QUARTERLY

THREE LAKES ASSOCIATION SERVING LAKE BELLAIRE, CLAM LAKE AND TORCH LAKE IN ANTRIM COUNTY, MICHIGAN FEBRUARY 2021

Bright Yellow Seaplane

By Jeanie Williams
TLA Executive Director

When Art Hoadley first started volunteering for Three Lakes Association years ago he barely knew anything about TLA, and he certainly wasn't a member. However, his parents were on the TLA board and the board needed someone to measure water clarity on Clam Lake, so they asked Art to help out. He said yes. From there he participated in the Phosphorus Balance Study in 2006, let TLA install a monitoring well at his dock, and helped with other small data collection activities, but he still wasn't a member. Joining officially required a friendly sports rivalry and a bright yellow seaplane.

As a freshman at The Ohio State University, Art attended a flying club meeting, which hooked him immediately. He earned an FAA Private pilot license in 1967 and then a whole slew of other FAA licenses and ratings and an Aeronautical and Astronautical Engineering MS degree, also from Ohio State. He then worked at Rockwell International in Columbus, Ohio before moving to Western Michigan University to teach aviation courses. This led to starting WMU's Aeronautical Engineering program and eventually to initiating and directing their Applied Aeronautical Research Lab. When Art retired in 2004 he came up to Clam Lake to, in his words, "bum around with airplanes."

Before retiring Art had built a retirement home on his family's Locusta Preserve property. With his eye on retirement, Art sold his beloved Bellanca 260 and bought a Kitfox IV kit that he completed in 1994. It took him about two years to build the Kitfox and he did all of his own flight testing. Art says, "If you want a real thrill, build your own airplane and then fly it for the first time!" After earning his FAA Commercial Seaplane rating and adding floats to the Kitfox, he decided flying off Clam Lake was just too much fun and thus he now only flies on floats. What he likes about water runways is that it's "bush flying." Unlike at an airport, you have to look at the boat traffic, waves, and wind and make your own decisions.

Art's plane is in the hanger right now for the winter, but in the spring, after inspections, he will fold up the wings and put it on a trailer. He will drive the trailer to the DNR boat launch, open the wings and launch the plane. He will then water taxi the plane over to his dock where it will rest on a lift between daily flights all summer (weather permitting of course). In the fall, Art will bring his plane back to the DNR boat launch and return it to winter storage.

It's here in the fall of 2006, at the boat launch, that Art's yellow and blue plane stirred, in then TLA board president, Bob Bagley, the enduring rivalry between University of Michigan and The Ohio State University. The sociable Mr. Bagley, wearing an Ohio State hat, stopped Mr. Hoadley to make a lighthearted jab about the blue and gold color of his plane. Art, ever the engineer, made it clear that the bright yellow color made the plane more visible, completely missing the joke, at first! Then, Art confessed his shared commitment to

SEAPLANE continued on page 3

Sneak peek

THREE LAKES ASSOCIATION

Officers

Fred Sittel, Interim President
Rick Doornbos, Interim Vice President
Ed Gourley, Treasurer
Tina Norris Fields, Secretary
Mike Bertram, Past President
Len Franseen & Stan Dole, Directors Emeritus

Zone Directors

A. Clearwater Township: Cheryl Lynn Fields, Tina Norris Fields
B. Milton Township: Rick Doornbos, Greg Fredericksen
C. Torch Lake Township: Mike Novak, Vacant
D. Central Lake Township: Todd Collins, Steve Laurenz
E. Forest Home Township: Fred Sittel, Phil Weiss
F. Helena Township: Richard Knopf, Vacant
G. Custer Township: Mike Bertram, Vacant
H. Kearney Township: Duane Drake, Ann McClelland

Directors at Large

Leslie Meyers, Norton Bretz, Art Hoadley, Becky Norris, Dean Branson, Gary Knapp

Committee Chairs

Vacant, Water Quality
Todd Collins, Membership
Tina Norris Fields, Education
Art Hoadley, Water Safety
Vacant, Lake Monitoring Program
Vacant, Publicity

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Executive Director

Jeanie Williams

Administrative Assistant

Lois MacLean

Thank you ...

The entire TLA family extends a heartfelt thank you to Mike Bertram who served as President of the TLA Board of Directors from 2018 through 2020. Mike stepped down at the end of last year but plans to stay active on the board as immediate Past President and to remain engaged in our mission to provide the leadership to preserve, protect and improve the environmental quality of our lakes. Mike retired from a career in nursing and joined the TLA board while at the time also serving on Antrim County's 911 and Ambulance Authority boards and as President of Mancelona Rotary. At the beginning of last year, the advent of the pandemic added considerable demands on Mike's time and experience but he never turned his back on our important work, beginning each monthly meeting with a full recitation of our mission statement. Mike's wife also has had a long and successful career in nursing and is currently following him by transitioning into retirement. They found a sunny, warm place in Florida and together will begin riding out the long Michigan winters down south. While that may make it a bit harder for Mike to pursue his passion for ice fishing, we wish them the best in enjoying their new winter surroundings. Thanks Mike, for all you have done for TLA and for your past and future service on the board.

New Board Member

On August 6, 2020 we held our annual meeting to affirm the actions of the Three Lakes Association board and to elect board members and officers to two-year terms. Our congratulations and gratitude go to all of the board members who will continue to serve until August 2022: President: Mike Bertram; Secretary: Tina Fields; Directors at Large: Norton Bretz, Becky Norris, and Leslie Meyers; and Zone Directors – Clearwater Township: Cheryl Fields; Milton Township: Rick Doornbos, Central Lake Township: Todd Collins, Forest Home Township: Phil Weiss, Kearney Township: Duane Drake.

Rick Knopf

We were also delighted to welcome a new board member, Rick Knopf, as the Zone Director for Helena Township. We asked him to briefly introduce himself for this newsletter. Here is Rick Knopf:

My passion and vocation is anchored in environmental stewardship and caregiving. I have witnessed many fundamental changes in the Three Lakes region over my fifty year history here. Some are certainly good, but many are clearly disruptive and threatening to the ecosystem.

I joined the board because it is time for me to give back, and work with other like-minded people to leave a positive legacy for our grandchildren. I will contribute in any way the board needs me; I do have particular interests in history, public engagement, environmental education, public policy and land use zoning.

I am a professor of community sustainability, and have a science bent – a fun blend of natural science (forest management) and social science (environmental psychology). A good chunk of my career was with the U.S. Forest Service, working on a national river project with a focus on encouraging citizen input on waterway carrying capacities and public satisfaction with water management practices.

I love the serenity of nature's embrace, the memory-making experiences that meaningfully thread generations together, and the wonderful magic of clean air, clean waters, curious wildlife, and unblemished natural habitat.

I look forward to serving with you! My goal is to work closely with the board to make the Three Lakes region a wonderful place to live, work and play.

To contact any of our board members, or your Zone Director, please visit our website: 3lakes.com/contact-us

Seaplane

Continued from page 1
Ohio State and this led to Art being recruited for the TLA board. Before accepting, Art warned, "I'll have to become a member first!"

Art served as Secretary for a while (which he hated) but became Director at Large as soon as he was able, where he serves today.

Art started flying airplanes with floats in 1996 and began taking pictures out the window to document things. Early on he documented propeller scars along the lake bottom, and wrote an article about it in the TLA newsletter. Then he bought a camera that could collect GPS (global positioning) data. It was about this time that golden brown algae (GBA) showed up in Torch Lake and Art proposed that he take aerial photos of the whole lake to document it. The first GPS tagged photos of GBA were taken in 2012. He started with one flight a year, then did monthly flights for several summers. In 2020, Art took photos in May, to see how much GBA remained after the winter, and in August, when GBA proliferation peaks.

Each trip around the lake yields around 1,800 photos. That many photos can be unwieldy, so Art worked with Howard Yamaguchi to get the photos into Google Earth and Art wrote a program in Visual Basic to automatically move photos from Google Drive to Google Earth. This allows us to easily look at photos for any location, month, or year and make comparisons. It's an incredible resource!

Observing from the air is valuable for many water quality issues. Art's flights have been useful to verify shoreline survey data, report on the degree of development along the shoreline, and to spot and keep track of buoys. But most of all, his flights remind us of the beauty and wealth of water and landscape that we are entrusted with. If you'd like to take a virtual flight with Art, please visit his YouTube Channel: www.youtube.com/user/KitfoxArt

New Members and Donations

A Big TLA WELCOME to these new 2021 members! We are so happy to have you join us.

Dennis & Jennifer Bruce
Richard Cicone
Deborah Ehrlich
Christopher Green
Mitchell & Melinda Harris
Wayne & Patricia Holden
Patrick & Stephanie Howell
Paul Janes
Steven & Melinda Lawrence
Fredrick & Barbara Manuel
Karen McDiarmid
Chad Munger
John Nicholson
Onpahwee Lodge-Caroline Jacob
David Rodgers
Bruce & Cindy Schmitt
David & Cynthia Senatore
The Clamelot Company
Theodore Tubekis

We are honored to receive memorial contributions in memory of these beloveds:

Bob Harrison
Don Havenstein
Gary Hutchens
R Keith & Margaret Harrison

A special thank you to everyone who contributed $200 or more to TLA during our membership recruitment for 2021.

Brad & Margaret Baxter
Jeff & Stephanie Bigelow
Richard & Susan Bingham
Norton & Mary Lee Bretz
Tim & Deb Broderick
Curt & Beverly Bunte
Richard Cicone
Todd Collins
James Grady
Harrison Family
David & Jean Heinz
Mr. & Mrs. Robert Hough
Thomas & Elizabeth Irwin
Caroline Jacobs - Onpahwee Lodge
Bob & linda Lanphier
Mike & Helen Lambert
Mic & Mary Lajiness
Duane & Jill Meyer
Merrill & Jena Morey
Eric & Maria Morgan
Schuss Mtn. POA
Alan & Stacy Sollenberger
Charles & Chris Ward

Coordinated Activities on Torch Lake

By Jeanie Williams
TLA Executive Director

Torch Lake is the second largest lake in Michigan (by surface area), but it's also the deepest (over 300 feet) and the one with the most water (over 858 billion gallons). Its enormous size means that lots of people are needed to track its health and to protect it.

Three Lakes Association understands that the best results for our lakes will happen when individuals and groups coordinate their efforts. When we work together we can amplify our impact and make efficient use of our resources.

Thankfully Torch Lake is protected by three organizations: Three Lakes Association, Torch Conservation Center, and Torch Lake Protection Alliance. Representatives from the three groups meet on a regular basis to update each other about the activities in each group and to cooperate on lake-wide protection efforts.

This year we put together a summary of our recent projects. The projects are organized according to objectives set out in the Elk River Chain of Lake Watershed Protection Plan (see next page for an explanation of this document).

The Watershed Protection Plan outlines widely agreed upon goals and objectives for protection and preservation of all of the waterways in the Elk River Chain of Lakes. TLA, TCC, and TLPA concentrate resources (funds, volunteers and expertise) to plan and orchestrate programs and activities that accomplish these goals and objectives on Torch Lake. Community members, including you, take individual stewardship actions to promote water health. Together we will keep Torch Lake Blue.

NOTE: You may notice that some TLA activities are not included on this chart, such as our work with schools. These efforts are included in the other Education and Outreach goals of the Watershed Plan.

See WATERSHED MANAGEMENT PLAN on page 3

Elk River Chain of Lakes Watershed Management Plan	Goal #1 Protect the diversity of aquatic habitats	Goal #2 Protect & improve water quality
	1.1 Inventory & monitor aquatic habitats to document conditions & changes	2.2 Reduce nutrient inputs to surface waters & groundwater
Baseline Studies - Previous	Lake Bottom Survey (TLA, 2009)	Torch Lake Trend Analysis (GLEC, 2018)
	Adopt-A-Stream: Macroinvertebrates (TWC, 2017)	Torch Lake Assessment (GLEC, 2018)
	Torch Lake Shoreline Survey (TWC 2007 & TOTM 2017)	Torch Lake Phosphorus Loading Model (GLEC & TLA, 2007)
	Torch Lake Shoreline Algal Survey (IWQR, 1984)	
Baseline Studies - Current	Torch Lake Fish Community: Status & Trends (MDNR, 2019)	Near Shore Zone Baseline Study (TLPA)
		Tributary Nutrient Baseline Study (TLPA)
		GBA Baseline Study (TLPA)
		Forest Inventory (TCC)
Research Studies - Current	6 GBA studies (TLA)	Whole Lake Phosphorus Loading Study (TLA)
Long-term Monitoring		Deep Basin Monitoring - Clarity, P, ChlA (CLMP-TLA) and (CLMP-TOTM)
Management	1.6 Monitor and manage invasive species	
	Milfoil Treatment Project (TLPA & TLA)	
	Purple Loosestrife Treatment Project (TLPA & TLA)	
	1.4 Create new habitats & structures to support wildlife populations	
	Torch Lake Fish Shelters Project (TLA)	
Elk River Chain of Lakes Watershed Management Plan	**Goal #3 Promote sustainable land management practices**	**Goal #4 Enhance & maintain recreational opportunities**
Education	Newsletters- print (TLPA, TLA)	Torch Lake Fun - Website (TCC)
	Stewardship Postcards Project (TLPA, TCC, TLA)	Swimmer's Itch card (WPIT - led by TLA with ESLA, ILA, TCC, TLPA)
	Lake-friendly Tips- True Blue News (TCC)	Torch Lake Hiking Trails card (TCC)
	Lake-friendly Practices- Website (TCC)	Torch Lake Paddling Trails card (TCC)
	13 Lake-friendly Care cards (TCC)	Torch Lake Swimming Beaches card (TCC)
		Torch Lake History Trail (TCC)
Outreach	True Blue Living Display in Gallery (TCC)	True Blue Fun Display in Gallery (TCC)
	True Blue Gardening Display in Gallery (TCC)	Star Buoy Project (TLA)
	Site Visits (TLPA, TCC, TLA)	
	Hot Line-questions by phone & email (TLPA, TCC, TLA)	
Advocacy	Monitor State MEGL Permits (TLPA & TLA)	Sand Bar- South (TLPA)
	Monitor Township Zoning Permits (TLPA & TLA)	Sand Bar- North (TLPA)
	Monitor County Soil Erosion Permits (TLPA & TLA)	MDNR Boat Launch Project (TLPA)
	Monitor RV Park Project (TLPA, TLA, TESA)	
	Monitor Hill Marina Project (TLPA, TLA)	
	Monitor Bishop Project (TLPA)	

Watershed Management Plan

Who creates it?

The creation of the Elk River Chain of Lakes Watershed Management Plan was guided by Tip of the Mitt Watershed Council with support from The Watershed Center of Grand Traverse Bay. All of the Lake Associations in the Chain, including Three Lakes Association, participated in putting together the plan. Local and national databases provided supporting information. Next, the plan will be submitted to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) and the Environmental Protection Agency (EPA). Our plan will be submitted soon!

What does it include?

The plan describes threats to water quality in the watershed. It also summarizes the current state of the watershed and outlines the actions that should be taken to prevent further harm, restore damaged areas, and improve human interactions with the watershed.

How will it be used?

Groups like TLA, as well as policy makers and resources managers, can use the plan to make coordinated and focused efforts to solve problems and protect sensitive areas. Additionally, when an approved watershed management plan is on file, our watershed becomes eligible for many large grants to implement the plan.

TLA receives a grant from the Dole Family Foundation: *Sediment Trap Study*

By Dean Branson

TLA would like to thank the Dole Family Foundation for financially underwriting a portion of TLA's special Sediment Trap Study. This study was designed to help respond to one of the basic questions about Golden Brown Algae (GBA) in area lakes: Has the amount of phosphorus entering these lakes changed in the last 8 to 10 years, when GBA was first noticed near shore on rocks and sand?

In 2006, TLA used two different methods to estimate the amount of phosphorus that entered Torch Lake. The first method was to add together the amounts of phosphorus entering the lake from tributaries, groundwater, and rainfall, and then subtract from that the amount of phosphorus leaving the lake in the Torch River. We found that about 15% of the total amount of the phosphorus that enters the lake leaves the lake through the River. This makes Torch Lake unusual. In a typical lake 60% of the incoming phosphorus leaves through combined outflows.

The second method was to measure the amount of phosphorus that settles out of the lake water and deposits on the bottom of the lake. The phosphorus that settles out of lake water is bound to very small particles of hard-water crystals (calcium carbonate). We collected these particles in sediment traps, which were designed by the National Oceanic and Atmospheric Administration for this purpose (see diagram). Using this method we found that about 85% of the phosphorus that enters the lake from all sources settles on the bottom of the lake, to eventually become limestone.

It's been 14 years since those studies and a lot of changes have occurred around Torch Lake in that time. It seems reasonable to check in on the amount of phosphorus that is settling out of the lake to see if it has changed as well. The diagram shows the configuration of the equipment that is currently being used to suspend these sediment traps in Torch Lake. The estimates from 2006 represent a baseline to help interpret the findings from the current sediment-trap study.

Deployment setup - Elevation view

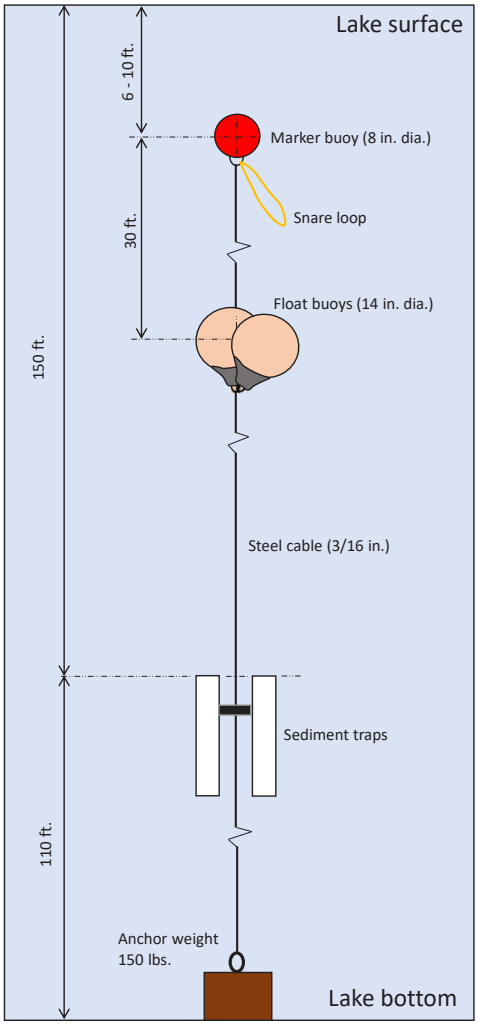
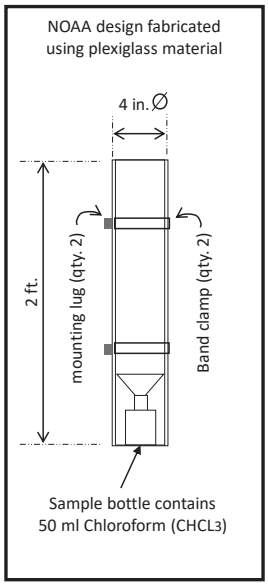


Diagram of the sediment trap apparatus. This is suspended 150 feet below the surface and 100 feet from the bottom of the lake.

When TLA applied for grant-funding from the Dole Foundation, TLA had enough money

Sediment trap - Detail



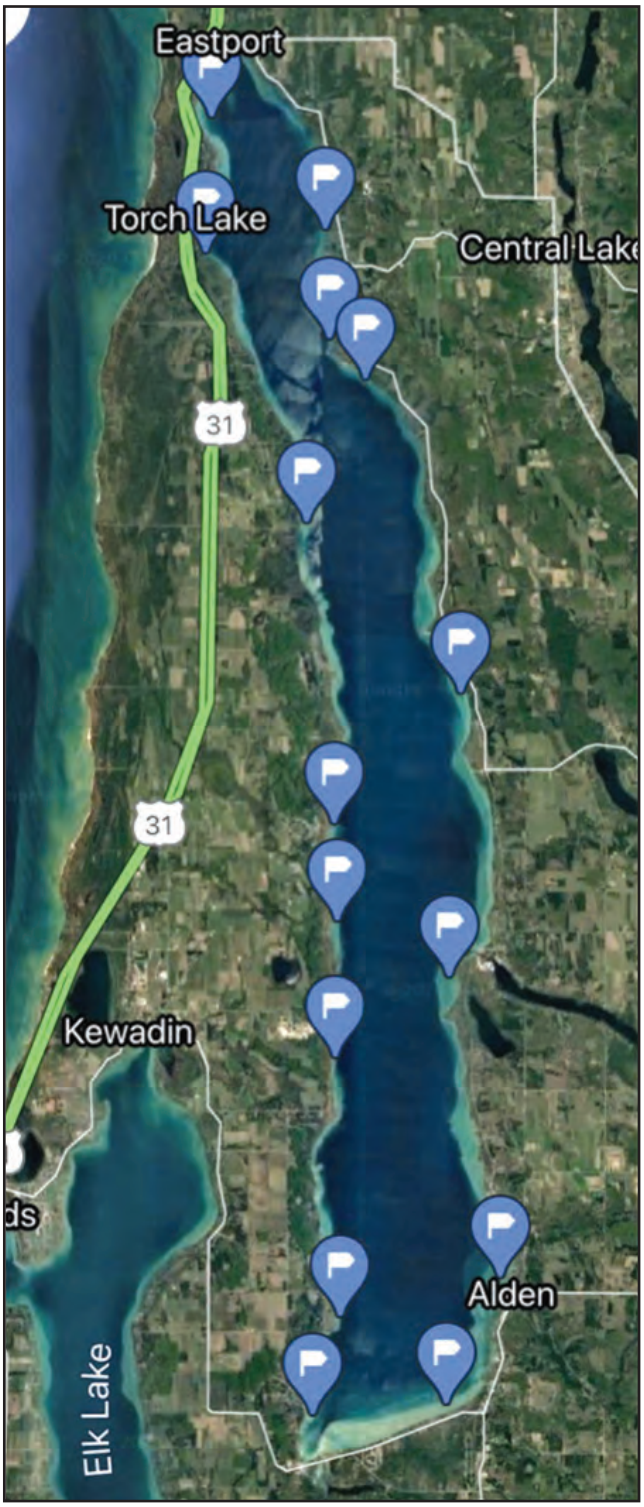
To read about the 2006 studies visit our website: 3lakes.com/projects/water-quality-model/

to collect samples from these traps for two time periods, during late spring/early summer (June and July), and during late summer/early fall (August to October). Fortunately, with the award of this grant, we now have enough funds to collect samples for the remaining time from October to June; for a full year of data from June 2020 to June 2021. Samples collected over a full year will duplicate the duration of the 2006 sediment trap study.

Most phosphorus settles out during the summer months when warm water near the surface of the lake triggers the formation of the insoluble crystals that grab onto phosphorus and then sink slowly to the bottom of the lake. Although the summer and fall samples have been analyzed, a final report is not expected until August 2021. For now and until June, the sediment traps hang 150 feet below the surface and silently collect anything that is raining down. We are looking forward to what we find in those traps!

Summer 2020 Studies of Golden Brown Algae

By Becky Norris



This summer we continued aerial surveys of the Torch Lake shallows, nutrient chemistry monitoring, added a nutrient flux study, obtained a more extensive spatial examination of GBA distribution, and obtained a more extensive deep water chemistry profile.

The nutrient chemistry monitoring was carried out every two weeks at three sites and included surface grab water samples, benthic surface water samples (just above the bottom of the lake), and lake floor groundwater samples. The samples were analyzed for a routine chemistry profile, consisting of nitrogen, phosphorus, chloride, fluoride, and sulfate. As in the past, a benthic algae sample was also collected. Pictures of the lake floor and a "scuzziness" score were also obtained at each visit. The scuzziness score is a number that represents the visual appearance of the algae based on its color, thickness, and percent coverage on the lake floor. These results will be added to those of the preceding five years of data and assessed for any indication of emerging patterns.

We added a nutrient flux study to more fully characterize the availability of nutrients to the benthic algae. The nutrient levels in the vicinity of the algae are affected by both the rates of delivery of nutrients and their consumption by the algae. The algae, when metabolically active during daylight hours, are constantly consuming the nutrients available to them, and these levels may decline if consumption exceeds delivery. During the dark hours the algae are not metabolically active, so any nutrients arriving in their vicinity through groundwater could be accumulating, potentially affecting the levels in the benthic and surface lake water. We collected benthic surface and lake water surface samples every four weeks at four locations before dawn and in the late afternoon on the same days we carried out the nutrient chemistry monitoring, and analyzed these samples using the same routine nutrient chemistry profile.

We also added an assessment of the levels of the enzyme alkaline phosphatase associated with benthic algae samples collected along with the water samples in the nutrient flux study. Alkaline phosphatase is an enzyme that helps algae get more phosphorus from the environment when supplies run low. In a situation where there is an abundant supply of phosphorus there should be low levels of the enzyme. As the phosphorus supply diminishes more enzyme should be synthesized by the algae. The enzyme levels, in association with the nutrient levels, at different times of day and as the growing season progresses, are expected to help us more completely understand the fluxes that are occurring and how those fluxes impact the growth of the algae.

Dr. Stevenson, MSU professor and algae expert, made two circuits of Torch Lake to more fully characterize the locations and algal composition of the GBA, one in mid-June and one in mid-August. In addition to the actual harvested algae samples at each of sixteen sites, he obtained video imaging of the appearance of the algae mats on the benthic surface. These data will provide a much more detailed assessment of the distribution of the different types of algae that make up the GBA.

Dr. Stevenson also did an experiment with algae harvested from Torch Lake, in small containers at his lake cottage. He collected algae samples from Torch Lake and subjected them to different amounts of nutrients (high, medium, low, very low) to see how they responded. This will help him understand the nutrient preferences of different algae species.

Finally, our teams that monitor water clarity, chlorophyll-a and total phosphorus over the deep basins in Torch, Clam, and Bellaire Lakes **obtained integrated water samples from deep water to the surface**. This is a mixture of lake water from several depths, collected by having a weighted sample container fill gradually as it is raised from deep in the lake. These samples, collected monthly over the summer, will also be analyzed for the same routine nutrient chemistry profile, and will provide previously unavailable profiles for comparison with the near-shore profiles associated with the GBA.

Analyzing all these samples and working to understand what they tell us about the GBA should keep us busy over the winter. We will report on our results in future newsletters.

What happens if you rake up GBA?

By Sydney Frederick

Over the past few years, residents of Torch Lake have observed a significant increase in the levels of Golden Brown Algae (GBA) in the water near shore. There are many potential reasons for this. One hypothesis is that the presence of phosphorus in groundwater causes more algae to grow on the floor of the lake (benthic) than float freely (planktonic). As an intern for Three Lakes Association (TLA) this past summer, I conducted an experiment to see if disturbing the algae -- removing it from the lake floor -- would reduce its repopulation rate.

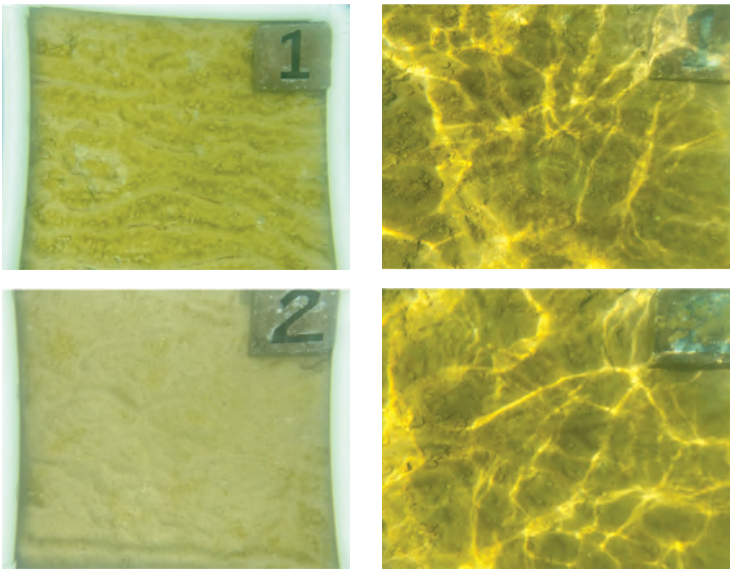
I based my hypothesis on this potential cause for GBA increase, reasoning that removing algae from the substrate (lake floor) would reduce the repopulation rate by separating it from nutrients causing it to grow. Additionally, removing the algae more frequently would further decrease the rate of repopulation. Thus the hypothesis was two-fold:

1. Disturbing the algae once would reduce its repopulation rate over the repopulation rate of algae that is left alone; and
2. Disturbing it multiple times would reduce it's repopulation rate over the repopulation rate of algae that is disturbed only once.

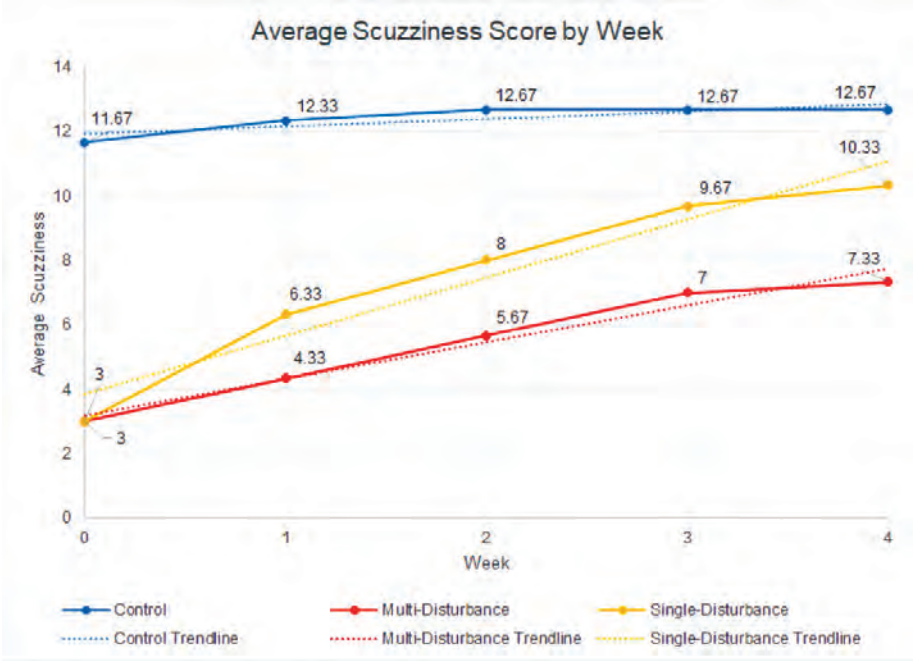
The experiment set-up was simple: I created three groups of three test areas (plots), each two feet by two feet, all of which were in four feet of water. Placement of the nine plots was random, so that any results could not be attributed to the location. The three groups were as follows:

- **Control,** which received no disturbance treatments;
- **Single Disturbance,** which was disturbed once at the beginning of the experiment; and
- **Multiple Disturbance,** which received disturbance treatments three times in the week before the experiment began, and then not again after that.

Disturbing the algae consisted simply of "dredging" it with my foot, to remove it from the lake floor. While it may not sound like a very scientific process, it turned out to be the most efficient way to remove the algae from a 2x2 ft area.



The photos on the left show plots on the first week of observation: a control plot (1, top) and a single disturbance plot (2, bottom). The photos on the right show the same two plots on the final week of observation.



At each treatment, all nine areas were measured for factors in the scuzziness score: thickness of the algal mat, shade of golden brown, and percent coverage of the area. The scuzziness score is a way of assessing the GBA, indicating how much it has grown. This system was developed by TLA member Becky Norris.

The results of this experiment indicate that in fact, disturbance does reduce the repopulation rate of GBA. The control group's scuzziness score increased minimally over the experiment period. The single disturbance group's score increased over the period, but did not reach the same level as the control group's score. Additionally, the multiple disturbance group's repopulation rate and final score were lower than those of the other two groups.

The scuzziness scores of each treatment group were shown to be statistically different from one another. For the interested reader, the full study report can be found on TLA's website. (http://3lakes.com/)

While these observations are promising, there is still too little data to prompt any action. More experiments should be conducted to determine the impacts of disturbing the algae, including any unintended consequences of releasing the algae into the water. It is difficult to tell if any large-scale disturbance would be helpful or harmful. Additional testing could include more experiments of the same design but with more groups of varying numbers of disturbance treatments. Comparison of the repopulation rates based on how many times that group was disturbed could be used to determine how frequently one would need to disturb the sand to keep GBA away for the whole summer. Future studies could also incorporate observations of areas surrounding the plots, to determine if the disturbances have impact beyond the test location.

I'd like to thank several people for their assistance with this project: Ed Gourley, a member of TLA, who was kind enough to allow me to use his lakefront, and host me for an hour each Sunday for six weeks in a row. To design the experiment, I worked with Dr. Jan Stevenson of Michigan State University. He provided me with help in determining an effective way to test my hypothesis, the details of running an effective experiment with benthic algae, and how to statistically analyze the end results. Becky Norris, another member of TLA, designed the scuzziness score determination scale and also provided me with information on the GBA in Torch Lake. Finally, a special thank you to Executive Director Jeanie Williams, who helped me organize and interpret the results according to scientific standards and provided encouragement and support throughout my internship.

Temperature in Lake Bellaire and Intermediate Lake

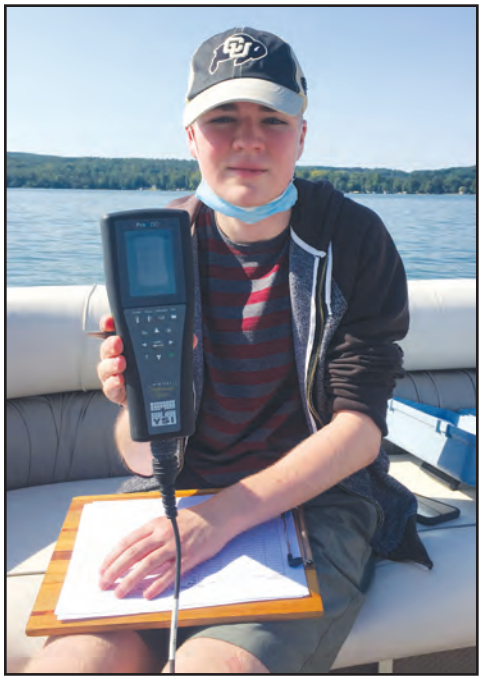
By Sydney Frederick
and Jeanie Williams

As a student at Traverse City West Senior High School, I have taken several science classes, as that is my main interest. My favorite topics are molecular biology, evolution, and genetics. I research and learn as much about science as I can, even as a hobby.

When I had the opportunity to do an internship with Three Lakes Association during the summer of 2020, I grabbed at the chance to experience science in a real-world environment. One of my experiences was to conduct water temperature and dissolved oxygen testing on Lake Bellaire and Intermediate Lake.

Water temperature is important for lakes because most aquatic animals are cold-blooded. They are highly sensitive to their surroundings and have a preferred temperature range. Also, the level of oxygen within the temperature range must be appropriate for the species. If the water temperature varies too much, the animals will move to a better area of the lake, but the oxygen in that area may not be sufficient. Therefore, it's very important to monitor both the lake temperature and the dissolved oxygen.

I worked with a team of TLA members to conduct the monitoring of Lake Bellaire and Intermediate Lake. Unfortunately, the dissolved oxygen levels collected were unreliable due to equipment issues. However, we successfully collected temperature readings at descending depths, once in July and again in August over the deepest portion of the lakes. This allowed us to locate the thermocline, an important factor in assessing the health of the lake. The thermocline is a layer of the lake where the temperature drops severely.



Sydney Fredrick collecting temperature readings.

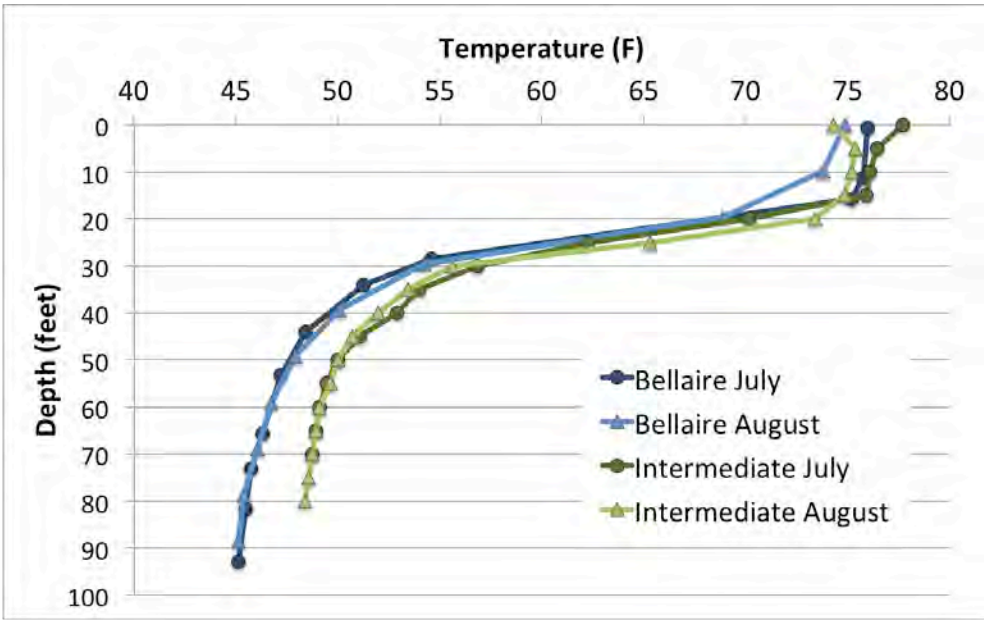


Figure 1: Temperature of Lake Bellaire and Intermediate Lake on July 20 and August 21, 2020

Comparing Lake Bellaire and Intermediate Lake in July and August 2020

Lake Bellaire and Intermediate Lake are similar lakes in many ways, so they make for a nice pair to compare. They are adjacent to one another, connected by the Intermediate River, and have a similar size and depth. Lake Bellaire covers about 1770 acres, and Intermediate Lake covers about 1570 acres. Lake Bellaire is a little bit deeper (95 feet) than Intermediate Lake (80 feet) at the deepest point.

Table 1: Surface and Bottom Water Temperatures in Lake Bellaire and Intermediate Lake in July and August 2020

		Surface (F)	Bottom (F)
Lake Bellaire	July	76	45
	Aug	75	45
Intermediate Lake	July	78	49
	Aug	74	48

The surface temperature of both lakes cooled down between July to August. In contrast, the bottom temperatures of both lakes did not change over the course of the month (Table 1).

The temperature was relatively uniform from the surface of each lake to the start of the thermocline (this is the part of the graph at the top with the near vertical lines). However, this graph reveals that both lakes experienced cooling in the upper layer of the lake between July and August, most likely in response to the cooling air that also tends to take place during this time period.

The thermocline is the part of the graph where the lines are nearly horizontal; this is the zone of rapid temperature change. The location of the thermocline was about the same in both lakes (beginning at about 16 feet and ending at about 29 feet). The temperature at the top of the thermocline dropped a bit in both lakes, between July and August. Therefore, it appears that the surface temperature has an impact on the maximum temperature of the thermocline.

The temperature below the thermocline did not change between July and August in either lake. This is because the bottom of the lake is thermally isolated from the top of the lake in the summer time. This isolation makes the bottom part of the lake very temperature stable, which a lot of species like. In contrast the top portion of the lake will vary a lot as sun exposure, wind, and air temperature shift hour by hour. You can see this variation in the graph.

I recommend that the Three Lakes Association do more monitoring of temperature and dissolved oxygen levels throughout each summer. This way, they can build a historical data set that shows trends over time and can indicate when problems may occur.

Thank you to Dean Branson, Richard Knopf, Sue Thomas and Steve Young for their help with taking the data. Special thanks to John Curtis and Jim Gilleylen who allowed TLA to use their properties and drove the measurement teams out on the lakes, and to Larry Cooley who provided the YSI measuring device and historical data for Intermediate Lake. Finally, thank you to Jeanie Williams who has been my supervisor for my whole internship experience, and gave me so much guidance on the scientific aspects of my project. She was the reason I could participate in this internship and I'm grateful for her help.

Thank you to the volunteers!

2020 was an unusual year in many respects, but in one way things stayed the same: We had a fantastic group of committed and skillful volunteers. Thank you to everyone who got out on the water with us in 2020!

Our sincere thanks go to the CLMP volunteers Dennis Fitzpatrick and his team on Torch North (Don Watkins, Bob Ford, Bill Donberg and Robert Atkinson), Christian Stoldt on the Torch South site, Art Hoadley on the Clam Lake site, and Duane Drake on the Lake Bellaire site.

We thank the GBA volunteers Rick Doornbos, Greg and Karen Frederickson, Jeanie Williams, and Tina Norris Fields; Art Hoadley for his aerial imaging; and especially to Trish Narwold who accompanied Becky on the three pre-dawn twilight outings needed for the nutrient balance study, tasks which would have been far more lonely and difficult without her hands and flashlight.

A special thanks also goes to Jan Stevenson whose guidance with GBA research has been invaluable. He was also the speaker at our annual meeting, and advised our summer intern, Sydney Frederick, on his project.

We are grateful for those who helped our intern Sydney Frederick: Dean Branson, Richard Knopf, Sue Thomas, and Steve Young all helped with lake measurements; John Curtis and Jim Gilleylen allowed TLA to use their properties and drove the measurement teams out on the lakes; and Ed Gourley let Sydney set up his GBA experiment in front of his house.

And great appreciation also goes to the numerous folks who helped us with the sediment trap study: Fred Sittel, Norton Bretz, Becky Norris, Richard Knopf and in the spotter boats Bob Ford, Don Watkins and Steve Detwiler.

There will be more to do in 2021. Reach out if you'd like to help: 3lakes.info@gmail.com

CLMP sampling April 30th, with Volunteer Duane Drake, DEQ's William Dimond and driver Dan Anderson.

Retrieving sediment trap samples, Oct 14, 2020; GLEC's Jim Stricko, TLA's Richard Knopf, Doug Endicott.

Youngest volunteer of 2020: Mirabel Fitzpatrick collecting CLMP data on Torch North.

Intern Sydney Frederick setting up his GBA study plots.

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