QUARTERLY
THREE LAKES ASSOCIATION
SERVING LAKE BELLAIRE, CLAM LAKE AND TORCH LAKE IN ANTRIM COUNTY, MICHIGAN
JULY 2020

Monitoring Water Levels on the Elk River Chain of Lakes

By Fred Sittel
TLA Vice President

A year ago, area lake associations and riparian property owners, led by a committee of the Intermediate Lake Association, began working with Antrim County's operator of dams to address complaints of nuisance flooding on the upper chain of lakes. As a result of this collaboration the County engaged the U.S. Army Corps of Engineers (USACE) to develop a hydrological model of water movement through the lakes, connecting rivers and two dams of the chain of lakes.

A group of area riparian property owners decided to support this effort by recording changing lake levels on eight lakes of the chain and the Bellaire dam impoundment starting last spring. Volunteers used measuring sticks to record water levels on their lake relative to an underwater datum established specifically for that purpose along their frontage.

This community-based effort resulted in more than 1,400 measurements being made between April and October and the data helped us identify characteristics of individual lakes during rain events. USACE believes this type of long-term lake level information will be useful for calibrating their model.

This year the volunteers are being tasked to host automated measuring equipment called *level loggers* which combine underwater pressure and temperature sensors with data processing and storage. The use of automated equipment enables measurements to be made more frequently but also raises a number of technical considerations about sensor function, sampling rate and data analysis to ensure that having more data will result in gaining better information.

TLA volunteer Fred Sittel and property owner Linda VanHuysen in mid-April after installation of a level logger (arrow) adjacent to VanHuysen's frontage on Benway Lake.

The design and function of the level loggers allows them to be compact, self-contained and easy to deploy in larger numbers. Each deployable unit consists of a one-inch diameter tube, six-inches long, with an optical communications port under waterproof cover at one end.

The logger's sensor does not directly measure water depth, it records the pressure and temperature at its position underwater. The loggers can only sense absolute pressure, not relative pressure, so additional steps are required to determine water depth. A "dry" logger positioned above water at a location central to the region where the other loggers are located must be dedicated to recording changes in atmospheric pressure.

After data from all loggers are downloaded, software calculates the difference in pressure at the time of each measurement between what the loggers recorded under water and the atmospheric pressure measured by the dry logger. Water temperature data are used to determine the density of water at the time of measurement, which then enables the differential pressure to be converted into inches of water above the logger's sensor.

Level loggers can be programmed to make measurements every minute or more frequently, if desired. But just having more measurements does not guarantee better information is obtained. Measurement frequency should be selected relative to the dynamic response anticipated from the system being measured.

Last year, volunteers observed individual lake levels changing noticeably in as little as a half hour during heavy rain storms. However, with a goal of understanding how water levels on multiple lakes behave in relation to each other during rain events, changes that are of interest likely will occur more slowly.

Last year, volunteers observed individual lake levels changing noticeably in as little as a half hour during heavy rain storms. However, with a goal of understanding how water levels on multiple lakes behave in relation to each other during rain events, changes that are of interest likely will occur more slowly. This year's level loggers are programmed to make measurements six times every day, which is

WATER LEVELS continued on page 3

Sneak peek

PRESIDENT'S MESSAGE	PAGE 2
CATCHING PHOSPHORUS	PAGE 4
INVASIVE MILFOIL	PAGE 5
SEOP GRANT	PAGE 6
ALGAL DIVERSITY	PAGE 7
WALK THE TALK	PAGE 8
GBA	PAGES 8 - 9

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President's Message

Summer has finally arrived. What happened to spring? We seemed to have transitioned from snow to heat in less than a week!

TLA will have a busy summer once again. We have an amazing board and an executive director that really cares about our land and our lakes.

Our Facebook page is constantly being updated. I encourage you to review it to get the latest information on TLA activities on our three lakes.

Our annual meeting will be different this year, due to Covid 19. A notice will be sent out related to those changes.

If you enjoy fishing, I encourage you to go to our web page to look up our fish shelters throughout the lakes. Great fishing hotspots! Take your grandkids out to enjoy fishing.

Please be cautious if you are boating on our lakes. There are a lot more paddleboarders and other non-motorized water-craft sharing the waters these days. And take note of the "no wake" laws that are there to protect the shoreline.

This newsletter has a lot of information for you to review. Feel free to contact any of our board members with questions.

Enjoy our lakes, be safe this summer.
Mike

Memberships Matter

Summertime is when our lakes really deliver: the endless fishing on Clam Lake; the loon families on Lake Bellaire; the crisp blue of Torch Lake - to name just a few. It is also when the Three Lakes Association is doing the vast majority of our water action activities.

- Homeowners are present and have questions about their shorelines and the things they are noticing in the water.
- Our water quality monitoring program, which began decades ago, continues monthly.
- Golden-brown algae returns so we track its extent with fly-overs and sample the species and environmental conditions around it.
- The nuisance species, Eurasian water milfoil can be treated only in the summer, when the plants are growing.
- Youth are out of school and available to help us study our lakes in our internship program, (although it is suspended for 2020 due to Covid-19).
- Summer is a great time for special studies, such as the sediment trap study explained in this newsletter.

All of these activities (and more) help keep our waters healthy and enjoyable to play in and live near, and members like you make it possible.

The vast majority of our funding comes from annual memberships. And right now we are looking to gain 100 new or renewed members for 2020. Please renew your membership before August 31, or if your membership is current, consider buying a gift membership for a neighbor or family member.

Members of Three Lakes Association are investing in the current and future health of our water. They hold a commitment to lakes that are swimmable and fishable for their children, grandchildren, and the community at large. They know that clean water is not a given; it requires action on the part of everyone, and coordinated efforts to track the quality of our water and plan for future actions to keep it healthy.

Three Lakes Association is the longest-standing group protecting Lake Bellaire, Clam Lake, and Torch Lake. We have deep expertise on water quality concerns such as nutrient inputs, septic systems, and erosion. You will see us at every meeting in the region that pertains to water quality in the Elk River Chain of Lakes. This is because we are committed to making sure our lakes remain spectacular for generations to come. Please join us with your membership or financial contribution today. Visit www.3lakes.com/membership.

Water Levels

Continued from page 1

more frequent than the once a day observations from last year. This more frequent measuring means that sometimes a measurement will occur just as a wave passes by.

Loggers could be programmed to measure more frequently and data could be averaged over any time interval desired. If wave passage is more or less random, averaging may provide a better estimate of true lake level. However, averaging over too long a time period reduces the resolution to detect changing lake levels. Also, the monitoring will continue for months and there will be many times when the water is calm. That means a lot of data storage, handling and averaging must be dedicated just to counteracting the influence of waves which only exist at certain times.

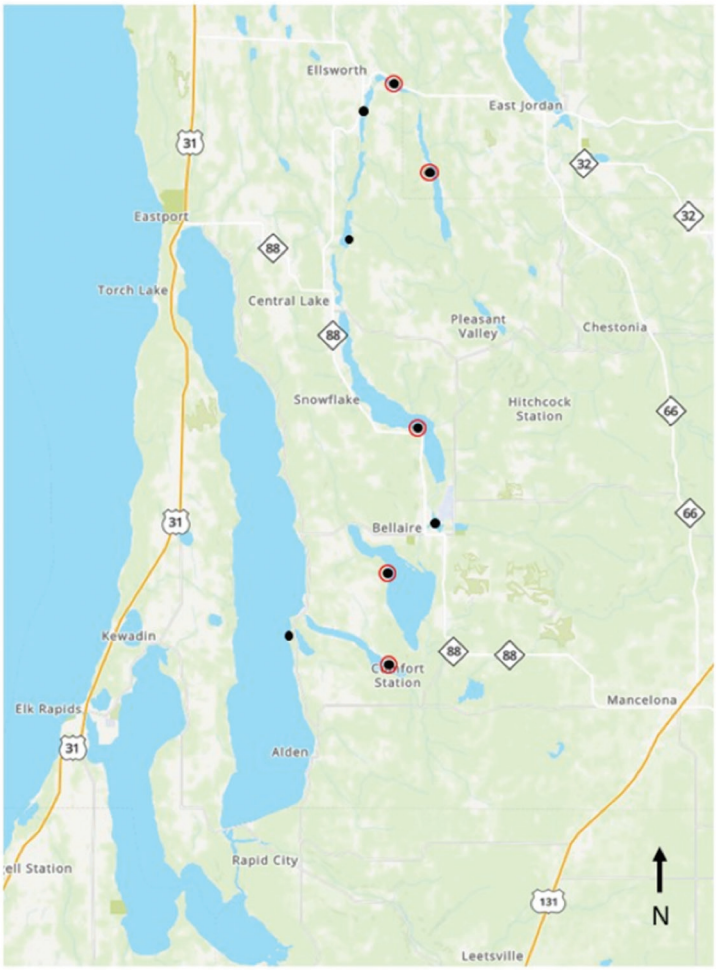
Another option that reduces the volume of data involves mechanically counteracting waves by mounting the logger inside a stilling well. The well consists of a vertical tube mounted on a post driven into the lake bottom. The top cap and lower half of the submerged tube have holes drilled in them to allow pressure inside and outside the tube to equalize. The holes are small so pressure equalization takes longer than the time for a wave to pass by, reducing its influence inside the well. Most of our loggers have been installed inside of stilling wells.

The data volunteers collected last year was reported as the change in water level from the lake's initial level in mid-April. This year, thanks to the Antrim County Benchmark Project, the level of many lakes can be reported relative to an established sea level datum.

In 2016, County Commissioners approved setting elevation benchmarks for the purpose of establishing the Floodplain Limit Line (FPLL) required by the Building Department for approving new construction. The benchmarks are set at a known elevation above sea level and the vertical distance to the FPLL, which the State established for each lake, is also documented. Benchmarks were installed at public access sites on Six Mile Lake, Lake Bellaire, Clam Lake and at the North and South ends of Torch Lake. The benchmarks will make it possible to compare the difference in surface elevation between individual lakes which provides a measure of hydraulic potential.

Stilling wells fabricated from three-inch diameter sections of PVC drain tube. The well standing vertically in the foreground has the top cap removed revealing the level logger (black) hanging from its support cable.

2020 lake level monitoring locations



- **Automated level logger**
- **Automated level logger and manual rain gage**

The level loggers were deployed in mid-April and started recording every four hours beginning at 12 a.m. on April 20th. At the same time, five volunteers hosting level loggers on their lake frontages also began recording twenty-four-hour rainfall amounts using coordinated equipment and procedures.

USACE completed channel cross-section surveys of the connecting rivers of the chain last fall and they plan to visit the area again in July. Additional survey work which Antrim County is responsible to perform was awarded to Grand Traverse Engineering Company and their field work started in May. Also in the month of May, representatives from the County and members of the Lake Level Committee held a conference call with USACE to discuss the most effective way to report water levels so the information is most helpful to modeling and calibration. During the call, USACE reported that their hydrology work was around 25% complete and that hydraulic modeling, for which the survey data is required, will begin this October.

For the volunteer lake level monitoring effort, a change to automated equipment with more frequent measurements offers the potential to identify relationships between individual lakes that could not be resolved using last season's data. Combined with information on localized rainfall amounts and the predictive capability of a properly calibrated model of water movement through the chain, it is hoped this effort can help identify management opportunities to reduce nuisance flooding, potential property damage and shoreline erosion on the Elk River chain of lakes.

Catching Phosphorus in Torch Lake

By Jeanie Williams
TLA Executive Director

On June 3rd, after weeks of quarantine and months of planning, three pontoon boats and the Poseidon Marine launched from the Dockside on a calm, blue sky morning to suspend a pair of sediment traps in the southern deep basin of Torch Lake. These sediment traps (see photo) were suspended in 260 feet of water, 150 feet below the surface and 110 feet from the bottom. Their task is be to collect the silent and steady fall of sediments and particulates that rain down through the water column of Torch Lake.

Anything might fall into the traps, including pollen grains, silt, expired phytoplankton, and mineral deposits. What we are after is the phosphorus part of that "rain." Phosphorus is a critical component of every living cell. All life requires it, and in many ecosystems, particularly Torch Lake, the amount of available phosphorus determines the amount of life that is possible. Here, phosphorus acts as a limiting nutrient so it's an important one to track. If phosphorus amounts increase, we will likely see more algae growth in the water.

The phosphorus we find in the traps will be partly from the biological things that rain down. It will also be from mineral deposits, and this part is interesting. Torch Lake is a high calcium lake, which is part of what makes it so clear and nutrient poor. When carbon dioxide levels decrease, such as when water warms, calcium will fall out of solution to form a solid called calcite (aka marl, aka that white stuff that collects inside your tea kettle), which then sinks to the bottom of the lake. On the way, calcite will grab onto phosphorus and take it down with it. The calcium in the water is literally stripping phosphorus out of the lake, which keeps plant and algae growth low, since phosphorus is an essential nutrient for their growth.

Even with this phosphorus stripping, we are seeing increasing algae growth along our shores (see articles on golden-brown algae in this issue). We still don't know exactly what the cause of this is, but increased algae growth very often means increased nutrients, and in Torch Lake that probably means increased phosphorus. Can the sediment these traps collect help us understand if phosphorus is increasing on Torch Lake? We sure hope so, but lakes are complex, and studies have their limits, so exactly what we learn from this study is yet to be revealed.

Installing sediment traps in Torch Lake (left to right), Back row: Jeremy Toyra (an employee of Poseidon Marine) and Richard Moran (owner of Poseidon Marine). Front row: Jeanie Williams (TLA's Executive Director), Norton Bretz (TLA board member), and Doug Endicott (Environmental Engineer, Great Lakes Environmental Center).

The traps will be left in the water all summer. At the end of the season we will recover the traps, remove the collection bottles, and bring them back to the lab for analysis. There should be a tiny amount of material in the sample bottle, maybe about a gram. And this material will be tested for the amount of phosphorus it contains.

In 2005, TLA carried out a phosphorus-balance study that looked at all of the inputs and outputs of phosphorus in Torch Lake. We estimated that stream inputs, groundwater seepage, and atmospheric deposition each contributed about one third of the phosphorus that entered Torch Lake. For all of the phosphorus that entered the lake flows, about 20% of it flowed out through the Torch River. Where did the rest of the phosphorus end up? The phosphorus-balance study answered that question. It determined that 75-85% of all of the phosphorus that entered Torch Lake on an annual basis sank to the bottom of the lake! This percentage is much higher than for most lakes, and helps explain the high water clarity in Torch Lake.

When we collect the sample bottles at the end of the summer, we will attach new bottles and leave the traps out again for fall. If funding comes through we will be able to deploy the traps a third time and collect the sedimentation from the winter months as well, for a full 12 months of data collection.

If you want to prevent phosphorus from entering your lake, consider limiting the amount of fertilizer you place on your lawn. Fertilizer often contains phosphorus, and if applied at the wrong time or in too large an amount it can end up in the lake, exactly where no one wants it to be. More tips for lake-friendly lawn care can be found here: https://conservetorch.org/caring-for-water/true-blue-gardening/

To see a video of the sediment trap launch, visit our Facebook page: https://www.facebook.com/3lakes This study is designed, guided, and analyzed by Doug Endicott of Traverse City's Great Lakes Environmental Center (GLEC). The results and interpretations from this study should be available next summer, and are expected to guide future initiatives designed to protect water quality.

These dark patches are EWM.

TLA Partners with TLPA to Remove Invasive Milfoil from Torch Lake

By Jeanie Williams
TLA Executive Director

Three Lakes Association (TLA) and Torch Lake Protection Alliance (TLPA) are working together in a joint effort to control an invasive aquatic plant that poses a potential threat to Torch Lake. Eurasian watermilfoil (EWM) has established itself in the harbor at the mouth of Clam River; and in Torch Lake in the embayment between Stony and Lone Tree Points, in the harbor in Alden, and in the sucker holes east of the south sandbar.

Eurasian Water Milfoil has a feathery appearance and can grow to more than 10 feet tall, all the way to the surface of the lake. While not harmful to humans or animals, EWM forms large mats of floating vegetation that can shade-out native aquatic plants and impede recreational activities such as swimming and boating. EWM plants are easily fractured and the broken pieces can develop roots and establish new infested sites where the fragments settle. Several Michigan lakes have been completely covered by this invasive plant.

On June 15, these patches were treated with Renovate pellets, an herbicide that specifically targets EWM. The application was carried out by PLM Lake and Land Management Corp., a highly-respected company that has been treating EWM in the Chain of Lakes for years. The treated patches will be monitored and may require a second application in the fall if EWM is still detectable.

Members of both organizations, Bob Milliron of TLPA and Becky Norris, Rick Doornbos, and Jeanie Williams of TLA were present during the application, to guide the PLM team and ensure that only the target areas were treated. You can see a video of us out on the water and "fishing" for milfoil on our Facebook page. https://www.facebook.com/3lakes/

Our combined TLPA-TLA team will also be creating a long-term monitoring plan for existing patches as well as for Torch Lake as a whole. It can be difficult to eradicate EWM completely, but it is possible to keep patches small and stop new patches from forming with an ongoing management plan. Identifying and treating any new EWM patches early on protects the lake and is far more cost-effective than treating large, established patches.

You can protect our three lakes from the introduction of additional invasive milfoil and other invasive plants and animals by practicing responsible boating – this even applies to kayaks and paddleboards:

1. Remove any visible mud, plants or animals from your boat.
2. Drain water from any holds: live well, motor, bilges, etc.
3. Dry your boat before launching into a new body of water.

For more excellent tips visit the Tip of the Mitt Watershed Council's website on clean boating: https://www.watershedcouncil.org/clean-boating.html

This article is based on a similar article that ran in the TLPA newsletter in May. TLPA kindly gave us permission to modify and update their text for our newsletter.

Summer is the Season for Swimming – Not Itching!

By Jeanie Williams
TLA Executive Director

There is nothing more enticing on a hot summer day than a dip in the cooling waters of Torch, Bellaire, or Clam. But it's not so enticing if you might come out of the water with a case of swimmer's itch! Fortunately, Freshwater Solutions, a regional research lab that we have been collaborating with, is fully engaged in research to come up with the best swimmer's itch prevention and avoidance strategies, so we can swim itch free.

A summary of those strategies, and a little bit about the ecology of the pesky creature who causes swimmer's itch, are now available on a new rack card to educate the public on how to avoid "The Itch." The rack card is included in this newsletter and can be found throughout our service area. We hope you find these tips useful.

You can also participate directly in the research efforts that will help us learn where swimmer's itch is most common and what conditions minimize its effects by taking this survey whenever you swim in any lake. Take a photo of this QR (quick response) code with your phone and follow the on screen instructions, or go to this website www.swimmersitch.info. Thank you for participating!

TLA led the collaborative effort to create the new version of the Swimmer's Itch rack card with our partners: Intermediate Lake Association, Elk-Skegamog Lake Association, Torch Lake Protection Alliance, Torch Conservation Center, and Freshwater Solutions. Scientists at the University of Alberta Canada in partnership with Freshwater Solutions are coordinating several swimmer's itch studies in our region and manage the data collected from the QR code.

What to do to avoid the Itch	Why it Helps
Avoid onshore winds.	*Swimmer's itch parasites float near the surface of the water and can be blown about by the wind. Onshore winds can push and accumulate parasites near shore.*
Swim in deeper water according to your abilities.	*Swimmer's itch parasites originate in the shallows, so are less likely to be found in deeper water.*
Swim in the afternoon.	*Swimmer's itch parasites emerge in the morning and have largely dispersed or died back by late afternoon.*
Protect your skin from parasites: • **Cover up with rash guard clothing.** • **Try out swimmer's itch prevention creams.** • **Towel off and wash up and after swimming.**	*Parasites burrow into skin and cause an allergic, itchy reaction. These actions can block them from getting at your skin, or can rub them off before they can burrow in.*
Don't feed waterfowl.	*Where waterfowl are fed, they congregate.* *Many species of waterfowl are involved in the life cycle of different swimmer's itch parasites.* *These birds can bring more parasites to our lakes.*

SEOP Grants Selected for Academic Year 2020-2021

By Tina Fields
TLA Education Chair

The educational outreach granting program that TLA has conducted for the past eleven years met with serious and unprecedented obstacles in the spring of 2020. It kicked off just as the global COVID-19 pandemic set in. Schools closed down and teachers scrambled to support their students in a new, virtual, setting, which hardly left time for them to consider applying for TLA's Science Education Outreach Program's grant cycle for the 2020-2021 academic year.

Still, three teachers from three schools in three of our four school districts did apply: Greg Beach, who teaches Grade 2 Science at Birch Street Elementary School in Kalkaska; Mackenzie Foster, who teaches Kindergarten at John R. Rodger Elementary School in Bellaire; and Donovan Eggleston, who teaches Grade 6 Science at Central Lake Elementary School.

Greg Beach applies virtually every year seeking support for the annual field trip to the Au Sable Institute for Environmental Studies. His statement of rationale is: "Our students are required to learn about habitats, water cycles, and the human effects upon those natural systems as part of the common core state standards. The visit to the Au Sable Institute of Environmental Studies supports students' learning and greater understanding of their natural environment." The grant amount applied for was $10 per student for 90 students - $900.00.

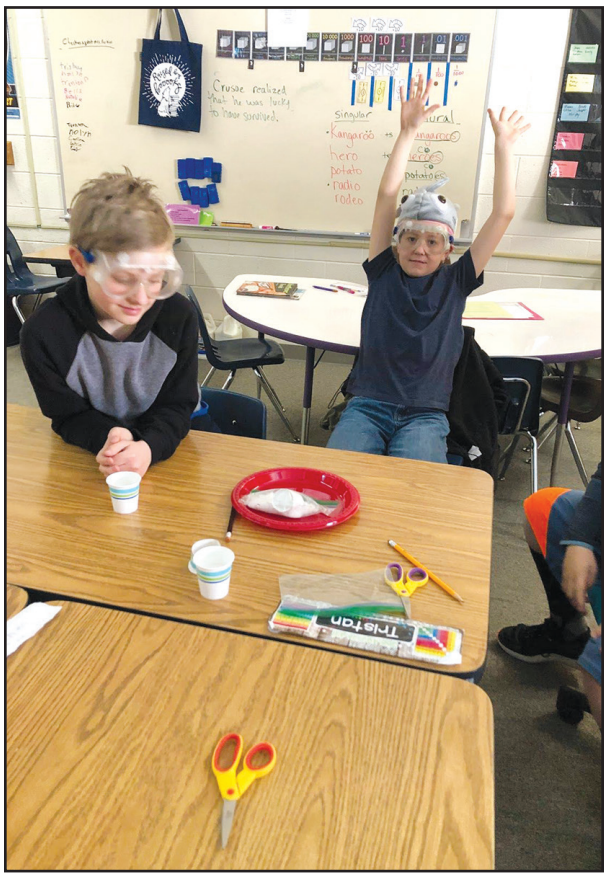
Mackenzie Foster applied this year for the third science module that completes the set to meet the science learning state requirements for kindergarten. Her statement of rationale is: "We do not have a school-supplied science curriculum. Over the past two years, TLA grants have purchased two FOSS* kits for my kindergarten class. There are a total of three kits for kindergarten - together, the three kits cover all of the NGSS (Next Generation Science Standards) for kindergarten. My students love using the FOSS kits because they get to touch and see and play with science. They get so excited when they see 'science' written on the board on days that we use the kits. The kits truly make learning fun and engaging, as well as provide me with all the resources and curriculum that I need. This kit will be used year after year … to teach approximately one-third of the kindergarten science standards." The grant amount applied for was $1,061.00.

(* FOSS = Full Option Science System by UC Berkeley Lawrence Hall of Science.)

Donovan Eggleston applied for two projects. Project 1 is support for Inland Seas Scholarship Field Trip. His rationale statement is: "Students are able to get hands-on science experience that connects to the Great Lakes through the Inland Seas Field Trip. They will be able to connect material learned in our life science class to topics that affect our region directly. From environmental issues to living organisms such as fish, students will be able to see the real world impact our topics for learning delve into." The grant amount requested was $420.00

Project 2 is support for tools and supplies to create the Central Lake Public Schools garden. His rationale statement is: "With this grant money, we at Central Lake Public Schools will be able to continue our work toward establishing a School Agriculture Club. In addition to the recent grant we received from the MiStem Network that will allow us to build several raised garden beds on school grounds, we will be able to use these monies to purchase the necessary tools for cultivating and maintaining the garden area. We will also be able to start experimenting with composting and recycling cafeteria waste that would otherwise find its way to the trash. The study of agriculture and horticulture connects students to multiple science concepts, as well as being cross curricular. Not only will students learn important science concepts by studying plants, weather, insects, etc., they will also learn important math, technology, and engineering concepts. The materials bought will be used throughout multiple school years and will help students connect relevant class curriculum to hands-on real world situations." The grant amount requested is $545.00.

This year's grants total $2,926.00, about half of our usual SEOP award amount. Notice of these awards will soon be sent out to the schools. Because of the unavoidable uncertainty imposed on all plans by the ongoing COVID-19 pandemic, various conditions will attend these awards. We are hoping that next year will be easier.



Three Lakes Association Annual Meeting is August 6

A Short Primer on Algal Diversity and Ecology

By Jan Stevenson

Tens of thousands of species of algae are described from waters around the world, and 5 to 10 times that are likely undescribed. Each of those species responds somewhat differently to its environment. These algae are the base of marine and freshwater food webs, just as plants are the base of terrestrial food webs.

Algae are responsible for about half of the oxygen produced on earth. The many species of algae represent about ten distinct evolutionary lineages. The three most common of the evolutionary groups in freshwaters are green algae, golden brown algae, and cyanobacteria.

Did you know: Algae are defined as all photosynthetic organisms with simple reproductive structures that restrict them to living primarily in water. So algae are an ecological group, defined by their lifestyle, rather than a single-lineage evolutionary group. Many different evolutionary groups (bacteria and protists) are also in the algae group. For example, cyanobacteria, even though they are bacteria, are considered algae because they have the same basic ecology (lifestyle) as all the other algae in marine and freshwater ecosystems.

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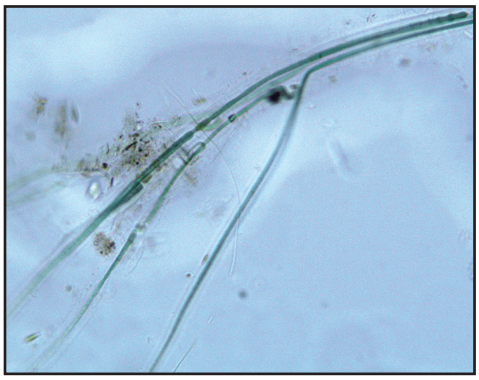
Some major evolutionary groups of algae have common names based on the color of the dominant pigment within them. These pigments are used to capture light energy in photosynthesis, which creates sugars as a basic form of nutrition for algae. Green algae have a dominance of the green pigment chlorophyll, like plants. Green algae are the evolutionary ancestors of all plants. Golden brown algae have a very different dominant pigment, fucoxanthin, which is golden brown.

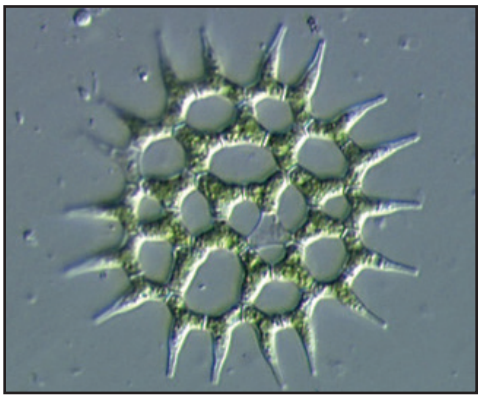
Algae live in two very different habitats in water. They can live suspended in the water itself or attached to surfaces, including sands and mud. The algae in the water column are called plankton, or phytoplankton more specifically. The algae living on surfaces in the water are called benthic algae.

Different species of algae are adapted to live in planktonic and benthic habitats. For example, phytoplankton are more buoyant and benthic algae have special adaptations that help them attach to rocks, sand, logs, and even muds.

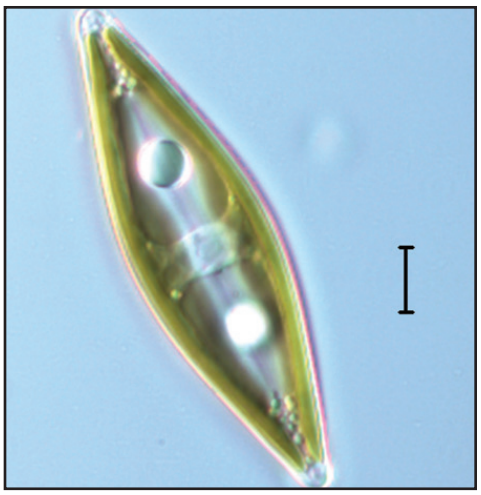
Diatoms (see photo), one of the kinds of golden brown algae, attach to surfaces as small as sand grains. They attach with mucilage pads or a slit



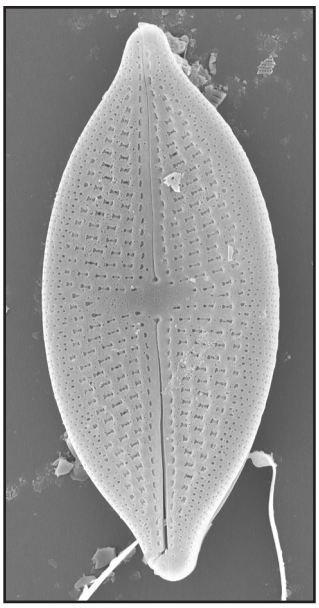
Dichothrix - a filament of hundreds of cyanobacterial cells, finer than the finest human hair, and about ½ of a millimeter long.



Pediastrum - a colony of green algal cells about 1/10th of a millimeter in diameter.



Craticula - a single diatom. The scale bar in the Craticula image shows size of this large diatom. The scale bar is 1/100th of a millimeter long. Craticula is slightly less than 1/10th of a millimeter long.



Aneumastus - scanning electron image of a single diatom, about a 1/3 the size of Craticula. Notice the intricate pattern in the glass wall.

in their glass cell wall that allows them to move across sands and rocks or through silts and muds.

Yes, diatoms are encased in glass. Diatoms have glass cell walls with fine pores and elaborations that make them the microscopic jewels of our waters. Diatoms are often the most abundant algae both in the plankton and benthos.

The ecology of algae in water is very much like the ecology of plants on land. Algae, like plants, use basic earth elements and sunlight to survive and reproduce. The main earth elements that limit reproduction of algae in lakes are nitrogen, phosphorus, and sometimes silica. These elements are called nutrients.

Increases in light and nutrient concentrations will stimulate reproduction of algae. Water temperature also regulates algal reproduction, with lower reproduction in cold than in warm water (e.g. summer conditions). Nutrient pollution in combination with warm summer temperatures stimulates reproduction of algae, particularly cyanobacteria, and thereby causes the harmful algal blooms that have become a worldwide matter of concern.

Grazers are creatures that eat algae, such as microscopic protozoa and macroscopic snails and insect larvae. Bacteria, fungi, and viruses can also kill algae. Increases in these algal consumers can slow or stop growth of algal blooms or mats of algae on lake bottoms. Grazers, as well as bacteria, fungi and viruses will increase in abundance after algae start to accumulate and can regulate algal blooms, but often this regulation is too late when nutrient pollution causes algal reproduction that is too fast for consumers to control.

If consumers are themselves limited by other factors, such as fish that eat insect larvae, they may not be able to stop algal accumulation in a habitat. As a result, even in low nutrient habitats like Torch Lake and Lake Bellaire, algae can reproduce and accumulate slowly into thick blooms and dense mats over a longer undisturbed period.

There isn't a lot of evidence to conclude that the golden-brown algae in Torch Lake is present because of a lack of grazers, but it is one of the hypotheses we are considering. If we don't want GBA to become more abundant, we should probably figure out what is going on. Read the article in this issue on Nuisance Golden Brown Algae to start getting caught up on the latest information.

Dr. R. Jan Stevenson is a professor in the Department of Integrative Biology at Michigan State University. He has studied and published extensively on the ecology of algae, particularly benthic algae, for 46 years.

Walk the Talk on Shorelines, Part 2

By Steve Laurenz
TLA Board Member

A lake's shoreline is a gateway to experience. It is also a sensitive area where care must be taken to prevent damage and consequent impacts to water quality.

In the last TLA newsletter, my wife and I spoke with TLA Executive Director Jeanie Wiliams about the cottage we co-own on Torch Lake, and how we are wanting to walk the talk to protect our beautiful lakes. We shared the history of the cottage, and our concerns about how to protect our shoreline - our treasured gateway to the Torch Lake experience.

Since then, we have been educating ourselves on: steps to take to safeguard the shoreline, a method to evaluate the current state of the shoreline, means to understand all the alternatives to improve the shoreline, a process to determine how to pick the correct steps to take, and a process to execute the improvements.

The first step we took was to invite Heidi Shaffer (Soil Erosion specialist with Antrim County) to visit our cottage. She, along with her assistant from Americorp (Austin Jackson) walked the area to provide expert advice. Here are her conclusions.

1. There is little obvious erosion at the shoreline, since we haven't done much development there.
2. The toe is slightly compromised (where the water meets the shore).
3. Possible methods to mitigate toe erosion:
   a. A combination coconut fiber roll (CSI Geoturf or Harbor Pipe out of TC carries the coconut) and good solid reed/rush plantings into the coir (coconut fiber roll) and low shrub plantings on the bank.
   b. Plant some sweet gale, willow, or dogwood near the water line and ninebark, willow, dogwood, and/or *Spirea alba* up the bank.
   c. Switchgrass and blue stems might be pretty up the bank, too.
   d. For the area that slopes down to the lake she recommends a geoweb: CSI geoturf. This helps to hold the soil while supporting plants.

We thoroughly enjoyed working with Heidi. Not only did she have tremendous knowledge of how to protect our precious lakes but also has a keen eye for what would work best for our shoreline. What impressed me most was that she fully understood that riparians need a practical approach to improve a shoreline. She understands that cottage owners have limits on what they can do and oftentimes cannot make improvements that require high dollar investments. We will take a step by step approach to add improvements. The first one will probably be to add the geoweb to the slope because it is likely to have the greatest benefit.

Linda and I and her family are looking forward to many years of enjoyment at the cottage. The cottage and its shoreline are our special gateway to enjoy one of the most beautiful lakes in the world. Yes we are biased!! To that end we will continuously make incremental improvements to ensure a healthy lake can be enjoyed for generations to come.

If you would like your own shoreline consultation with Heidi and Austin, reach out to the Antrim Conservation District: 231-533-8363

To read the first article in our Walk the Talk series with Board Member Steve Laurenz, visit our website to find the April 2020 newsletter: http://3lakes.com/february-2020-newsletter-2/ The article is on page 6.

Nuisance Golden Brown Algae and Hypotheses for its Cause

By Jan Stevenson

People living around northern Michigan Lakes, particularly Torch Lake and Lake Bellaire, have reported an increase in the appearance of golden brown algae, or GBA as many people call it, on the bottoms of lakes over the last 10-20 years. In 2014, members of the Water Quality Committee of Three Lakes Association (TLA) contacted me and other scientists from Michigan State University (MSU) and the University of Michigan Biological Station (UMBS) to discuss possible causes of GBA and a strategy to determine likely causes. As far as we know, this kind of problem has not been studied in other lakes. Of course, problems with filamentous green algae or cyanobacteria have been studied because of the nuisance and harmful effects they can have, but they are two very different kinds of algae compared to golden brown algae.

So what could cause an increase in GBA in northern Michigan lakes? Members of TLA and university scientists developed a list of possible causes for GBA based on what we know about algae growing on the bottoms of lakes and what environmental conditions could have changed in Torch Lake, Lake Bellaire, and other northern Michigan lakes.

We then developed a strategy to investigate these hypotheses, step by step. We realized that one or more of these hypotheses could help explain increases in GBA, and we have kept our minds open to other hypotheses based on what we have learned. In fact in 2014 we added two more hypotheses to the original eight as we learned more about GBA and environmental conditions in Torch Lake and Lake Bellaire.

Before we get into too much detail about our hypotheses, make sure you check out the primer on algae in this newsletter, because the hypotheses are based on what we know about algae and their ecology in lakes.

Assuming you have a basic understanding of algae and of diatoms in particular, let's get to the hypotheses about why GBA is increasing. Like problems with other algae, nutrient pollution

GBA continued on page 9

Ten Hypotheses for Golden Brown Algae Problems

1. Surface water input of nutrients via runoff and streams
2. Groundwater contamination by nutrients, likely from septic tanks and lawn fertilizers
3. Non-native zebra mussels and relatives
4. Lake warming by global climate change
5. Loss of grazers that eat algae and prevent algal accumulation
6. Increasing light availability
7. Invasion of non-native species of algae
8. "Algae in the News and on Your Mind"
9. Atmospheric nitrogen deposition from farms throughout the Midwest
10. Increasing salt pollution in groundwater

GBA

Continued from page 8

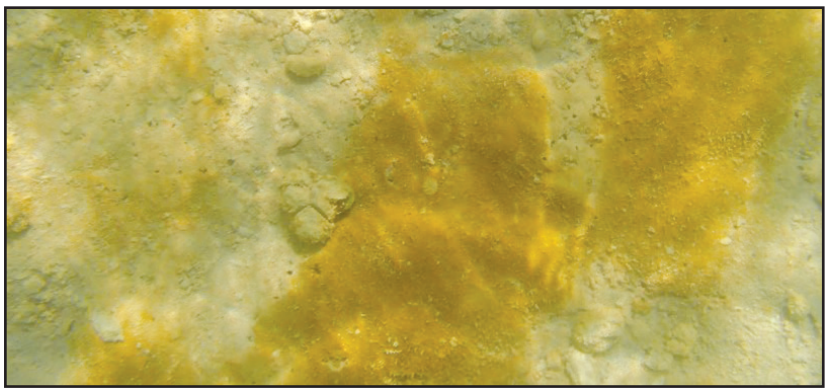
was the starting place for our hypotheses. We considered both surface water and groundwater routes of nutrient input in our first two hypotheses.

First let's consider surface water. Unlike many regions of the world, very little water actually runs off the land surface into surface waters of northern Michigan because of the sandy soils. But surface runoff and stream inputs from surrounding housing and agricultural activities can contribute nutrient pollution to the lakes. If this were happening, we would expect a response in planktonic algae more than benthic algae. And wouldn't the effects be localized around the inputs of those runoff sources and streams? This is not what we see. Benthic algae are having the strongest response, and GBA is widespread rather than localized.

Therefore, the presence of GBA seems more likely associated with sources of nutrients from groundwater than from surface water (if nutrients are the problem). A 2006 report by TLA members described groundwater as an important source of phosphorus into Torch Lake. They focused on phosphorus because algal growth in most lakes is more limited by low phosphorus than by low nitrogen concentrations. The TLA team reported that stream inputs, groundwater, and atmospheric deposition each contribute about one third of the phosphorus that enters Torch Lake. Thus a large proportion of the phosphorus entering Torch Lake enters via the groundwater rather than surface waters, which is different from most lakes in the world.

GBA increases could be related to movement of nutrients from septic systems or lawn fertilizers into the groundwater and then up to the surface of the sands and rocks at the bottom of the lake. Groundwater nutrient pollution into the lake would first enrich the habitat in which benthic algae live, rather than the water column where phytoplankton live. The slow

Trish Narwold holding GBA in Lake Bellaire, courtesy of Trish and Andrew Narwold



GBA in Lake Bellaire, courtesy of Trish and Andrew Narwold

transport of groundwater nutrients into the lake could get diluted greatly when mixed with the water column. So groundwater nutrients would stimulate benthic algae but not phytoplankton, at least at low levels of groundwater nutrient pollution.

A variety of lines of evidence that we have produced in the last 5 years indicate that groundwater contamination is a likely cause of GBA proliferation; but this hypothesis is still being tested and other hypotheses (potential causes of GBA) have not yet been excluded.

What about all of the other hypotheses on the list? (See Ten Hypotheses box)

1. Surface water was covered above.
2. Groundwater was also described. At this time, most of the evidence supports this hypothesis.
3. Invasion of Dreissenid mussels, including the zebra mussel, also enriches bottom waters with nutrients. Mussels, from their home on the bottom of the lake, filter algae from the water column and then excrete nutrient-rich wastes into the bottom waters. In addition, decomposition of dead mussels adds nutrients to sediments of lakes. These processes move nutrients from the water column where they have been historically, to the bottom of the lake, and they do stimulate benthic algal growth in many lakes. For example, Dreissenid mussels have caused major problems in shallow rocky habitats of moderately nutrient-enriched regions of the Great Lakes. However, Dreissenid mussel populations are low in Torch Lake because the water column has little algae to feed them. Are mussel abundances high enough to cause GBA proliferations?
4. Warming waters could stimulate algal growth, but the small climate-change related increases in water temperatures are probably tiny compared to interannual variation in summer water temperatures.
5. Losses of grazers that eat algae are very rare in freshwaters, and there is no evidence of major changes in grazers in northern Michigan lakes. This could be a reason to start monitoring grazer abundances in your lakes.
6. Waters of many northern Michigan lakes are very clear and small changes would probably not increase light levels enough to cause the great changes reported for GBA abundance.
7. It is possible that non-native species of algae have invaded and caused GBA, but we will need closer examination of GBA and historical samples from northern Michigan lakes to evaluate this hypothesis.
8. Algae have been in the news more often in recent years, either because they can cause problems with recreation or drinking water or because of their benefit as a new source of fuel. We considered the hypothesis that the increase in algae as a topic of news reports may have increased people's awareness of algae in the lake and caused a perception that GBA had increased. The obvious nuisance level of GBA in some locations would have been very difficult to overlook had it been present in past decades, which makes lack of awareness of GBA unlikely.
9. After a couple years of research, the possibility of nitrogen deposition from midwestern farms upwind from northern Michigan lakes was recognized as a possible cause of a shift in nitrogen and phosphorus concentrations that could change algal species composition and cause GBA.
10. In the same way, increases in chloride concentration in groundwater from road salts was detected in some water chemistry results, and that could cause a shift in algal species composition to form GBA. Available data to evaluate these two hypotheses is minimal at this point and is being pursued in current research.

GBA is important to study because it could be an early indicator of nutrient pollution from groundwater reaching the lakes, and be a warning of greater problems with nutrient pollution in the future. GBA could also be a signal of other changes occurring in the lakes, and therefore it seems prudent to give it our attention.

This article provides the background for research projects conducted from 2015-2020 by the research team from TLA, MSU, and UMBS. The results of these projects have been presented in three early reports and a new forthcoming report. Summaries of these results will be presented in future newsletters. Stick around!

Dr. R. Jan Stevenson is a professor in the Department of Integrative Biology at Michigan State University. He has studied and published extensively on the ecology of algae, particularly benthic algae, for 46 years.

The mission of the Association is to provide leadership to preserve, protect, and improve the environmental quality of the Elk River Chain of Lakes Watershed for all generations with emphasis on Lake Bellaire, Clam Lake, Torch Lake and their tributaries.

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