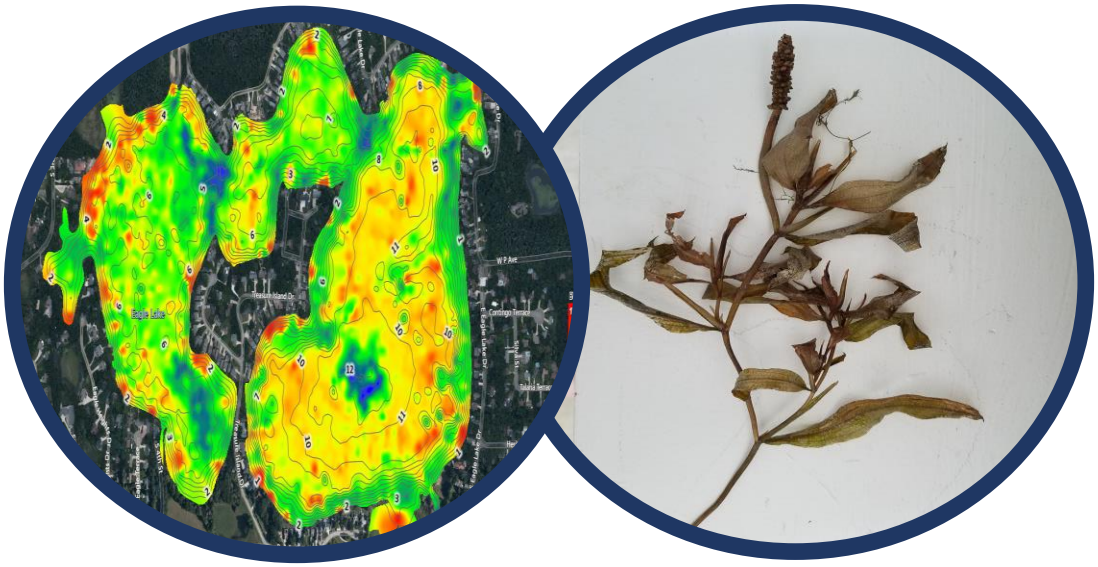
Eagle Lake Baseline Inversion Oxygenation Data 2021
Kalamazoo County, Michigan



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Eagle Lake Baseline Inversion Oxygenation Data 2021
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1.0 PROJECT INTRODUCTION & SUMMARY

Eagle Lake is located in Section 8,9,16 and 17 of Texas Township (T.3S, R.12W) in Kalamazoo County, Michigan. The lake has a surface area of approximately 230 acres (Michigan Department of Natural Resources, 2004) and is classified as a eutrophic (nutrient-enriched) aquatic ecosystem with three distinct deep basins. The entire lake serves as a littoral (shallow) zone. Eagle Lake contains a volume of approximately 1,120 acre-feet of water and has a mean depth of 4.9 feet and a maximum depth of 12 feet. The maximum depth was confirmed by RLS scientists in 2014 with the use of a bottom-scanning GPS system that created a modernized depth contour bathymetric map. In addition to the depth contour map, a map of soft versus hard bottom was also created. The bottom hardness map shows that the majority of the lake bottom contains soft deposits of organic content and small areas of hard sand and gravel bottom. Eagle Lake receives water from a groundwater well that pumps at a rate of 1,000-1,200 gallons per minute (USGS, 1970) and the lake does not contain an inlet or outlet but contains some springs. Eagle Lake has a lake perimeter of approximately 4.5 miles (Michigan Department of Natural Resources, 1999). The longest point across the lake (fetch) is 0.7 feet and thus the lake may produce sizeable waves during high winds. A laminar flow aeration (LFA) system or inversion oxygenation technology was recommended to improve previously studied impairments of the lake which are discussed below.

1.1 Summary of Eagle Lake Aeration Operations:

Laminar Flow Aeration (LFA) was installed in Eagle Lake in 2017 with a permit from EGLE. This data set serves as the new baseline data for a new LFA operational permit from EGLE for 2022.

1.2 Summary of Aeration Operation Purpose/Goals:

Eagle Lake is a well-recreated lake and is utilized by many for fishing, swimming, boating, and waterfront living. In recent years, the lake has become dominated by aggressive watermilfoil and pondweed growth and has a very mucky bottom throughout most of the lake. The local residents have desired a more holistic approach to addressing both the aquatic plant issues as well as the muck reduction. The residents desired a lake restoration strategy that would make the lake healthier and accomplish the following objectives:

The primary objectives of the implemented LFA system for Eagle Lake include:

1) Reduction of nuisance rooted submersed aquatic vegetation such as milfoil and pondweed (accomplished)
2) Reduction of muck in problem areas (fluctuates annually)

2.0 EAGLE LAKE SAMPLING METHODS & PARAMETERS

2.1 Summary of Equipment/Sampling Devices/Replicates/Parameters Measured:

Restorative Lake Sciences sampled 5 locations in Eagle Lake to satisfy the EGLE permitting requirements for a lake this size. This baseline water quality data was collected on May 28, 2021, July 21, 2021, and September 8, 2021.

All chemical water samples were collected at the specified depths (one each at the top, middle, and bottom depths of each of the sampling sites) using a 4-liter VanDorn horizontal water sampler with weighted messenger (Wildco® brand). Water quality physical parameters (such as water temperature, dissolved oxygen, conductivity, and pH) were measured with a calibrated Hanna® multi-probe meter at top, middle, and bottom depths of the 4 sampling sites. Total phosphorus was titrated and analyzed in the laboratory according to method SM 4500-P E. Ortho-phosphorus was titrated and analyzed in the laboratory according to method SM 4500-P E. Total suspended solids were analyzed for each sample using SM 2540 D-97. Chlorophyll-*a* was analyzed with the SM 10200H method. All of the aforementioned chemical parameters were analyzed at Trace Analytical Laboratories in Muskegon, Michigan.

Prior to analysis of the samples as described above, water samples were placed in clean, unpreserved polyethylene bottles for ortho-phosphorus and total suspended solids and placed in H_2SO_4-preserved, clean, polyethylene bottles for total phosphorus analysis. Chlorophyll-*a* samples were placed in glass brown, amber 1-liter bottles. All water samples were maintained on ice in a large cooler prior to being taken to the laboratory.

Samples used for microscopic analysis of algal community composition were preserved with magnesium carbonate and counted with a Sedgewick Rafter® Counting Cell under high power objective on a bright-field Zeiss® compound microscope. Multiple 1 micro-liter (µL) aliquots were used to determine the relative abundance of algal genera in the samples.

A zooplankton tow using a Wildco® pelagic plankton net (63 micrometer) with collection jar was conducted by RLS scientists on July 21, 2021 and September 8, 2021 in the five basins of Eagle Lake. The plankton net was left at depth for 30 seconds and then raised slowly to the surface at an approximate rate of 4 feet/second. The net was then raised above the lake surface and water was splashed on the outside of the net to dislodge any zooplankton from the net into the jar. The jar was then drained into a 125-mL bottle with a CO_2 tablet to anesthetize the zooplankton. The sample was then preserved with a 70% ethyl alcohol solution.

Plankton sub-samples (in 1 ml aliquots) were analyzed under a Zeiss® dissection scope with the use of a Bogorov counting chamber.

2.2 Sampling Dates and Locations:

In pursuance of a new LFA permit for Eagle Lake, the 2021 baseline data collection occurred on May 28, 2021, July 21, 2021, and September 8, 2021. In addition to the aforementioned parameters, 12 sediment organic matter samples were collected with an Ekman hand dredge and were analyzed for percentage of organic matter and particle size.

All water quality samples were collected from the sampling locations according to Figure 1. Sediment samples were collected from the sampling locations according to Figure 2.

Figure 1. 2021 water quality sampling locations on Eagle Lake, Kalamazoo County, MI.

3.0 EAGLE LAKE 2021 BASELINE WATER QUALITY SAMPLING RESULTS

All baseline physical water quality data is shown in tables 1-15 below. Baseline chemical water quality data is shown in tables 16-30 below. Sediment muck depth data can be found in Table 31 below.

3.1 Eagle Lake Baseline Physical Water Quality Data Tables:

Pre-Aeration Data Table (May 28, 2021): Site 1

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0	19.7	9.4	8.7	186	2.0+
0.5	19.7	8.6	8.8	189	
1.0	19.7	8.4	8.8	188	
1.5	19.7	8.3	8.8	189	
2.0	19.7	8.3	8.7	189	

Table 1. Eagle Lake baseline physical water quality parameter data collected from Site 1 on May 28, 2021.

Pre-Aeration Data Table (May 28, 2021): Site 2

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0	19.8	9.5	8.8	188	2.0+
0.5	19.8	8.9	8.8	188	
1.0	19.8	8.6	8.8	188	
1.5	19.8	8.6	8.8	188	
2.0	19.8	8.5	8.8	187	

Table 2. Eagle Lake baseline physical water quality parameter data collected from Site 2 May 28, 2021.

Pre-Aeration Data Table (May 28, 2021): Site 3

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0	19.6	9.8	8.8	192	2.5+
0.5	19.6	9.1	8.8	192	
1.0	19.6	9.0	8.8	192	
1.5	19.6	8.9	8.8	192	
2.0	19.5	8.9	8.8	192	
2.5	19.3	8.6	8.7	193	

Table 3. Eagle Lake baseline physical water quality parameter data collected from Site 3 May 28, 2021.

Pre-Aeration Data Table (May 28, 2021): Site 4

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0	19.9	9.1	8.8	206	3.5
0.5	19.9	9.1	8.8	206	
1.0	19.9	9.1	8.8	206	
1.5	19.9	9.1	8.8	206	
2.0	19.9	9.1	8.8	206	
2.5	19.9	9.1	8.8	206	
3.0	19.9	9.1	8.8	206	
3.5	19.9	9.1	8.8	206	
4.0	19.9	8.9	8.8	207	

Table 4. Eagle Lake baseline physical water quality parameter data collected from Site 4 May 28, 2021.

Pre-Aeration Data Table (May 28, 2021): Site 5

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0	19.7	10.5	8.8	196	3.3
0.5	19.7	10.5	8.8	196	
1.0	19.8	10.5	8.8	196	
1.5	19.8	10.6	8.8	196	
2.0	19.8	10.6	8.8	196	
2.5	19.8	10.6	8.8	196	
3.0	19.8	10.6	8.8	196	
3.5	19.2	9.5	8.2	223	

Table 5. Eagle Lake baseline physical water quality parameter data collected from Site 5 May 28, 2021.

Pre-Aeration Data Table (July 21, 2021): Site 1

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0.5	26.3	9.7	8.8	204	1.6
1.0	26.4	10.1	8.7	205	--
2.0	26.4	10.1	8.7	204	--
2.5	25.7	10.7	8.8	201	
3.0	25.5	11.3	8.8	202	

Table 6. Eagle Lake baseline physical water quality parameter data collected from Site 1 on July 21, 2021.

Pre-Aeration Data Table (July 21, 2021): Site 2

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0.5	26.0	8.9	8.8	199	1.96
1.0	26.1	9.8	8.8	198	
1.5	26.1	10.1	8.8	197	
2.0	25.8	10.4	8.8	192	
2.5	25.7	10.5	8.8	193	
3.0	25.5	9.5	8.4	198	

Table 7. Eagle Lake baseline physical water quality parameter data collected from Site 2 July 21, 2021.

Pre-Aeration Data Table (July 21, 2021): Site 3

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0.5	26.1	9.4	8.8	119	2.16
1.0	26.2	10.3	8.8	185	
1.5	26.1	10.5	8.8	187	
2.0	25.9	10.7	8.8	188	
2.5	25.8	10.8	8.0	189	

Table 8. Eagle Lake baseline physical water quality parameter data collected from Site 3 July 21, 2021.

Pre-Aeration Data Table (July 21, 2021): Site 4

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0.5	26.0	9.2	8.1	172	2.46
1.0	26.0	10.5	8.1	172	
1.5	26.0	10.8	8.1	172	
2.0	25.6	10.9	8.2	170	
2.5	25.5	11.8	8.2	171	
3.0	25.4	11.4	8.2	172	
3.5	25.4	11.2	8.1	172	
4.0	24.3	9.6	8.2	182	
4.5	23.4	5.7	8.5	203	

Table 9. Eagle Lake baseline physical water quality parameter data collected from Site 4 July 21, 2021.

Pre-Aeration Data Table (July 21, 2021): Site 5

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0.5	25.6	9.7	8.9	179	2.16
1.0	26.0	9.9	8.9	179	
1.5	25.7	10.2	8.9	179	
2.0	25.7	10.2	8.9	179	
2.5	25.6	10.2	8.9	178	
3.0	25.5	10.2	8.9	178	
3.5	25.3	10.2	8.8	178	

Table 10. Eagle Lake baseline physical water quality parameter data collected from Site 5 July 21, 2021.

Pre-Aeration Data Table (September 8, 2021): Site 1

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0	23.5	8.6	8.3	201	2.20
0.5	23.5	8.5	8.3	201	--
1.0	23.5	8.5	8.3	201	--
1.5	23.5	8.5	8.3	201	
2.0	23.5	8.5	8.3	201	

Table 11. Eagle Lake baseline physical water quality parameter data collected from Site 1 on September 8, 2021.

Pre-Aeration Data Table (September 8, 2021): Site 2

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0	23.5	8.4	8.4	192	2.0
0.5	23.6	8.3	8.4	193	
1.0	23.5	8.3	8.4	192	
1.5	23.5	8.3	8.4	193	
2.0	23.4	8.4	8.4	194	

Table 12. Eagle Lake baseline physical water quality parameter data collected from Site 2 September 8, 2021.

Pre-Aeration Data Table (September 8, 2021): Site 3

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0	23.7	8.2	8.4	186	1.70
0.5	23.7	8.1	8.5	186	
1.0	23.7	8.1	8.5	186	
1.5	23.7	8.1	8.5	186	
2.0	23.6	8.1	8.5	185	
2.5	23.4	8.3	8.5	184	

Table 13. Eagle Lake baseline physical water quality parameter data collected from Site 3 September 8, 2021.

Pre-Aeration Data Table (September 8, 2021): Site 4

Depth	*Water*	*DO*	*pH*	*Cond.*	*Secchi Depth*
m	*Temp ºC*	*mg L^{-1}*	*S.U.*	*µS cm^{-1}*	*(m)*
0	24.0	7.4	8.2	180	2.7
0.5	24.0	7.3	8.2	180	
1.0	24.0	7.3	8.2	180	
1.5	24.0	7.2	8.2	180	
2.0	23.9	7.2	8.2	180	
2.5	23.7	7.2	8.1	181	
3.0	23.6	6.9	8.1	182	
3.5	23.6	6.6	8.0	182	

Table 14. Eagle Lake baseline physical water quality parameter data collected from Site 4 September 8, 2021.

Pre-Aeration Data Table (September 8, 2021): Site 5

Depth *m*	*Water Temp ºC*	*DO mg L^{-1}*	*pH S.U.*	*Cond. µS cm^{-1}*	*Secchi Depth (m)*
0	24.0	8.1	8.4	179	1.89
0.5	24.0	8.0	8.4	179	
1.0	24.0	8.0	8.4	179	
1.5	24.0	8.0	8.5	179	
2.0	23.9	8.1	8.5	179	
2.5	23.8	8.1	8.5	178	
3.0	23.8	8.2	8.6	178	

Table 15. Eagle Lake baseline physical water quality parameter data collected from Site 5 September 8, 2021.

3.2 Eagle Lake Baseline Chemical Water Quality Data Tables:

Pre-Aeration Data Tables (May 28, 2021): Site 1

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
1.0	0.016	<0.010	12	0.038	1.1	0.534

Table 16. Eagle Lake baseline chemical water quality parameter data collected from Site 1 on May 28, 2021.

Pre-Aeration Data Tables (May 28, 2021): Site 2

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
1.0	0.022	<0.010	16	0.052	1.0	0.890

Table 17. Eagle Lake baseline chemical water quality parameter data collected from site 2 on May 28, 2021.

Pre-Aeration Data Tables (May 28, 2021): Site 3

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
1.0	0.019	<0.010	14	0.050	1.0	0.890

Table 18. Eagle Lake baseline chemical water quality parameter data collected from site 3 on May 28, 2021.

Pre-Aeration Data Tables (May 28, 2021): Site 4

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
2.0	0.011	<0.010	16	0.025	0.9	0.534

Table 19. Eagle Lake baseline chemical water quality parameter data collected from site 4 on May 28, 2021.

Pre-Aeration Data Tables (May 28, 2021): Site 5

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
2.0	0.030	<0.010	22	0.030	0.9	0.534

Table 20. Eagle Lake baseline chemical water quality parameter data collected from site 5 on May 28, 2021.

Pre-Aeration Data Tables (July 21, 2021): Site 1

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
2.5	0.017	<0.010	10	0.012	0.8	2.14

Table 21. Eagle Lake baseline chemical water quality parameter data collected from Site 1 on July 21, 2021.

Pre-Aeration Data Tables (July 21, 2021): Site 2

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
2.0	0.021	<0.010	<10	<0.010	0.8	4.98

Table 22. Eagle Lake baseline chemical water quality parameter data collected from site 2 on July 21, 2021.

Pre-Aeration Data Tables (July 21, 2021): Site 3

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
1.5	0.014	<0.010	<10	<0.010	0.8	3.56

Table 23. Eagle Lake baseline chemical water quality parameter data collected from site 3 on July 21, 2021.

Pre-Aeration Data Tables (July 21, 2021): Site 4

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
0.5	0.013	<0.010	<10	0.018	0.8	2.14
2.5	0.016	<0.010	<10	0.022	0.9	
4.0	0.013	<0.010	<10	0.011	0.8	

Table 24. Eagle Lake baseline chemical water quality parameter data collected from site 4 on July 21, 2021.

Pre-Aeration Data Tables (July 21, 2021): Site 5

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
0	0.015	<0.010	<10	0.014	0.7	0.00
2.0	0.016	0.010	<10	<0.010	0.6	
3.5	0.014	<0.010	<10	0.015	0.8	

Table 25. Eagle Lake baseline chemical water quality parameter data collected from site 5 on July 21, 2021.

Pre-Aeration Data Tables (September 8, 2021): Site 1

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
1.5	0.017	<0.010	<10	<0.10	0.9	0.00

Table 26. Eagle Lake baseline chemical water quality parameter data collected from Site 1 on September 8, 2021.

Pre-Aeration Data Tables (September 8, 2021): Site 2

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
1.0	0.018	<0.010	<10	<0.10	0.8	6.41

Table 27. Eagle Lake baseline chemical water quality parameter data collected from site 2 on September 8, 2021.

Pre-Aeration Data Tables (September 8, 2021): Site 3

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
1.0	0.019	<0.010	<10	<0.10	0.7	6.14

Table 28. Eagle Lake baseline chemical water quality parameter data collected from site 3 on September 8, 2021.

Pre-Aeration Data Tables (September 8, 2021): Site 4

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
0	0.020	<0.010	<10	<0.10	0.9	2.94
1.5	0.021	<0.010	<10	<0.10	0.8	
3.0	0.027	<0.010	12	<0.10	1.0	

Table 29. Eagle Lake baseline chemical water quality parameter data collected from site 4 on September 8, 2021.

Pre-Aeration Data Tables (September 8, 2021): Site 5

Depth (m)	*Total Phosphorus (mg/L)*	*Ortho-Phosphorus (mg/L)*	*Total Suspended Solids (mg/L)*	*TIN (mg/L)*	*TKN (mg/L)*	*Chlorophyll-a (µg/L)*
0	0.019	<0.010	<10	<0.10	0.8	3.20
1.5	0.018	<0.010	<10	<0.10	0.8	
3.0	0.037	<0.010	14	<0.10	1.0	

Table 30. Eagle Lake baseline chemical water quality parameter data collected from site 5 on September 8, 2021.

3.3 Eagle Lake Baseline Sediment Organic Matter and Particle Size Data Table and Bottom Scan:

Figure 2 below shows the sampling locations (n=12) for sediment sampling of percentage of organic matter and particle size. Each location was marked by GPS. RLS also scanned the lake bottom on September 13, 2021 for sediment bottom hardness which is shown below in Figure 3 with accumulative data shown in Table 32.

Sediment Sample ID (GPS)	% OM	% Gravel	% Sand	% Fines
1 (350)	57.0	0	98.9	1.1
2 (347)	54.0	0	95.2	4.8
3 (353)	50.0	0	86.7	13.3
4 (356)	48.0	0	98.0	2.0
5 (355)	52.0	0	97.2	2.8
6 (352)	60.0	0	94.8	5.2
7 (349)	65.0	0	98.1	1.9
8 (346)	61.0	0	95.6	4.4
9 (345)	76.0	0	98.1	1.9
10 (348)	79.0	0	96.5	3.5
11 (351)	65.0	0	98.7	1.3
12 (354)	62.0	0	96.3	3.7

Table 31. Baseline sediment organic matter and particle size measurements (October 29, 2021).

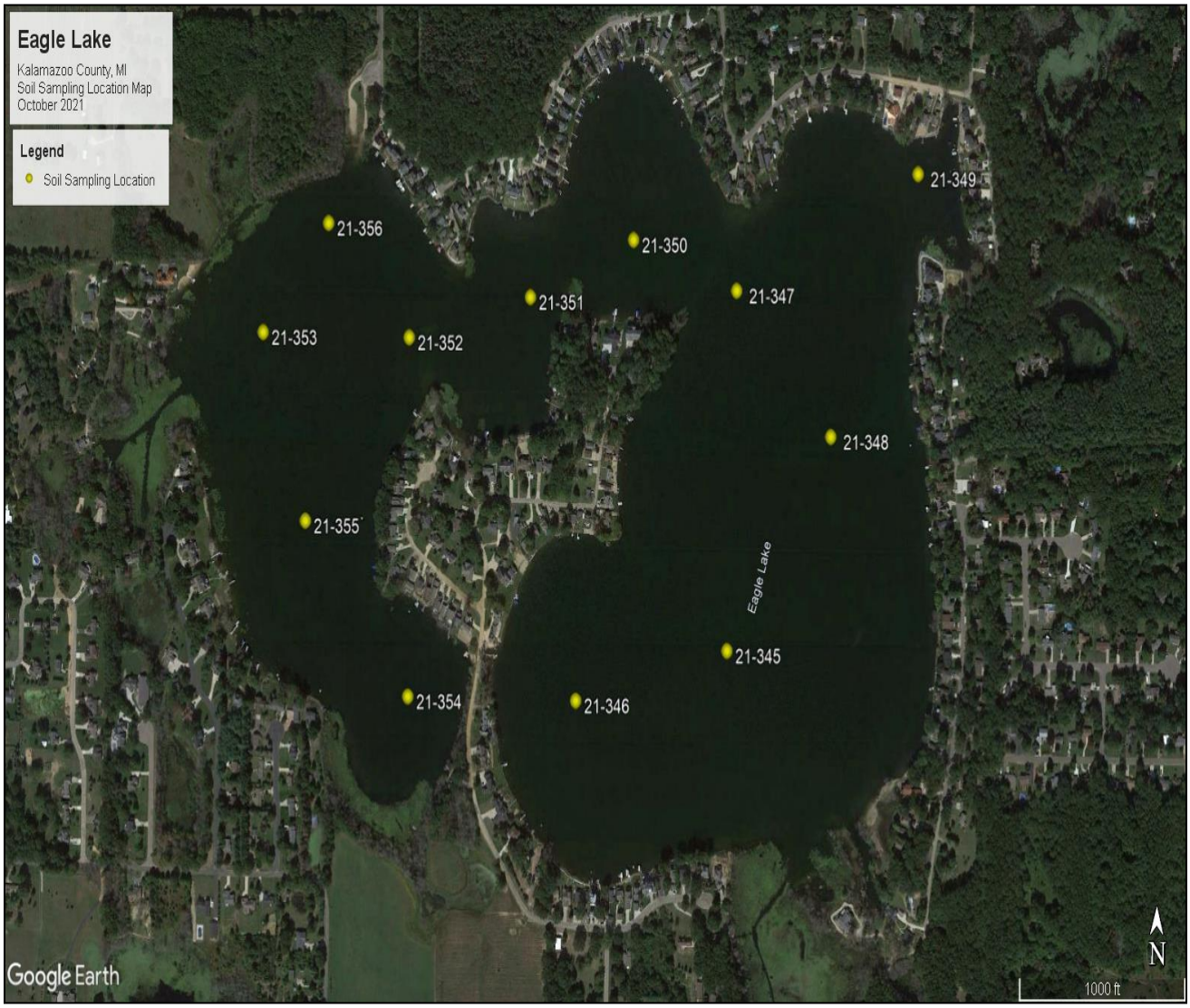

Figure 2. Eagle Lake sediment sampling locations (RLS, October 29, 2021).

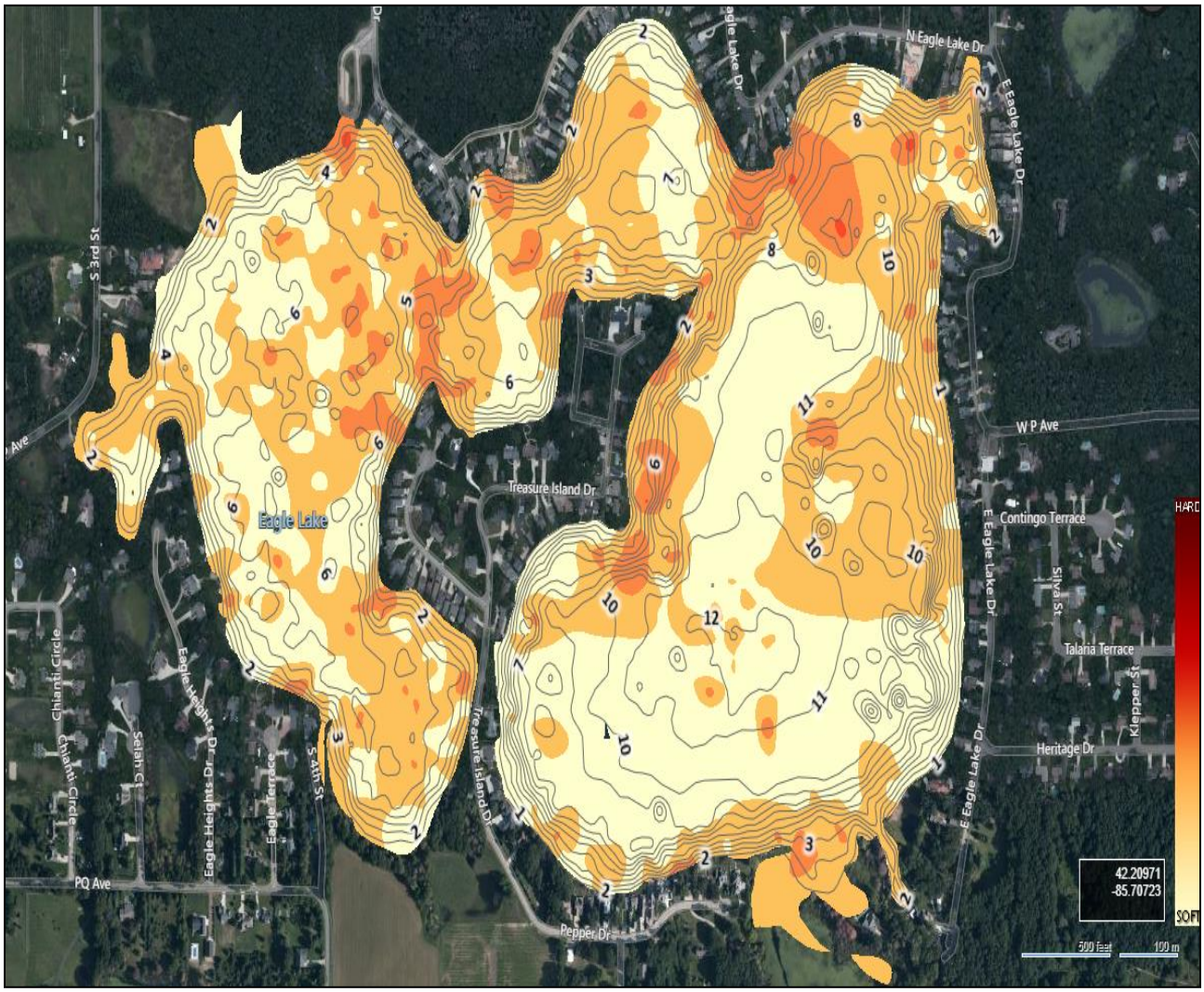

Figure 3. Bottom hardness map of Eagle Lake (RLS, September 13, 2021).

Hardness Category	May 2017 %	Oct 2017 %	May 2018 %	Oct 2019 %	Oct 2020 %	Sept 2021 %
<0.1	0.1	0.0	0.1	0.2	0.0	3.6
0.1-0.2	2.5	0.6	0.1	2.1	0.2	30.7
0.2-0.3	59.7	62.9	14.3	74.3	38.9	45.3
0.3-0.4	32.0	30.9	57.1	21.5	48.7	19.9
>0.4	5.8	5.5	28.4	1.9	12.1	0.5

Table 32. Eagle Lake sediment bottom hardness comparisons (2017-2021).

3.4 Eagle Lake Baseline Phytoplankton Community:

Algal Community Composition Data:

To determine the presence of algal genera from the composite water samples collected from the five basins of Eagle Lake, 500 ml of preserved sample were collected, and a 1-mL subsample was placed to settle onto a Sedgewick-Rafter counting chamber (Woelkerling et *al*., 1076). The ocular micrometer scale was calibrated. The samples were observed under a Zeiss® compound microscope at 400X magnification and scanned at 100X magnification to allow for the detection of a broad range of taxa present. All taxa were identified to Genus level. Phytoplankton samples were enumerated for the May 28, 2021, July 21, 2021 and September 8, 2021 sampling events and are shown below in Table 33. The genera present included the Chlorophyta (green algae), the Cyanophyta (blue-green algae), and the Bascillariophyta (diatoms).

Algal community composition data were collected during the 3 sampling periods at each of the 5 basins. Genera are listed here in the order of most abundant to least abundant. The genera present included the Chlorophyta (green algae): *Haematococcus* sp., *Chlorella* sp., *Rhizoclonium* sp., *Mougeotia* sp., *Pandorina* sp., *Pediastrum* sp., *Spirogyra* sp., and *Chloromonas* sp. the Cyanophyta (blue-green algae): *Oscillatoria* sp.; the Bascillariophyta (diatoms): *Navicula* sp., *Fragilaria* sp., *Synedra* sp., and *Cymbella* sp.

Table 33. Relative abundance of Eagle Lake algal taxa by Basin and date.

Basin	Green Algae	Blue-Green Algae	Diatoms
	May 28, 2021		
Basin #1	**21**	**2**	**71**
Basin #2	**15**	**1**	**31**
Basin #3	**36**	**2**	**47**
Basin #4	**39**	**1**	**69**
Basin #5	**46**	**0**	**27**
	July 21, 2021		
Basin #1	**88**	**1**	**46**
Basin #2	**70**	**6**	**22**
Basin #3	**56**	**2**	**57**
Basin #4	**51**	**0**	**83**
Basin #5	**65**	**1**	**42**
	September 8, 2021		
Basin #1	**81**	**2**	**105**
Basin #2	**70**	**9**	**75**
Basin #3	**118**	**2**	**67**
Basin #4	**66**	**1**	**82**
Basin #5	**124**	**4**	**72**

3.5 Eagle Lake Baseline Zooplankton Community:

The zooplankton make up part of the food chain base in an aquatic ecosystem and thus are integral components. Zooplankton are usually microscopic, but some can be seen with the unaided eye. The zooplankton migrate throughout the water column of the lake according to daylight/evening cycles and are prime food for the lake fishery. The biodiversity and relative abundance of both food chain groups are indicative of water quality status and productivity.

Lake Zooplankton

A zooplankton tow using a Wildco® pelagic plankton net (63 micrometer) with collection jar was conducted by RLS scientists on July 21, 2021, and September 8, 2021 in the five basins of Eagle Lake. The plankton net was left at depth for 30 seconds and then raised slowly to the surface at an approximate rate of 4 feet/second. The net was then raised above the lake surface and water was splashed on the outside of the net to dislodge any zooplankton from the net into the jar. The jar was then drained into a 125-mL bottle with a CO_2 tablet to anesthetize the zooplankton. The sample was then preserved with a 70% ethyl alcohol solution.

Plankton sub-samples (in 1 ml aliquots) were analyzed under a Zeiss® dissection scope with the use of a Bogorov counting chamber. Taxa were keyed to species when possible and are shown in Tables 34-35 below.

Table 34. Zooplankton taxa and count data from the five basins of Eagle Lake (July 21, 2021).

Zooplankton Taxa	**Basin #1**	**Basin #2**	**Basin #3**	**Basin #4**	**Basin #5**
Cladocerans					
Daphnia sp.	12	6	15	21	7
Daphnia spp.	2	4	8	11	1
Bosmina sp.	0	1	3	1	0
Copepods/Cyclopods					
Diaptomus sp.	2	4	1	1	0
Mesocyclops sp.	1	2	2	2	0
Rotifers					
Keratella	5	8	2	1	0
Asplanchna	2	1	0	0	1

Table 35. Zooplankton taxa and count data from the four basins of Eagle Lake (September 8, 2021).

Zooplankton Taxa	**Basin #1**	**Basin #2**	**Basin #3**	**Basin #4**	**Basin #5**
Cladocerans					
Daphnia sp.	5	13	2	1	7
Daphnia spp.	2	5	1	0	17
Bosmina sp.	6	2	2	1	8
Copepods/Cyclopods					
Diaptomus sp.	2	0	0	0	1
Mesocyclops sp.	3	6	1	2	0
Rotifers					
Keratella	5	9	2	7	2
Asplanchna	1	2	4	0	0

3.6 Eagle Lake Aquatic Vegetation Biovolume Scan:

A whole lake scan using a Lowrance HDS 8® sonar unit with GPS software was used to create an aquatic vegetation biovolume map (Figure 4) of the lake on September 13, 2021 as a baseline. Table 36 below demonstrates the changes in aquatic vegetation biovolume over the past several years. Overall, there have been significant reductions in biovolume since the program began. It must be emphasized that other management efforts such as the use of aquatic herbicides have occurred annually to reduce the presence of Eurasian Watermilfoil and also reduce excessive and dense native and invasive pondweeds. Figures 5-6 show the distribution of problem aquatic vegetation in 2021 which required treatment.

LFA Not Operational

Biovolume Category	2014	2015	2016	2017	2018	2019	2020	2021
0-5%	11.1	33.0	13.8	16.0	38.6	53.2	28.9	6.06
5-20%	12.7	21.0	7.2	8.0	4.0	5.3	9.0	16.0
20-40%	11.0	9.0	5.6	10.9	2.5	25.0	24.6	25.3
40-60%	9.3	6.4	6.3	10.0	2.9	13.8	11.3	37.1
60-80%	11.9	4.4	8.1	8.5	8.5	2.2	6.7	9.1
>80%	41.1	26.2	58.9	46.5	43.5	0.6	19.5	6.4

Table 36. Changes in annual aquatic vegetation biovolume in Eagle Lake, Kalamazoo County, MI (2014-2021).

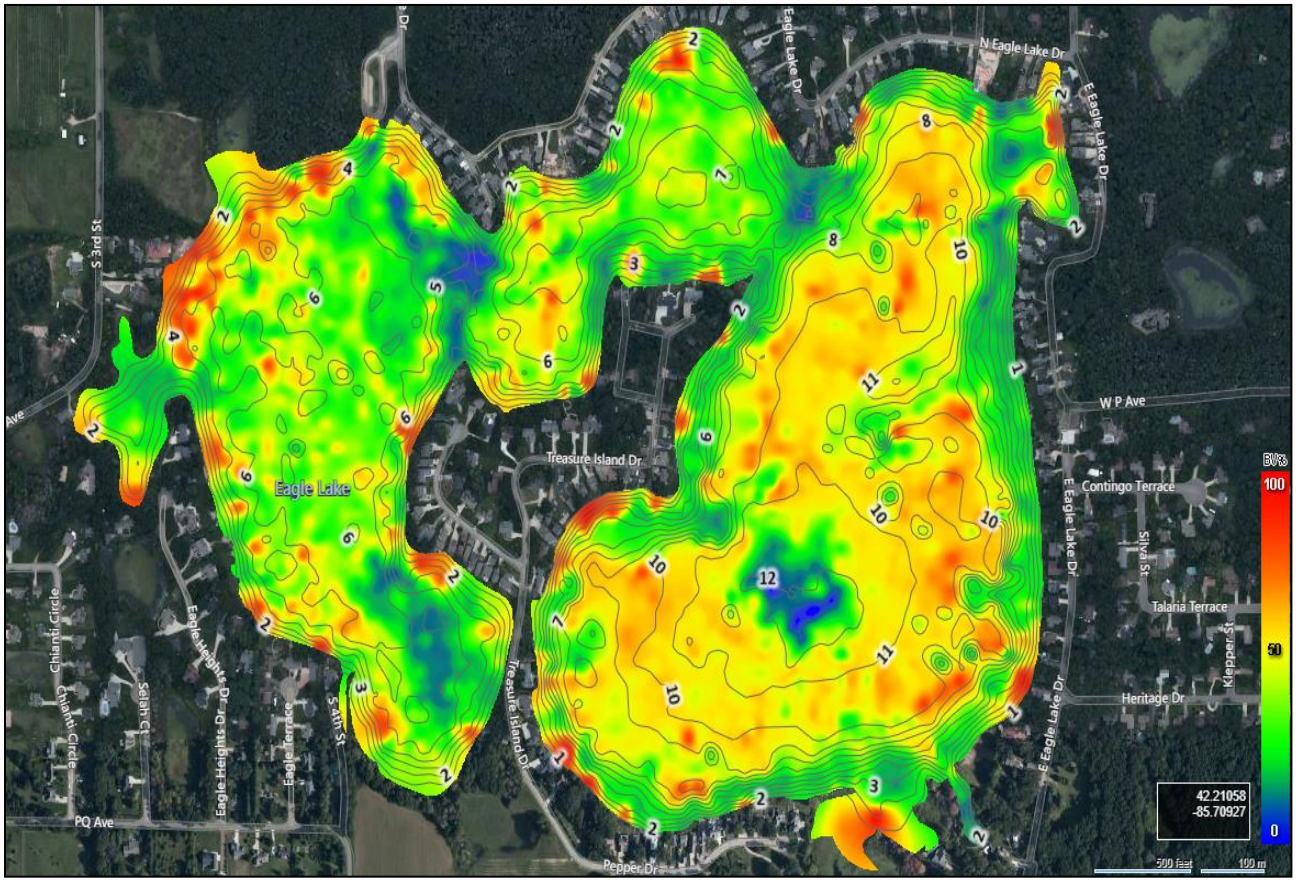

Figure 4. An aquatic vegetation biovolume scan map of Eagle Lake (September 8, 2021, RLS).

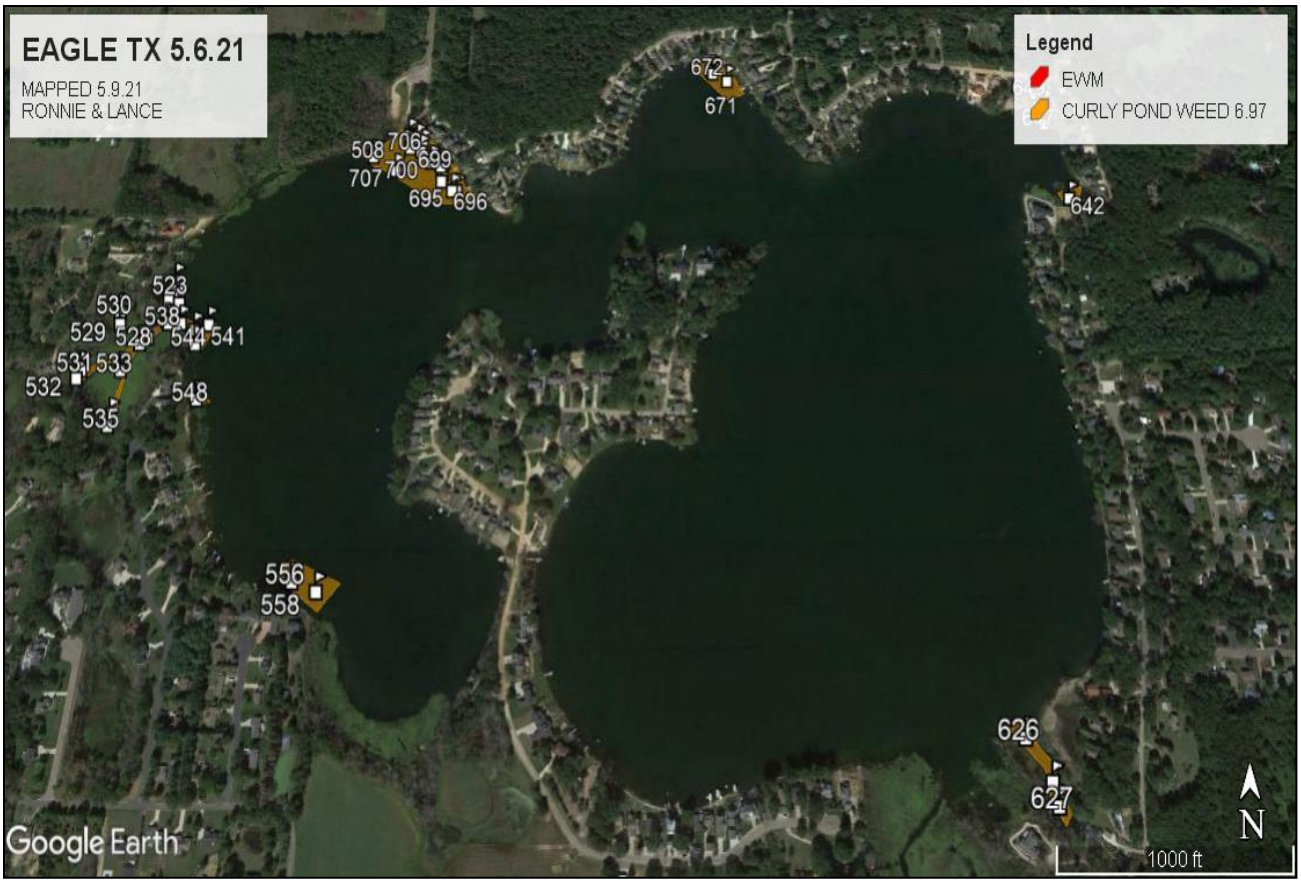

Figure 5. A map of invasive milfoil and Curly-leaf Pondweed locations within Eagle Lake (May 9, 2021, RLS).

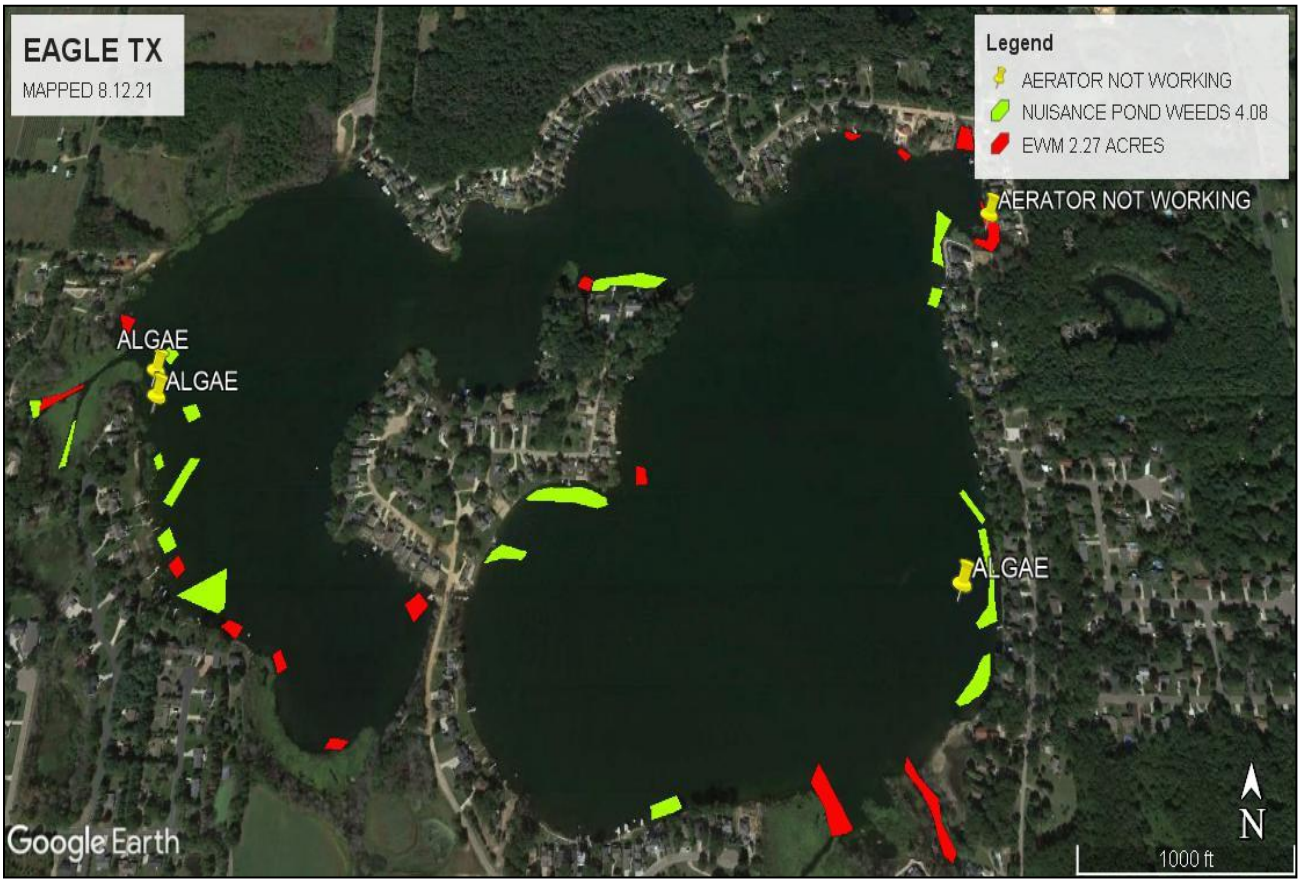

Figure 6. A map of invasive milfoil and nuisance pondweed locations within Eagle Lake (August 12, 2021, RLS).

APPENDIX A

2021 EAGLE LAKE FIELD DATA

APPENDIX B

(2021 EAGLE LAKE LABORATORY DATA REPORTS)