



freshwater solutions^{LLC}
innovative swimmer's itch strategies

Lime Lake Biologist 2020 Final Report

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In collaboration with Freshwater Solutions, LLC



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Executive Summary

There were five main focus areas for Lime Lake in 2020. First and foremost was to complete a thorough aquatic plant survey to investigate the presence of invasive species. No invasive submergent aquatic plants were located. Ten (10) plant or macrophytic algae types were found. The shoreline plant survey showed several species of rushes, sedges and cattails, all of which are native to Michigan. The survey did reveal the presence of one invasive terrestrial species- Yellow Iris.

The second focus was to complete a microscopic algal survey using a plankton tow for water collection. Twenty-four (24) algal species were found and named to the genus level of classification, along with eight rotifers, three arthropods, one protozoan and one larval mollusk species. Only commonly found species were identified.

The third focus for the summer was to collect water samples for both the swimmer's itch study and enteric bacteria study conducted by Freshwater Solutions. Water was collected and delivered on the requested dates.

The fourth focus was to analyze the drone shoreline survey video completed in 2019 by ZeroGravity Aerial LLC. Twelve (12) categories were documented. Notably, over 60% of lakefront properties on Lime Lake do not have a greenbelt between their lawn and the water. Further educational materials and ideas for improvement are included in this report.

Finally, an ongoing effort is underway to organize and digitize various data sets from water studies conducted on Lime Lake over the past several decades. This work will be conducted in the offseason.

Submergent Plant Survey

Two types of plant surveys were completed on Lime Lake. During the second week of July, 9 break line sites (~8-12 feet water) were sampled around the lake where aquatic gardens were known to exist, to determine the diversity of submergent plants. In addition, a shoreline survey was completed on 9 August to assess both aquatic and terrestrial emergent plant species.

Break Line Sampling Sites

One of the biggest concerns the lake board communicated was the presence of invasive aquatic species, including Eurasian Watermilfoil. A thorough plant survey was completed at major plant beds to identify and document all species. We are pleased to report that no invasive species were found during our survey.

Methods

Nine (9) aquatic plant beds were located along the 8 to 12-foot break line. The plant beds were sampled by tossing a double-sided rake in each of the four cardinal directions at each site. The rake was pulled back to the boat and all plants were identified to at least the genus level of classification using our previous knowledge along with validation from the "Aquatic Plants of the Upper Midwest" key (Paul M. Skawinski). Relative abundance was recorded (Table 1) as the presence of plants observed with each toss. The number in the box represents the number of rakes that pulled up a plant at a particular site. For example, *Chara contraria* was found on all four rake throws at Site 1 and 6, but only one throw at Site 2. To facilitate repeated surveys in future years, GPS coordinates and approximate depth of sampling for each site were recorded (Table 2). Visual representation of each location can be seen in Figure 1.

Results & Conclusions

No invasive species were found at the 15 plant beds. This is great news for the health of our lake. It is recommended that this plant survey be replicated each year, so that if a plant, like Eurasian Watermilfoil, is found we can treat and eradicate it early before it has a chance to take hold in the ecosystem. Illinois Pondweed, Whorled Watermilfoil, Common Bladderwort, Slender Naiad and Common Stonewort were the most commonly found plants in the survey. Common Stonewort, Nitella, and Cladophora are actually macrophytic algae; we included them in this survey because of their large size, prevalence and proximity to aquatic vascular plants.

The species richness and relative abundance of plants found during the survey showed a balanced diversity, indicating good health of the Lime Lake ecosystem.



		Site															
Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10*	11	12	13	14	15	16
<i>Chara contraria</i>	Common stonewort	4	1	3		2	4	4	4	4		3	4	4	3		4
<i>Cladophora</i> sp.			1	2		1											
<i>Myriophyllum verticillatum</i>	Whorled watermilfoil	3	4	3	4	4			1	1		1			1		
<i>Najas</i> sp.	Najas									1							
<i>Najas flexilis</i>	Slender naiad		1	2		1							4		3		4
<i>Nitella</i> sp.																4	
<i>Potamogeton illinoensis</i>	Illinois Pondweed	2	1		1	1	3	2	3	1		1	4	1	1		2
<i>Potamogeton gramineus</i>	Variable Pondweed										1						
<i>Spongilla lacustris</i>	Freshwater Sponge														1		
<i>Utricularia macrorhiza</i>	Common bladderwort	2	1	2	1	2	3	3	2				2				

*Site 10 was collected during a shoreline survey on 8/10/20. It was added to this data table because it had not been previously found.

Table 1: Relative abundance of each species of plant found at each site.

Site	Depth	Latitude	Longitude
1	10 ft	44.8994	-85.8329
2	10-12 ft	44.8877	-85.8474
3	10-12 ft	44.8876	-85.847
4	10-12 ft	44.8873	-85.8467
5	10-12 ft	44.8865	-85.8462
6	10-12 ft	44.8949	-85.8358
7	10-12 ft	44.8916	-85.8365
8	10-12 ft	44.8936	-85.842
9	10-12 ft	44.8988	-85.8479
10	3 ft	44.8970312	-85.8488506
11	6-8 ft	44.8945768	-85.841246
12	9-10 ft	44.8944416	-85.8419222
13	8 ft	44.9003376	-85.8443858
14	7-8 ft	44.9000464	-85.8429945
15	12 ft	44.8994748	-85.8418274
16	6 ft	44.8936082	-85.8492142

Table 2: GPS coordinates and approximate depth for each site in the plant survey.



Figure 1. Sites sampled during the plant survey along the break line.

Emergent Plant Survey

Shoreline Sampling

Methods

A shoreline survey was completed on 10 August using kayaks to allow closer monitoring of the shoreline. Specifically, during this survey, we looked for emergent aquatic plants (rushes, sedges, cattails), invasive species (both terrestrial and aquatic), drain pipes, Cladophora and inlets. Findings were drawn on a laminated map while in the field and later transferred to an electronic map. GPS coordinates were not recorded while drawing the maps; all locations are approximate.

Results & Conclusions

There were no aquatic invasive species found during the shoreline survey. We did find a new species of Pondweed which we included in Table 1 of the break line submergent plant survey. It was notable to report a large portion of the shoreline has sedges and/or rushes growing along it. We also found cattails in many marshy areas, as well as nearby most inlets.

We did confirm the presence of several patches of the terrestrial invasive Yellow Iris, which was also seen during drone survey analysis. It is recommended we contact homeowners and the Leelanau Conservancy to get those plants removed in 2021, since they are highly invasive. Other common invasive species were not seen, including Purple Loosestrife and Phragmites. This is great news for the lake. A visual map of our findings can be found below (Figure 2).

Sporadic Narrow Leaf Cattail (*Typha angustifolia*) was seen around the lake, which is also an invasive species. We were not specifically looking for it, but have since learned of its invasive behavior. It can be difficult to identify because it often hybridizes with broadleaf cattail (*Typha latifolia*). Our recommendation would be to monitor it next year and then discuss removal options if found to be a nuisance or spreading problem.

During the shoreline survey, we found two more drain pipes that could not be seen during drone survey analysis. We also noticed that several inlets had Cladophora growing nearby. This is generally a sign of nutrients in the water and it is my recommendation to have several of those areas tested for phosphorus and nitrates. If the lake is getting excess nutrients, we can work to find the source and work towards a potential solution.

During our shoreline survey, it was noted that although the drone survey is incredibly beneficial, as I'll discuss later, the survey from the water was also necessary to see under some heavily wooded areas or to spot check what we saw on the drone. A combination of the two methods is the most effective method to get a comprehensive look at the shoreline health of Lime Lake.

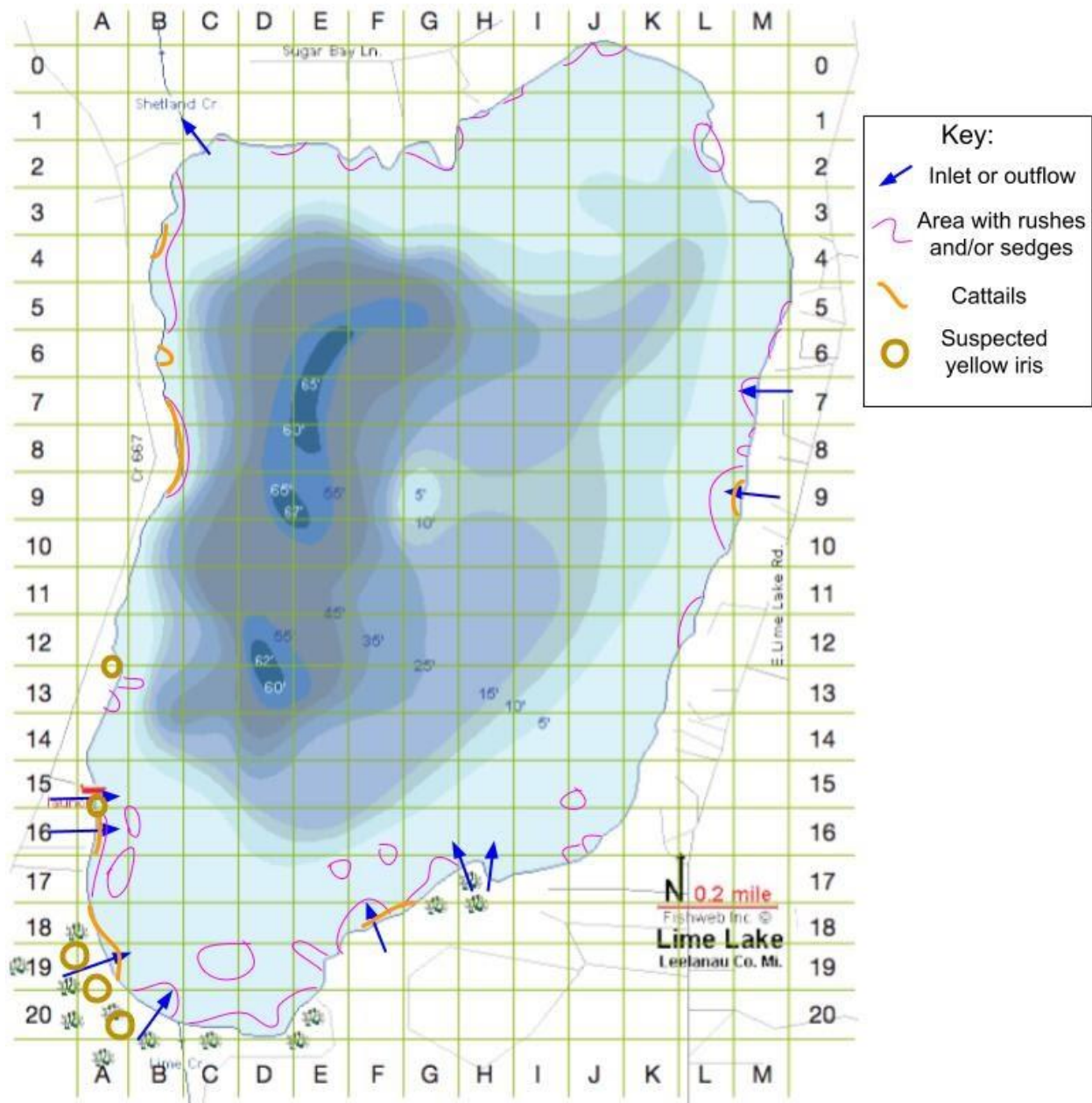


Figure 2: A visual representation of emergent aquatic plants, invasive species, and inlets.

Algal Survey

Microscopic organisms, including algae, rotifers and arthropods are important organisms in a lake ecosystem. Algae, along with submergent plants and photosynthetic bacteria, are the base of most aquatic food webs and their presence ultimately allows birds, fish and other animals to live in and around the lake.



Method

A plankton tow (20um) was dragged slowly behind a boat for 5-10 minutes on 10 July. Another plankton tow was dropped in a deep part of the lake and slowly brought to the surface for vertical collection on that day. All samples were brought back to the lab and examined using a compound microscope. Common species were identified to at least the genus level of classification. On 15 July, another plankton tow sample was obtained to get a fresh sample for comparison. This plankton tow method was done yet another time on 11 August for monthly comparison. Figure 3 shows the areas sampled.

In Appendix 2, you will find a visual representation of many species found. All images are from a simple google search. Please do not publish this portion of the final report on the website, since image credit is not properly documented.

Results & Conclusions

There is a vast diversity of microscopic organisms in Lime Lake, as reported in Appendix 2. Documenting the current organisms will help to determine if any changes in the lake are occurring, including new chemicals, nutrients, or invasive species. Rob Karner, Glen Lake Watershed Biologist, has conducted a similar survey for a number of years and has been able to show the loss of diversity caused by zebra mussel introduction. From an ecological standpoint, knowing what makes up the base of the aquatic food web is both fascinating and important.

One of the most common algal species present was *Microcystis aeruginosa*, which in extremely high numbers can cause toxic algal blooms. At this time, we have no concerns about the levels of this blue-green algae. During the July 10th sampling date, we also found high numbers of the larval stage of zebra mussels (veliger). If zebra mussels were not already populating the lake, this would be concerning. However, because they are well established, veliger presence was not a surprise. The most common rotifer found in the sampling was *Keratella cochlearis*. This is not surprising either, since it is found in almost all standing bodies of water around the world (1).

During the 11 August survey, there was an algal bloom of *Peridinium* occurring. The water was visibly cloudy and had a slight yellow tint to it. *Peridinium* is a non-toxic algal species that has 'safe' blooms throughout the summer. There is no concern raised from this bloom. Interestingly, *Peridinium* has been extensively studied because of the blooms that occur in the Sea of Galilee (2). In every case, the blooms were found to be non-toxic.

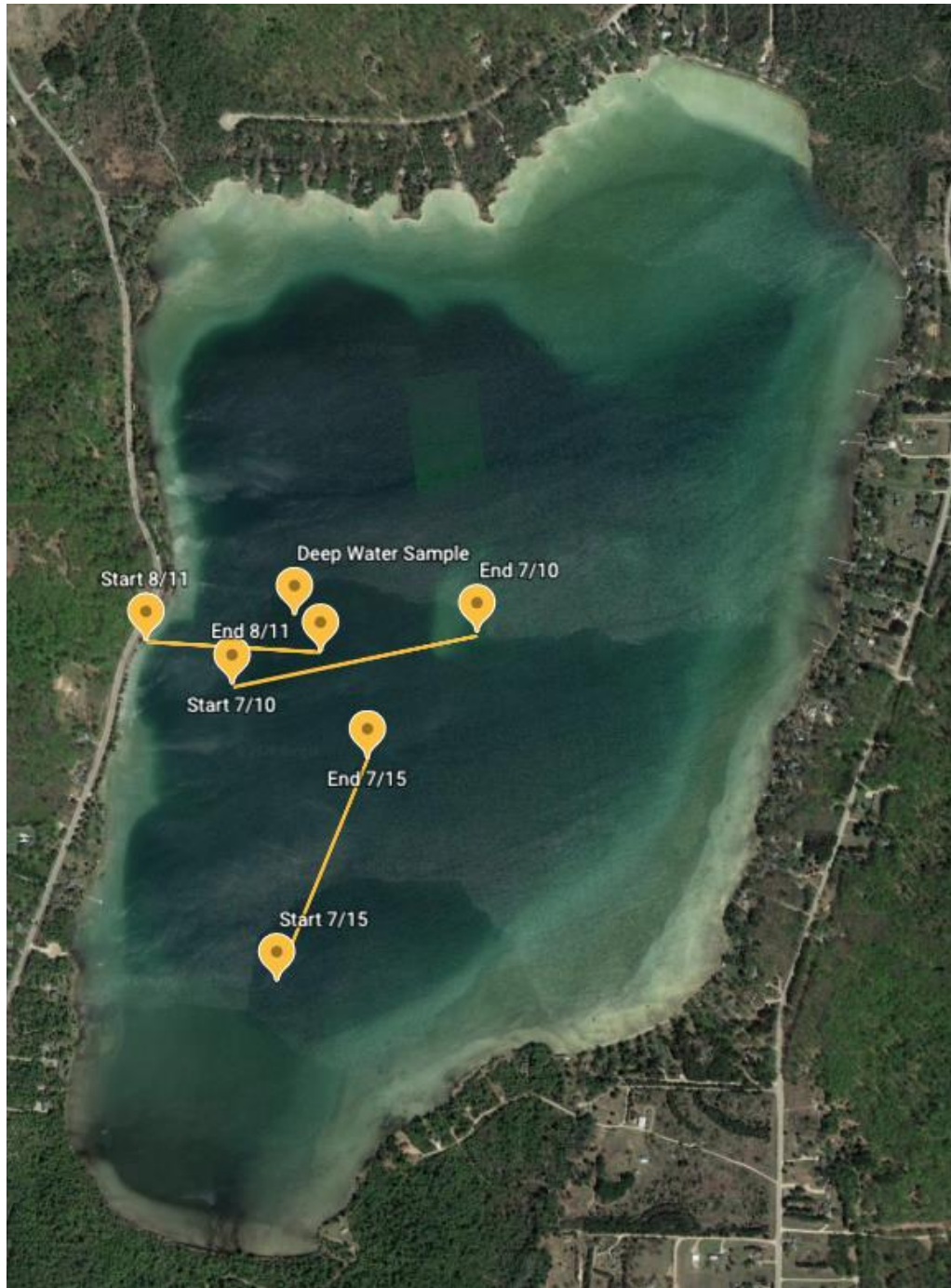


Figure 3: Areas sampled during the algal surveys.

Water Collections

Enteric Bacteria Water Collection

Water was drawn from the well and lakefront surface water of 8 cottage owners on 23 June, 13 July, and 4 August as part of the FWS Enteric Bacteria Research Initiative. Samples were extracted by scientists at Freshwater Solutions and more information about this data will be coming in the Freshwater Solution's Final Report.

Swimmer's Itch Water Collection

Water was collected at 10 sites around the lake using Freshwater Solution's standard collection protocol each Tuesday morning in July. Sites were chosen based on past data collection, reports of swimmer's itch and general vicinity on the lake. Water samples were then suction-filtered and processed by scientists at University of Alberta. See Freshwater Solution's Final Report for more information.

Drone Survey Analysis

Using archived video footage collected via drone by Dennis Wiand in 2019, comprehensive shoreline analysis was completed. The shoreline was examined for a number of different features. Each occurrence for each feature was recorded and cataloged via a screenshot. Table 4 shows the number and percentages of properties within each category. A brief description of each category follows, along with commentary of what was found. Using Google Earth, the number of lakefront properties were counted to be 120. This number was used to find the percentage of properties with certain features.

Overall, only 12.5% of riparians have beach sand brought in. We can reduce that number by continued education. Over 60% of lakefront properties lack a green belt. This number is higher than hoped. Again, through education over time we can reduce that number significantly. These results might provide a good opportunity for a video explaining the benefit of greenbelts, or even just an email blast with information included (Appendix I). I put together a brief summary below. If funds are available, another idea would be to have a matching program, where the lake association matches up to \$500 (for example) of costs for any riparian who wishes to convert their frontage to a greenbelt.

Note: None of these categories or suggestions are meant to be divisive amongst Lime Lake riparians. This survey is not meant to 'point a finger' at those people who have certain characteristics in their landscape. The most useful action steps are purely from an education standpoint of letting riparians know what is best for the lake and perhaps providing incentive for making a more eco-friendly landscape.



Category	2019	Percentage of properties
Beach Sanding	15	12.50%
Cladophora	13	10.83%
Drain Pipes	6	5.00%
Erosions	13	10.83%
Greenbelts	35	29.17%
Inlets	14	n/a
Lk Water Irri	2	1.67%
Natural Shoreline	7	5.83%
No greenbelt	73	60.83%
Rip Rap	49	40.83%
Sea Walls	7	5.83%
Terres Invas	4	n/a

Table 4: Categories analyzed using drone footage.

Beach Sanding

These are shorelines where beach sand has been brought in. A permit is necessary for this activity. Having non-natural sand continue down to the lake generally has a negative impact on lake ecology. Much of the sand gets washed into the lake and eroded in the winter, causing more sand to be needed. There is also no barrier between runoff waters and the lake. Any chemicals or nutrients in runoff water will immediately drain into the lake. There are 15 properties or 12.5% of properties on Lime Lake with beach sanding.

Cladophora

Cladophora is an alga that indicates an excess of nutrients in the water. It is not always clear what the nutrient source is, but in some cases riparians may want to gather more information to find the source. We found 13 'areas of interest' in regards to Cladophora. These areas will be interesting to watch if future drone surveys are completed to see if they are consistently present, or if they were just a short-term occurrence.

Drain Pipes

Drain pipes are often used to direct stormwater away from houses and into the lake. Tiles will be placed underground around the house to filter the water towards the drain. This can put excess runoff and nutrients into the lake, as the water is not filtered through soil and plants do not have a chance to uptake the nutrients. Lime Lake only showed four drain pipes into the lake via the drone survey, but an additional two were found during the shoreline survey to bring the lake total to six, or 5% of properties.

Erosion

Erosion is not necessarily a good or bad thing, but it is something that can be monitored for changes year to year. There were 13 erosion sites that were earmarked to watch in the future as our lake continues to change.

Inlets

We have many inlets into Lime Lake. We should continue monitoring these inlets in future years to document changes. Inlets are natural and positive for the lake, but excess nutrients through an inlet can cause problems. The drone footage was key to finding all the inlets, as they were easier to see from above than during our shoreline survey.

Lack of Green Belt

We calculated the number of properties that did not have a greenbelt between their lawn and water. See Appendix 1 for more information about greenbelts and why they are important. A major goal to improve and maintain lake health would be to increase the number of properties that have a greenbelt. Seventy-three (73) properties do not have a greenbelt or natural shoreline present, which makes up 61% of the properties on Lime Lake.

Lake Water Irrigation Systems

If riparians feel the need to have a manicured lawn, a lake water irrigation system is a great way to do that. This utilizes nutrient-rich water from the lake, eliminating the need for fertilizer application. Two irrigation systems were noted during the drone survey analysis.

Rip Rap Barriers

Rip rap is defined as a rock barrier at the water's edge that is not natural. This has historically been a popular way to minimize erosion, but more ecofriendly methods have been developed. We would recommend having a greenbelt instead, or core logs that help a greenbelt take hold. Rip rap was seen on 49 properties (41%) and it would be recommended to continue educating riparians about options other than riprap to keep shorelines from eroding.

Sea Walls

Sea walls are a barrier at the water's edge made of material other than rock, generally consisting of wood, steel or concrete. Seven (7) seawalls were noted during analysis. Sea walls are not necessary in a lake our size and cause excess damage to neighboring lake frontage.

Terrestrial Invasive Species

Any invasive species, either aquatic or terrestrial, is problematic for a lake habitat. Invasive species have few natural predators or competition and can easily take over an area, pushing out native species and reducing diversity. We specifically looked for Phragmites, Purple Loosestrife and Yellow Iris. Coltsfoot is another common invasive species, but is very difficult to identify via drone footage at this time of year, and was not flowering during our shoreline survey. In the 2019 survey, there were several areas that had Yellow Iris growing. Two properties had just one plant growing; these were private residences. The most concerning area is the south end of the lake, in the lowland area owned by the Leelanau Conservancy where there are several clumps of Yellow Iris.

Recommendations

I put together a list of recommendations for future work to be considered by the Lime Lake Association. While all would benefit the lake, completing all projects would probably not be feasible. I compiled my thoughts here with hopes that the lake association board could more easily discuss 'next steps' and choose those that best fit the needs of the lake.

1. I recommend that the algal and plant surveys be conducted each year to consistently document the organisms in our lake, while ensuring invasive species do not become established.
2. Education of our riparians is key. I would recommend we start educating about the benefits of greenbelts. As a board, you may want to discuss a goal for the future (i.e. decrease the number of 'non-greenbelt' homes by 20% by 2025) or possible ways to motivate riparians to add a greenbelt.
3. Swimmer's itch is a constant problem and it would be my recommendation to continue monitoring the severity, but also trying new techniques to give riparians power to decrease cases of itch. Look for Freshwater Solution's proposals next winter for more information.
4. Reporting swimmer's itch is something we have never had great success doing. One idea would be to have riparians sign-up to be part of a swimmer's itch reporting initiative. These volunteers would report anytime anyone swam in their waters and whether or not they got swimmer's itch. It is my hypothesis that by being part of an initiative, riparians will take more ownership of the process and report more consistently. Look for Freshwater Solution's proposals next winter for more information.
5. I would recommend that drone surveys continue to be completed every two years (the next would be in 2021). This would allow us to monitor all shoreline information, and quantify any progress we are making at a lake wide level. There is also the option to have Dennis Wiand complete a survey at 100 feet above the shore. If this was completed, we could compile data about our aquatic gardens, any channels we might have and prop damage to our lake bottom.
6. Consider creating a greenbelt at the boat launch to "lead by example" and show riparians the beauty that can be created.
7. Consider joining The Leelanau School 'hub' for qPCR. More information can be found through Freshwater Solutions, but this would allow for potentially cheaper sampling and complete control of questions being answered using qPCR.
8. Contact owners of areas with Yellow Iris and remove the plants, especially on the south end of the lake. More precise directions to the area can be given, if needed.
9. Have water tested for nitrogen and phosphorus at inlets that show Cladophora. Knowing what nutrients are present and trying to link it to a source may be beneficial for future action plans. One option might be to rent the Glen Lake Association's Hydrolab to collect data on a variety of parameters.
10. Become part of Michigan's Cooperative Lakes Management Program in 2021, which is a statewide program to monitor water quality.

Acknowledgements

A big thanks to Rob Karner for the hours he spent training Ron and me on algal studies and drone analysis. Thanks also for his expertise, ideas and excitement for conserving the lakes in Leelanau County. Much of what we did this summer is a replica of the work on Glen Lake, which is an amazingly robust program. Thanks also to Chris Froelich for collecting water samples. This work could not have been completed without the shared efforts between myself and Ron Reimink. Without the support and resources of Freshwater Solutions, this program would not have been able to run at its current capacity and would have had much greater costs incurred to the lake association.

Citations

1. *Zooplankton of the Great Lakes*, Central Michigan University (people.cst.cmich.edu/mcnau1as/zooplankton%20web/keratella/ker.html)
2. Rogers, Kara. "Peridinium." *Encyclopædia Britannica*, (www.britannica.com/science/Peridinium)

Appendix 1: What is a greenbelt

This writeup is meant to serve as a template that could be used to send out to lake association members to start educating them on greenbelts and their importance.

What is a greenbelt?

A greenbelt is a strip of land (no smaller than 20 feet) next to the shoreline that has natural vegetation growing. It acts as a buffer zone between a manicured lawn and the lake. One of the largest benefits of a greenbelt is controlling erosion of your shoreline. The roots of plants hold the soil and sand in place. Another large benefit of a greenbelt is its ability to stop nutrients from leaching into the lake. Having too many nutrients can lead to algal blooms and nutrient loading. Smaller, but noteworthy benefits of a greenbelt include providing a natural habitat for insects and larger animals and deterring geese from spending time on lawns. It also can cut down on cost and time spent manicuring a lawn.

What plants should be included in a greenbelt?

There are many beautiful perennial plants that can be included in a greenbelt. Plants should only be used if they are native to our area. These do not need to be trees that block your view of the lake, but can be low shrubs or flowers. Below are some beautiful examples of greenbelts.

Does my entire shoreline need to be a greenbelt?

Of course, there needs to be accessibility to the lake and any amount of greenbelt is better than none! It is suggested that 75% of your shoreline is covered with a greenbelt, leaving plenty of space for water accessibility. The more, the better!

How can my frontage become a greenbelt?

Our lake biologist, Kelsey Froelich, would love to come to your property and discuss ideas to incorporate a greenbelt into your property! Send an email to: kelsey.froelich@gmail.com to schedule a time to chat. For more information about greenbelts, check out the Tip of the Mitt's website [here](#).