2008 SUMMARY REPORT
of
Wooster Lake

Lake County, Illinois

Prepared by the

LAKE COUNTY HEALTH DEPARTMENT
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LAKES MANAGEMENT UNIT

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LAKE FACTS

Lake Name:	Wooster Lake
Historical Name:	None
Nearest Municipality:	Round Lake, Fox Lake
Location:	T45N, R9E, Section 23
Elevation:	742.0 feet
Major Tributaries:	None
Watershed:	Fox River
Sub-watershed:	Fish Lake Drainage
Receiving Water body:	Duck Lake
Surface Area:	98.5 acres
Shoreline Length:	2.0 miles
Maximum Depth:	29.0 feet
Average Depth:	16.3 feet
Lake Volume:	1,612.1 acre-feet
Lake Type:	Glacial
Watershed Area:	4,653.8 acres
Major Watershed Land uses:	Agriculture, forest and grassland
Bottom Ownership:	Village of Round Lake, Village of Fox Lake and Private
Management Entities:	Village and Private
Current and Historical uses:	Fishing, swimming and boating
Description of Access:	No public access

In 2005, Wooster Lake was chosen to be one of seven “sentinel” lakes in the county the Lakes Management Unit (LMU) will monitor annually for five years. This report summarizes the water quality sampling results and aquatic plant surveys conducted in 2008 on Wooster Lake. Similar reports have been written on data collected in 1999, 2003, and 2005 through 2007; these reports are available online from the LMU (http://www.lakecountyil.gov/Health/want/LakeReports.htm). 2009 will be the final year of the annual “sentinel” lake monitoring. A comprehensive summary report detailing all five years will be completed and available for review in 2010.

SUMMARY OF WATER QUALITY

Water samples were taken monthly from April through October at the deepest location in the lake (Figure 1). They were analyzed for nutrients, solids concentration and other physical parameters. Two samples were taken, one from the upper waters (epilimnion) from a depth of three feet , and one from the lower water layer (hypolimnion) taken three feet off the bottom and varied from 25-26 feet deep (Appendix A). Wooster Lake was stratified from May until September, with the strongest thermal stratification occurring from July through September (Appendix C).

Two swimming beaches were tested by the LMU in 2008. Camp Henry Horner is the only state licensed beach on Wooster Lake and was tested bimonthly, resulting in no closure recommendations (i.e. *E. coli* concentrations >235 colony forming units/100 mL). Holiday Park was sampled in August as part of the initial state licensing process. Results from the test were satisfactory and the beach should be licensed for the 2009 swimming season. It is required by law to have a beach licensed if it serves more than 5 households, thus the LMU strongly recommends any additional beaches on the lake to become licensed.

The average epilimnetic dissolved oxygen (DO) concentration was 8.20 mg/L, with the highest reading in April (12.7 mg/L) and the lowest in October (4.03 mg/L) (Table 1). The average hypolimnetic DO concentration was 2.42 mg/L, with the highest reading in April (12.04 mg/L) and the lowest in July (0.20 mg/L). DO concentrations above 5.0 mg/L are recommended by the Illinois Department of Natural Resources (IDNR) in order to sustain a healthy bass/sunfish fishery. Anoxic conditions (DO < 1.0 mg/L) ranged from below 20 feet in May to below 12 feet in July (Appendix B). While an accurate bathymetric map for Wooster Lake does not exist, the apparent anoxic volume in July may be a concern. It is highly recommended to lake residents that a new bathymetric map be created.

The 2008 average epilimnetic total suspended solids (TSS) concentration for Wooster Lake was 4.4 mg/L. This was below the county median of 8.2 mg/L (Appendix D), however it has increased approximately 52% since 2005 (2.9 mg/L). The TSS was highest in April (9.5 mg/L) and lowest in May (1.8 mg/L). The high value recorded in April was likely due to heavy spring rains and snowmelt.

Due to the low TSS average, Secchi depth (water clarity) in Wooster Lake was good (Figure 2). The median county Secchi depth from 2000-2008 was 3.12 feet; approximately two times shallower than that of Wooster Lake. The average Secchi depth in 2008 was 7.28 feet. Secchi depths ranged from a depth of 16.57 feet measured in May to a depth of 3.28 feet in April. Poor water clarity measured in April is likely due to heavy spring rains and snowmelt.

The Volunteer Lake Monitoring Program (VLMP) has been continuously active on Wooster Lake since 1995 with data also collected in 1992 (Figure 3). The VLMP average Secchi depth in 2008 was 7.18 feet, which comparable to the LCHD average of 7.28. Differences between VLMP and LCHD data can be attributed to discrepancies between samplers, as well as date and time samples were taken.

Average conductivity in 2008 was 0.7431 mS/cm. There was minimal change from the 2007 average of 0.7466 and remained below the county median (0.8934 mS/cm). The road salts used in winter road management runoff into surface waters (i.e. lakes and streams) and increase both conductivity and chloride ion (Cl^-) concentrations, which are correlated (Figure 4). The median Cl^- concentration in the county is 166 mg/L, however, Wooster Lake contains less than this concentration (110 mg/L). Almost all of the lakes in the county are experiencing similar increases in conductivity for the same reason. It is recommended that alternatives to road salt use in the watershed be explored.

In 2007, the average epilimnetic total phosphorus (TP) concentration in Wooster Lake was 0.062 mg/L, which was just below the county median (0.065 mg/L). Average TP concentrations have risen 94% since the 2005 sampling (0.032 mg/L). The 2008 average TP concentration decreased slightly from the 2007 concentration of 0.066 mg/L. The trophic state of Wooster Lake in terms of its phosphorus concentration in 2008 was eutrophic, with a TSIp score of 63.7. This indicates a continual decrease in water quality since 2005 when the TSIp score was 54.3. In 2008, Wooster Lake was 74th out of 163 lakes in Lake County based on TP concentrations, which is up from 80th in 2007 but a drop from 51st in 2006 (Table 2).

TSI values along with other water quality parameters can be used to make other analyses based on use impairment indexes established by the Illinois Environmental Protection Agency (IEPA). Most water quality standard impairment assessments were listed as *None*. However, widespread aquatic vegetation was the source of impairments based on excessive plant growth and exotic species. Wooster Lake TP concentrations remained impaired, and the DO concentration recorded in October was impaired as well. Furthermore, based on IEPA indices, Wooster Lake had *Full* support for aquatic life and *Partial* support for recreational use during 2008. Based on these indices, this lake was listed as providing *Partial* overall use support.

Figure 1. Water quality sampling point on Wooster Lake, 2008.

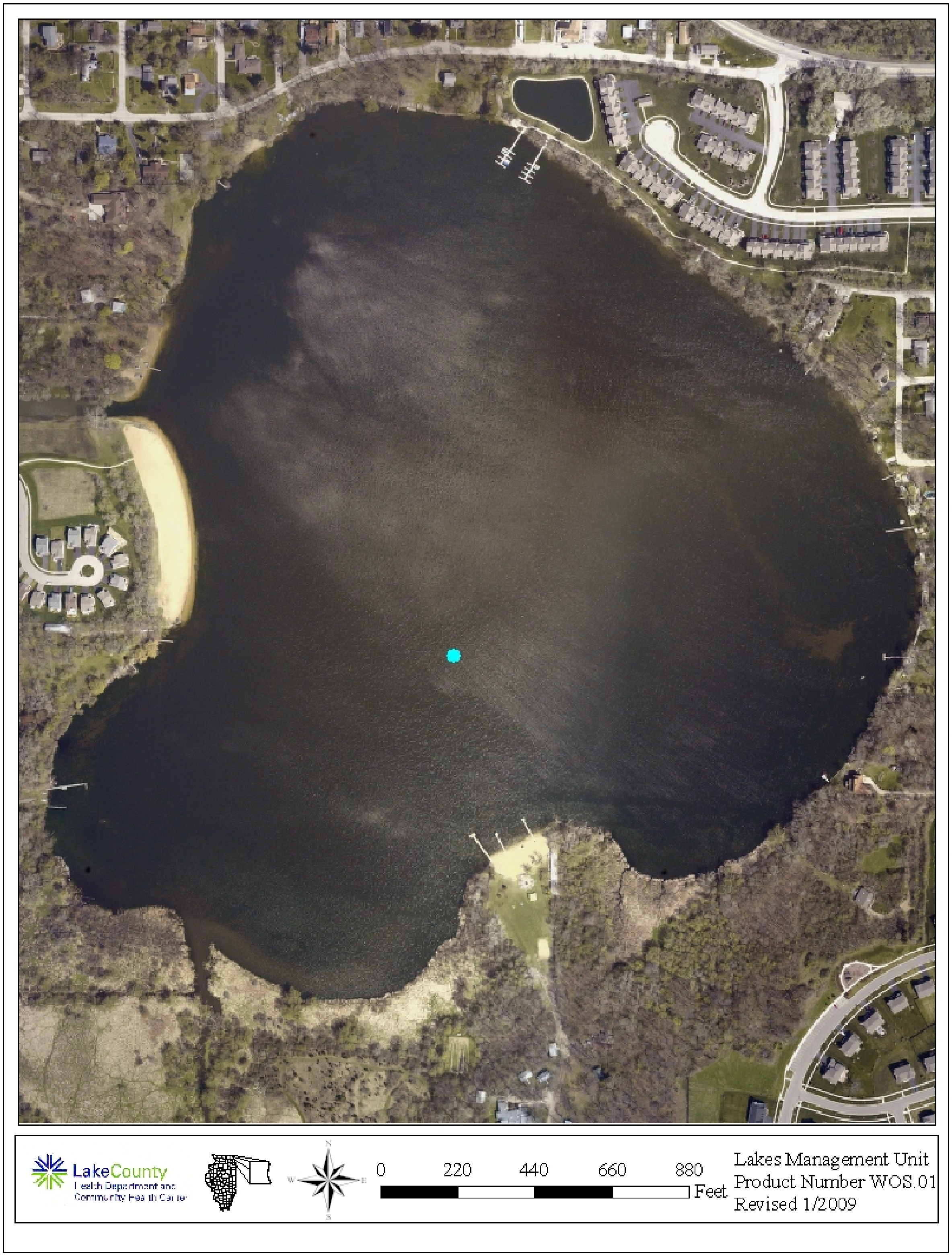

Table 1. Water quality data for Wooster Lake, 2005 - 2008.

2008	**Epilimnion**														
DATE	DEPTH	ALK	TKN	NH_3-N	NO2+NO_3	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-Apr	3	197	1.04	<0.1	0.177	0.080	<0.005	107	9.5	453	103	3.28	0.7516	8.28	12.70
13-May	3	200	1.16	0.158	<0.05	0.065	0.019	115	1.8	468	98	16.57	0.7799	8.43	9.06
10-Jun	3	188	1.06	<0.1	<0.05	0.048	<0.005	115	2.7	457	110	7.55	0.7601	8.64	8.11
8-Jul	3	190	1.05	<0.1	<0.05	0.045	<0.005	113	5.5	455	104	4.72	0.7558	8.74	8.56
12-Aug	3	180	0.87	<0.1	<0.05	0.014	<0.005	112	2.8	450	120	7.55	0.7494	8.55	8.42
9-Sep	3	178	0.86	<0.1	<0.05	0.039	<0.005	110	4.9	458	125	6.56	0.7370	8.10	6.54
29-Oct	3	189	1.81	0.675	<0.05	0.145	0.083	101	3.6	436	117	4.75	0.6681	7.11	4.03
	Average	189	1.12	0.417[k]	0.177[k]	0.062	0.051[k]	110	4.4	454	111	7.28	0.7431	8.26	8.20

2007	**Epilimnion**														
DATE	DEPTH	ALK	TKN	NH_3-N	NO2+NO_3	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-Apr	3	189	1.35	0.216	0.273	0.078	0.012	120	2.3	507	124	19.55	0.8084	8.29	12.71
15-May	3	186	1.02	<0.1	<0.05	0.043	<0.005	124	1.6	497	110	11.65	0.8182	8.63	9.21
19-Jun	3	164	1.26	<0.1	<0.05	0.041	<0.005	126	4.6	501	134	3.61	0.7936	8.46	7.51
17-Jul	3	165	1.15	<0.1	<0.05	0.028	<0.005	128	3.9	493	136	4.43	0.7967	8.30	7.87
14-Aug	3	156	1.92	<0.1	<0.05	0.118	<0.005	99	11.0	436	131	1.96	0.6695	7.62	4.28
18-Sep	3	172	1.36	<0.1	<0.05	0.058	<0.005	88	7.1	432	127	3.03	0.6545	7.84	7.67
23-Oct	3	184	1.36	0.527	<0.05	0.098	0.042	90	3.7	405	104	6.07	0.6850	7.64	4.66
	Average	174	1.35	0.372[k]	0.273[k]	0.066	0.027[k]	111	4.9	467	124	7.19	0.7466	8.11	7.70

2006	**Epilimnion**														
DATE	DEPTH	ALK	TKN	NH_3-N	NO2+NO_3	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	3	180	1.37	<0.1	0.148	0.090	<0.005	104	9.1	459	121	3.61	0.7292	8.46	11.57
10-May	3	164	2.09	<0.1	<0.05	0.049	<0.005	108	15.0	454	124	1.60	0.7207	8.71	10.90
14-Jun	3	148	1.38	<0.1	<0.05	0.027	<0.005	111	3.7	472	147	5.41	0.7222	8.84	9.34
12-Jul	3	150	1.32	<0.1	<0.05	0.023	<0.005	114	2.0	478	150	11.48	0.7404	8.57	6.00
09-Aug	3	150	1.27	<0.1	<0.05	0.020	<0.005	117	2.4	490	161	10.17	0.7591	8.55	6.86
13-Sep	3	153	1.21	<0.1	<0.05	0.021	<0.005	116	2.1	461	133	9.51	0.7431	8.20	5.80
31-Oct	3	172	1.83	0.728	<0.05	0.073	0.039	113	1.6	473	129	13.29	0.7571	7.40	8.69
	Average	160	1.50	0.728[k]	0.148[k]	0.043	0.039[k]	112	5.1	470	138	7.87	0.7388	8.39	8.45

2005	**Epilimnion**														
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N[*]	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	3	180	1.43	<0.1	0.200	0.050	<0.005	90.2	3.7	431	117	6.00	0.6662	8.67	11.95
17-May	3	173	1.40	<0.1	0.058	0.035	<0.005	92.1	3.2	412	114	9.02	0.6633	8.16	10.03
21-Jun	3	163	1.30	<0.1	<0.05	0.016	<0.005	97.2	<1.0	421	115	17.45	0.6761	8.18	8.23
19-Jul	3	163	1.24	<0.1	<0.05	0.021	<0.005	103.0	1.0	472	160	13.45	0.7094	8.05	6.53
16-Aug	3	167	1.34	<0.1	<0.05	0.038	<0.005	101.0	3.3	458	151	5.90	0.7055	8.86	7.79
20-Sep	3	174	1.32	<0.1	<0.05	0.027	<0.005	105.0	3.0	448	130	8.53	0.7232	8.28	6.12
18-Oct	3	180	1.46	0.209	<0.05	0.040	<0.005	101.0	2.9	432	117	6.40	0.7181	8.08	5.58
	Average	171	1.36	NA	0.130[k]	0.032	<0.005	98.5	2.9[k]	439	129	9.54	0.6945	8.33	8.03

Table 1. Continued

2008	Hypolimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO2+NO_3	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-Apr	26	198	1.21	<0.1	0.181	0.071	<0.005	107	9.2	453	101	NA	0.7531	8.58	12.04
13-May	26	207	1.77	0.983	<0.05	0.203	0.154	109	2.0	455	96	NA	0.7707	7.74	0.25
10-Jun	26	214	2.60	1.710	<0.05	0.406	0.305	110	3.7	478	113	NA	0.7851	7.39	0.21
8-Jul	25	222	2.94	1.800	<0.05	0.421	0.359	109	3.5	471	103	NA	0.7933	7.23	0.20
12-Aug	26	243	5.01	4.340	<0.05	0.869	0.720	111	6.0	486	118	NA	0.829	7.01	0.21
9-Sep	26	246	4.67	3.820	<0.05	0.703	0.654	226	6.2	470	102	NA	0.8234	6.90	0.21
29-Oct	25	187	1.79	0.692	<0.05	0.146	0.084	99.8	4.0	441	116	NA	0.6681	7.31	3.82
	Average	217	2.86	2.224[k]	0.181	0.403	0.009[k]	125	4.9	465	107	NA	0.7747	7.45	2.42

2007	Hypolimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO2+NO_3	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-Apr	25	190	1.22	0.269	0.281	0.058	0.019	119	1.3	505	124	NA	0.8090	8.11	10.92
15-May	24	201	1.68	0.798	0.140	0.182	0.144	119	1.1	488	107	NA	0.8295	7.49	0.68
19-Jun	26	209	2.44	1.370	<0.05	0.294	0.025	120	3.6	541	149	NA	0.8498	7.23	0.14
17-Jul	25	222	3.34	2.420	<0.05	0.411	0.340	122	3.6	522	135	NA	0.8721	6.99	0.23
14-Aug	25	231	3.61	2.670	<0.05	0.436	0.390	121	4.2	543	155	NA	0.8635	6.73	0.06
18-Sep	25	242	4.99	1.220	<0.05	0.671	0.616	121	4.1	528	144	NA	0.8982	6.70	0.07
23-Oct	24	214	3.50	2.580	<0.05	0.391	0.337	104	3.2	468	122	NA	0.8736	7.05	0.29
	Average	216	2.97	1.618	0.211[k]	0.349	0.267	118	3.0	514	134	NA	0.8565	7.19	1.77

2006	Hypolimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO2+NO_3	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	24	180	1.53	<0.1	0.188	0.066	<0.005	103	5.8	438	109	NA	0.7340	8.08	7.72
10-May	24	179	1.93	0.498	<0.05	0.104	0.039	105	5.6	446	113	NA	0.7560	7.33	0.13
14-Jun	25	218	4.15	3.020	<0.05	0.428	0.336	105	3.7	485	141	NA	0.7930	6.93	0.09
12-Jul	25	229	5.04	3.530	<0.05	0.467	0.394	106	5.8	483	137	NA	0.8004	6.84	0.10
09-Aug	24	230	5.06	3.650	<0.05	0.439	0.358	109	4.8	484	139	NA	0.8209	6.96	0.13
13-Sep	24	263	7.18	6.250	<0.05	0.724	0.652	108	4.6	497	137	NA	0.8293	6.97	0.08
31-Oct	25	172	1.89	0.735	<0.05	0.074	0.033	113	2.0	469	129	NA	0.7587	7.55	8.43
	Average	210	3.83	2.947[k]	0.188[k]	0.329	0.302[k]	107	4.6	472	129	NA	0.7846	7.24	2.38

2005	Hypolimnion														
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	26	186	2.09	0.951	0.133	0.065	0.022	87	2.7	421	111	NA	0.6717	7.56	2.51
17-May	24	186	2.00	0.771	0.063	0.137	0.099	90	<1.0	420	111	NA	0.6914	7.32	0.34
21-Jun	24	194	2.58	1.070	<0.05	0.210	0.129	90	4.8	442	122	NA	0.7062	6.85	0.05
19-Jul	24	198	2.97	<0.1	<0.05	0.245	0.140	91	8.4	456	132	NA	0.7297	6.87	0.06
16-Aug	23	225	4.60	3.100	<0.05	0.649	0.544	91	5.2	476	156	NA	0.7413	6.85	0.10
20-Sep	24	173	1.48	<0.1	<0.05	0.041	0.000	104	3.0	447	135	NA	0.7787	6.75	0.19
18-Oct	23	237	5.42	4.490	<0.05	0.713	0.617	92	4.0	437	101	NA	0.7592	7.24	0.11
	Average	200	3.02	2.076[k]	0.098[k]	0.294	0.222	92	4.7[k]	443	124	NA	0.7255	7.06	0.48

Table 1. Continued

Glossary	
ALK = Alkalinity, mg/L $CaCO_3$	TDS = Total dissolved solids, mg/L
TKN = Total Kjeldahl nitrogen, mg/L	TSS = Total suspended solids, mg/L
NH_3-N = Ammonia nitrogen, mg/L	TS = Total solids, mg/L
NO_2+NO_3-N = Nitrate + Nitrite nitrogen, mg/L	TVS = Total volatile solids, mg/L
NO_3-N = Nitrate + Nitrite nitrogen, mg/L	SECCHI = Secchi disk depth, ft.
TP = Total phosphorus, mg/L	COND = Conductivity, milliSiemens/cm
SRP = Soluble reactive phosphorus, mg/L	DO = Dissolved oxygen, mg/L
Cl- = Chloride, mg/L	

k = Denotes that the actual value is known to be less than the value presented.

NA= Not applicable

* = Prior to 2006 only Nitrate - nitrogen was analyzed

Figure 2. Total suspended solid (TSS) concentrations vs. Secchi depth for Wooster Lake, 2000 - 2008.

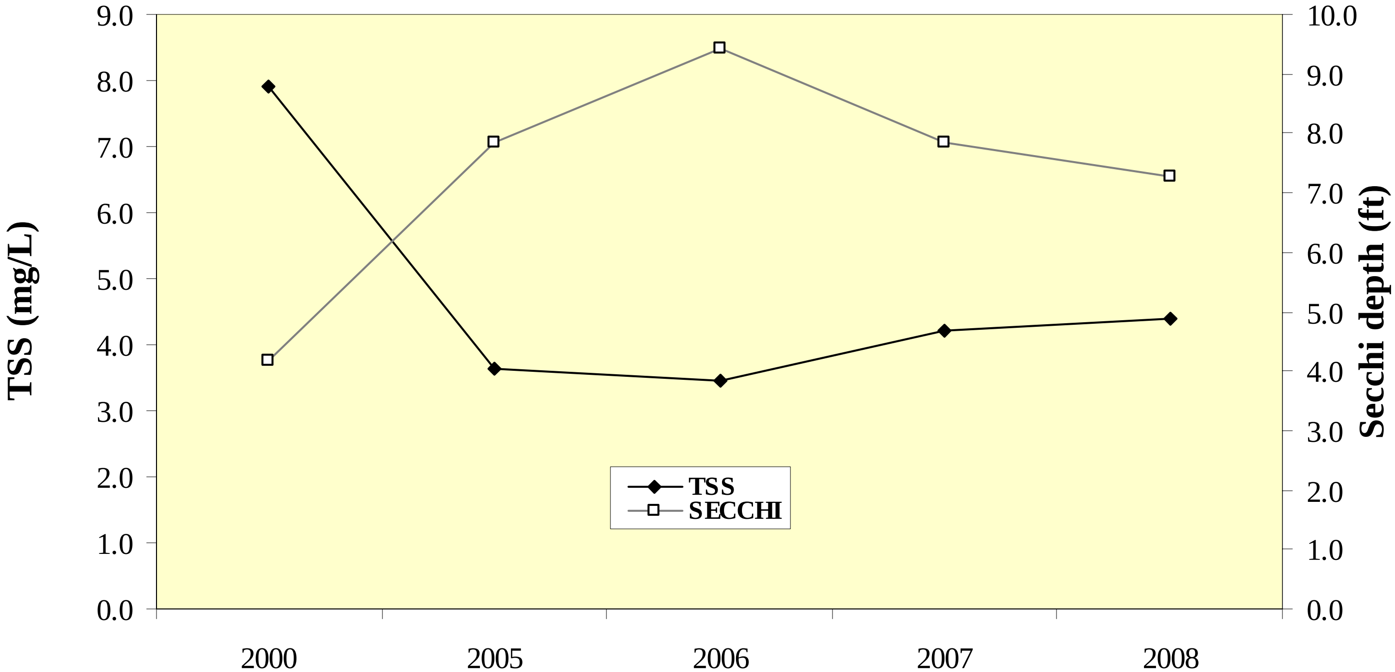

Figure 3. Comparison of average Secchi disk depths between VLMP records and LCHD records from 1992-2008 for Wooster Lake.

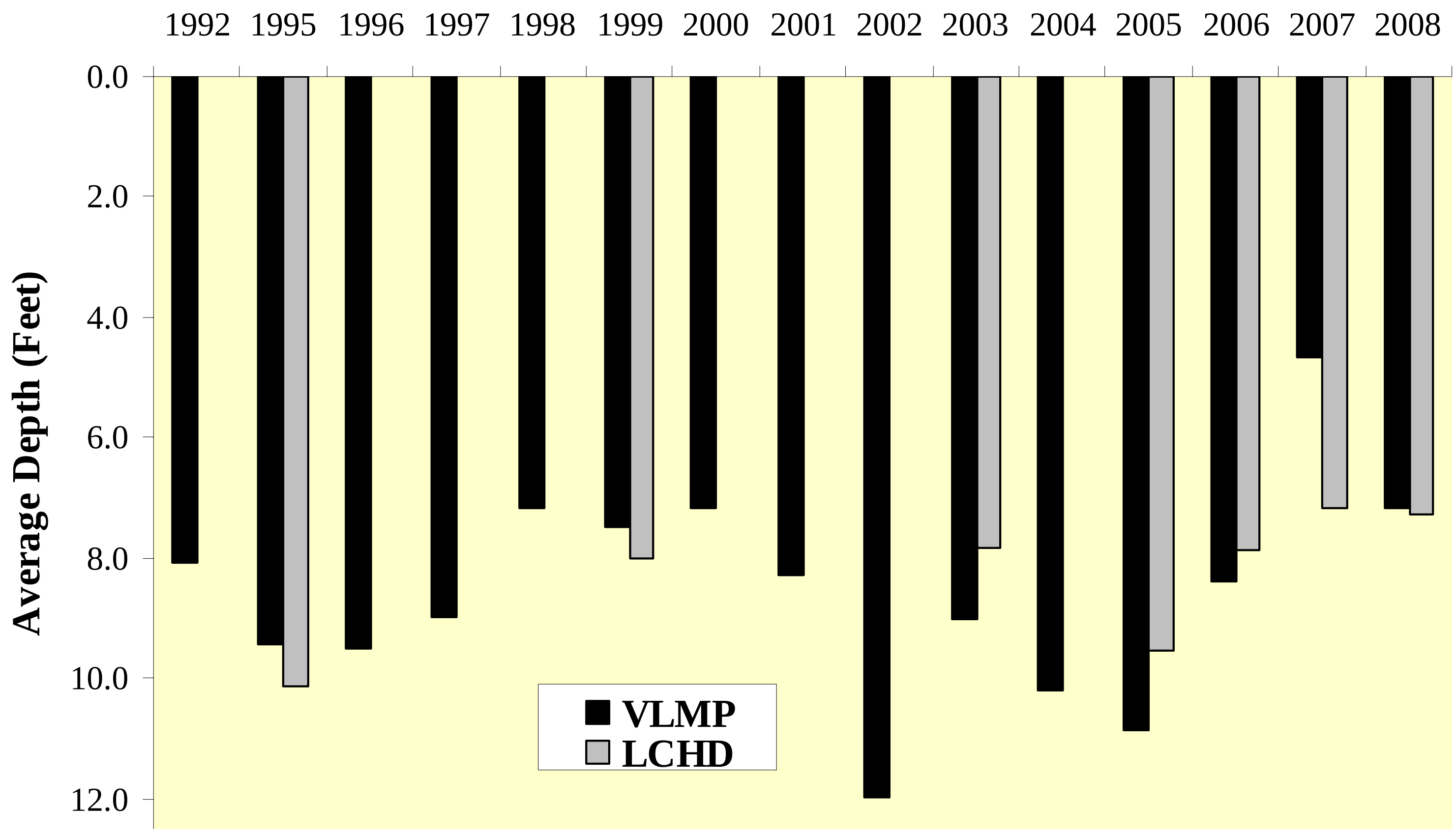

Figure 4. Chloride vs. conductivity concentrations in Wooster Lake, 2008.

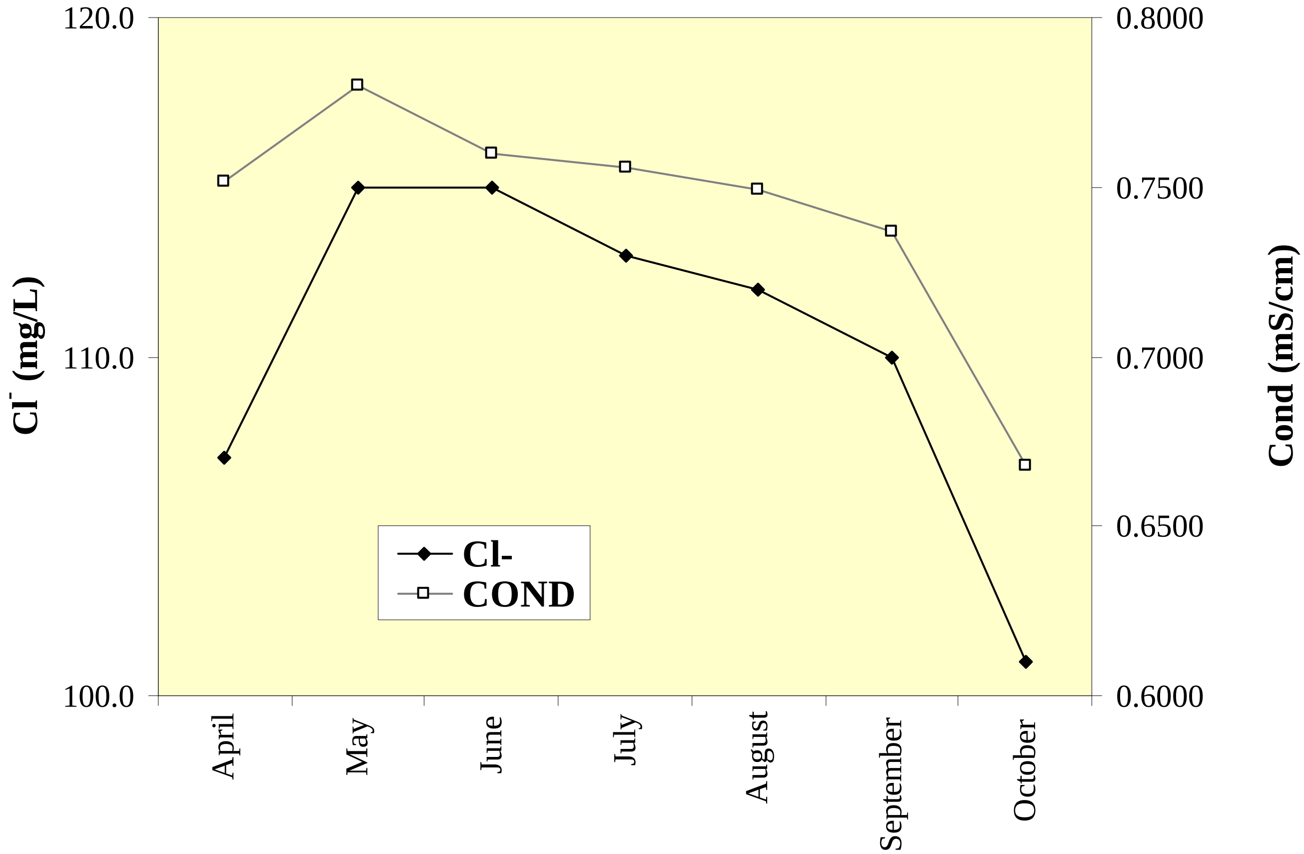

Table 2. Lake County average TSI phosphorous (TSIp) ranking 2000-2008.

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Independence Grove	0.0135	39.24
4	Lake Zurich	0.0130	41.14
5	Sand Pond (IDNR)	0.0165	41.36
6	West Loon Lake	0.0140	42.21
7	Windward Lake	0.0158	43.95
8	Bangs Lake	0.0170	45.00
9	Pulaski Pond	0.0180	45.83
10	Timber Lake	0.0180	45.83
11	Fourth Lake	0.0182	45.99
12	Lake Kathryn	0.0200	47.35
13	Lake of the Hollow	0.0200	47.35
14	Banana Pond	0.0202	47.49
15	Lake Minear	0.0204	47.63
16	Cedar Lake	0.0220	48.72
17	Cross Lake	0.0220	48.72
18	Sun Lake	0.0220	48.72
19	Dog Pond	0.0222	48.85
20	Stone Quarry Lake	0.0230	49.36
21	Deep Lake	0.0234	49.61
22	Druce Lake	0.0244	50.22
23	Little Silver	0.0250	50.57
24	Round Lake	0.0254	50.80
25	Lake Leo	0.0256	50.91
26	Cranberry Lake	0.0270	51.68
27	Dugdale Lake	0.0274	51.89
28	Peterson Pond	0.0274	51.89
29	Lake Miltmore	0.0276	51.99
30	Third Lake	0.0280	52.20
31	Lake Fairfield	0.0296	53.00
32	Gray's Lake	0.0302	53.29
33	Highland Lake	0.0302	53.29
34	Hook Lake	0.0302	53.29
35	Lake Catherine (Site 1)	0.0308	53.57
36	Lambs Farm Lake	0.0312	53.76
37	Old School Lake	0.0312	53.76
38	Sand Lake	0.0316	53.94
39	Sullivan Lake	0.0320	54.13
40	Lake Linden	0.0326	54.39
41	Gages Lake	0.0338	54.92
42	Honey Lake	0.0340	55.00
43	Hendrick Lake	0.0344	55.17
44	Diamond Lake	0.0372	56.30
45	Channel Lake (Site 1)	0.0380	56.60
46	Ames Pit	0.0390	56.98

Table 2. Continued.

RANK	LAKE NAME	TP AVE	TSIp
47	White Lake	0.0408	57.63
48	Potomac Lake	0.0424	58.18
49	Duck Lake	0.0426	58.25
50	Old Oak Lake	0.0428	58.32
51	Deer Lake	0.0434	58.52
52	Schreiber Lake	0.0434	58.52
53	Nielsen Pond	0.0448	58.98
54	Turner Lake	0.0458	59.30
55	Seven Acre Lake	0.0460	59.36
56	Willow Lake	0.0464	59.48
57	Lucky Lake	0.0476	59.85
58	Davis Lake	0.0476	59.85
59	East Meadow Lake	0.0478	59.91
60	East Loon Lake	0.0490	60.27
61	College Trail Lake	0.0496	60.45
62	Lake Lakeland Estates	0.0524	61.24
63	Butler Lake	0.0528	61.35
64	West Meadow Lake	0.0530	61.40
65	Heron Pond	0.0545	61.80
66	Little Bear Lake	0.0550	61.94
67	Lucy Lake	0.0552	61.99
68	Lake Christa	0.0576	62.60
69	Lake Charles	0.0580	62.70
70	Crooked Lake	0.0608	63.38
71	Waterford Lake	0.0610	63.43
72	Lake Naomi	0.0616	63.57
73	Lake Tranquility S1	0.0618	63.62
74	**Wooster Lake**	**0.0620**	**63.66**
75	Countryside Lake	0.0620	63.66
76	Werhane Lake	0.0630	63.89
77	Liberty Lake	0.0632	63.94
78	Countryside Glen Lake	0.0642	64.17
79	Lake Fairview	0.0648	64.30
80	Leisure Lake	0.0648	64.30
81	Tower Lake	0.0662	64.61
82	St. Mary's Lake	0.0666	64.70
83	Mary Lee Lake	0.0682	65.04
84	Hastings Lake	0.0684	65.08
85	Spring Lake	0.0726	65.94
86	ADID 203	0.0730	66.02
87	Bluff Lake	0.0734	66.10
88	Harvey Lake	0.0766	66.71
89	Broberg Marsh	0.0782	67.01
90	Sylvan Lake	0.0794	67.23
91	Big Bear Lake	0.0806	67.45
92	Petite Lake	0.0834	67.94

Table 2. Continued.

RANK	LAKE NAME	TP AVE	TSIp
93	Timber Lake (South)	0.0848	68.18
94	Lake Marie (Site 1)	0.0850	68.21
95	North Churchill Lake	0.0872	68.58
96	Grand Avenue Marsh	0.0874	68.61
97	Grandwood Park, Site II, Outflow	0.0876	68.65
98	North Tower Lake	0.0878	68.68
99	South Churchill Lake	0.0896	68.97
100	Rivershire Pond 2	0.0900	69.04
101	McGreal Lake	0.0914	69.26
102	International Mine and Chemical Lake	0.0948	69.79
103	Eagle Lake (Site I)	0.0950	69.82
104	Valley Lake	0.0950	69.82
105	Dunns Lake	0.0952	69.85
106	Fish Lake	0.0956	69.91
107	Lochanora Lake	0.0960	69.97
108	Owens Lake	0.0978	70.23
109	Woodland Lake	0.0986	70.35
110	Island Lake	0.0990	70.41
111	McDonald Lake 1	0.0996	70.50
112	Longview Meadow Lake	0.1024	70.90
113	Lake Barrington	0.1053	71.31
114	Redwing Slough, Site II, Outflow	0.1072	71.56
115	Lake Forest Pond	0.1074	71.59
116	Bittersweet Golf Course #13	0.1096	71.88
117	Fox Lake (Site 1)	0.1098	71.90
118	Osprey Lake	0.1108	72.04
119	Bresen Lake	0.1126	72.27
120	Round Lake Marsh North	0.1126	72.27
121	Deer Lake Meadow Lake	0.1158	72.67
122	Long Lake	0.1170	72.82
123	Taylor Lake	0.1184	72.99
124	Columbus Park Lake	0.1226	73.49
125	Nippersink Lake (Site 1)	0.1240	73.66
126	Echo Lake	0.1250	73.77
127	Grass Lake (Site 1)	0.1288	74.21
128	Lake Holloway	0.1322	74.58
129	Lakewood Marsh	0.1330	74.67
130	Summerhill Estates Lake	0.1384	75.24
131	Redhead Lake	0.1412	75.53
132	Forest Lake	0.1422	75.63
133	Antioch Lake	0.1448	75.89
134	Slocum Lake	0.1496	76.36
135	Drummond Lake	0.1510	76.50
136	Pond-a-Rudy	0.1514	76.54
137	Lake Matthews	0.1516	76.56
138	Buffalo Creek Reservoir	0.1550	76.88

Table 2. Continued.

RANK	LAKE NAME	TP AVE	TSIp
139	Pistakee Lake (Site 1)	0.1592	77.26
140	Grassy Lake	0.1610	77.42
141	Salem Lake	0.1650	77.78
142	Half Day Pit	0.1690	78.12
143	Lake Eleanor Site II, Outflow	0.1812	79.13
144	Lake Farmington	0.1848	79.41
145	Lake Louise	0.1850	79.43
146	ADID 127	0.1886	79.71
147	Dog Bone Lake	0.1990	80.48
148	Redwing Marsh	0.2072	81.06
149	Stockholm Lake	0.2082	81.13
150	Bishop Lake	0.2156	81.63
151	Hidden Lake	0.2236	82.16
152	Fischer Lake	0.2278	82.43
153	Lake Napa Suwe (Outlet)	0.2304	82.59
154	Patski Pond (outlet)	0.2512	83.84
155	Oak Hills Lake	0.2792	85.36
156	Loch Lomond	0.2954	86.18
157	McDonald Lake 2	0.3254	87.57
158	Fairfield Marsh	0.3264	87.61
159	ADID 182	0.3280	87.69
160	Slough Lake	0.4134	91.02
161	Flint Lake Outlet	0.4996	93.75
162	Rasmussen Lake	0.5025	93.84
163	Albert Lake, Site II, outflow	1.1894	106.26

SUMMARY OF AQUATIC MACROPHYTES

An aquatic plant (macrophyte) survey was conducted in July of 2008. On Wooster Lake, there were 54 sampling sites sampled covering all but the deepest parts of the lake (Figure 5). There were 12 plant species and one macro algae (*Chara* spp.)(Table 3) found during the July vegetation survey. Coontail and White Water Lily dominated the vegetation throughout the lake. (Table 3a). Eurasian Water Milfoil was detected at a frequency of 39%, this was a decrease of 15% from the frequency recorded in 2007 (46%). The number of species detected during the survey had decreased by two species (May 2007) and four (August 2007). One of the species not found during the 2008 sampling was White-Stemmed Pondweed, a species listed as endangered in Illinois. It has been found in very low numbers in the lake in the past most recently in 2007. Care should be taken to ensure that White-Stemmed Pondweed is not eradicated from Wooster Lake. Others not detected were Floating-leaf Pondweed, Grass-leaved Arrowhead, Illinois Pondweed, Slender Naiad, Spiny Naiad and Water Star Grass. Only sampling once in 2008 could be a reason why some of these species were not found. Plants need at least 1% of surface light levels in order to survive. In July, plants were found down to a depth of 5.5 feet, which was only about half the 1% light level depth of 10.0 feet recorded during the July water sampling indicating plants could grow at more areas than they were found at in 2008. Out of the 54 sample sites, plants were found at 49 of them (91%; Table 3b).

Plant coverage in July 2008 was calculated to be 43%. In 2007 plant coverage in May and August was 49% and 45%, respectively. Since, the land uses and existing water bodies in the watershed inevitably contribute high nutrient inputs to Wooster Lake, the high-density plant community helps utilize these nutrients and keep the water clarity high. If plants were reduced, algal populations may increase causing a decrease in water clarity. Also, the Starhead Topminnow (*Fundulus dispar*) and Blackchin Shiner (*Notropsis heterodon*), both threatened in Illinois, and the state endangered Blacknose Shiner (*Notropsis heterolepsis*) in the lake require high densities of plants for proper habitat.

Floristic Quality Index (FQI) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. The median FQI for 2000-2008 Lake County lakes is 12.5. Wooster Lake had a FQI of 18.5 and ranked 36th out of 163 lakes in 2008. (Table 4).

Figure 5. Aquatic plant sampling grid illustrating plant density on Wooster Lake, July 2008.

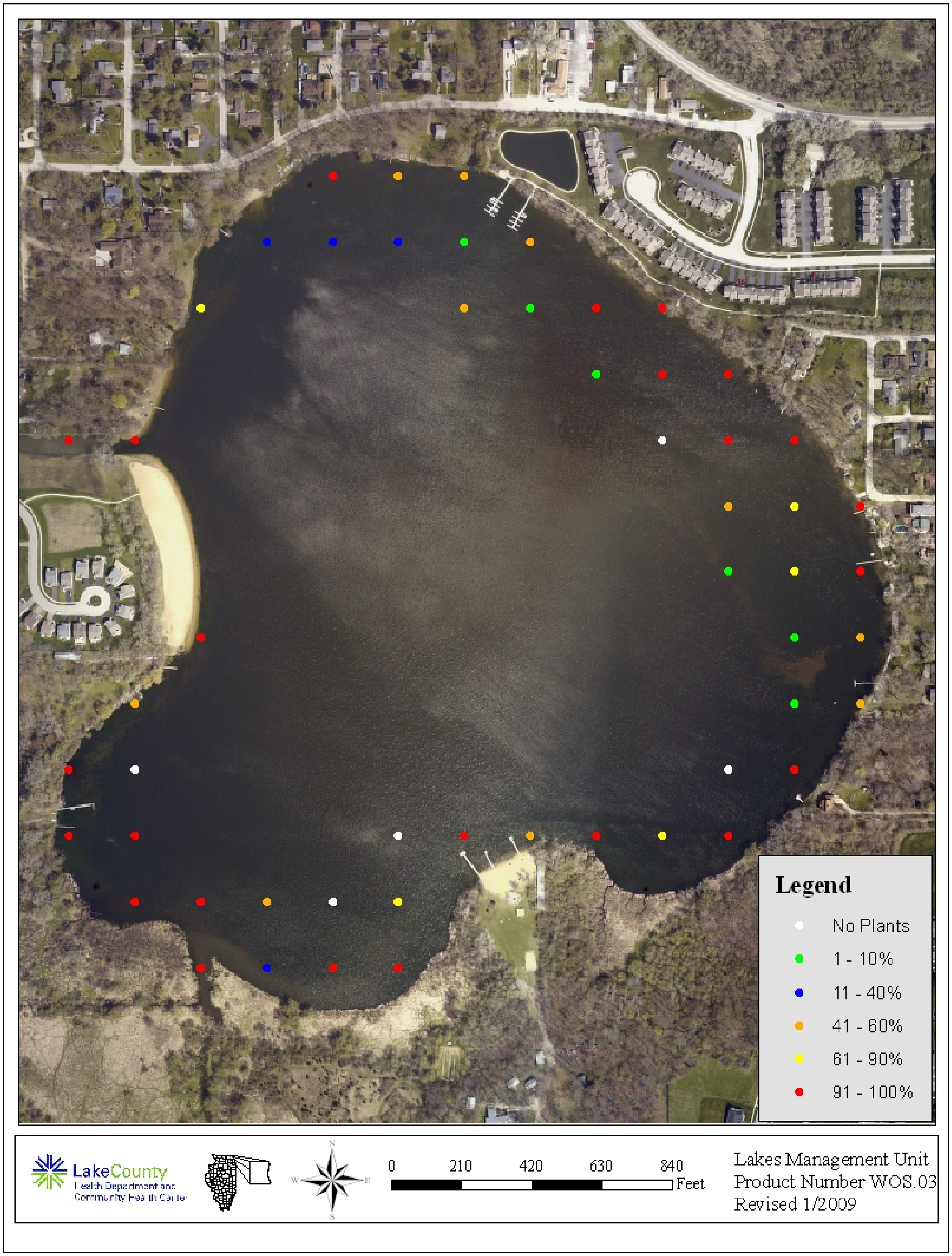

Table 3: Aquatic plant species found in Wooster Lake, 2008.

Coontail	*Ceratophyllum demersum*
Chara (Macro algae)	*Chara* spp.
Common Waterweed	*Elodea canadensis*
Duckweed	*Lemna* spp.
Star Duckweed	*Lemna trisulca*
Eurasian Water Milfoil^	*Myriophyllum spicatum*
Spatterdock	*Nuphar variegata*
White Water Lily	*Nymphaea tuberosa*
Curlyleaf Pondweed^	*Potamogeton crispus*
Sago Pondweed	*Potamogeton pectinatus*
Flat-Stemmed Pondweed	*Potamogeton zosteriformis*
Eel Grass	*Vallisneria americana*
Watermeal	*Wolffia* spp.

*** Endangered in Illinois**
^ Exotic plant

Table 3a. Aquatic plant species found at the sampling sites in July on Wooster Lake, 2008. Maximum depth that plants were found was 5.5 feet.

Plant Density	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed
Absent	52	11	48	43	52	33	52
Present	2	11	5	8	1	6	2
Common	0	5	0	3	0	9	0
Abundant	0	10	0	0	0	4	0
Dominant	0	17	1	0	1	2	0
% Plant Occurrence	3.7	79.6	11.1	20.4	3.7	38.9	3.7

Plant Density	Sago Pondweed	Spatterdock	Star Duckweed	Vallisneria	Watermeal	White Water Lily
Absent	39	53	41	44	39	19
Present	12	0	12	3	10	14
Common	2	1	1	0	5	12
Abundant	1	0	0	4	0	7
Dominant	0	0	0	3	0	1
% Plant Occurrence	27.8	1.9	24.1	18.5	27.8	64.2

Table 3b. Distribution of rake density across all sampling sites in July.

Rake Density (Coverage)	# of Sites	%
No plants	5	9.3%
>0 to 10%	6	11.1%
>10 to 40%	4	7.4%
>40 to 60%	10	18.5%
>60 to 90%	5	9.3%
>90%	24	44.4%
Total Sites with Plants	49	90.7%
Total # of Sites	54	100.0%

Table 4. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/Adventives) and with native species only (native).

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	36.3	38.4
2	East Loon Lake	30.6	32.7
3	Cranberry Lake	30.1	31.6
4	Deep Lake	29.7	31.2
5	Little Silver	29.6	31.6
6	Round Lake Marsh North	29.1	29.9
7	Deer Lake	28.2	29.7
8	Sullivan Lake	28.2	29.7
9	Schreiber Lake	26.8	27.6
10	Bangs Lake	25.7	27.4
11	West Loon Lake	25.7	27.3
12	Cross Lake	25.2	27.8
13	Independence Grove	24.6	27.5
14	Sterling Lake	24.5	26.9
15	Lake Zurich	24.3	27.1
16	Sun Lake	24.3	26.1
17	Lake of the Hollow	23.8	26.2
18	Lakewood Marsh	23.8	24.7
19	Round Lake	23.5	25.9
20	Honey Lake	23.3	25.1
21	Fourth Lake	23.0	24.8
22	Druce Lake	22.8	25.2
23	Countryside Glen Lake	21.9	22.8
24	Butler Lake	21.4	23.1
25	Duck Lake	21.1	22.9
26	Timber Lake (North)	20.8	22.8
27	Broberg Marsh	20.5	21.4
28	Davis Lake	20.5	21.4
29	ADID 203	20.5	20.5
30	McGreal Lake	20.2	22.1
31	Lake Kathryn	19.6	20.7
32	Fish Lake	19.3	21.2
33	Owens Lake	19.3	20.2
34	Redhead Lake	19.3	21.2
35	Turner Lake	18.6	21.2
36	**Wooster Lake**	**18.5**	**20.2**
37	Salem Lake	18.5	20.2
38	Lake Miltmore	18.4	20.3
39	Hendrick Lake	17.7	17.7
40	Summerhill Estates Lake	17.1	18.0
41	Seven Acre Lake	17.0	15.5
42	Gray's Lake	16.9	19.8
43	Lake Barrington	16.7	17.7
44	Bresen Lake	16.6	17.8

Table 4. Continued.

Rank	LAKE NAME	FQI (w/A)	FQI (native)
45	Diamond Lake	16.3	17.4
46	Lake Napa Suwe	16.3	17.4
47	Windward Lake	16.3	17.6
48	Dog Bone Lake	15.7	15.7
49	Redwing Slough	15.6	16.6
50	Osprey Lake	15.5	17.3
51	Lake Fairview	15.2	16.3
52	Heron Pond	15.1	15.1
53	Lake Tranquility (S1)	15.0	17.0
54	North Churchill Lake	15.0	15.0
55	Dog Training Pond	14.7	15.9
56	Island Lake	14.7	16.6
57	Highland Lake	14.5	16.7
58	Grand Avenue Marsh	14.3	16.3
59	Taylor Lake	14.3	16.3
60	Dugdale Lake	14.0	15.1
61	Eagle Lake (S1)	14.0	15.1
62	Longview Meadow Lake	13.9	13.9
63	Ames Pit	13.4	15.5
64	Bishop Lake	13.4	15.0
65	Hook Lake	13.4	15.5
66	Long Lake	13.1	15.1
67	Buffalo Creek Reservoir	13.1	14.3
68	Mary Lee Lake	13.1	15.1
69	McDonald Lake 2	13.1	14.3
70	Old School Lake	13.1	15.1
71	Dunn's Lake	12.7	13.9
72	Old Oak Lake	12.7	14.7
73	Timber Lake (South)	12.7	14.7
74	White Lake	12.7	14.7
75	Hastings Lake	12.5	14.8
76	Sand Lake	12.5	14.8
77	Stone Quarry Lake	12.5	12.5
78	Lake Carina	12.1	14.3
79	Lake Leo	12.1	14.3
80	Lambs Farm Lake	12.1	14.3
81	Pond-A-Rudy	12.1	12.1
82	Stockholm Lake	12.1	13.5
83	Grassy Lake	12.0	12.0
84	Lake Matthews	12.0	12.0
85	Flint Lake	11.8	13.0
86	Harvey Lake	11.8	13.0
87	Rivershire Pond 2	11.5	13.3
88	Antioch Lake	11.3	13.4
89	Lake Charles	11.3	13.4
90	Lake Linden	11.3	11.3

Table 4. Continued.

Rank	LAKE NAME	FQI (w/A)	FQI (native)
91	Lake Naomi	11.2	12.5
92	Pulaski Pond	11.2	12.5
93	Lake Minear	11.0	13.9
94	Redwing Marsh	11.0	11.0
95	Tower Lake	11.0	11.0
96	West Meadow Lake	11.0	11.0
97	Nielsen Pond	10.7	12.0
98	Lake Holloway	10.6	10.6
99	Third Lake	10.2	12.5
100	Crooked Lake	10.2	12.5
101	College Trail Lake	10.0	10.0
102	Lake Lakeland Estates	10.0	11.5
103	Valley Lake	9.9	9.9
104	Werhane Lake	9.8	12.0
105	Big Bear Lake	9.5	11.0
106	Little Bear Lake	9.5	11.0
107	Loch Lomond	9.4	12.1
108	Columbus Park Lake	9.2	9.2
109	Sylvan Lake	9.2	9.2
110	Lake Louise	9	10.4
111	Fischer Lake	9.0	11.0
112	Grandwood Park Lake	9.0	11.0
113	Lake Fairfield	9.0	10.4
114	McDonald Lake 1	8.9	10.0
115	Countryside Lake	8.7	10.6
116	East Meadow Lake	8.5	8.5
117	Lake Christa	8.5	9.8
118	Lake Farmington	8.5	9.8
119	Lucy Lake	8.5	9.8
120	South Churchill Lake	8.5	8.5
121	Bittersweet Golf Course #13	8.1	8.1
122	Woodland Lake	8.1	9.9
123	Albert Lake	7.5	8.7
124	Banana Pond	7.5	9.2
125	Fairfield Marsh	7.5	8.7
126	Lake Eleanor	7.5	8.7
127	Patski Pond	7.1	7.1
128	Rasmussen Lake	7.1	7.1
129	Slough Lake	7.1	7.1
130	Lucky Lake	7.0	7.0
131	Lake Forest Pond	6.9	8.5
132	Leisure Lake	6.4	9.0
133	Peterson Pond	6.0	8.5
134	Gages Lake	5.8	10.0
135	Slocum Lake	5.8	7.1
136	Deer Lake Meadow Lake	5.2	6.4

Table 4. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
137	ADID 127	5.0	5.0
138	Drummond Lake	5.0	7.1
139	IMC Lake	5.0	7.1
140	Liberty Lake	5.0	5.0
141	Oak Hills Lake	5.0	5.0
142	Forest Lake	3.5	5.0
143	Sand Pond (IDNR)	3.5	5.0
144	Half Day Pit	2.9	5.0
145	Lochanora Lake	2.5	5.0
146	Echo Lake	0.0	0.0
147	Hidden Lake	0.0	0.0
148	North Tower Lake	0.0	0.0
149	Potomac Lake	0.0	0.0
150	St. Mary's Lake	0.0	0.0
151	Waterford Lake	0.0	0.0
152	Willow Lake	0.0	0.0
	Mean	**13.6**	**14.9**
	Median	**12.5**	**14.3**

APPENDIX A. METHODS FOR FIELD DATA COLLECTION AND LABORATORY ANALYSES

Water Sampling and Laboratory Analyses

Two water samples were collected once a month from May through September. Sample locations were at the deepest point in the lake (see sample site map), three feet below the surface, and 3 feet above the bottom. Samples were collected with a horizontal Van Dorn water sampler. Approximately three liters of water were collected for each sample for all lab analyses. After collection, all samples were placed in a cooler with ice until delivered to the Lake County Health Department lab, where they were refrigerated. Analytical methods for the parameters are listed in Table A1. Except nitrate nitrogen, all methods are from the Eighteenth Edition of Standard Methods, (eds. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1992). Methodology for nitrate nitrogen was taken from the 14th edition of Standard Methods. Dissolved oxygen, temperature, conductivity and pH were measured at the deep hole with a Hydrolab DataSonde® 4a. Photosynthetic Active Radiation (PAR) was recorded using a LI-COR® 192 Spherical Sensor attached to the Hydrolab DataSonde® 4a. Readings were taken at the surface and then every two feet until reaching the bottom.

Plant Sampling

In order to randomly sample each lake, mapping software (ArcMap 9.3) overlaid a grid pattern onto an aerial photo of Lake County and placed points 60 or 30 meters apart, depending on lake size. Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At designated sampling sites, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, plant coverage was assessed for overall abundance. Then plants were individually identified and placed in categories based on coverage. Plants that were not found on the rake but were seen in the immediate vicinity of the boat at the time of sampling were also recorded. Plants difficult to identify in the field were placed in plastic bags and identified with plant keys after returning to the office. The depth of each sampling location was measured either by a hand-held depth meter, or by pushing the rake straight down and measuring the depth along the rope or rake handle. One-foot increments were marked along the rope and rake handle to aid in depth estimation.

Wildlife Assessment

Species of wildlife were noted during visits to each lake. When possible, wildlife was identified to species by sight or sound. However, due to time constraints, collection of quantitative information was not possible. Thus, all data should be considered anecdotal.
Some of the species on the list may have only been seen once, or were spotted during their migration through the area.

Table A1. Analytical methods used for water quality parameters.

Parameter	*Method*
Temperature	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Dissolved oxygen	Hydrolab DataSonde ®4a or YSI 6600 Sonde®
Nitrate and Nitrite nitrogen	USEPA 353.2 rev. 2.0 EPA-600/R-93/100 Detection Limit = 0.05 mg/L
Ammonia nitrogen	SM 18th ed. Electrode method, #4500 NH_3-F Detection Limit = 0.1 mg/L
Total Kjeldahl nitrogen	SM 18th ed, 4500-N_{org} C Semi-Micro Kjeldahl, plus 4500 NH_3-F Detection Limit = 0.5 mg/L
pH	Hydrolab DataSonde® 4a, or YSI 6600 Sonde® Electrometric method
Total solids	SM 18th ed, Method #2540B
Total suspended solids	SM 18th ed, Method #2540D Detection Limit = 0.5 mg/L
Chloride	SM 18th ed, Method #4500C1-D
Total volatile solids	SM 18th ed, Method #2540E, from total solids
Alkalinity	SM 18th ed, Method #2320B, patentiometric titration curve method
Conductivity	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Total phosphorus	SM 18th ed, Methods #4500-P B 5 and #4500-P E Detection Limit = 0.01 mg/L
Soluble reactive phosphorus	SM 18th ed, Methods #4500-P B 1 and #4500-P E Detection Limit = 0.005 mg/L
Clarity	Secchi disk
Color	Illinois EPA Volunteer Lake Monitoring Color Chart
Photosynthetic Active Radiation (PAR)	Hydrolab DataSonde® 4a or YSI 6600 Sonde®, LI-COR® 192 Spherical Sensor

APPENDIX B. MULTI-PARAMETER DATA FOR WOOSTER LAKE IN 2008.

Wooster Lake 2008 Multiparameter data

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.92
41608	75600	0.25	0.35	7.66	12.71	110.1	0.7516	7.8	3633	Surface		
41608	75708	1	1.02	7.66	12.74	110.2	0.7515	8.19	4081	Surface	100%	
41608	75807	2	2.07	7.65	12.72	109.9	0.7516	8.25	1242	0.32	30%	3.72
41608	75848	3	3.07	7.64	12.7	109.8	0.7516	8.28	430	1.32	11%	0.80
41608	75939	4	4.06	7.64	12.7	109.8	0.7518	8.33	309	2.31	8%	0.14
41608	80106	6	6.00	7.63	12.66	109.4	0.7513	8.37	102	4.25	2%	0.26
41608	80150	8	8.02	7.62	12.61	108.9	0.7517	8.48	28	6.27	0.7%	0.21
41608	80325	10	10.00	7.63	12.57	108.7	0.752	8.47	1	8.25	0.02%	0.40
41608	80409	12	12.06	7.62	12.51	108.1	0.7521	8.52	0	10.31		
41608	80511	14	14.03	7.63	12.48	108.1	0.7522	8.55	0	12.28		
41608	80601	16	16.07	7.63	12.44	107.4	0.7528	8.59	0	14.32		
41608	80707	18	18.04	7.63	12.38	107.1	0.7518	8.61	0	16.29		
41608	80817	20	20.01	7.62	12.38	106.9	0.7515	8.61	0	18.26		
41608	80923	22	21.97	7.63	12.24	105.9	0.7521	8.62	0	20.22		
41608	81055	24	24.03	7.52	12.1	104.3	0.753	8.57	0	22.28		
41608	81205	26	26.03	7.45	12.04	103.6	0.7531	8.58	0	24.28		
41608	81307	28	28.00	7.38	11.97	102.8	0.7534	8.59	0	26.25		

Date MMDDYY	Time HHMMSS	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.33
51308	92614	0.25	0.21	14.26	9.1	91.4	0.7777	8.38	4475	Surface	100%	
51308	92645	1	1.00	14.28	9.06	91.1	0.7801	8.39	2761	Surface	62%	
51308	92728	2	1.99	14.27	9.05	90.9	0.7803	8.41	938	0.24	21%	4.50
51308	92816	3	3.03	14.26	9.06	91	0.7799	8.43	1058	1.28	24%	-0.09
51308	92854	4	3.99	14.25	9.06	91	0.7803	8.44	1012	2.24	23%	0.02
51308	93001	6	5.99	14.21	9	90.3	0.7803	8.46	379	4.24	8%	0.23
51308	93056	8	8.00	14.21	8.96	89.9	0.7802	8.5	459	6.25	10%	-0.03

51308	93206	10	9.99	14.18	8.92	89.5	0.7802	8.51	183	8.24	4%	0.11
51308	93252	12	12.02	13.98	8.71	87	0.7803	8.52	81	10.27	2%	0.08
51308	93346	14	14.00	13.04	7.61	74.4	0.7794	8.41	64	12.25	1%	0.02
51308	93436	16	16.00	12.67	6.29	61.1	0.7775	8.27	48	14.25	1.1%	0.02
51308	93531	18	18.04	11.18	4.44	41.6	0.7749	8.1	30	16.29	0.7%	0.03
51308	93657	20	20.00	9.76	2.06	18.7	0.7712	7.88	15	18.25	0.3%	0.04
51308	93805	22	22.02	8.98	0.42	3.8	0.7683	7.79	8	20.27	0.2%	0.03
51308	93858	24	23.97	8.72	0.27	2.4	0.769	7.77	7	22.22	0.2%	0.01
51308	93952	26	25.98	8.34	0.25	2.2	0.7707	7.74	6	24.23	0.1%	0.01
51308	94038	28	27.98	8.01	0.24	2.1	0.7745	7.7	5	26.23	0.1%	0.01
		Text								Depth of Light	% Light	Extinction
Date	Time	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Meter	Transmission	Coefficient
MMDDYY	HHMMSS	feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet	Average	0.09
61008	93051	0.25	0.32	22.63	8.19	98.3	0.7605	8.62	4271	Surface	100%	
61008	93201	1	1.04	22.65	8.21	98.6	0.7609	8.63	4228	Surface	99%	
61008	93301	2	1.96	22.63	8.18	98.1	0.7608	8.63	2006	0.21	47%	0.05
61008	93409	3	2.98	22.61	8.11	97.3	0.7601	8.64	1235	1.23	29%	0.61
61008	93548	4	3.99	22.53	8.04	96.2	0.7589	8.63	1132	2.24	27%	0.22
61008	93626	6	5.96	22.42	7.94	94.8	0.7564	8.66	477	4.21	11%	0.02
61008	93726	8	7.96	22.36	7.88	94	0.7558	8.65	386	6.21	9%	0.14
61008	93819	10	10.02	22.2	7.4	88.1	0.7519	8.56	198	8.27	4.6%	0.03
61008	93917	12	12.05	21.46	6.9	81	0.7695	8.58	108	10.3	2.5%	0.06
61008	94051	14	14.01	18.68	5.79	64.3	0.7847	8.45	66	12.26	1.5%	0.05
61008	94151	16	15.99	15.89	4.03	42.3	0.7888	8.18	41	14.24	1.0%	0.03
61008	94253	18	18.07	14.64	1.63	16.6	0.7865	7.9	28	16.32	0.7%	0.03
61008	94357	20	20.01	13	0.28	2.7	0.7864	7.7	20	18.26	0.5%	0.02
61008	94508	22	21.98	11.37	0.22	2.1	0.7834	7.55	14	20.23	0.3%	0.02
61008	94632	24	23.9	10.2	0.22	2	0.7782	7.45	7	22.15	0.2%	0.02
61008	94726	26	26.04	9.31	0.21	1.9	0.7851	7.39	4	24.29	0.1%	0.03
61008	94834	28	28	8.63	0.21	1.9	0.7883	7.31	3	26.25	0.1%	0.02
		Text								Depth of Light	% Light	Extinction
Date	Time	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Meter	Transmission	Coefficient

MMDDYY	HHMMSS	feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet	Average	0.13
70808	91020	0.25	0.27	25.17	8.63	108.6	0.7559	8.69	2320	Surface	100%	
70808	91200	1	1.01	25.2	8.61	108.4	0.7557	8.7	2262	Surface	98%	0.09
70808	91258	2	2.02	25.17	8.6	108.2	0.7558	8.72	798	0.27	34%	0.90
70808	91351	3	2.91	25.19	8.56	107.8	0.7558	8.74	489	1.16	21%	0.22
70808	91528	4	4.02	25.19	8.61	108.4	0.7558	8.74	234	2.27	10%	0.17
70808	91625	6	6.02	25.16	8.51	107.1	0.7558	8.76	248	4.27	11%	-0.01
70808	91718	8	8.08	25.12	8.42	105.8	0.756	8.77	98	6.33	4%	0.11
70808	91857	10	10.12	24.94	7.94	99.5	0.7558	8.71	30	8.37	1.3%	0.11
70808	92027	12	12.05	22.8	2.21	26.6	0.7635	8.1	30	10.3	1.3%	0.00
70808	92133	14	14.06	20.46	0.3	3.4	0.7811	7.87	15	12.31	0.6%	0.05
70808	92222	16	16.11	17.56	0.21	2.2	0.7907	7.82	12	14.36	0.5%	0.01
70808	92323	18	18.02	15.1	0.19	2	0.7889	7.7	6	16.27	0.3%	0.04
70808	92421	20	19.92	12.86	0.19	1.9	0.7863	7.55	4	18.17	0.2%	0.02
70808	92527	22	22.08	11.36	0.2	1.9	0.784	7.45	3	20.33	0.1%	0.01
70808	92629	24	24.08	10.16	0.19	1.8	0.7896	7.3	0	22.33		
70808	92727	26	25.91	9.24	0.2	1.8	0.7969	7.19	0	24.16		
70808	92757	28	27.99	8.88	0.2	1.8	0.8043	7.15	0	26.24		

		Text								Depth of Light	% Light	Extinction
Date	Time	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Meter	Transmission	Coefficient
MMDDYY	HHMMSS	feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet	Average	0.17
81208	94323	0.25	0.29	24.81	8.41	104.7	0.7494	8.56	2737	Surface	100%	
81208	94421	1	1.01	24.85	8.45	105.2	0.7495	8.54	2457	Surface	90%	0.43
81208	94523	2	2	24.87	8.44	105.1	0.7496	8.54	682	0.25	25%	1.03
81208	94613	3	2.99	24.86	8.42	104.9	0.7494	8.55	383	1.24	14%	0.26
81208	94659	4	4.01	24.78	8.41	104.6	0.7494	8.55	256	2.26	9%	0.10
81208	94813	6	5.99	24.73	8.26	102.6	0.7492	8.56	193	4.24	7%	0.05
81208	94919	8	7.99	24.63	7.99	99.1	0.7495	8.55	146	6.24	5.3%	0.03
81208	95001	10	10.01	24.48	6.97	86.2	0.7513	8.46	90	8.26	3.3%	0.05
81208	95047	12	11.99	24.35	6.29	77.6	0.7535	8.4	51	10.24	2%	0.05
81208	95204	14	13.99	22.47	1.36	16.2	0.7791	8.04	30	12.24	1.1%	0.04
81208	95310	16	16.06	19.26	1.2	13.4	0.7926	7.9	17	14.31	0.6%	0.03

81208	95415	18	18.01	15.75	0.28	2.9	0.8009	7.62	11	16.26	0.4%	0.02
81208	95527	20	19.99	13.69	0.22	2.2	0.8046	7.44	4	18.24	0.1%	0.05
81208	95617	22	22	11.8	0.21	2	0.808	7.27	3	20.25	0.1%	0.01
81208	95705	24	24	10.19	0.21	2	0.8216	7.13	0	22.25		
81208	95751	26	26	9.86	0.21	1.9	0.829	7.01	0	24.25		
81208	95834	28	28.03	9.4	0.21	1.9	0.8429	6.92	0	26.28		

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.14
90908	81113	0.25	0.24	20.69	6.69	76.5	0.7366	7.56	3807	Surface	100%	
90908	81215	1	1.02	20.73	6.57	75.2	0.7380	7.87	3709	Surface	97%	0.12
90908	81249	2	1.97	20.74	6.53	74.7	0.7371	7.98	876	0.22	23%	1.29
90908	81434	3	2.87	20.74	6.54	74.8	0.7370	8.10	919	1.12	24%	-0.02
90908	81335	4	4.01	20.72	6.50	74.3	0.7373	8.04	609	2.26	16.0%	0.10
90908	81628	6	6.02	20.69	6.55	74.8	0.7371	8.12	264	4.27	6.9%	0.13
90908	81752	8	8.01	20.67	6.65	76.0	0.7363	8.14	137	6.26	3.6%	0.08
90908	81912	10	10.02	20.60	7.19	82.0	0.7349	8.20	71	8.27	1.9%	0.06
90908	82059	12	12.01	20.57	7.21	82.2	0.7346	8.21	45	10.26	1.2%	0.04
90908	82241	14	14.01	20.54	6.82	77.8	0.7353	8.20	31	12.26	0.8%	0.03
90908	82402	16	15.99	20.41	5.65	64.2	0.7394	8.09	19	14.24	0.5%	0.03
90908	82514	18	18.00	18.41	0.38	4.1	0.7858	7.77	12	16.25	0.3%	0.03
90908	82615	20	20.01	14.88	0.25	2.5	0.7944	7.52	6	18.26	0.2%	0.03
90908	82727	22	22.02	12.43	0.22	2.1	0.7983	7.23	4	20.27	0.1%	0.02
90908	82727	24	24.00	11.13	0.22	2.0	0.8086	7.04	4	22.25	0.1%	0.00
90908	83001	26	26.00	10.14	0.21	1.9	0.8234	6.90	0	24.25		
90908	83059	28	28.02	9.41	0.21	1.9	0.8770	6.72	0	26.27		

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient 0.15
102908	81847	0.25	0.24	10.04	4.99	45.4	0.6681	6.5	3527	Surface	100%	
102908	82051	1	1.09	10.09	4.11	37.4	0.668	6.93	3774	Surface	107%	-0.29

102908	82154	2	1.98	10.08	4.09	37.3	0.6679	6.99	878	0.23	25%	1.18
102908	82253	3	2.99	10.09	4.03	36.8	0.6682	7.1	444	1.24	13%	0.30
102908	82329	4	4.05	10.09	4	36.4	0.668	7.09	276	2.3	8%	0.11
102908	82428	6	6.01	10.08	3.99	36.4	0.6682	7.12	111	4.26	3.15%	0.15
102908	82517	8	8	10.08	3.97	36.2	0.6679	7.2	44	6.25	1.25%	0.11
102908	82608	10	9.99	10.09	3.96	36.1	0.6682	7.2	21	8.24	0.60%	0.07
102908	82711	12	12.01	10.08	3.93	35.8	0.6683	7.21	11	10.26	0.31%	0.05
102908	82756	14	14.01	10.09	3.91	35.6	0.6673	7.23	6	12.26	0.17%	0.04
102908	82906	16	16	10.09	3.9	35.5	0.6682	7.25	4	14.25	0.11%	0.02
102908	82958	18	18	10.08	3.93	35.8	0.6682	7.27	3	16.25	0.09%	0.02
102908	83052	20	20.02	10.08	3.91	35.7	0.6684	7.28	3	18.27	0.09%	0.00
102908	83124	22	22.03	10.08	3.92	35.7	0.6679	7.28	3	20.28		
102908	83232	24	23.98	10.07	3.87	35.2	0.6688	7.29	2	22.23		
102908	83321	26	25.99	10.02	3.76	34.2	0.668	7.28	3	24.24		
102908	83429	28	28.01	9.89	3.7	33.6	0.6683	7.3	3	26.26		

APPENDIX C. INTERPRETING YOUR LAKE'S WATER QUALITY DATA

Lakes possess a unique set of physical and chemical characteristics that will change over time. These in-lake water quality characteristics, or parameters, are used to describe and measure the quality of lakes, and they relate to one another in very distinct ways. As a result, it is virtually impossible to change any one component in or around a lake without affecting several other components, and it is important to understand how these components are linked.

The following pages will discuss the different water quality parameters measured by Lake County Health Department staff, how these parameters relate to each other, and why the measurement of each parameter is important. The median values (the middle number of the data set, where half of the numbers have greater values, and half have lesser values) of data collected from Lake County lakes from 2000-2008 will be used in the following discussion.

Temperature and Dissolved Oxygen:

Water temperature fluctuations will occur in response to changes in air temperatures, and can have dramatic impacts on several parameters in the lake. In the spring and fall, lakes tend to have uniform, well-mixed conditions throughout the water column (surface to the lake bottom). However, during the summer, deeper lakes will separate into distinct water layers. As surface water temperatures increase with increasing air temperatures, a large density difference will form between the heated surface water and colder bottom water. Once this difference is large enough, these two water layers will separate and generally will not mix again until the fall. At this time the lake is thermally stratified. The warm upper water layer is called the ***epilimnion***, while the cold bottom water layer is called the ***hypolimnion***. In some shallow lakes, stratification and destratification can occur several times during the summer. If this occurs the lake is described as polymictic. Thermal stratification also occurs to a lesser extent during the winter, when warmer bottom water becomes separated from ice-forming water at the surface until mixing occurs during spring ice-out.

Monthly temperature profiles were established on each lake by measuring water temperature every foot (lakes $\leq$ 15 feet deep) or every two feet (lakes > 15 feet deep) from the lake surface to the lake bottom. These profiles are important in understanding the distribution of chemical/biological characteristics and because increasing water temperature and the establishment of thermal stratification have a direct impact on dissolved oxygen (DO) concentrations in the water column. If a lake is shallow and easily mixed by wind, the DO concentration is usually consistent throughout the water column. However, shallow lakes are typically dominated by either plants or algae, and increasing water temperatures during the summer speeds up the rates of photosynthesis and decomposition in surface waters. When many of the plants or algae die at the end of the growing season, their decomposition results in heavy oxygen consumption and can lead to an oxygen crash. In deeper, thermally stratified lakes, oxygen production is greatest in the top portion of the lake, where sunlight drives photosynthesis, and oxygen consumption is greatest near the bottom of a lake, where sunken organic matter accumulates and decomposes. The oxygen difference between the top and bottom water layers can be dramatic, with plenty of oxygen near the surface, but practically none near the bottom. The oxygen profiles measured during the water quality study can illustrate if this is occurring. This is important because the absence of oxygen (anoxia) near the lake bottom can have adverse effects in eutrophic lakes resulting in the chemical release of phosphorus from lake sediment and the production of hydrogen sulfide (rotten egg smell) and other gases in the bottom waters. Low oxygen conditions in the upper water of a lake can also be problematic since all aquatic organisms need oxygen to live. Some oxygen may be present in the water, but at too low a concentration to sustain aquatic life. Oxygen is needed by all plants, virtually all algae and for many chemical reactions that are important in lake functioning. Most adult sport-fish such as largemouth bass and bluegill require at least 3 mg/L of DO in the water to survive. However, their offspring require at least 5 mg/L DO as they are more sensitive to DO stress. When DO concentrations drop below 3 mg/L, rough fish such as carp and green sunfish are favored and over time will become the dominant fish species.

External pollution in the form of oxygen-demanding organic matter (i.e., sewage, lawn clippings, soil from shoreline erosion, and agricultural runoff) or nutrients that stimulate the growth of excessive organic matter (i.e., algae and plants) can reduce average DO concentrations in the lake by increasing oxygen consumption. This can have a detrimental impact on the fish community, which may be squeezed into a very small volume of water as a result of high temperatures in the epilimnion and low DO levels in the hypolimnion.

Nutrients:

Phosphorus:

For most Lake County lakes, phosphorus is the nutrient that limits plant and algae growth. This means that any addition of phosphorus to a lake will typically result in algae blooms or high plant densities during the summer. The source of phosphorus to a lake can be external or internal (or both). External sources of phosphorus enter a lake through point (i.e., storm pipes and wastewater discharge) and non-point runoff (i.e., overland water flow). This runoff can pick up large amounts of phosphorus from agricultural fields, septic systems or impervious surfaces before it empties into the lake.

Internal sources of phosphorus originate within the lake and are typically linked to the lake sediment. In lakes with high oxygen levels (oxic), phosphorus can be released from the sediment through plants or sediment resuspension. Plants take up sediment-bound phosphorus through their roots, releasing it in small amounts to the water column throughout their life cycles, and in large amounts once they die and begin to decompose. Sediment resuspension can occur through biological or mechanical means. Bottom-feeding fish, such as common carp and black bullhead can release phosphorus by stirring up bottom sediment during feeding activities and can add phosphorus to a lake through their fecal matter. Sediment resuspension, and subsequent phosphorus release, can also occur via wind/wave action or through the use of artificial aerators, especially in shallow lakes. In lakes that thermally stratify, internal phosphorus release can occur from the sediment through chemical means. Once oxygen is depleted (anoxia) in the hypolimnion, chemical reactions occur in which phosphorus bound to iron complexes in the sediment becomes soluble and is released into the water column. This phosphorus is trapped in the hypolimnion and is unavailable to algae until fall turnover, and can cause algae blooms once it moves into the sunlit surface water at that time. Accordingly, many of the lakes in Lake County are plagued by dense algae blooms and excessive, exotic plant coverage, which negatively affect DO levels, fish communities and water clarity.

Lakes with an average phosphorus concentration greater than 0.05 mg/L are considered nutrient rich. The median near surface total phosphorus (TP) concentration in Lake County lakes from 2000-2008 is 0.065 mg/L and ranged from a non-detectable minimum of <0.010 mg/L on five lakes to a maximum of 3.880 mg/L on Albert Lake. The median anoxic TP concentration in Lake County lakes from 2000-2008 was 0.181 mg/L and ranged from a minimum of 0.012 mg/L in Independence Grove Lake to a maximum of 3.880 mg/L in Taylor Lake.

The analysis of phosphorus also included soluble reactive phosphorus (SRP), a dissolved form of phosphorus that is readily available for plant and algae growth. SRP is not discussed in great detail in most of the water quality reports because SRP concentrations vary throughout the season depending on how plants and algae absorb and release it. It gives an indication of how much phosphorus is available for uptake, but, because it does not take all forms of phosphorus into account, it does not indicate how much phosphorus is truly present in the water column. TP is considered a better indicator of a lake's nutrient status because its concentrations remain more stable than soluble reactive phosphorus. However, elevated SRP levels are a strong indicator of nutrient problems in a lake.

Nitrogen:
Nitrogen is also an important nutrient for plant and algae growth. Sources of nitrogen to a lake vary widely, ranging from fertilizer and animal wastes, to human waste from sewage treatment plants or failing septic systems, to groundwater, air and rainfall. As a result, it is very difficult to control or reduce nitrogen inputs to a lake. Different forms of nitrogen are present in a lake under different oxic conditions. NH_4^+ (ammonium) is released from decomposing organic material under anoxic conditions and accumulates in the hypolimnion of thermally stratified lakes. If NH_4^+ comes into contact with oxygen, it is immediately converted to NO_2 (nitrite) which is then oxidized to NO_3^- (nitrate). Therefore, in a thermally stratified lake, levels of NH_4^+ would only be elevated in the hypolimnion and levels of NO_3^- would only be elevated in the epilimnion. Both NH_4^+ and NO_3^- can be used as a nitrogen source by aquatic plants and algae. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen plus ammonium. Adding the concentrations of TKN and nitrate together gives an indication of the amount of total nitrogen present in the water column. If inorganic nitrogen (NO_3^-, NO_2^-, NH_4^+) concentrations exceed 0.3 mg/L in spring, sufficient nitrogen is available to support summer algae blooms. However, low nitrogen levels do not guarantee limited algae growth the way low phosphorus levels do. Nitrogen gas in the air can dissolve in lake water and blue-green algae can "fix" atmospheric nitrogen, converting it into a usable form. Since other types of algae do not have the ability to do this, nuisance blue-green algae blooms are typically associated with lakes that are nitrogen limited (i.e., have low nitrogen levels).

The ratio of TKN plus nitrate nitrogen to total phosphorus (TN:TP) can indicate whether plant/algae growth in a lake is limited by nitrogen or phosphorus. Ratios of less than 10:1

suggest a system limited by nitrogen, while lakes with ratios greater than 20:1 are limited by phosphorus. It is important to know if a lake is limited by nitrogen or phosphorus because any addition of the limiting nutrient to the lake will, likely, result in algae blooms or an increase in plant density.

Solids:

Although several forms of solids (total solids, total suspended solids, total volatile solids, total dissolved solids) were measured each month by the Lakes Management Staff, total suspended solids (TSS) and total volatile solids (TVS) have the most impact on other variables and on the lake as a whole. TSS are particles of algae or sediment suspended in the water column. High TSS concentrations can result from algae blooms, sediment resuspension, and/or the inflow of turbid water, and are typically associated with low water clarity and high phosphorus concentrations in many lakes in Lake County. Low water clarity and high phosphorus concentrations, in turn, exacerbate the high TSS problem by leading to reduced plant density (which stabilize lake sediment) and increased occurrence of algae blooms. The median TSS value in epilimnetic waters in Lake County is 8.2 mg/L, ranging from below the 0.1 mg/L detection limit to 165 mg/L in Fairfield Marsh.

TVS represents the fraction of total solids that are organic in nature, such as algae cells, tiny pieces of plant material, and/or tiny animals (zooplankton) in the water column. High TVS values indicate that a large portion of the suspended solids may be made up of algae cells. This is important in determining possible sources of phosphorus to a lake. If much of the suspended material in the water column is determined to be resuspended sediment that is releasing phosphorus, this problem would be addressed differently than if the suspended material was made up of algae cells that were releasing phosphorus. The median TVS value was 132.8 mg/L, ranging from 34.0 mg/L in Pulaski Pond to 298.0 mg/L in Fairfield Marsh.

Total dissolved solids (TDS) are the amount of dissolved substances, such as salts or minerals, remaining in water after evaporation. These dissolved solids are discussed in further detail in the *Alkalinity* and *Conductivity* sections of this document. TDS concentrations were measured in Lake County lakes prior to 2004, but was discontinued due to the strong correlation of TDS to conductivity and chloride concentrations.

Water Clarity:

Water clarity (transparency) is not a chemical property of lake water, but is often an indicator of a lake's overall water quality. It is affected by a lake's water color, which is a reflection of the amount of total suspended solids and dissolved organic chemicals. Thus, transparency is a measure of particle concentration and is measured with a Secchi disk. Generally, the lower the clarity or Secchi depth, the poorer the water quality. A decrease in Secchi depth during the summer occurs as the result of an increase in suspended solids (algae or sediment) in the water column. Aquatic plants play an important role in the level of water clarity and can, in turn, be negatively affected by low clarity levels. Plants increase clarity by competing with algae for resources and by stabilizing sediments to prevent sediment resuspension. A lake with a healthy plant community will almost always have higher water clarity than a lake without plants. Additionally, if the plants in a lake are removed (through herbicide treatment or the stocking of grass carp), the lake will probably become dominated by algae and Secchi depth will decrease. This makes it very difficult for plants to become re-established due to the lack of available sunlight and the lake will, most likely, remain turbid. Turbidity will be accelerated if the lake is very shallow and/or common carp are present. Shallow lakes are more susceptible to sediment resuspension through wind/wave action and are more likely to experience clarity problems if plants are not present to stabilize bottom sediment.

Common Carp are prolific fish that feed on invertebrates in the sediment. Their feeding activities stir up bottom sediment and can dramatically decrease water clarity in shallow lakes. As mentioned above, lakes with low water clarity are, generally, considered to have poor water quality. This is because the causes and effects of low clarity negatively impact the plant and fish communities, as well as the levels of phosphorus in a lake. The detrimental impacts of low Secchi depth to plants has already been discussed. Fish populations will suffer as water clarity decreases due to a lack of food and decreased ability to successfully hunt for prey. Bluegills are planktivorous fish and feed on invertebrates that inhabit aquatic plants. If low clarity results in the disappearance of plants, this food source will disappear too. Largemouth Bass and Northern Pike are piscivorous fish that feed on other fish and hunt by sight. As the water clarity decreases, these fish species find it more difficult to see and ambush prey and may decline in size as a result. This could eventually lead to an imbalance in the fish community. Phosphorus release from resuspended sediment could increase as water clarity and plant density decrease. This would then result in increased algae blooms, further reducing Secchi depth and aggravating all problems just discussed. The average Secchi depth for Lake County lakes is 3.12 feet. From 2000-2008, Fairfield Marsh and Patski Pond had the lowest Secchi depths (0.33 feet) and Bangs Lake had the highest (29.23 feet). As an example of the difference in Secchi depth based on plant coverage, South Churchill Lake, which had no plant coverage and large numbers of Common Carp in 2003 had an average Secchi depth of 0.73 feet (over four times lower than the county average), while Deep Lake, which had a diverse plant community and few carp had an average 2003 Secchi depth of 12.48 feet (almost four times higher than the county average).

Another measure of clarity is the use of a light meter. The light meter measures the amount of light at the surface of the lake and the amount of light at each depth in the water column. The amount of attenuation and absorption (decreases) of light by the water column are major factors controlling temperature and potential photosynthesis. Light intensity at the lake surface varies seasonally and with cloud cover, and decreases with depth. The deeper into the water column light penetrates, the deeper potential plant growth. The maximum depth at which algae and plants can grow underwater is usually at the depth where the amount of light available is reduced to 0.5%-1% of the amount of light available at the lake surface. This is called the euphotic (sunlit) zone. A general rule of thumb in Lake County is that the 1% light level is about 1 to 3 times the Secchi disk depth.

Alkalinity, Conductivity, Chloride, pH:

Alkalinity:

Alkalinity is the measurement of the amount of acid necessary to neutralize carbonate ($CO_3^{=}$) and bicarbonate (HCO_3^-) ions in the water, and represents the buffering capacity of a body of water. The alkalinity of lake water depends on the types of minerals in the surrounding soils and in the bedrock. It also depends on how often the lake water comes in contact with these minerals. If a lake gets groundwater from aquifers containing limestone minerals such as calcium carbonate ($CaCO_3$) or dolomite ($CaMgCO_3$), alkalinity will be high. The median alkalinity in Lake County lakes (162 mg/L) is considered moderately hard according to the hardness classification scale of Brown, Skougstad and Fishman (1970). Because hard water (alkaline) lakes often have watersheds with fertile soils that add nutrients to the water, they usually produce more fish and aquatic plants than soft water lakes. Since the majority of Lake County lakes have a high alkalinity they are able to buffer the adverse effects of acid rain.

Conductivity and Chloride:

Conductivity is the inverse measure of the resistance of lake water to an electric flow. This means that the higher the conductivity, the more easily an electric current is able to flow through water. Since electric currents travel along ions in water, the more chemical ions or dissolved salts a body of water contains, the higher the conductivity will be. Accordingly, conductivity has been correlated to total dissolved solids and chloride ions. The amount of dissolved solids or conductivity of a lake is dependent on the lake and watershed geology, the size of the watershed flowing into the lake, the land uses within that watershed, and evaporation and bacterial activity. Many Lake County lakes have elevated conductivity levels in May, but not during any other month. This was because chloride, in the form of road salt, was washing into the lakes with spring rains, increasing conductivity. Most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. Beginning in 2004, chloride concentrations are one of the parameters measured during the lake studies. Increased chloride concentrations may have a negative impact on aquatic organisms. Conductivity changes occur seasonally and with depth. For example, in stratified lakes the conductivity normally increases in the hypolimnion as bacterial decomposition converts organic materials to bicarbonate and carbonate ions depending on the pH of the water. These newly created ions increase the conductivity and total dissolved solids. Over the long term, conductivity is a good indicator of potential watershed or lake problems if an increasing trend is noted over a period of years. It is also important to know the conductivity of the water when fishery assessments are conducted, as electroshocking requires a high enough conductivity to properly stun the fish, but not too high as to cause injury or death.

pH:

pH is the measurement of hydrogen ion (H^+) activity in water. The pH of pure water is neutral at 7 and is considered acidic at levels below 7 and basic at levels above 7. Low pH levels of 4-5 are toxic to most aquatic life, while high pH levels (9-10) are not only toxic to aquatic life but may also result in the release of phosphorus from lake sediment. The presence of high plant densities can increase pH levels through photosynthesis, and lakes dominated by a large amount of plants or algae can experience large fluctuations in pH levels from day to night, depending on the rates of photosynthesis and respiration. Few, if any pH problems exist in Lake County lakes. Typically, the flooded gravel mines in the county are more acidic than the glacial lakes as they have less biological activity, but do not usually drop below pH levels of 7. The median near surface pH value of Lake County lakes is 8.32, with a minimum of 7.06 in Deer Lake and a maximum of 10.28 in Round Lake Marsh North.

Eutrophication and Trophic State Index:

The word *eutrophication* comes from a Greek word meaning “well nourished.” This also describes the process in which a lake becomes enriched with nutrients. Over time, this is a lake’s natural aging process, as it slowly fills in with eroded materials from the surrounding watershed and with decaying plants. If no human impacts disturb the watershed or the lake, natural eutrophication can take thousands of years. However, human activities on a lake or in the watershed accelerate this process by resulting in rapid soil erosion and heavy phosphorus inputs. This accelerated aging process on a lake is referred to as cultural eutrophication. The term trophic state refers to the amount of nutrient enrichment within a lake system. *Oligotrophic* lakes are usually deep and clear with low nutrient levels, little plant growth and a limited fishery. *Mesotrophic* lakes are more biologically productive than oligotrophic lakes and have moderate nutrient levels and more plant growth. A lake labeled as *eutrophic* is high in nutrients and can support high plant densities and large fish populations. Water clarity is typically poorer than oligotrophic or mesotrophic lakes and dissolved oxygen problems may be present. A *hypereutrophic* lake has excessive nutrients, resulting in nuisance plant or algae growth. These lakes are often pea-soup green, with poor water clarity. Low dissolved oxygen may also be a problem, with fish kills occurring in shallow, hypereutrophic lakes more often than less enriched lakes. As a result, rough fish (tolerant of low dissolved oxygen levels) dominate the fish community of many hypereutrophic lakes. The categorization of a lake into a certain trophic state should not be viewed as a “good to bad” categorization, as most lake residents rate their lake based on desired usage. For example, a fisherman would consider a plant-dominated, clear lake to be desirable, while a water-skier might prefer a turbid lake devoid of plants. Most lakes in Lake County are eutrophic or hypereutrophic. This is primarily as a result of cultural eutrophication. However, due to the fertile soil in this area, many lakes (especially man-made) may have started out under eutrophic conditions and will never attain even mesotrophic conditions, regardless of any amount of money put into the management options. This is not an excuse to allow a lake to continue to deteriorate, but may serve as a reality check for lake owners attempting to create unrealistic conditions in their lakes.

The Trophic State Index (TSI) is an index which attaches a score to a lake based on its average total phosphorus concentration, its average Secchi depth (water transparency) and/or its average chlorophyll *a* concentration (which represent algae biomass). It is based on the principle that as phosphorus levels increase, chlorophyll *a* concentrations increase and Secchi depth decreases. The higher the TSI score, the more nutrient-rich a lake is, and once a score is obtained, the lake can then be designated as oligotrophic, mesotrophic or eutrophic. Table 1 (below) illustrates the Trophic State Index using phosphorus concentration and Secchi depth.

Table 1. Trophic State Index (TSI).

Trophic State	TSI score	Total Phosphorus (mg/L)	Secchi Depth (feet)
Oligotrophic	<40	≤ 0.012	>13.12
Mesotrophic	≥40<50	>0.012 ≤ 0.024	≥6.56<13.12
Eutrophic	≥50<70	>0.024 ≤ 0.096	≥1.64<6.56
Hypereutrophic	≥70	>0.096	< 1.64

APPENDIX D. WATER QUALITY STATISTICS FOR ALL LAKE COUNTY LAKES.

2000 - 2008 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2008			ALKanoxic 2000-2008	
Average	**167**		Average	**202**	
Median	**162**		Median	**194**	
Minimum	**65**	**IMC**	Minimum	**103**	**Heron Pond**
Maximum	**330**	**Flint Lake**	Maximum	**470**	**Lake Marie**
STD	**42**		STD	**50**	
n =	**802**		n =	**243**	

	Condoxic <=3ft00-2008			Condanoxic 2000-2008	
Average	**0.8934**		Average	**1.0312**	
Median	**0.8195**		Median	**0.8695**	
Minimum	**0.2542**	**Broberg Marsh**	Minimum	**0.3210**	**Lake Kathyrn**
Maximum	**6.8920**	**IMC**	Maximum	**7.4080**	**IMC**
STD	**0.5250**		STD	**0.7985**	
n =	**806**		n =	**243**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2008			NH3- Nanoxic 2000-2008	
Average	**0.508**		Average	**2.192**	
Median	**0.156**		Median	**1.630**	
Minimum	**<0.05**	***ND**	Minimum	**<0.1**	***ND**
Maximum	**9.670**	**South Churchill Lake**	Maximum	**18.400**	**Taylor Lake**
STD	**1.073**		STD	**2.343**	
n =	**807**		n =	**243**	

*ND = Many lakes had non-detects (74.1%)
Only compare lakes with detectable
concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

*ND = 19.8% Non-detects from 28 different lakes

	pHoxic <=3ft00-2008			pHanoxic 2000-2008	
Average	**8.32**		Average	**7.28**	
Median	**8.32**		Median	**7.28**	
Minimum	**7.07**	**Bittersweet #13**	Minimum	**6.24**	**Banana Pond**
Maximum	**10.28**	**Round Lake Marsh North**	Maximum	**8.48**	**Heron Pond**
STD	**0.44**		STD	**0.42**	
n =	**801**		n =	**243**	

	All Secchi 2000-2008	
Average	**4.51**	
Median	**3.12**	
Minimum	**0.33**	**Fairfield Marsh, Patski Pon**
Maximum	**24.77**	**West Loon Lake**
STD	**3.78**	
n =	**749**	

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2000 - 2008 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2008	
Average	**1.450**	
Median	**1.200**	
Minimum	**<0.1**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.845**	
n =	**802**	

*ND = 3.9% Non-detects from 15 different lakes

	TKNanoxic 2000-2008	
Average	**2.973**	
Median	**2.330**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.324**	
n =	**243**	

*ND = 2.9% Non-detects from 4 different lakes

	TPoxic <=3ft00-2008	
Average	**0.105**	
Median	**0.065**	
Minimum	**<0.01**	***ND**
Maximum	**3.880**	**Albert Lake**
STD	**0.218**	
n =	**808**	

*ND = 2.6% Non-detects from 9 different lakes

	TPanoxic 2000-2008	
Average	**0.316**	
Median	**0.181**	
Minimum	**0.012**	**Independ. Grove**
Maximum	**3.800**	**Taylor Lake**
STD	**0.419**	
n =	**243**	

	TSSall <=3ft00-2008	
Average	**15.5**	
Median	**8.2**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**813**	

*ND = 1.5% Non-detects from 9 different lakes

	TVSoxic <=3ft00-2008	
Average	**132.8**	
Median	**129.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**39.8**	
n =	**757**	

No 2002 IEPA Chain Lakes

	TDSoxic <=3ft00-2004	
Average	**470**	
Median	**454**	
Minimum	**150**	**Lake Kathryn, White**
Maximum	**1340**	**IMC**
STD	**169**	
n =	**745**	

No 2002 IEPA Chain Lakes.

	CLanoxic <=3ft00-2008	
Average	**234**	
Median	**139**	
Minimum	**41**	**Timber Lake (N)**
Maximum	**2390**	**IMC**
STD	**364**	
n =	**125**	

	CLoxic <=3ft00-2008	
Average	**210**	
Median	**166**	
Minimum	**30**	**White Lake**
Maximum	**2760**	**IMC**
STD	**233**	
n =	**470**	

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Anoxic conditions are defined <=1 mg/l D.O.
pH Units are equal to the -Log of [H] ion activity
Conductivity units are in MilliSiemens/cm
Secchi Disk depth units are in feet
All others are in mg/L

Minimums and maximums are based on data from all lakes from 2000-2008 (n=1351).

Average, median and STD are based on data from the most recent water quality sampling year for each lake.

LCHD Lakes Management Unit ~ 12/1/2008

APPENDIX E. GRANT PROGRAM OPPORTUNITES.

Table E1. Potential Grant Opportunities

Grant Program Name	Funding Source	Contact Information	Funding Focus: Water Quality/ Wetland	Funding Focus: Habitat	Funding Focus: Erosion	Funding Focus: Flooding	Cost Share
Challenge Grant Program	USFWS	847-381-2253 or 309-793-5800		X	X		
Chicago Wilderness Small Grants	CW	312-346-8166 ext. 30					None
Partners in Conservation (formerly C2000)	IDNR	http://dnr.state.il.us/orep/c2000/		X			None
Conservation Reserve Program	NRCS	http://www.nrcs.usda.gov/programs/crp/		X			Land
Ecosystems Program	IDNR	http://dnr.state.il.us/orep/c2000/ecosystem/		X			None
Emergency Watershed Protection	NRCS	http://www.nrcs.usda.gov/programs/ewp/			X	X	None
Five Star Challenge	NFWF	http://www.nfwf.org/AM/Template.cfm		X			None
Illinois Flood Mitigation Assistance Program	IEMA	http://www.state.il.us/iema/construction.htm				X	None
Great Lakes Basin Program	GLBP	http://www.glc.org/basin/stateproj.html?st=il	X		X		None
Illinois Clean Energy Community Foundation	ICECF	http://www.illinoiscleanenergy.org/		X			
Illinois Clean Lakes Program	IEPA	http://www.epa.state.il.us/water/financial-assistance/index.html					None
Lake Education Assistance Program (LEAP)	IEPA	http://www.epa.state.il.us/water/conservation-2000/leap/index.html	X				$500

CW = Chicago Wilderness
ICECF = Illinois Clean Energy Community Foundation
IEMA = Illinois Emergency Management Agency
IEPA = Illinois Environmental Protection Agency
IDNR = Illinois Department of Natural Resources
IDOA = Illinois Department of Agriculture
LCSMC = Lake County Stormwater Management Commission
LCSWCD = Lake County Soil and Water Conservation District
NFWF = National Fish and Wildlife Foundation
NRCS = Natural Resources Conservation Service
USACE = United States Army Corps of Engineers
USFWS = United States Fish and Wildlife Service

Table E1. Continued

Grant Program Name	Funding Source	Contact Information	Funding Focus: Water Quality/ Wetland	Habitat	Erosion	Flooding	Cost Share
Northeast Illinois Wetland Conservation Account	USFWF	847-381-2253	X				
Partners for Fish and Wildlife	USFWS	http://ecos.fws.gov/partners/		X			> 50%
River Network's Watershed Assistance Grants Program	River Network	http://www.rivernetwork.org	X	X	X		na
Section 206: Aquatic Ecosystems Restoration	USACE	312-353-6400, 309-794-5590 or 314-331-8404		X			35%
Section 319: Non-Point Source Management Program	IEPA	http://www.epa.state.il.us/water/financial-assistance/non point.html	X	X			>40%
Section 1135: Project Modifications for the Improvement of the Environment	USACE	312-353-6400, 309-794-5590 or 314-331-8404		X			25%
Stream Cleanup And Lakeshore Enhancement (SCALE)	IEPA	http://www.epa.state.il.us/water/watershed/scale.html	X	X			None
Streambank Stabilization & Restoration (SSRP)	IDOA/ LCSWCD	http://www.agr.state.il.us/Environment/conserv/ or call LCSWCD at (847) 223-1056		X	X		25%
Watershed Management Boards	LCSMC	http://www.co.lake.il.us/smc/projects/wmb/default.asp	X		X	X	50%
Wetlands Reserve Program	NRCS	http://www.nrcs.usda.gov/programs/wrp/	X	X			Land
Wildlife Habitat Incentive Program	NRCS	http://www.nrcs.usda.gov/programs/whip/		X			Land

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