Golden-Brown Benthic Algae Project

Responses to Frequently Asked Questions

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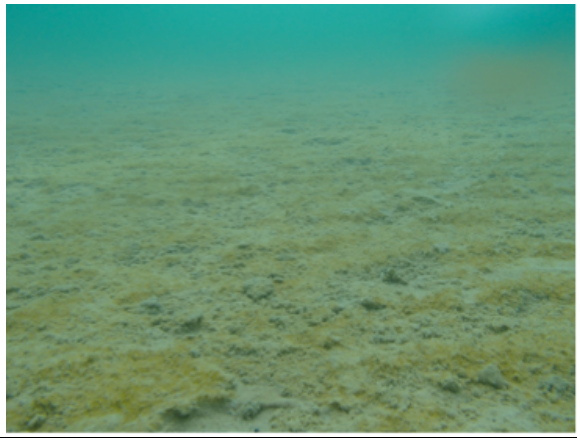
Background Information:

Golden-brown benthic algae is not new to Torch Lake, but its prevalence in recent years seems to be increasing. More riparians are asking questions about this "crud" on near-shore bottomland. The photos (below) show an aerial photo of an area on Torch Lake shows a typical pattern where it grows, and what it looks like underwater. The most common questions are… What is it? What causes it? And what can be done about it?

Preliminary examinations of samples indicated the presences of a various phytoplankton including species of blue green algae in crusty mats of precipitated calcium carbonate, which is presumed to be more of an aesthetic nuisance than a serious threat to water quality. Similar observations have been made in other inland lakes in northern Michigan. Michigan State University (MSU) zoology and hydrology experts hypothesize that increases in groundwater nutrient migrating into these inland lake may be stimulating the growth of these benthic diatoms in areas where groundwater in seeping into the lake. To test that hypothesis, our water quality teams invited MSU and U of M researchers to provide a collaborative proposal to investigate the groundwater nutrients and golden-brown benthic algae in Torch lake.

Aerial photo of Torch Sunset Condos showing areas with and without golden-brown benthic algae



Underwater photo showing mats of golden-brown benthic algae in 2014, an aesthetic nuisance

Frequently Asked Questions (FAQs) about the research proposal:

1. What are the credentials of Professor R. Jan Stevenson (principle investigator of this proposed investigation), and co-investigators Rex Lowe, and Sherry Martin?

   Dr. Rex Lowe is a biological science professor from Bowling Green State University in Ohio. He continues speaking, teaching and collecting freshwater samples all around the United States (Hawaii, Alaska, and California) and the world (Palau, New Zealand, Cuba). He continues to teach a summer program at the U of M Biological Station at Douglas Lake. List of his consultantships include but is not limited to: Michigan DNR, US EPA, US Park Services, USGS, Proctor and Gamble, Bristol-Meyers, Detroit Edison, Nature Conservancy and Leelanau Nature Conservancy In 2006, a commemoration of the work of Rex Lowe in the Advances of Algal Biology was compiled in the journal Hydrobiologia. At that time Dr. Lowe had published more than 80 papers, books and book chapters. The preface to the journal characterized Dr. Lowe to have" extraordinary effects on his students and colleagues with his engaging personality, sometimes dangerous senses of humor and fun and infectious fascination with the biodiversity and ecology of algae."

   A research design was specifically designed by **Dr. Jan Stevenson**, a professor of Zoology at MSU, an author of 98 publications (as of 2006). Dr. Stevenson employs his "technical expertise in algal taxonomy and ecology to test ecological theory and to develop approaches for solving environmental problems." Additionally, he has provided expert testimony to Environmental Resource Commission on national and international perspectives on environmental criteria particularly nutrients.

   Sherry Martin is a Research Associate in the Department of Geological Sciences at MSU. Her area of expertise is groundwater hydrology. Last summer her research addressed questions regarding Higgins Lake ground water hydrology. The Higgins Lake Association has funded this research for $30K in 2014 and committing to another $30K this summer. Our research design will benefit from techniques developed during this fieldwork.

2. What are the research questions and how will they be tested, in simple terms?

   The questions raised are: **does the benthic algae have the same species composition around Torch Lake?** More importantly, **are groundwater nutrients causing the proliferation of this benthic algae?**

   To determine the extent and species composition of the algal proliferation in Torch Lake, samples from 2 study sites (Hay-o went-ha and Sunset Torch Condos) and from 8 other sites around the lake (taken from similar depth and distances from creeks) would be analyzed 3 times during the summer (to address potential changes in the growing season) for species composition. We are also interested in comparing the growth of these mats of benthic algae during the summer growing season in an area with multiple riparians

dwellings and comparing that growth pattern with the benthic algal growth an undeveloped area. This would answer our first question.

To answer the second question, the research design has two experiments that complement each other and potentially provide supportive evidence that specific groundwater nutrients are giving rise to the identified benthic algae.
The first experiment is to measure groundwater nutrient concentration in areas with known benthic algal composition in Torch Lake off sites with low and high development density. This would allow comparison of nutrient concentrations in groundwater from areas with benthic algae.

In order to find the groundwater seeps, thermistors (fancy thermometers) would be used to look for a colder temperature at the lake bottom. A lower temperature along the bottom of a shoal during summer months is indicative of groundwater entering the lake. Piezometers would be installed and using MSU techniques, groundwater would be drawn (without "contamination" from lake water if pumps are to be used to draw the groundwater out of the wells.) Nutrient concentrations would be needed throughout the summer to identify if nutrient levels and ratios change throughout the season. As phosphorus concentrations in groundwater were obtained 10 years ago, a comparison can determine if concentrations have increased over time which would be supportive of the second hypothesis. Additionally, analysis will identify the nitrogen concentrations of the groundwater- a measurement not previously analyzed and that will be used to compare to the results of the second experiment.

For the second experiment it is important to know that algae, more specifically diatoms (unicellular phytoplankton with silica cell walls), respond to differences not only in nutrient concentration but also pH, light availability, alkalinity, and other microelements present in each body of water. Thus, diatoms can tell a story about the conditions of a specific lake as these variables are often known about common dominant diatoms. So, in the second experiment different combinations of nutrients in agar (a gelatin like substance) would be placed on or near the bottom of a shoal area for 2 weeks. At the end of that time, the species of diatoms growing on each treated agar would be identified. These diatom communities would be compared to the diatom communities collected around Torch Lake. Where there is a match in diatom composition, the agar with that specific nutrient mixture would be compared to the nutrient concentrations found in the groundwater samples. Thus, proof of specific groundwater nutrients concentrations are promoting the golden brown benthic algal growth.

Or to say that is another way, the design would compare the groundwater nutrient concentration found in the first experiment to the nutrient ratio that promoted the same diatom community found in Torch Lake in the second experiment. This provides greater reliability in the findings that groundwater is causing the benthic algae proliferations than doing just one or the other of the experiments. We will rely on our experienced professors to assure a statistically sound result.

3. Since the concentrations of groundwater phosphorus in Torch Lake was measured in 2005, and found to be highly variable (8 to 20 times higher than the concentrations in the lake water), why do the concentrations of groundwater nutrients need to be measured again?

   The 2005 study focused on the **average amount total phosphorus** entering Torch Lake from groundwater at 13 locations. One of the locations will be in common with two locations in the proposed investigation, which will measure the concentrations of **two forms of phosphorus** (total and bio-available soluble phosphorus), and **three forms of nitrogen** in groundwater samples from **four groundwater wells (piezometers) at each of two locations.** This data will allow a more reliable interpretation of the relationship between specific groundwater nutrients and the profile of algal species growing at each location.

4. What useful information is learned from the nutrient-enriched agar experiments?

   The experiments will confirm that phosphorus is the rate-limiting nutrient that drives the growth of the golden-brown benthic algae. Additionally, we also envision the findings from the nutrient–enriched agar experiments will reveal the connection between specific groundwater nutrients at the two well-studied locations on Torch Lake with the profile of specific species of diatoms & algae at other less well-studied areas around the lake. The findings from these experiments will also improve the expert's interpretation of the specific types of groundwater nutrients that yield this type of golden-brown algal growth in the benthic regions of Torch Lake.

5. Is measuring three human-related chemicals in groundwater an important part of this investigation?

   Although measuring the concentrations of caffeine, Trichlosan antimicrobial agent, and birth control estrogen in groundwater is **not a necessary part of this investigation**, these "marker" chemicals are currently part of another MSU study so the cost per sample ($20) seems like a very practical way to

confirm that source of some of the groundwater nutrients could be septic systems since these chemicals are known to pass through conventional septic systems.

6. In addition to managing the nutrients from septic systems that percolate into the groundwater, what are some other possible sources of groundwater nutrients that could be stimulating the growth of these patches of golden brown benthic algae?

   Reducing the use of lawn fertilizers, especially those that contain phosphorus, is another way to reduce the nutrients in groundwater. Additionally, enhancing the shoreline greenbelt with deep-rooted plants and shrubs can also help reduce the concentrations of groundwater nutrients and hence the growth of golden-brown benthic algae, **if the findings from this investigation show that groundwater nutrients contribute** to the occurrence of golden-brown benthic algae. Tools are available to units of government to help manage these sources of groundwater nutrients.

7. In addition to the fees-for-services from the MSU and U of M staff, how much volunteer time will be needed to conduct this investigation?

   In addition to a budget of nearly $18,000 for the fees-for-services, to be split between co-sponsoring organizations, this investigation will require a significant amount of in-kind volunteer support to install the piezometers, collect groundwater and benthic algae samples, and systematically take & compile photos; perhaps several hundred person-hours of volunteer time. Although research conducted by universities normally include a significant percentage of the budget to pay for indirect overhead fees, it may be waived for this investigations as currently being proposed. It is a rare opportunity to have this much expertise focused on Torch Lake in such a collaborative manner.