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Culver Lake – Status 2014 (a brief mid-summer report)

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, warm water floats on the deeper cold water and 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.

Dissolved Oxygen (mg/L)			<0.5mg/L	<2 mg/L					
Depth (m)	1-Feb-14	12-May-14	21-May-14	27-May-14	6-Jun-14	12-Jun-14	27-Jun-14	3-Jul-14	10-Jul-14
0	20.3	10.8	10.4	9.8	9.3	9.7	9.2	9.2	9.3
1	22.4	11	10.5	9.8	9.3	9.7	9.3	9	9.3
2	14.1	10.8	10.5	10.1	9.3	9.7	9.3	8.9	9.2
3	14.3	11	10.4	9.9	8.8	9.3	9.2	8.6	9.1
4	12.3	10.9	10.3	9.8	8.3	9.4	8.3	7.7	7.79
5	11.2	10.5	9.6	9.3	7.3	8.8	7.4	6.2	6.6
6	11.1	10.2	9.4	8.1	6.2	6.2	4.2	3.6	3.6
7	11.3	9.8	9.3	8.1	6.4	4.2	2.6	2.4	1.6
8	11.5	9.8	9.2	8.2	6.6	4.5	3.2	2.8	1.6
9	11.2	9.6	9.1	8.3	7.1	5.8	3.5	2.5	2.2
10	10.4	9.1	8.6	7.9	5.8	6.1	5.4	2.6	4.2
11	9.9	9	7.9	7.3	4.7	4.2	3.5	1.9	0.6
12	8.8	8.5	6.4	6.5	3.7	2.8	1.9	0.9	0.6
13	7.8	8.2	4.6	5.1	2.7	0.5	0.5	0.6	0.6
14	5.1	8.2	3.2	2.3	0.5	0.5	0.5	0.6	0.6
15									

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. Aerobic conditions have been maintained through mid-July in the deepest water layer. Later this summer the rate of air delivery to the deep hypolimnetic aerator will is planned to be decreased, while maintaining Layer Aeration, in order to take advantage of the sediment iron amendment for phosphorus removal from lake water.

Percent Saturation DO			>120						
Depth (m)	1-Feb-14	12-May-14	21-May-14	27-May-14	6-Jun-14	12-Jun-14	27-Jun-14	3-Jul-14	10-Jul-14
0	148.0	113.6	108.7	109.7	104.3	113.7	110.7	114.6	113.2
1	164.6	113.8	109.3	108.4	104.3	113.7	111.5	111.9	112.8
2	102.5	108.7	109.1	110.4	104.3	113.3	111.3	109.5	111.3
3	104.5	109.5	108.0	108.0	97.0	107.0	109.9	105.2	110.1
4	89.7	106.0	106.1	104.6	89.5	106.7	96.8	92.3	94.1
5	81.6	98.5	94.2	95.4	76.3	97.2	84.0	71.6	78.3
6	81.1	94.6	88.4	78.8	59.0	66.0	45.0	39.1	40.5
7	82.6	90.3	85.9	75.5	59.4	41.0	26.5	24.8	16.8
8	84.3	89.5	83.6	75.0	60.5	42.2	30.9	27.3	15.8
9	82.1	87.3	82.5	75.4	64.2	53.2	32.7	23.7	20.6
10	76.4	82.3	77.6	71.5	52.2	55.3	49.2	24.2	38.4
11	72.8	81.0	71.0	65.6	42.1	37.8	31.6	17.3	5.4
12	64.8	76.2	57.1	58.1	33.1	25.0	17.0	8.1	5.4
13	57.8	73.2	40.8	45.4	24.0	4.4	4.4	5.3	5.3
14	38.1	72.5	28.3	20.3	4.4	4.4	4.4	5.3	5.3

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. Percent oxygen saturation in surface waters of Culver Lake have been lower than during recent years; no intense photosynthetic bloom activity has been observed.

RTRM			>20	>50					
Depth (m)	1-Feb-14	12-May-14	21-May-14	27-May-14	6-Jun-14	12-Jun-14	27-Jun-14	3-Jul-14	10-Jul-14
0	0	0	0	0	0	0	0	0	0
1	1	18	4	16	0	0	6	3	6
2	-1	27	2	15	0	6	3	20	3
3	1	10	0	2	23	23	3	10	0
4	0	20	9	27	27	20	39	35	3
5	0	26	45	42	35	37	40	60	31
6	0	7	31	48	84	44	74	83	77
7	0	4	12	30	17	84	53	58	89
8	0	5	9	11	7	29	47	50	59
9	0	3	1	4	8	14	24	22	36
10	0	3	2	3	2	7	15	13	15
11	0	2	2	4	2	4	5	12	8
12	0	2	4	2	1	4	4	7	5
13	1	2	4	2	2	4	5	5	4
14	0	5	1	3	3	3	2	3	2
15									
SUM	2	133	126	209	212	278	319	381	338
MAX	1	27	45	48	84	84	74	83	89

Relative Thermal Resistance to Mixing (RTRM) is a quantitative measure of the strength and location of thermal stratification. Culver Lake became stratified in late May and the thermocline strengthened at 5-7m deep.

Secchi									
Date	1-Feb-14	12-May-14	21-May-14	27-May-14	6-Jun-14	12-Jun-14	27-Jun-14	3-Jul-14	10-Jul-14
Depth (ft)	4.9	7	7	7	7	6	6	4.5	4.6
Depth (m)	1.50	2.13	2.13	2.13	2.13	1.83	1.83	1.37	1.40
CD (m)	3.00	4.27	4.27	4.27	4.27	3.66	3.66	2.74	2.80

Secchi transparency (clarity) has gradually decreased from approximately 7 ft in May and early June to approximately 4.5 ft in July.

Total Phosphorus as P (µg/L)			**>20**
Depth (m)	**1-Feb**	**12-May**	**12-Jun**
1	30	18	29
3		19	27
5	13	15	19
7		15	14
8			
9	11	17	11
10			
12	29	21	29
13			
14	17.5	39	146

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.

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 low 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.

Silica (mg/L)			
Depth (m)	1-Feb	12-May	12-Jun
1		0.43	0.2
3			
5		0.53	
9		0.78	
10			
14		2.35	

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 again this Spring, which favors Bluegreen algae over the Diatoms. Additional depth sampling and analyses for Silica is planned for late Summer and Fall.

Iron (mg/L)			
Depth (m)	1-Feb	12-May	12-Jun
1		0.03	0.09
3		0.02	
5		0.07	0.03
7		0.04	
8			
9	<.05	0.04	0.03
12	0.200	0.09	0.2
13			
14	0.14	0.24	1.4

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 water. Iron has been scarce in the bottom of Culver Lake, which limits the natural removal of phosphorus from the 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. The Association performed an iron replenishment this year, essentially adding “rust powder” to the deep sediments. Later this summer oxygen input to the deepest

waters will be reduced in order to mobilize iron from the sediment and take advantage of its phosphorus removal function.

Later this summer the management emphasis will be on mobilizing iron from the deep sediments and using it to precipitate/remove phosphorus from lake water. The intent is to "set the stage for lower nutrient availability and less algae in future years". The goal is to achieve Secchi Disk Transparency of approximately 2-3m through the summer by using iron generated by anaerobic respiration at the bottom of the lake to remove phosphorus.