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Hemlock Lake Annual Report

Background

In August 2019, Clean-Flo International performed a preliminary scan of Hemlock Lake. The purposes of the scan were to establish baseline conditions for depth and vegetation, and to design a oxygenation-inversion system and bioaugmentation program to improve the lake. The system was installed and bioaugmentation began in October 2019.

Clean-Flo has been contracted by the Hemlock Property Owners Association to perform annual scans and submit progress reports. The scan this year took place on October 21st, 2021. The objectives of the scan were to measure basic water quality data, develop bathymetric maps, evaluate vegetative biovolume, , and make qualitative observations of the condition of Hemlock Lake.

The scan was accomplished with a Lowrance Elite Ti^2 fish finder/chartplotter with broadband sounder technology, built-in GPS antenna, and high-definition mapping. The data obtained was uploaded to Biobase GIS, a cloud-based mapping service, to produce contour and vegetative biovolume maps. A handheld YSI water quality meter was used to measure temperature, ammonia, nitrate, and dissolved oxygen (DO).

At the time of the preliminary scan, a benchmark was established for determining water surface levels during each subsequent scan. The benchmark for Hemlock Lake is the top of east end of the railroad ties on the west side of the beach. At the time of the 2021 scan, the water level was 1.25 inches below the original scan water level (13.25 inches below top of rail tie).

Summary

Hemlock Lake is fed by a creek flowing into its northeastern corner. The lake empties over a dam spillway on its southwest corner. The lake has a surface area of 6.84 acres.

At the time of the 2021 scan, the dissolved oxygen (DO) levels in Hemlock Lake are healthy (above 5 mg/L) and range from 9.78 mg/L near the surface to 9.57 mg/L near the bottom of the water column. The lake is fully mixed, as demonstrated by the minimal differences between top and bottom measurements of DO and temperature. Nutrient levels (nitrate and ammonia) are within healthy ranges, with a nitrate maximum of 0.11 mg/L and an ammonia maximum of 0.02 mg/L.

Hemlock Lake has a volume of 62.95 acre-feet (21.51 million gallons), which is nearly 3 acre-feet more than calculated in 2020. Its average depth is 9.2 ft, and deepest point is 19.4 ft, also representing significant increases since 2020.

The vegetative biovolume levels for 2021 show that 59.3% percent of the lake's area contains vegetation, and 9.1% average percentage of the lake's volume is occupied by vegetation. These levels are higher than the biovolume levels seen in 2020.

Water Quality

Table 1 indicates the water quality at the time of the October scan. DO levels in the lake range from 9.78 mg/L at the surface to 9.57 mg/L at the bottom of the water column. The average DO levels at the top and bottom of the lake water column over the summer were 9.29 and 8.99 mg/L respectively. These levels indicate that the oxygenation-inversion system is working properly in both mixing, and maintaining oxygenation above the minimum of 5 mg/L in the lake.

Water temperatures at the time of the scan and throughout the summer were consistent throughout the water column. The average difference in water temperature between top and bottom of water column was 0.64º F. The maximum difference between top and bottom of water column was 0.8º F.

The nitrate level observed on 10/21 was 0.11 mg/L. Some fluctuation occurred throughout the year, with a peak of 0.67 mg/L observed in July. The concentration of ammonia in the lake currently ranges from 0.01-0.02 mg/L (see Table 1). This is below the threshold at which it becomes a problem. Ammonia is a nutrient source for many organisms that live near the bottom of the lake. Based on this standard and the concentrations measured, nitrogen levels overall are below the maximum recommended concentrations, but close enough that nitrate and ammonia should be monitored closely on a regular basis in the years to come.

Table 1. Hemlock Lake Water Quality Profile (10/21/2021)

Depth (ft)	Oxygen (mg/L)	Temperature (ºF)	Ammonia (mg/L)	Nitrate (mg/L)
2	9.78	61.6	0.02	0.11
4	9.75	61.5	0.01	0.11
6	9.72	61.3	0.01	0.1
8	9.7	61.2	0.01	0.09
10	9.69	61.1	0.01	0.09
12	9.7	61	0.02	0.08
14	9.68	60.9	0.02	0.08
16	9.61	60.9	0.02	0.07
17	9.57	60.8	0.02	0.07

Bathymetry (Depth Contours)

The bathymetric map of Hemlock Lake is shown in Figure 1. The maximum depth of the lake is 19.4 feet, and the average depth is 9.2 feet. Since 2020, these are increases of 1.3 feet in maximum depth and 0.4 feet (4.8 inches) in average depth. The volume of the lake is 62.95 acre-feet (21.5 million gallons). The lake has gained 2.77 acre-feet (902,546 gallons) of volume since last scan, a 4.6% increase. This is equivalent to the removal of 4,460 cubic yards of organic matter, or roughly 300 triaxle dump truck loads.

The map indicates that the deepest area of the lake is at the south end near the dam. This area has increased in depth as evidenced by the expansion of the 16, 17, and 18-foot contours since last year.

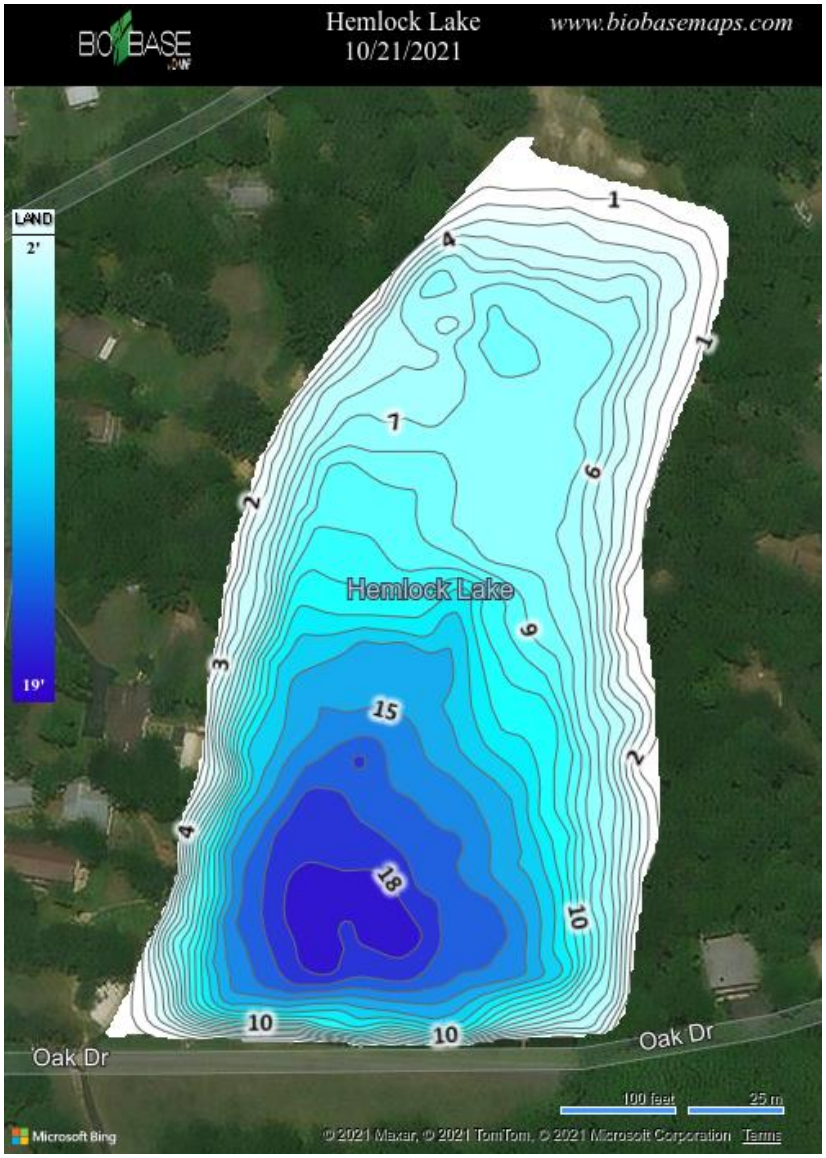

Figure 1. Bathymetric map of Hemlock Lake (10/21/2021)

Vegetative Biovolume

Figure 3 is the vegetative biovolume map from our scan of Hemlock Lake, with color-coded scale. The blue end of the scale represents little-to-no vegetation. The red end of the scale represents areas where the majority of the water column is occupied by vegetation. Most of the vegetative biovolume was located in the northern end of the lake indicated by the reddish-orange region, and along the shorelines. The more intense areas of vegetation detected in this year's scan account for the overall increases that were calculated, as shown in the survey statistics illustrated in Table 2. Because these spots are geographically isolated, they could represent point sources of nutrient pollution by external sources. External sources can include septic tank leaks, stormwater runoff carrying crop and lawn fertilizer, and animal waste. Because the beach tends to attract geese, it is

possible that goose excrement is one of the factors influencing the growth of vegetation at the north end of the lake.

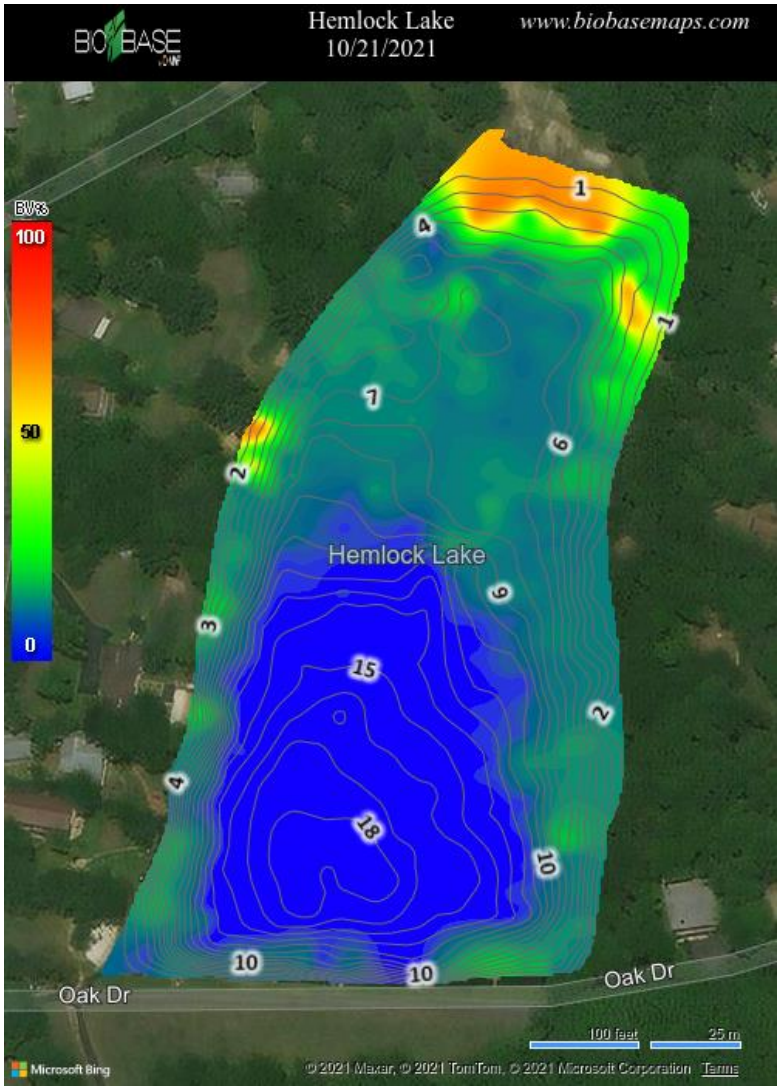

Figure 2. Vegetative Biovolume map of Hemlock Lake (10/21/2021)

Table 2 contains statistics on vegetative biovolume from the scan. It quantifies biovolume levels measured in the scan and can be compared to results from previous years to evaluate progress. Based on the "Grid" PAC (Percent Area Covered), vegetation is present in 59.3% of the lake's area. The "Grid" average BVw is 9.1% which means that 9.1% of the total water volume of the lake is occupied by vegetation. This is 6.3% higher than the BVw reported last year. It should be noted that the 2020 scan was done in November when the water temp was 53.6º F, while the current scan was done in October when the water temp was 61.6º F. The 10-degree difference in temperature could explain the difference in biovolume levels present in 2020 vs 2021. At the time of the 2020 scan, much of the vegetation may already have died off due to the relatively cold water. As mentioned previously, nutrient pollution at the north end of the lake may also explain the increase in vegetation measured since the 2020 scan.

Table 2. Biovolume Survey Statistics 2021

Survey Summary

Type	PAC	Avg BVp	SD BVp	Avg BVw	SD BVw	Depth Range	Depth Avg	Distance	No. Depth Records
Point	57.6%	12.1%	± 12.6%	7.0%	± 11.6%	2.44 - 19.43 ft	10.343 ft	1.089 miles	1642
Grid	59.3%	15.3%	± 14.8%	9.1%	± 13.6%	0.24 - 18.76 ft	9.204 ft	NA	1928

Conclusions

Based on water quality sampling data, Hemlock Lake was well-mixed throughout the year. The minimal differences in DO and water temperature between the top and bottom of the lake indicate that the oxygenation-inversion system is functioning properly. The DO in Hemlock is 9.78 mg/L near the surface, and 9.57 mg/L at the bottom. Oxygenation and inversion will continue to contribute to the reduction of organic material in the lake and keep nutrient concentrations in check.

The depth and volume of Hemlock Lake have increased since 2020. The 16, 17, and 18-foot contours have seen significant growth. The average depth of the lake has increased from 8.8 ft to 9.2 ft., and the maximum depth in 2021 is 19.43 feet, an increase from 18.59 feet in 2020. The calculated volume of the lake is 62.59 acre-feet (21.5 million gallons).

Changes in the bathymetry represent gains of 1.3 feet in maximum depth and 0.4 feet (4.8 inches) in average depth. The lake has gained 2.77 acre-feet (902,545 gallons) of volume, an increase of 4.6% since 2020. This is equivalent to the removal of 4,460 cubic yards of organic matter, or roughly 300 triaxle dump truck loads.

The vegetative biovolume has increased since the last scan. It is likely that the time of the scan influenced the observed difference in biovolume. The 2020 scan was performed in November, and the water temperature was 53.6º**.** The 2021 scan was performed in October, and the water temperature was 61.6º. The lower temperature in 2020 may have caused greater die-back of vegetation at the time of the scan than might have occurred at the time of the 2021 scan, when much of the summer growth was still present. Apart from this, the change may also be attributable to the significantly higher concentration of vegetation recorded in 2021 near the beach and generally in shallower water throughout the lake than observed in 2020. The relative geographic isolation of intense vegetative growth may indicate point sources of nutrient pollution.

Recommendations

Based on the 2021 scan results, we recommend first that the oxygenation-inversion system continue to operate year-round. Second, due to the increases in biovolume recorded this year, we recommend that the product application program be adjusted to prioritize the reduction of vegetation. Adjustments would be made to product type and quantity, as well as to the geographic areas of focus. Third, we recommend continued monthly monitoring of nitrate and ammonia concentrations. Finally, we recommend that the Hemlock Lake POA investigate point sources of nutrient pollution in the watershed and address them in the year to come through active watershed management practices. This could include prevention of grass clippings and leaves from entering the lake, building sediment-traps in streams that feed the lake, regulating fertilizer use, and reducing the resident geese population.