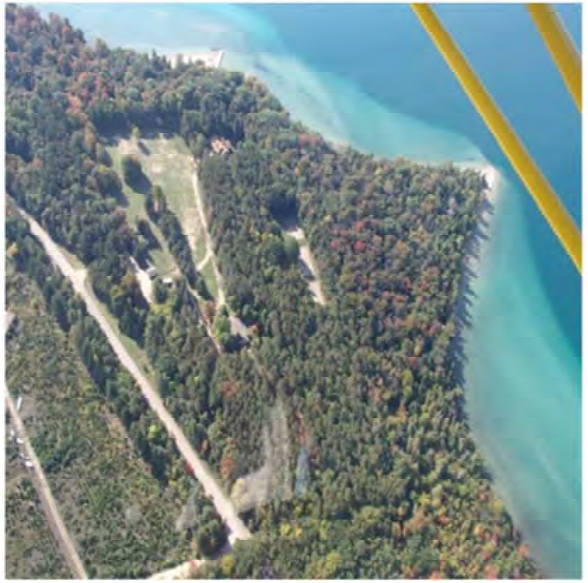
Underwater photo of golden brown benthic algae in Torch Lake

Notes:

Initial Research Strategy

Compare two sites:

Low density land use



Camp Hayo-Went-Ha

High density land use

Petty property, August 2015

Notes:

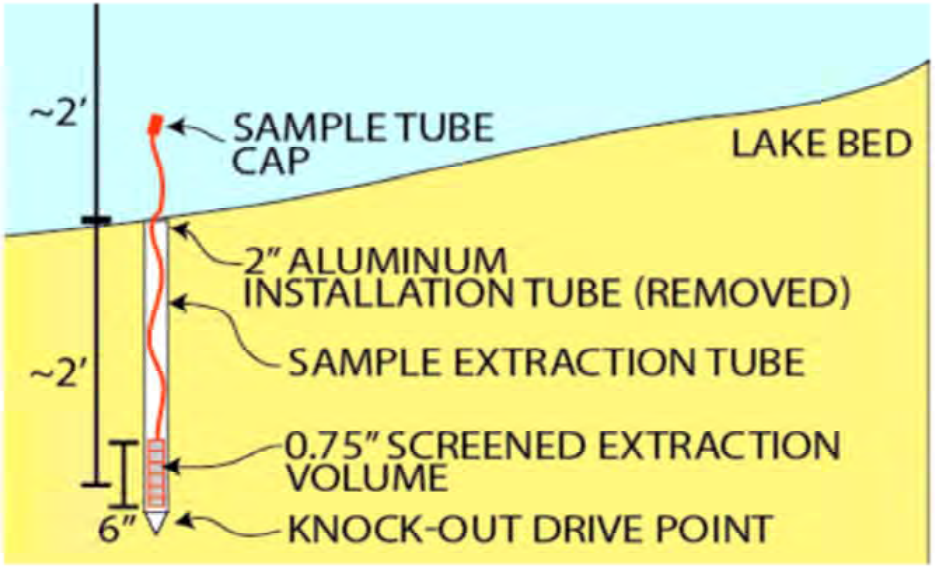
At both sites, 4 shallow water wells were installed; 2 near shore in approximately 1' of water and 2 at a depth of 4'. A well was also located at the Gourley property near the Dockside – Torch Lake.

The samples were collected with TLA built piezometers.

Piezometers

Near-shore groundwater wells

Sampling Methods



Notes:

Piezometers (shallow groundwater wells) were used to obtain the samples of the groundwater to determine the concentration of nutrients present.

Since the piezometers needed to be driven at least 2' into the lake bed, the volunteers faced difficulty due to the rocky lake floor. After several attempts, all 9 sites were sampled.

10 years earlier, TLA sampled a near shore groundwater well at Camp Hayo-Went-Ha in the same location as the 2015 samples. This information will hopefully provide valuable historical data once the new results are compared.

Paul, Trish, Art, and Fred assembling a piezometer; well point, perforated ¼-inch tubing and fine-mesh screen.

Notes:

Again, we are so thankful to the TLA volunteers. They have the skill and knowledge to build (and re-build) what we need.

Art Hoadley (purple shirt) made the well points on his lathe.

This photo shows the process of attaching the well point to perforated ¼" tubing with fine screen mesh screen.

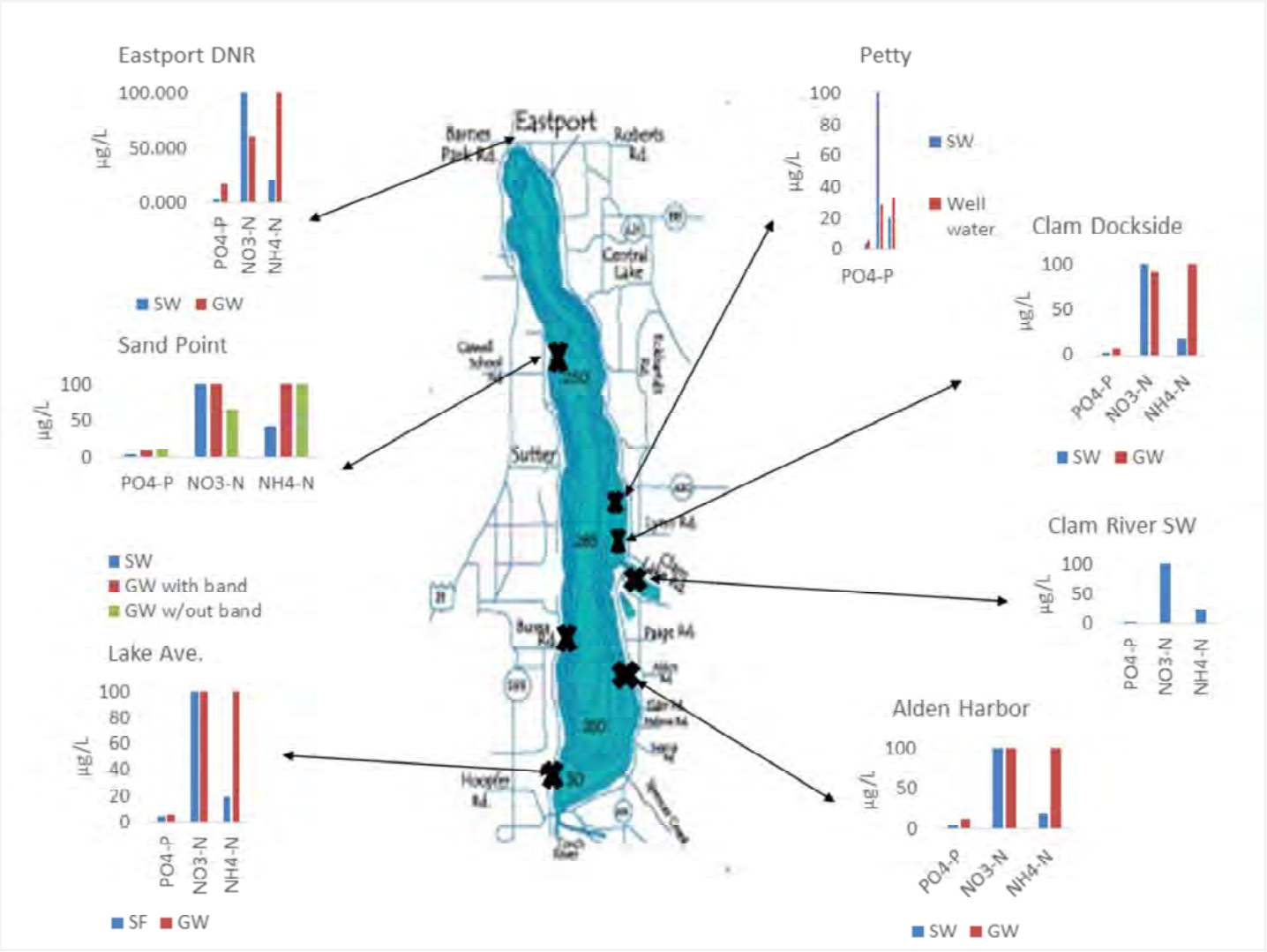
Driving a piezometer into the lake bottom

Notes:

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

Notes:

It is just amazing how much information can be gathered with simple tools, ingenuity and time!



Notes:

This graph was created by a graduate student, Krystal Sanchez, who worked for Dr. Lowe. Her summer project was to determine if there were variations in different areas of Torch Lake due to its incredibly large size. Using the equivalent of a turkey baster, she obtained samples of interstitial water from the 7 locations shown.

What is interstitial water? It is subsurface water contained in pore spaces between the grains of rock and sediments. It is not actually groundwater but groundwater contributes to it. The samples were analyzed for Phosphorus, Nitrate Nitrogen and Ammonium Nitrate.

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

Notes:

Wow! What a difference. The phosphorous in the interstitial waster is over 2x higher than the lake water.

Big Question: Why the higher concentration of phosphorus in interstitial water?

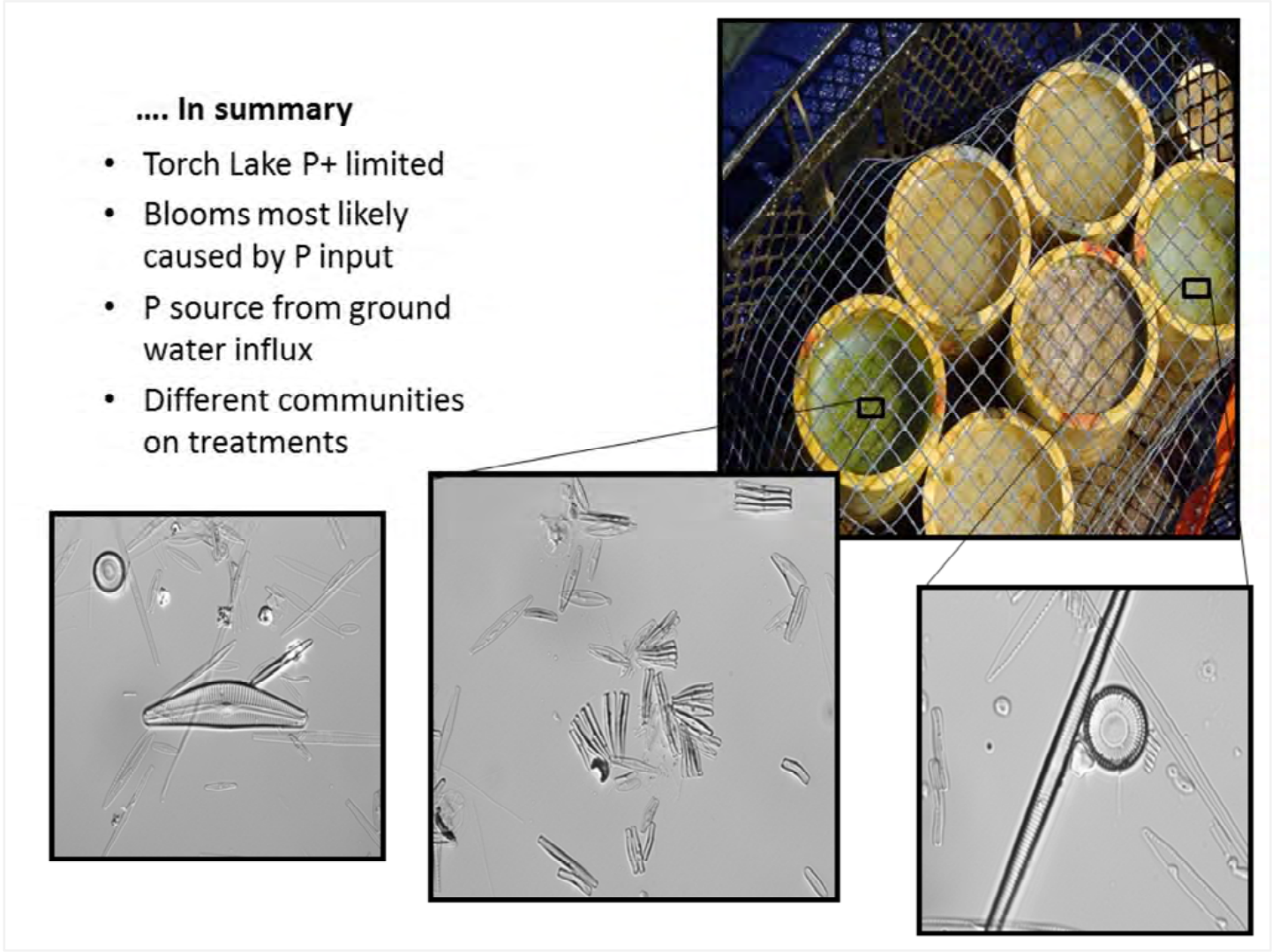
25 years of data collected by TLA supports a consistent level of phosphorus.

Notes:

We call this “Science in a Basket “ or the nutrient diffusing substrate experiment .

Nutrient-enriched agar (a culture medium for bacteria - kind of like jello) was placed in PVC cylinders with certain nutrient concentrations to see what algae would grow and which nutrients limited or promoted the growth of GBA.

140 species of diatoms have been identified in the algae. Eight (8) of which are new to science. Diatoms are unicellular organisms that sometimes join together to form colonies.



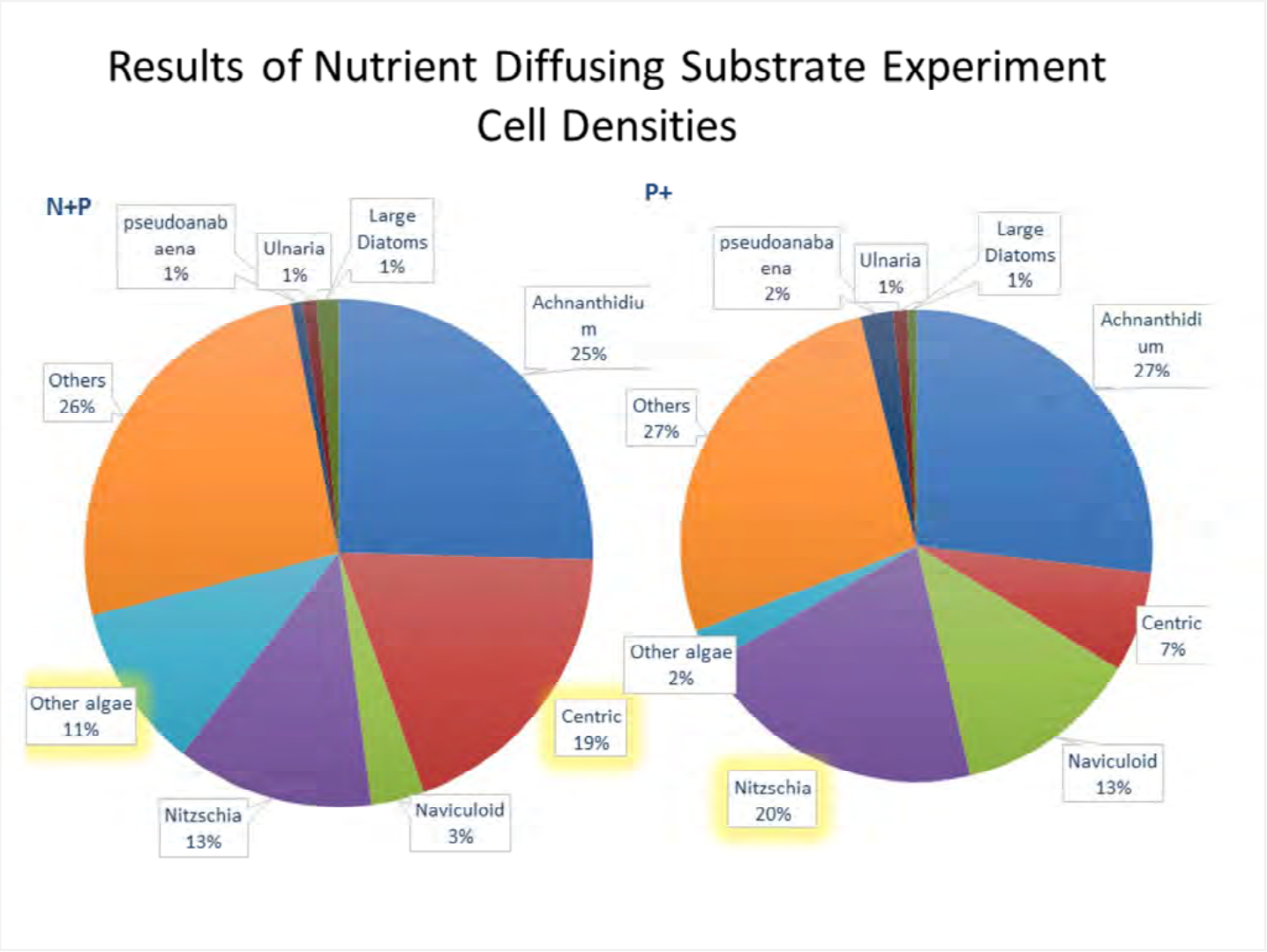
Notes:

Torch Lake is phosphorus limited . Phosphorus limitation occurs when there is proportionally less phosphorus than nitrogen.

Think of it like a recipe. Usually, you need 1 cup of phosphorus to 16 cups of nitrogen for algae and plants to grow. Torch Lake water has little phosphorus in it. So, it limits the amount of what can grow. Therefore, Torch Lake is phosphorus limited.

Additional phosphorus in the lake is most likely causing the bloom. It appears that the phosphorus is coming from the groundwater and is encouraging the GBA growth.

In the "Science in a Basket" experiment , different communities of diatoms (organisms) grow in the agar (jello) mixtures.



Notes:

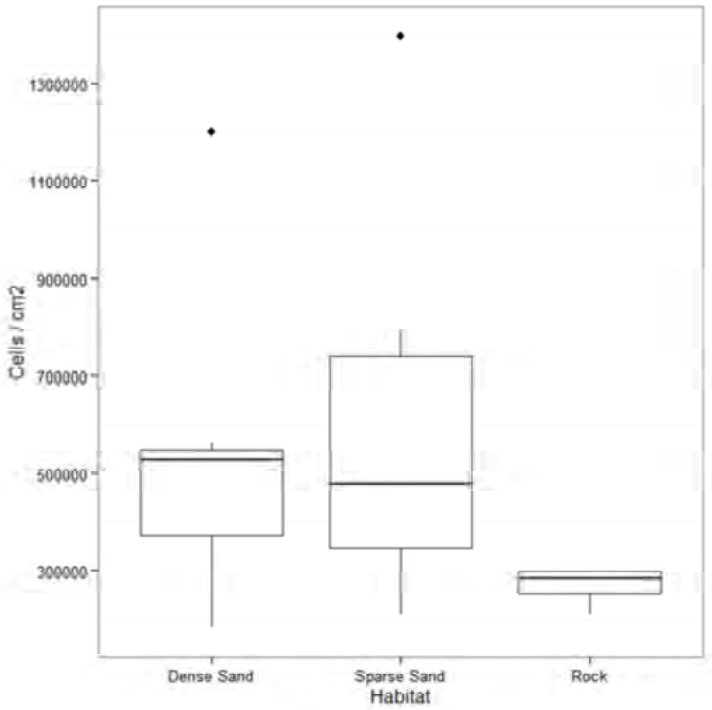
Results of the “Science in a Basket:”

Changes in the agar nutrient composition changes the types of algae that grow.

This information is still being analyzed BUT the bad types of blue-green algae were not detected.

Cell Density (Cells/cm^2) of All Benthic Algae

- Averaging about 500,000 cells/cm^2
- Mostly diatoms
- Density in sand more than rock
- Density in sparse sand same as dense sand
- What causes diatoms to move from the top centimeter to the surface of the sand?



Notes:

Samples were collected in areas within the patterns of visible algae (breakouts or assemblages) and where it was not visible.

This information has led to an additional hypothesis: The GBA may have been growing in the sand all the while. The right nutrients and environmental factors are allowing it to migrate up to the lake floor, reminding us that groundwater is an important part of the overall surface water in the lake.

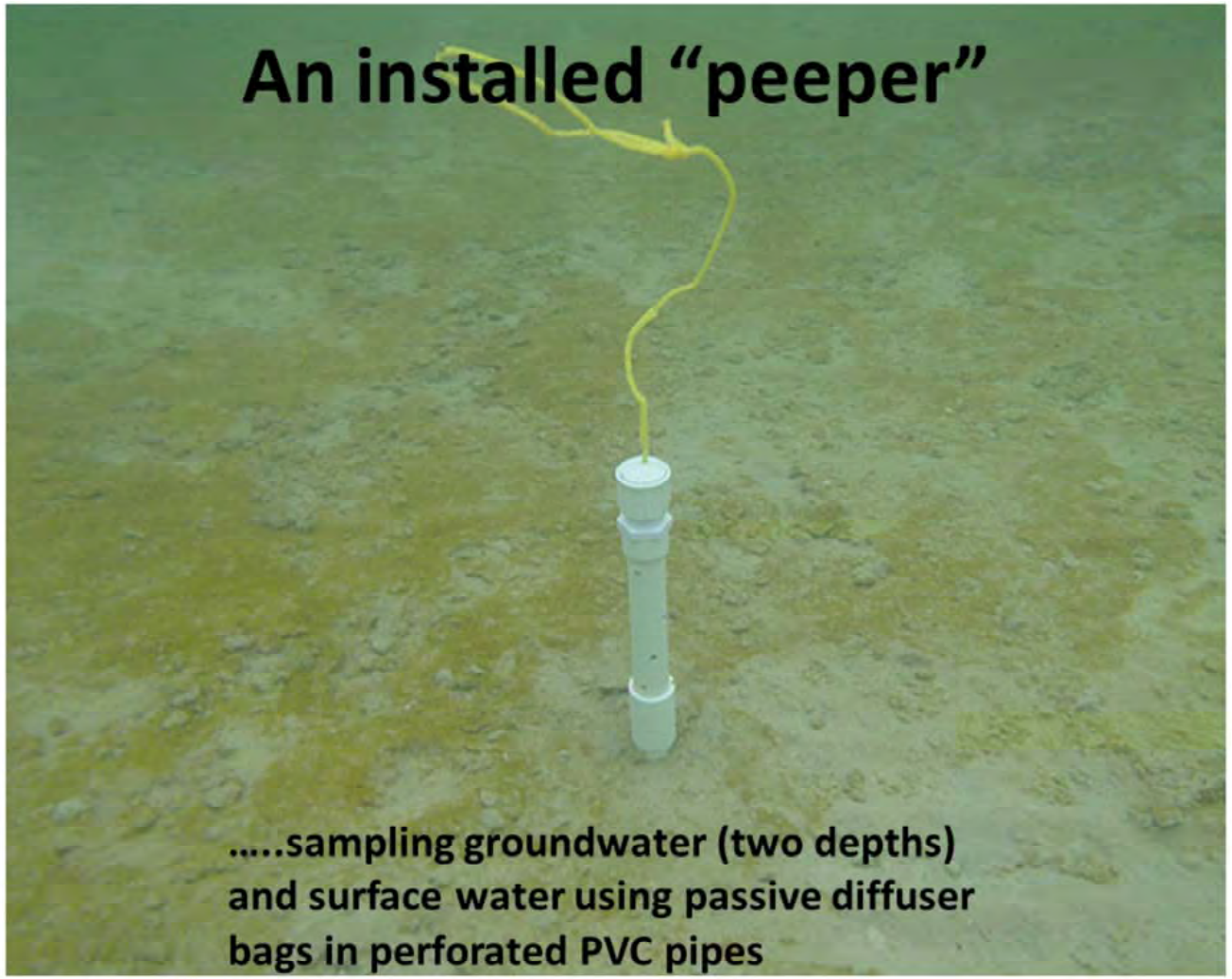
Notes:

Another opportunity arose to collect groundwater samples using a different method. Built from PVC, the peeper contains two collection chambers. Each chamber contains distilled water in tubing (the equivalent of a sausage casing) and over time the nutrients diffuse into the chambers.

Driving a "peeper" into the lake bottom

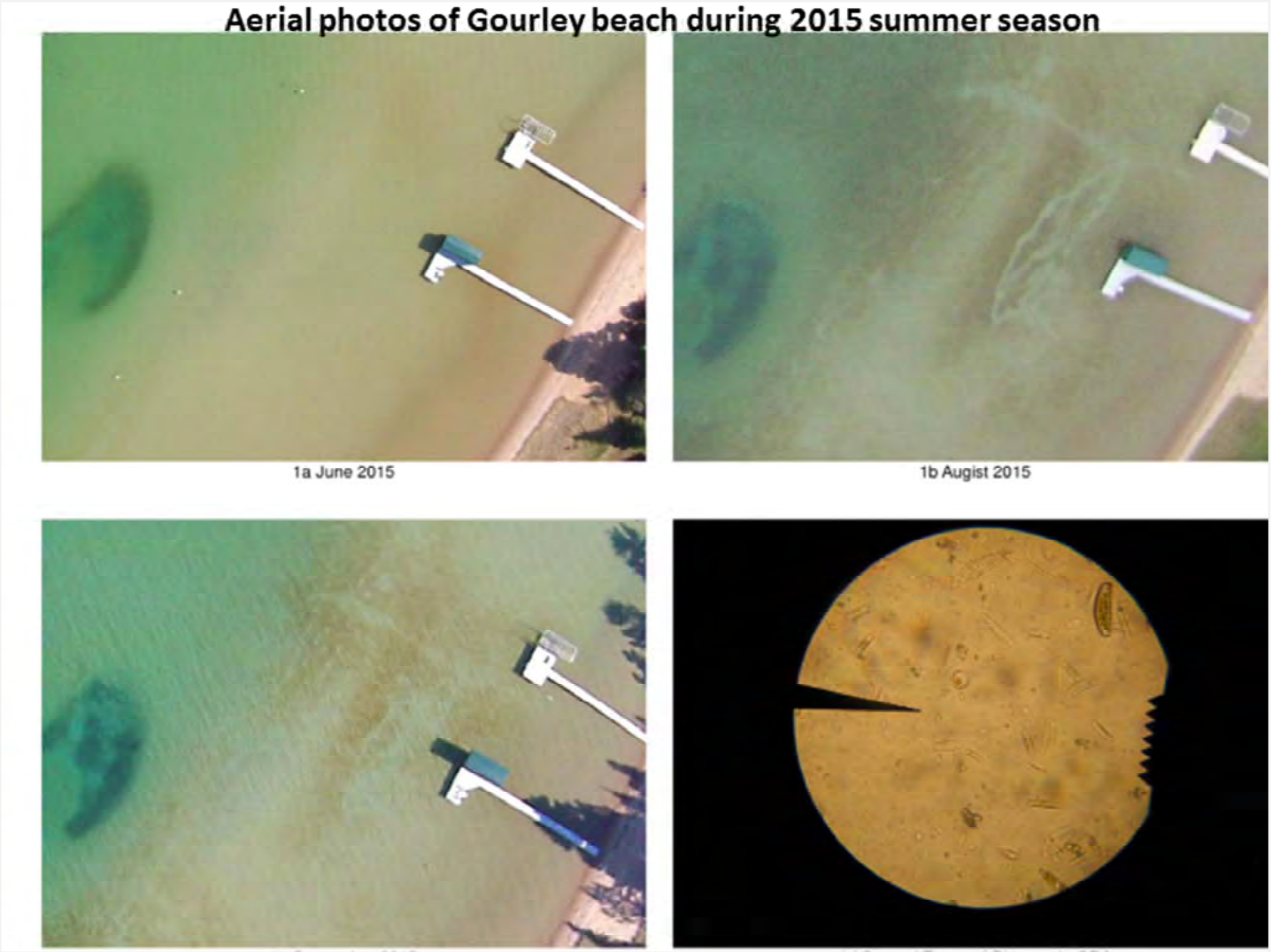
Notes:

Installing the peepers proved to be difficult. While not all samples proved worthy, several good ones were obtained.



Notes:

The peeper shows the top chamber collecting nutrients from lake water while the other chamber collects nutrients at a depth about 1’ below.



Notes:

An aerial lifecycle of GBA over the summer 2015.

Intriguing research questions, not yet investigated

- Are groundwater nutrients inducing outbreaks of 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?

Notes:

While awaiting the remaining information from 2015, the 2016 Study Plan is being formulated. The Water Quality Committee will present the plan in early April. Stay tuned.