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Culver Lake – Status 2013 (a brief mid-summer report)

Overall, weather this Spring-Early Summer has been either "dreary" with the daily rains, or a heat wave. Culver Lake has gained heat rapidly in June, and developed strong thermal stratification, with warmer (less dense) water floating on the deeper colder (more dense) water.

Temperature °C			>25°C		
Depth (m)	3-May-13	10-May-13	19-Jun-13	26-Jun-13	3-Jul-13
0	15.8	20.3	21.4	26.4	25.8
1	15.7	19.3	21.3	26.1	25.8
2	15.3	18.1	20.8	25.8	25.7
3	14.6	17.6	20.5	25.6	25.7
4	12.9	14.4	20.4	18.4	23.2
5	11.8	12.8	18.3	16.7	19.1
6	10.8	11.6	16.9	14.1	16.1
7	10.4	10.9	16.7	13.3	14.1
8	10.1	10.2	14.4	12.9	13.5
9	9.6	9.8	12.8	12.2	12.9
10	9.2	9.2	11.6	10.8	12.3
11	8.8	8.8	10.5	10.4	11
12	8.4	8.4	9.2	9	9.9
13	8.2	7.8	8.4	8.6	8.8
14	7.6	7.6	8.2	8.3	8.4

Cold water fish need water temperatures below about 24 degrees C (for Brown Trout, below 20 degrees preferred), with adequate dissolved oxygen.

During thermal stratification, the deep cold water doesn't get circulated to the surface where it can be replenished with oxygen. As a result, oxygen is consumed in deep strata and is not replenished naturally through the Summer. The Layer Aerators replenish dissolved oxygen in the middle depths of Culver Lake while maintaining stratification and cooler temperatures at depth. The influence of circulation and oxygen input by the Layer Aerators can clearly be seen between 5-10m deep. The deepest water (> 11m) becomes depleted of dissolved oxygen and accumulates products of anaerobic respiration (decomposition/respiration in the absence of oxygen). The Hypolimnetic Aerator introduces dissolved oxygen to the deepest strata. Although dissolved oxygen concentrations are not maintained all summer in the deepest waters, the oxygen input remains very beneficial by decreasing the amount of hydrogen sulfide accumulation and maintaining a higher oxidation-reduction potential. The Hypolimnetic Aerator was activated late this year due to a problem with its buoyancy control system. That was corrected and the Hypolimnetic Aerator is now in full service. To date hydrogen sulfide odor has not been detected near the aerator. It may be desirable to reduce airflow to the hypolimnetic aerator for several weeks during late summer stratification to allow iron to be mobilized from the sediments (especially if a sediment amendment with iron is conducted).

Dissolved Oxygen (mg/L)			<0.5mg/L	<2 mg/L	
Depth (m)	3-May-13	10-May-13	19-Jun-13	26-Jun-13	3-Jul-13
0	11.5	11.2	10.6	10.6	11.8
1	11.4	11.5	10.5	10.7	11.8
2	11.5	11.6	10.4	10.7	11.9
3	11.6	11.6	`10.4	10.6	11.7
4	11.6	13.7	10.2	7	6.9
5	11.4	12.8	8	5.9	5.3
6	10.7	12	7.1	6.1	4
7	10.6	11	6.9	6.1	4.4
8	10.2	10.9	6.2	6.1	4.4
9	10.1	10.9	6.2	5.4	4.2
10	9.9	9.9	5.6	4.3	3.9
11	9.8	10	5.1	3.6	2.6
12	9.5	9.71	6.3	1.5	1.6
13	9.4	6.8	2.5	1.2	0.6
14	7.5	7.5	0.9	1.1	0.5

Percent Saturation DO			>120		
Depth (m)	3-May-13	10-May-13	19-Jun-13	26-Jun-13	3-Jul-13
0	116.0	123.9	119.8	131.6	144.9
1	114.8	124.7	118.5	132.1	144.9
2	114.8	122.8	116.2	131.4	145.9
3	114.0	121.5	115.5	129.7	143.4
4	109.8	134.1	113.1	74.5	80.7
5	105.3	120.9	85.0	60.7	57.3
6	102.9	117.7	73.3	57.4	40.6
7	95.7	108.6	70.9	58.3	42.8
8	94.1	97.9	60.7	57.8	42.2
9	89.5	96.1	58.6	56.9	39.8
10	87.8	94.7	51.5	48.7	36.4
11	85.2	85.2	45.7	38.4	23.6
12	83.6	85.3	54.8	31.1	14.1
13	80.6	81.6	21.3	12.9	5.2
14	62.7	62.7	7.6	9.4	4.3

The % saturation with dissolved oxygen compares the oxygen concentration to what the concentration would be if in equilibrium with our 21% oxygen atmosphere at the observed water temperature. Respiration consumes oxygen, photosynthesis produces oxygen; so % saturation greater than 100% is an indication of how intense photosynthesis is. From mid-June to mid-July % oxygen saturation has increased to approximately 145% in surface waters, indicating significant photosynthetic activity (by rooted plants and phytoplanktonic algae).

Relative Thermal Resistance to Mixing (RTRM) is a quantitative measure of the strength and location of thermal stratification. Culver Lake is well mixed to a depth of approximately 4m (13-14ft), and exhibits a very strong thermocline zone between 4-6m. Recently an oxygen depression was observed at the 4-6m thermocline due to respiration/decomposition of organic matter retained on the thermocline.

RTRM			>50		
Depth (m)	3-May-13	10-May-13	19-Jun-13	26-Jun-13	3-Jul-13
0	0.0	0.0	0.0	0.0	0.0
1	1.9	25.2	2.7	10.0	0.0
2	7.7	28.6	13.4	9.8	3.2
3	12.9	11.2	7.8	6.4	0.0
4	28.6	64.0	2.6	201.2	77.5
5	16.1	26.5	51.7	37.7	110.4
6	13.0	17.3	31.2	49.9	66.7
7	4.7	9.2	4.1	13.3	37.5
8	3.5	8.2	44.5	6.4	10.0
9	5.2	4.3	26.5	10.4	9.7
10	4.0	6.0	17.3	18.7	8.9
11	3.7	3.7	13.9	4.7	17.8
12	3.3	3.3	13.9	14.7	12.7
13	1.7	4.6	7.0	3.3	10.7
14	4.3	1.3	1.7	2.5	3.3
15			0.6		
SUM	110.6	213.4	239.0	389.1	368.4
MAX	28.6	64.0	51.7	201.2	110.4

Secchi transparency (clarity) has gradually decreased from almost 8 ft in May to approximately 4.5 ft in July.

Secchi					
Date	3-May-13	10-May-13	19-Jun-13	26-Jun-13	3-Jul-13
Depth (ft)	7.8	7.167	6	5	4.375
Depth (m)	2.36	2.18	1.83	1.52	1.33
CD	4.7244	4.3690032	3.6576	3.048	2.667

Total Phosphorus (TP as P) is an important nutrient which tends to be in shortest supply relative to the requirements of phytoplankton (algae). Therefore, although other nutrients and environmental conditions play important roles in determining "how much" and "what kind" of algae grows, TP tends to determine overall amount of algae and water quality at Culver Lake.

TP has remained relatively low so far. TP below about 25 ppb does support algae growth but doesn't support intense algae blooms. The Layer Aerators continue to keep TP that accumulates in the deepest strata from reaching the surface waters. TP in the mid-depth Layer has been consistently lower at Culver through the Summer –many years of observation. That may provide an opportunity for future management of late Summer conditions. If algae become more abundant and water clarity decreases, the mid-depth layer could be circulated into the surface layer- cooling temperatures, diluting algae and nutrients, circulating buoyant bluegreens below the compensation depth, etc. Expanding the epilimnetic mixing depth, and incorporating the mid-depth layer, could improve lake conditions further in late July through the end of stratification. The relatively low TP in surface water, while transparency becomes poor, suggests accumulation of biomass due to slow rate of removal by grazing.

Total Phosphorus as P (µg/L)

Depth (m)	27-Mar	23-Apr	27-May	14-Jun	26-Jun
1	22	20	23		23
3		20			
5	20	22	12		15
7		19			
8				13	
9		16	9		11
10	20				
12		22		14	29
13				38	
14		194	410	448	86

Ammonia as N (µg/L)				
Depth (m)	27-Mar	23-Apr	27-May	14-Jun
1	11	15	22	
3				
5	23		13	
7		15		
8				20
9			23	
10	12			
12				39
13				312
14		113	390	254
Blue Ridge	12			
Causeway	14			

Ammonia-N is also a plant nutrient, and accumulates in deep strata when oxygen is depleted due to breakdown of proteins/amino acids, and the lack of nitrification to Nitrate in the absence of dissolved oxygen.

Silica is a material that is needed in significant amounts (>0.5 mg/L) by Diatoms and Chrysophytes (algae types that are more desirable to have than Bluegreen Algae). Silica concentrations have been low this Spring, which favors Bluegreen algae over the Diatoms. Additional depth sampling and analyses for Silica is planned for late Summer and Fall.

Silica (mg/L)			
Depth (m)	27-Mar	23-Apr	27-May
1	0.2	0.066	0.12
5	0.20		
9			
10	0.23		
14		0.47	
Blue Ridge			
Causeway			

Iron is an important substance in the bottom of Culver Lake. It serves as an alternate terminal electron acceptor for respiration when oxygen is depleted. As long as iron is available for that role hydrogen sulfide will not accumulate. It is oxidized iron that provides sediment-binding capacity for phosphorus. When iron is chemically reduced as a result of anaerobic respiration it becomes soluble and the phosphorus that had been bound to it is released. As a result, increases in both iron and phosphorus are often observed in deep waters devoid of dissolved oxygen. Iron that accumulates in bottom waters is mixed upward when stratification is lost in the Fall, becomes oxidized, and removes phosphorus from lake water (sediments it to the bottom). Many lakes exhibit 5-15 mg/L of iron accumulation in deep anoxic strata. Iron is scarce in the bottom of Culver Lake. That is probably the result of many years of hydrogen sulfide production when the lake exhibited highly eutrophic characteristics. Hydrogen sulfide combines with reduced ferrous iron, permanently removing it to the sediments (the iron no longer functions as an electron acceptor or P-binding agent; eutrophication and internal P loading becomes an accelerating cycle.

In late May and early June, higher iron concentrations were observed in bottom waters than had been seen previously. Additional confirmation testing suggests that the deep samples may have contained sediment from bottom disturbance during sampling. Restoring iron availability in Culver Lake can sequester sulfide production, and can help to further control the availability of TP to reduce phytoplankton abundance. The recent observations of iron at the bottom, and methods to restore iron availability to improve conditions further, are being evaluated further.

Iron (mg/L)

Depth (m)	27-Mar	23-Apr	27-May	14-Jun	26-Jun	3-Jul
1						
8				0.15		0.11
9					0.10	
12				0.12	0.09	0.16
13				0.25		0.39
14		0.8	6.8	4.8	0.45	0.47