Henderson Lake
Bill Olsen – Primary Contact
2937 Chippewa Trail
Lupton MI. 48635

February 22nd, 2023

Henderson Lake Property Owners,

It has really been a pleasure managing Henderson Lake over the years. Every year seems to bring a unique set of challenges and we welcome the opportunity to meet these challenges for you every single year. We hope that you continue to feel that your lake was managed professionally, economically, and effectively. I have prepared and attached to this document the 2022 annual report for Henderson Lake. This report includes a descriptive timeline of services rendered, a summary, the 2022 treatment maps, and the water quality report for Henderson Lake.

Please keep in mind that we are a fully integrated lakes management company offering solutions including but not limited to mechanical harvesting, herbicide control, dredging, bio-augmentation, and aeration. Savin Lake Services also offers a complete range of water quality testing, depth contour mapping, individual property solutions, and even aquatic plant density reporting.

We look forward to continuing as the Lakes Management service provider for Henderson Lake again next year. Until then; if you have any questions, comments, or require additional information, feel free to contact us.

Sincerely,

Matthew Novotny

Matt Novotny – Operations Manager
Savin Lake Services

Henderson Lake - 2022 Lake Management Report

In 2022, Savin Lake Services was on Henderson Lake a total of 6 times to provide services. Henderson Lake received 3 herbicide/algaecide applications, and 2 bacterial augmentation (Muck Buster) treatments. However the second muck treatment was completed at double rate. In addition to the treatments, we also conducted water quality testing twice. Below is a descriptive timeline and information pertaining to the services we completed.

Timeline of Services Rendered

April 27th, 2022

- Savin Lake Services conducted spring portion of the water quality studies.
  - Our Aquatic Biologist collected data and samples to test the water quality of Henderson Lake.
  - Water samples and data were collected and analyzed from three sites on the lake.
  - Data is collected for 9 different parameters at each site.
    - Parameters we tested for are Temperature, Dissolved Oxygen, Secchi Disk, pH, Chlorophyll a, Nitrate, Phosphorus, Alkalinity, and Conductivity.
  - Report was generated from data and can be found after the treatment maps of this document.

June 14th, 2022

- Savin Lake Services conducted our initial herbicide/algaecide treatment.
  - This treatment was for any non-native invasive plant communities that existed throughout the entire lake.
    - 2.5 acres of the lake was treated for curly leaf pondweed.
  - We also treated for algae and nuisance natives in the near shore developed areas of the lake that required treatment.
    - 12.5 acres of the lake for algae.
    - 10 acres of various native vegetation like Illinois pondweed, Richardson's pondweed, and Naiad.
      - 2.5 acres of which utilized a different herbicide, flumioxazin, in the long canal to improve treatment efficacy
- Observations
  - Same curly leaf pondweed than previous season.
  - No Eurasian watermilfoil detected again in 2022.
  - Natives could be found in all the typical areas we have found them in the past.

July 20th, 2022

- Savin Lake Services completed our second herbicide/algaecide treatment.
  - This treatment was for algae and nuisance native plant communities in the near shore developed areas of the lake.
    - 7.5 acres of the lake was treated for algae.
    - 7.5 acres of the lake was treated for nuisance large-leaf pondweed, Illinois pondweed, and Naiad.

- Observations
  - Only native vegetation present.
    - Native plants could be found in several areas but still below the surface of the water.
  - Lake looked great contained minimal nuisance plant and algae growth that required treatment.
    - Only areas of the lake that contained nuisance natives that reached a level to impede desired recreational use were treated.

July 25th, 2022

- Savin Lake Services conducted our initial bacterial augmentation (Muck Buster) treatment.
  - 5.5 acres received treatment.
    - Same areas that we treated in 2021.
  - Equipment issues prevented us from completing the initial application in June.

September 13th, 2022

- Savin Lake Services conducted our final herbicide/algaecide application of the year.
  - This treatment was for algae and nuisance natives. Emergent vegetation was not treated this year.
    - 7.5 acres of the lake was treated for algae.
    - 7.5 acres of the lake was treated for various pondweeds like large leaf pondweed and Illinois Pondweed.
    - 5 acres of the lake was treated for naiad.
- Savin Lake Services conducted our initial bacterial augmentation (Muck Buster) treatment.
  - 5.5 acres received treatment.
    - Same areas that we treated in 2021.
    - Treatment was at double rate as this would be the last muck treatment.
- Observations
  - The lake continued to look great all season.
  - Only native submerged plant species found.

September 22nd, 2022

- Savin Lake Services conducted fall portion of the water quality studies.
  - Our aquatic biologist collected data and samples to test the water quality of Henderson Lake.
  - Water samples and data were collected and analyzed from three sites on the lake.
  - Data is collected for 9 different parameters at each site.
    - Parameters we tested for are Temperature, Dissolved Oxygen, Secchi Disk, pH, Chlorophyll a, Nitrate, Phosphorus, Alkalinity, and Conductivity.
  - Report was generated from data and can be found after the treatment maps of this document.

Summary:

The main objective for aquatic plant management is to mitigate and prevent non-native invasive plant infestations to create and/or sustain a healthy and diverse balance of plants. We successfully complete this objective by conducting routine monitoring (surveys and water quality studies) and utilizing the best management practices (BMP) to selectively mange aquatic plants.

Routine water quality monitoring provides us baseline data of current lake conditions to raise awareness and provide the available options to remediate any current ecological concerns. The productivity (the variety and number of aquatic organisms of food web) depends on the availability of energy (usually solar) and raw materials (nutrients, minerals) within the ecosystem. By limiting the availability of any these required resources you can limit the amount of productivity in ecosystem and vice-versa. Conducting water quality testing provides us the opportunity to be proactive instead of reactive in our management approach, reducing mitigation costs and financial burden imposed on stakeholders. We can “take control before things get out of control”.

Conducting routine plant surveys allows us to identify areas of the lake containing invasive plant communities capable of negatively impacting the lake’s ecology. Conducting these surveys also allows us to identify the developed near shore areas of the lake containing native plants that are detrimentally impeding recreational use. The information contained from the surveys is utilized to evaluate available control methods to reduce the nuisance plants. Best management practices for aquatic plant management include aggressively target invasive plant communities utilizing selective systemic herbicides whenever possible, and only control native plant populations in areas they are detrimentally impeding the recreational use of the lake. This keeps the invasive plant species in check and allows native flora to outcompete the invasive plants reducing their probability of further establishment throughout the lake. This reduces the potential threat invasive plant species pose on a

lake's ecosystem, and aid in prevention of new infestations without detrimentally impacting other aquatic life in the process. Allowing native plant communities, the opportunity to outcompete the invasive plants will prevent, reduce, and/or remove invasive plant presence in a waterbody.

Henderson Lake is proof that this management strategy works. Henderson Lake is a mildly productive extremely healthy lake that becomes nutrient limited in the summer months. This limits the amount of additional biomass the ecosystem can produce. We continue to see success in the lake management strategy. The water quality data collected and analyzed shows no signs of any immediate imminent threat. Water quality parameters are in line or better than many of the other lakes in the area.

The 2022 season was another great year for Henderson Lake. Eurasian watermilfoil was not detected in the lake anywhere. We continued to see decreases in invasive plant presence, while also maintaining and/or increasing native plant densities and plant diversity/species richness. The lake continues to respond greatly to the herbicide management approach. Initial treatment acreages for curly leaf pondweed continue to decrease. Overall the necessity for herbicide treatments of native species was reduced this year in order to maintain a healthy abundance of native vegetation.

This report confirms the success and achievements, that were accomplished by the collaborative provision and continuous communication between Savin Lake Services and the Henderson Lake Milfoil Committee. By strategically working together we were able implement an efficient, effective, and successful lakes management plan for Henderson Lake.

The management approach for 2023 will be consistent and targeted to accomplish the same primary objects as the approach taken in previous season. We will be monitoring the lake regularly, aggressively managing the invasive plants throughout the entire lake, and manage nuisance natives (when necessary) in the near shore developed areas. We will continue to monitor the native plants offshore and implement a change to manage them if they reach the nuisance level threshold.

It has really been a pleasure being involved with the project and seeing the progress that has been made over the past 14 years. We look forward to another successful, efficient, and effective treatment season this year. If you have any questions, comments, or require any additional information, please feel free to contact us.

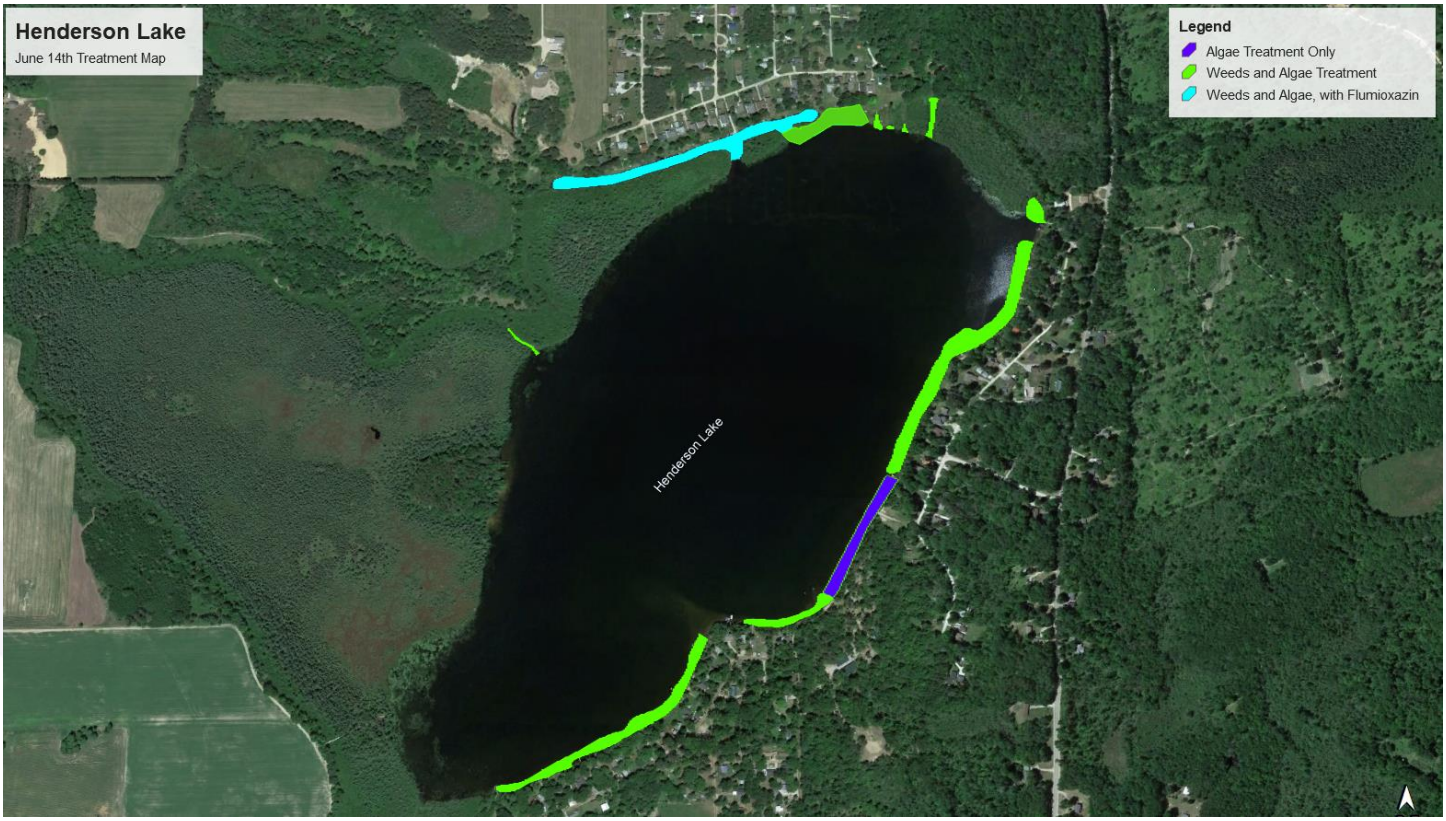
Sincerely,

Matthew Novotny

Matt Novotny – Operations Manager
Savin Lake Services

Treatment Maps:

June 14th, 2022 Herbicide Treatment



July 20th, 2022 Herbicide Treatment

September 13th, 2022 Herbicide Treatment & Muck Busster Treatment

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Henderson Lake 2022 Water Quality Report

Summary:

Water Quality Testing was only completed 2 times on Henderson Lake at 3 different locations around the lake. Of the parameters tested, Temperature, Dissolved Oxygen, Secchi Disk, and pH were sampled while on the lake. Chlorophyll α, Nitrate-N, Phosphorus, Alkalinity, and Conductivity were sampled by sending the water in sample bottles to an independent laboratory, White Water Associates located in Amasa, MI, where the analysis was ran.

A well known limnologist named Wally Fusilier developed a grading scale for various parameters of water quality. Data collected in 2022 is shown below and given a grade based on Fusilier's scale. Additionally, historical data and parameter descriptions are provided at the end of this report.

Because herbicide treatment of aquatic vegetation has occurred on Henderson Lake, it should be noted that the application of herbicide has no direct impact to the water quality of Henderson Lake.

Overall in 2022 based on the analysis results, Henderson Lake had excellent water quality figures again. The only thing that is different this year was the higher chlorophyll a values in both spring and fall. This primarily led to the overall B grades instead of the general A grades in years past. This generally means there was more algae present, such as a minor bloom, that correlates with the slightly worse secchi disk readings. Despite this, the values themselves are not that alarming.

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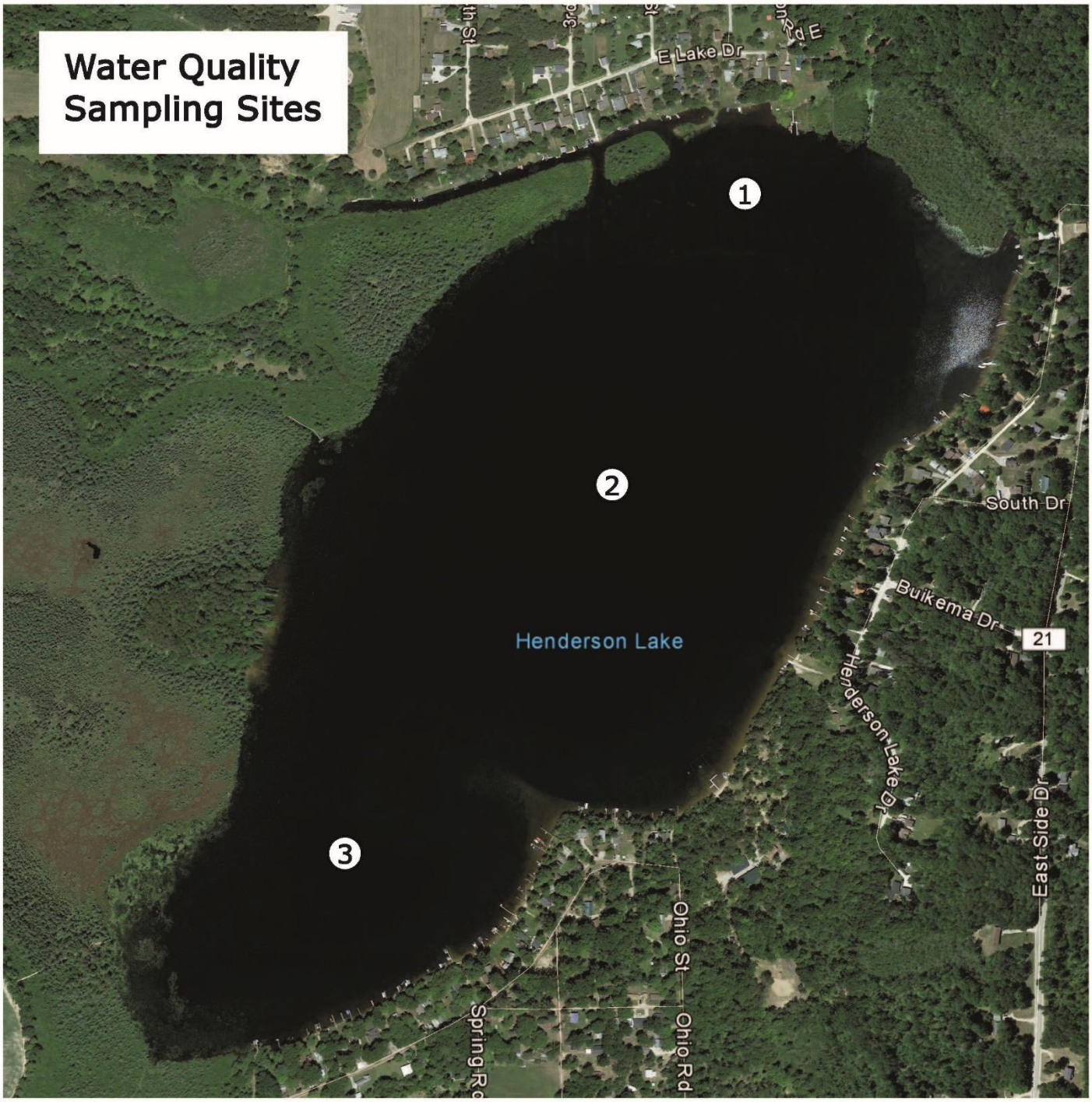

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2022 Results:

Date	4/27/2022		4/27/2022		4/27/2022		9/22/2022		9/22/2022		9/22/2022	
Station Number	1		2		3		1		2		3	
Temp (ºC)	9.6	A	10.2	A	10.1	A	20.4	A	20.6	A	20.1	A
Dissolved Oxygen (mg/L)	12.1		12.16		12.12		8.67		9.01		8.99	
Dissolved Oxygen (%saturation)	107.4	A	107.8	A	107.5	A	95.9	A	99.3	A	99.1	A
Chlorophyll a (ug/L)	3.1	C	2.7	B	2.5	B	2.9	B	3.7	C	4.3	D
Secchi Disk Depth (ft)	Bottom	D	9.0	D	7.7	F	Bottom	F	8.9	F	8.8	F
Total Nitrate Nitrogen (ug/L)	ND	A	ND	A	ND	A	ND	A	ND	A	ND	A
Alkalinity (mg/L)	71.0	A	76	A	71	A	72	A	75	A	72	A
pH	8.8	D	7.95	A	8.23	A	7.97	A	8.04	A	8.04	A
Conductivity (umhos/cm)	190.0	A	180	A	180	A	210	A	210	A	210	A
Total Phosphorus (ug/L)	<8	A	21	B	18	A	13	A	10	A	12	A
Overall Grade		B		B		B		B		B		B

Scale:

Grade	Temp	Dissolved Oxygen	Chloro-phyll α	Secchi Disk Depth	Total Nitrate Nitrogen	Alkalinity	pH	Conduc-tivity	Total Phosphorus
A	0-26.5	85-115	0-2	>19	0-275	50-225	5.75-8.27	0-380	0-20
B	26.5-28.5	85-77; 115-122	2-3	19-16	275-360	50-35; 225-255	5.75-5.55; 8.27-8.47	380-590	20-28
C	28.5-30	77-69; 122-131	3-4	16-12	360-450	35-23; 255-280	5.55-5.33; 8.47-8.69	590-720	28-39
D	30-31.5	69-62; 131-140	4-5	12-9	450-540	23-17; 280-310	5.33-5.14; 8.69-8.88	720-800	39-46
F	>31.5	<62; >140	>5	<9	>540	<17; >310	<5.14; >8.88	>800	>46

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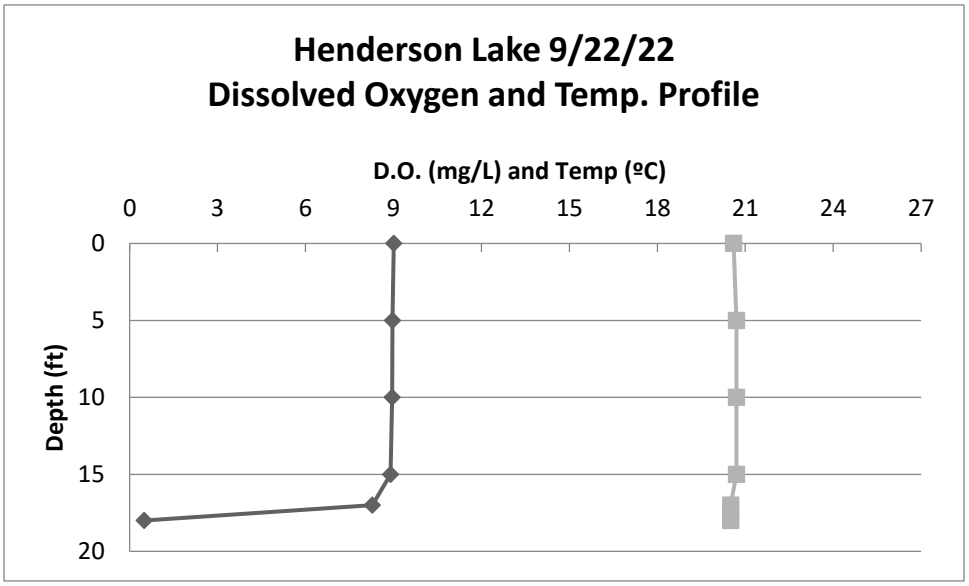
Dissolved Oxygen and Temp. Profile:

Temp (ºC)	D.O. (mg/L)	Depth (ft)
20.6	9.01	0
20.7	8.97	5
20.7	8.96	10
20.7	8.90	15
20.5	8.28	17
20.5	0.49	18



Matt Novotny
Matthew Novotny
Operations Manager
Savin Lake Services

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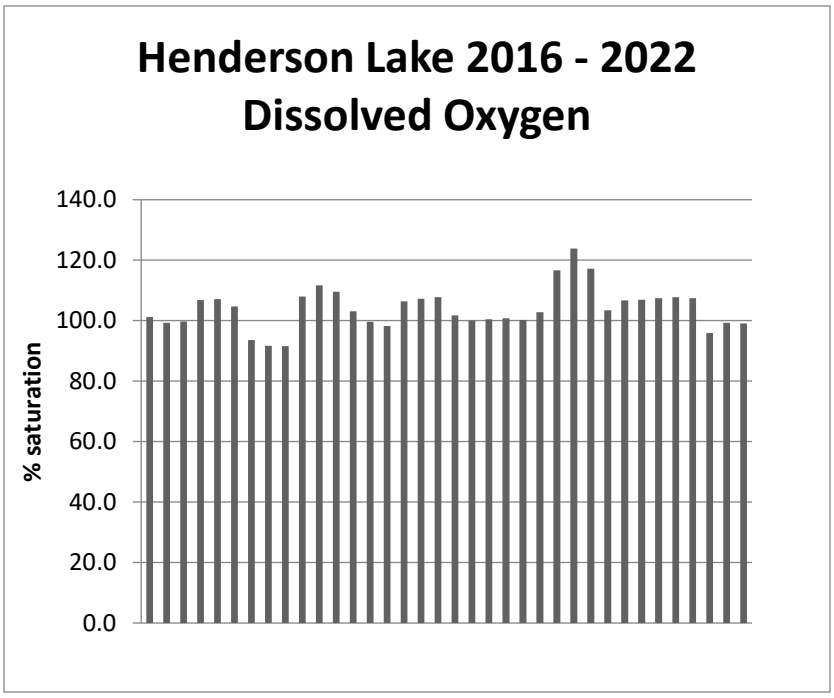
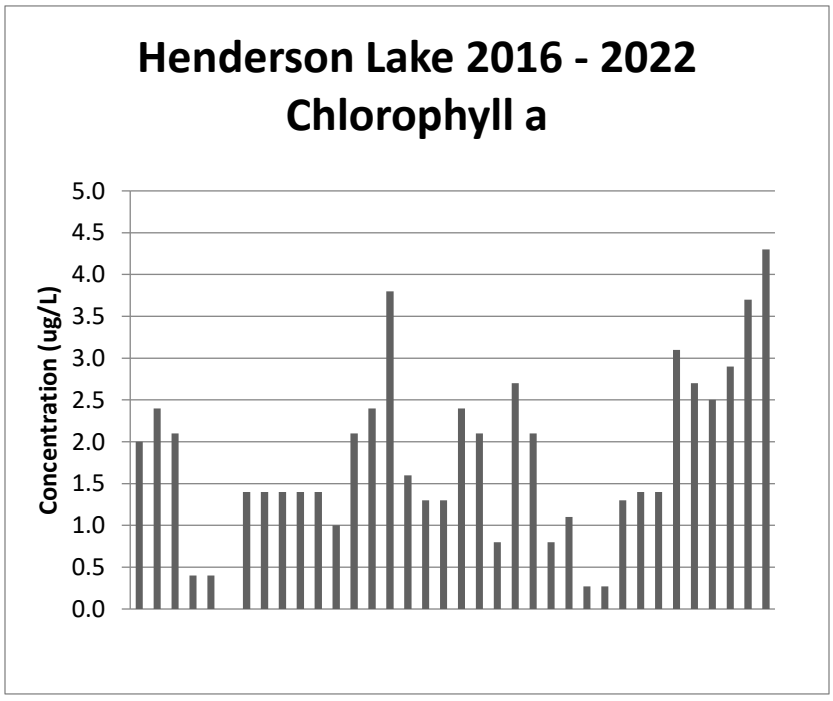
Historical Data:





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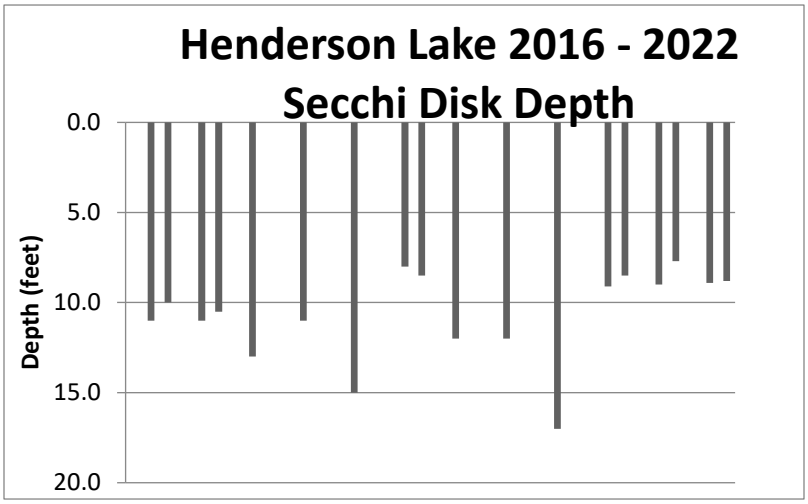

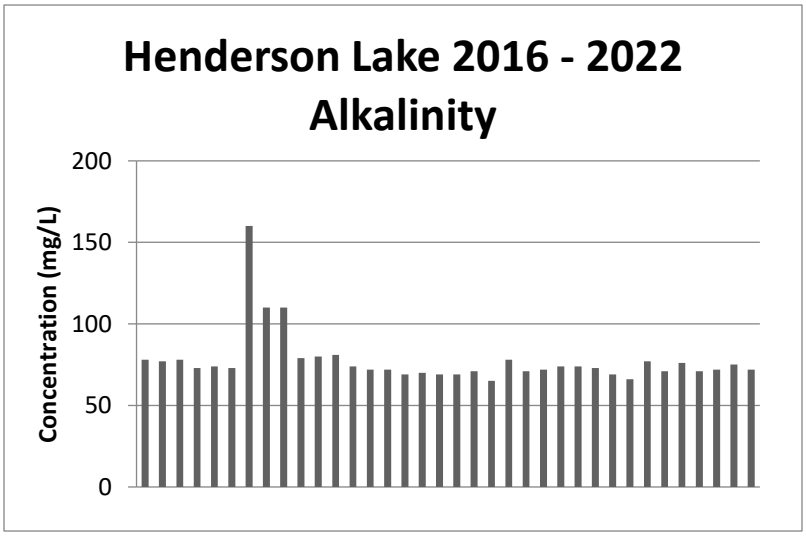

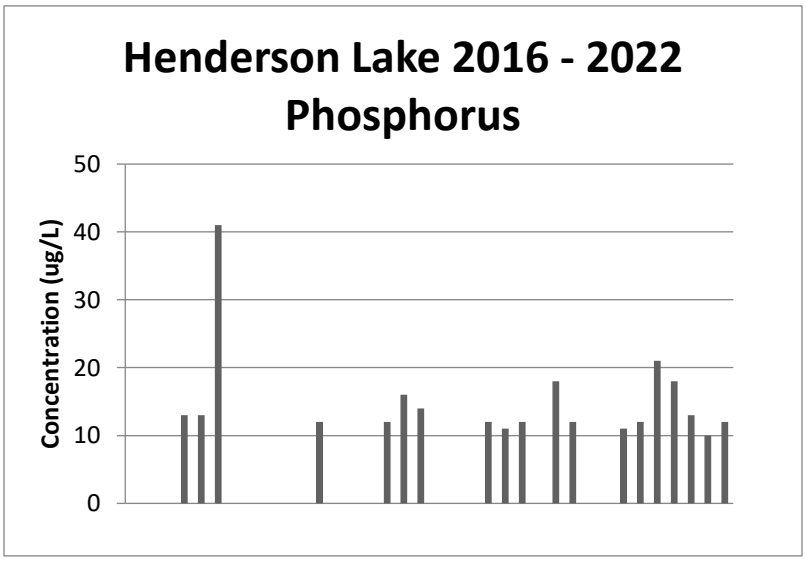

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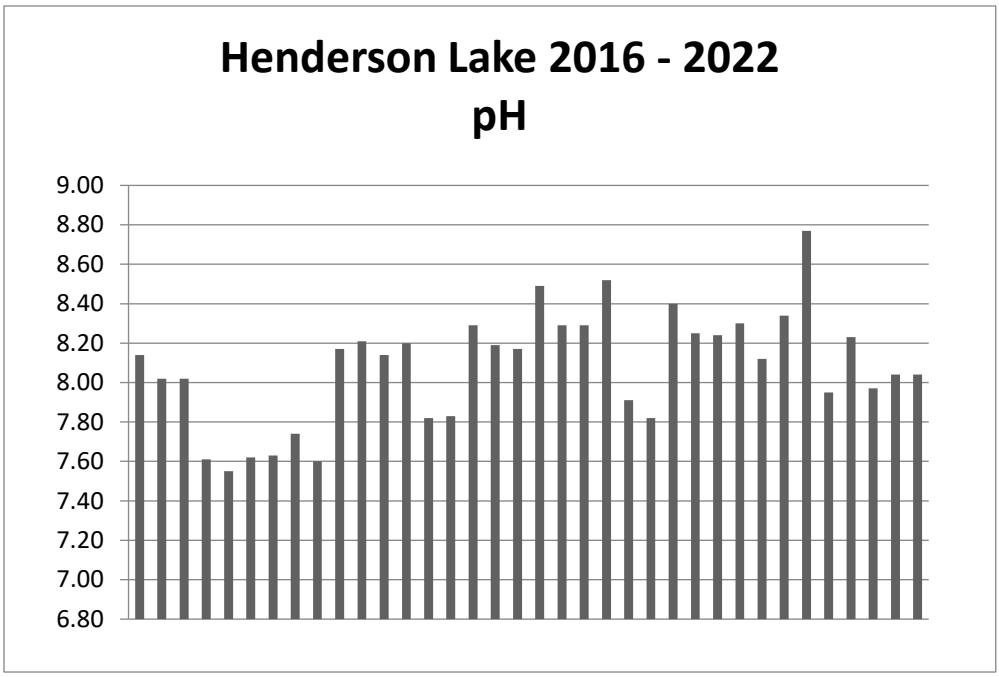

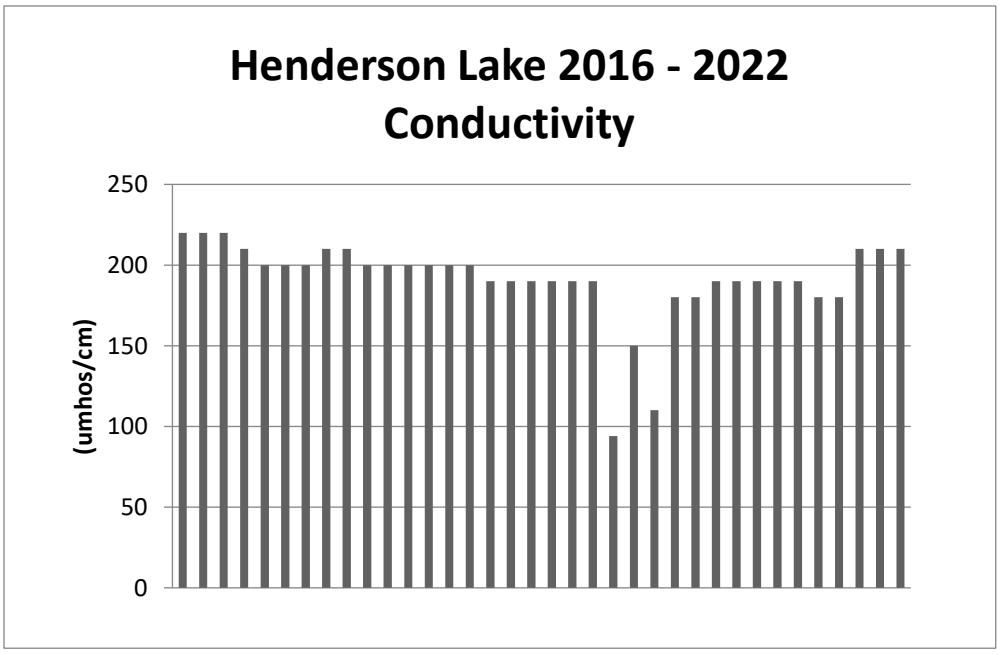

(Nitrate values are not shown due to majority of undefined values. Information is contained in data on next page)

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Date	Station Number	Temp (ºC)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%saturation)	Chlorophyll a (ug/L)	Secchi Disk Depth (ft)	Total Nitrate Nitrogen (ug/L)	Alkalinity (mg/L)	pH	Conductivity (umhos/cm)	Total Phosphorus (ug/L)	Grade
4/27/2022	1.00	9.6	12.11	107.40	3.10	Bottom	ND	71.00	8.77	190.00	12.00	B
4/27/2022	2.00	10.2	12.16	107.80	2.70	9.00	ND	76.00	7.95	180.00	21.00	B
4/27/2022	3.00	10.1	12.12	107.50	2.50	7.70	ND	71.00	8.23	180.00	18.00	B
9/22/2022	1.00	20.4	8.67	95.90	2.90	Bottom	ND	72.00	7.97	210.00	13.00	B
9/22/2022	2.00	20.6	9.01	99.30	3.70	8.90	ND	75.00	8.04	210.00	10.00	B
9/22/2022	3.00	20.1	8.99	99.10	4.30	8.80	ND	72.00	8.04	210.00	12.00	B
9/28/2016	1	17.2	9.77	101.2	2.0	Bottom	ND	78	8.14	220	<9	A
9/28/2016	2	17.0	9.58	99.3	2.4	11.0	ND	77	8.02	220	<9	A
9/28/2016	3	16.9	9.62	99.7	2.1	10.0	ND	78	8.02	220	<9	A
6/7/2017	1	23.4	9.14	106.8	0.4	Bottom	ND	73	7.61	210	13	A
6/7/2017	2	23.1	9.17	107.1	0.4	11.0	ND	74	7.55	200	13	A
6/7/2017	3	22.4	9.13	104.7	0.0	10.5	ND	73	7.62	200	41	A
10/4/2017	1	14.0	9.64	93.6	1.4	Bottom	ND	160	7.63	200	ND	A
10/4/2017	2	14.3	9.44	91.7	1.4	13.0	ND	110	7.74	210	ND	A
10/4/2017	3	14.1	9.43	91.6	1.4	Bottom	ND	110	7.60	210	ND	A
6/22/2018	1	25.3	8.90	108.0	1.4	Bottom	<80	79	8.17	200	<8	A
6/22/2018	2	24.7	9.20	111.7	1.4	11.0	<80	80	8.21	200	<8	A
6/22/2018	3	24.8	9.03	109.6	1.0	Bottom	<80	81	8.14	200	12.0	A
10/2/2018	1	15.8	10.2	103.1	2.1	Bottom	<80	74	8.20	200	<8	A
10/2/2018	2	15.3	10.0	99.6	2.4	15.0	<80	72	7.82	200	<8	A
10/2/2018	3	15.1	9.9	98.2	3.8	Bottom	<80	72	7.83	200	<8	A
5/24/2019	1	15.9	10.5	106.4	1.6	Bottom	<130	69	8.29	190	12.0	B
5/24/2019	2	15.7	10.6	107.2	1.3	8.0	<130	70	8.19	190	16.0	A
5/24/2019	3	15.7	10.6	107.8	1.3	8.5	<130	69	8.17	190	14.0	A
9/30/2019	1	14.5	10.2	101.7	2.4	Bottom	<130	69	8.49	190	<8	B
9/30/2019	2	14.8	10.1	100.0	2.1	12.0	<130	71	8.29	190	<8	B
9/30/2019	3	14.9	10.1	100.5	0.8	Bottom	<130	65	8.29	190	<8	A
9/24/2020	1	16.1	9.9	100.8	2.7	Bottom	<130	78	8.52	94	12	B
9/24/2020	2	16.2	9.9	100.2	2.1	12.0	<130	71	7.91	150	11	A
9/24/2020	3	16.4	10.1	102.7	0.8	Bottom	<130	72	7.82	110	12	A
5/14/2021	1	15.9	11.5	116.7	1.1	Bottom	ND	74	8.40	180	ND	A
5/14/2021	2	15.5	12.2	123.9	0.3	17.0	ND	74	8.25	180	18	A
5/14/2021	3	15.0	11.8	117.2	0.3	Bottom	140.0	73	8.24	190	12	A
9/17/2021	1	20.6	9.2	103.4	1.3	Bottom	ND	69	8.30	190	ND	A
9/17/2021	2	20.8	9.5	106.7	1.4	9.1	ND	66	8.12	190	ND	A
9/17/2021	3	20.1	9.7	106.9	1.4	8.5	ND	77	8.34	190	11	B
4/27/2022	1	9.6	12.1	107.4	3.1	Bottom	ND	71	8.77	190	12	B
4/27/2022	2	10.2	12.2	107.8	2.7	9.0	ND	76	7.95	180	21	B
4/27/2022	3	10.1	12.1	107.5	2.5	7.7	ND	71	8.23	180	18	B
9/22/2022	1	20.4	8.7	95.9	2.9	Bottom	ND	72	7.97	210	13	B
9/22/2022	2	20.6	9.0	99.3	3.7	8.9	ND	75	8.04	210	10	B
9/22/2022	3	20.1	9.0	99.1	4.3	8.8	ND	72	8.04	210	12	B

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Parameter Descriptions:

TEMPERATURE AND DISSOLVED OXYGEN

Temperature exerts a wide variety of influences on most lakes, such as the separation of layers of water (stratification), solubility of gases, and biological activity.

Dissolved oxygen is the parameter most often selected by lake water quality scientists as being important. Besides providing oxygen for aquatic organisms in natural lakes, dissolved oxygen is involved in phenomena such as phosphorus precipitation to, and release from, the lake bottom sediments and decomposition of organic material in the lake.

Low dissolved oxygen concentrations (below 4 milligrams per liter) are generally insufficient to support fish life. In most Michigan lakes, there is no dissolved oxygen below the thermocline in late summer. Some experts like to see some dissolved oxygen in the bottom water of a lake, even if it is almost zero. This is because as long as there is some dissolved oxygen in the water at the bottom of the lake, phosphorus precipitated by iron to the bottom sediments will remain there. Once a lake runs out of dissolved oxygen in the water at the bottom iron comes back into solution. When that happens, it releases the phosphorus back into the water. This can cause additional algae to grow when the lake mixes.

DISSOLVED OXYGEN, PERCENT SATURATION

Because the amount of dissolved oxygen a water can hold is temperature dependent with cold water holding more than warm water, dissolved oxygen saturation is often a better way to determine if oxygen supplies are adequate. The best is between 90 and 110 percent.

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CHLOROPHYLL α

Chlorophyll α is used by lake scientists as a measure of the biological productivity of the water. Generally, the lower the chlorophyll α, the better. High concentrations of chlorophyll α are indicative of an algal bloom in the lake, an indication of poor lake water quality. The highest surface chlorophyll α concentration found by Wallace Fusilier (Water Quality Investigators, WQI) in a Michigan lake was 216 micrograms per liter. Best is below one microgram per liter.

SECCHI DISK TRANSPARENCY (originally Secchi's disk)

In 1865, Angelo Secchi, the Pope's astronomer in Rome, Italy devised a 20-centimeter (8 inch) white disk for studying the transparency of the water in the Mediterranean Sea. Later an American limnologist (lake scientist) named Whipple divided the disk into black and white quadrants which many are familiar with today.

The Secchi disk transparency is a lake test widely used and accepted by limnologists. The experts generally felt the greater the Secchi disk depth, the better quality the water. However, one Canadian scientist pointed out acid lakes have very deep Secchi disk readings. (Would you consider a very clear lake a good quality lake, even if it had no fish in it? It would be almost like a swimming pool.) Most lakes in southeast Michigan have Secchi disk transparencies of less than ten feet. On the other hand, Elizabeth Lake in Oakland County had 34 foot Secchi disk readings in summer 1996, evidently caused by a zebra mussel invasion a couple of years earlier.

Most limnology texts recommend the following: to take a Secchi disk transparency reading, lower the disk into the water on the shaded side of an anchored boat to a point where it disappears. Then raise it to a point where it's visible. The average of these two readings is the Secchi disk transparency depth.

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Secchi disk measurements should be taken between 10 AM and 4 PM. Rough water will give slightly shallower readings than smooth water. Sunny days will give slightly deeper readings than cloudy days. However, roughness influences the visibility of the disk more than sunny or cloudy days.

TOTAL PHOSPHORUS

Although there are several forms of phosphorus found in lakes, the experts selected total phosphorus as being most important. This is probably because all forms of phosphorus can be converted to the other forms. Currently, most lake scientists feel phosphorus, which is measured in parts per billion (1 part per billion is one second in 31 years) or micrograms per liter (ug/L), is the one nutrient which might be controlled. If its addition to lake water could be limited, the lake might not become covered with the algal communities so often found in eutrophic lakes.

Based on WQI's studies of many Michigan inland lakes, they've found many lakes were phosphorus limited in spring (so don't add phosphorus) and nitrate limited in summer (so don't add nitrogen).

10 parts per billion is considered a low concentration of phosphorus in a lake and 50 parts per billion is considered a high value in a lake by many limnologists.

3088 Hottis Rd. Hale, MI 48739 Hale: 989.728.2200 Clare: 989.386.0600 Fax: 989.516.5900

NITRATE NITROGEN

Nitrate, also measured in the parts per billion range, has traditionally been considered by lake scientists to be a limiting nutrient. The experts felt any concentration below 200 parts per billion was excellent in terms of lake water quality. The highest value found by Fusilier was 48,000 parts per billion in an Ottawa County river which flowed into Lake Macatawa in Holland, Michigan.

On the other hand, WQI has studied hundreds of Michigan inland lakes, and many times they find them nitrate limited (very low nitrate nitrogen concentrations), especially in summer.

WQI was finding many lakes have lower nitrate nitrogen concentrations in summer than in spring. This is probably due to two factors. First, plants and algae growing in lakes as water warms can remove nitrates from the water column. And second, bacterial denitrification (where nitrates are converted to nitrogen gas by bacteria) also occurs at a much faster rate in summer when the water is warmer.

Generally limnologists feel optimal nitrate nitrogen concentrations (which encourage maximum plant and algal growth) are about 10-20 times higher than phosphorus concentrations. The reason more nitrogen than phosphorus is needed is because nitrogen is one of the chemicals used in the production of plant proteins, while phosphorus is used in the transfer of energy, but is not used to create plant material. If the nitrate concentration is less than 10-20 times the phosphorus concentration, the lake is considered nitrogen limited. If the nitrate concentration is higher than 10-20 times the phosphorus concentration, the lake is considered phosphorus limited.

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TOTAL ALKALINITY

Alkalinity is a measure of the ability of the water to absorb acids (or bases) without changing the hydrogen ion concentration (pH). It is, in effect, a chemical sponge. In most Michigan lakes, alkalinity is due to the presence of carbonates and bicarbonates which were introduced into the lake from ground water or streams which flow into the lake. In lower Michigan, acidification of most lakes should not be a problem because of the high alkalinity concentrations

HYDROGEN ION CONCENTRATION (pH)

pH has traditionally been a measure of water quality. Today it is an excellent indicator of the effects of acid rain on lakes. About 99% of the rain events in southeastern Michigan are below a pH of 5.6 and are thus considered acid. However, there seems to be no lakes in southern Michigan which are being affected by acid rain. Most lakes have pH values between 7.5 and 9.0.

SPECIFIC CONDUCTIVITY

Conductivity, measured with a meter, detects the capacity of a water to conduct an electric current. More importantly however, it measures the amount of materials dissolved in the water, since only dissolved materials will permit an electric current to flow. Theoretically, pure water will not conduct an electric current. It is the perception of the experts that poor quality water has more dissolved materials than does good quality water