2011 SUMMARY REPORT
of
West Loon Lake

Lake County, Illinois

Prepared by the

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ENVIRONMENTAL SERVICES

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LAKE FACTS

Lake Name:	West Loon Lake
Historical Name:	Loon Lake
Nearest Municipality:	Antioch
Location:	T46N, R10E, Section 20 and 21
Elevation:	772.7 feet mean sea level
Major Tributaries:	None
Watershed:	Fox River
Sub-watershed:	Sequoit Creek
Receiving Waterbody:	East Loon Lake
Surface Area:	166.2 acres
Shoreline Length:	2.1 miles
Maximum Depth:	38.0 feet
Average Depth:	14.8 feet
Lake Volume:	2466.7 acre-feet
Lake Type:	Glacial
Watershed Area:	1135.8 acres
Major Watershed Land Uses:	Single family, forest and grassland, and agriculture
Bottom Ownership:	LCFPD, private
Management Entities:	Loon Lakes Management Association
Current and Historical Uses:	Fishing, hunting, swimming, and boating
Description of Access:	Private (public may access for a fee)

In 2011 the Lake County Forest Preserve contracted with the Lake County Health Department-Environmental Services to continue monitoring East Loon Lake and West Loon Lake. This report summarizes the water quality sampling results and aquatic plant surveys conducted in 2011 on West Loon Lake. Similar more detailed reports have been written on data collected in 1998, 2003, 2008, and 2010 and are available from the LCHD-ES.

SUMMARY OF WATER QUALITY

Water samples were collected from May to September in the southeastern portion of West Loon Lake at the deepest portion of the lake (Figure 1). Samples were taken at 3 feet below the surface and approximately 3 feet above the lake bottom (Appendix A). Water level was taken from the seawall at near public boat launch each month during sampling. There was a seasonal lake level reduction of 5.25 inches from May to September. The highest lake level occurred in May and the lowest July. Similar to East Loon Lake, the lake level appears to be greatly influenced by rain events, the most significant increase in lake level occurred from July to August with an increase in lake level by 6.5 inches after the addition of 7.65 inches of rain. The driest weather during the sampling period occurred in July (0.80 inches of rain) correlating with the lowest lake level during the sampling season. In order to accurately monitor water levels it is recommended that a staff gauge be installed and levels measured and recorded frequently (daily or weekly).

West Loon Lake has exceptional water quality (Appendix C) with most parameters below the county medians. The lake nutrient concentrations have been steadily declining since 1991. In 2011, total suspended solid (TSS) concentrations averaged <1.1 mg/L, which was more than eight times lower than the county median of 8.6 mg/L and slightly lower than 2010 (<1.2 mg/L). High TSS values are typically correlated with poor water clarity (Secchi disk depth) and can be detrimental to many aspects of the lake ecosystem such as the plant and fish communities. As a result of low TSS concentrations, the average Secchi depth also slightly improved from 2010 (16.91 feet). The 2011 average Secchi depth was 16.97 feet, with the deepest reading on June 21st at 20.00 feet. In August there was a considerable decrease in the Secchi depth corresponding to an increase in TSS (Figure 2), which may have been influenced by rain events. Water quality in 2010 and 2008 was similar to 2011. The TSS average for 2003 was slightly higher 1.8 mg/L and Secchi disk readings were significantly reduced (11.96 feet). The West Loon Lake average historical Secchi depth by the LCHD-ES was 11.94 feet. Zebra mussels filter the water column, increasing water clarity. Zebra Mussels are much more abundant in West Loon Lake than East Loon Lake as they favor the substrate in West Loon Lake. West Loon Lake is deeper and has areas of sand and gravel bottom, whereas East Loon Lake has a more peat or wetland bottom. This is also factor in the abundance of zebra mussels that filter the water column

Stratification is typical of nutrient-enriched deep lakes like West Loon Lake. When stratified, the lower and upper layers of water do not mix, and the lower layer typically becomes anoxic (dissolved oxygen <1 mg/L). Nutrient concentrations were slightly higher in the lower layer than in the upper layer, which is expected in a stratified lake. The lake was stratified June through September of 2011. Dissolved oxygen (DO) concentrations became anoxic in the hypolimnion June through September. The maximum volume experiencing anoxia was approximately 44% (DO concentrations <1.0 mg/L below 18 feet in August), thus there are no apparent DO problems in West Loon Lake (Appendix B). Concentrations >5.0 mg/L are considered adequate to support aquatic life, since some aquatic life, such as fish, suffer from oxygen stress below this 5.0 mg/L.

Phosphorus is a nutrient that limits plant and algal growth, therefore any addition of phosphorus to the lake would likely produce algal blooms. Total phosphorus (TP) in the epilimnion of West Loon Lake has remained relatively stable over the years. The 2011 average was 0.015 mg/L (Table 1), which was a four times lower than the county median (0.066 mg/L) (Appendix D). This was a slight increase from the 2010 and 2008 TP average concentration of 0.014 mg/L and <0.014 mg/L, respectively. Nitrogen is the other nutrient critical for algal growth. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average TKN concentration for West Loon Lake was 0.51 mg/L, which was significantly lower than the county median (1.18 mg/L) and slightly lower than the 2010 and 2008 average concentrations (0.55 mg/L, 0.72 mg/L, respectively). The TN:TP (total nitrogen to total phosphorus) ratio looks at which nutrient was limiting plant and algal growth in a lake. West Loon Lake had a TN:TP ratio of 34:1 which indicated phosphorus was highly limiting. Another way to look at phosphorus levels and how they affect lake productivity is to use a Trophic State Index (TSI) based on phosphorus (TSIp). TSIp values are commonly used to classify and compare lake productivity levels (trophic state). A lake’s response to additional phosphorus is an accelerated rate of eutrophication. Eutrophication is a natural process where lakes become increasingly enriched with nutrients. Lakes start out with clear water and few aquatic plants and over time become more enriched with nutrients and vegetation until the lake becomes a wetland. This process takes thousands of years. However human activities that supply lakes with additional phosphorus that drives eutrophication is speeding up this process significantly. The TSIp index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich, productive). In 2011 West Loon Lake was considered mesotrophic with a TSIp value of 43.5. Out of 171 lakes in the county West Loon Lake ranked 6th and East Loon Lake 45th with a TSIp value of 57.0 (Table 2).

Another indice used by the IEPA for assessing lakes for aquatic life, and recreational use impairment is calculated using the mean trophic state index (TSI), percent macrophyte coverage, and the median nonvolatile suspended solids concentration. This index can be calculated using total phosphorus values obtained at or near the surface. In 2011 West Loon Lake had full support for aquatic life, and recreational use.

Conductivity readings in West Loon Lake have been relatively stable the past 10 years (Table 3). The 2011 average conductivity concentration was 0.6044 mS/cm, which was 4.1% lower than the 2010 average (0.6303 mS/cm), and below the county median of 0.7821 mS/cm. The most likely cause for these increases in conductivity readings was input from dissolved solids washed into the lake from storm events. One of the most common dissolved solids is road salt used in winter road maintenance. Because of the high conductivity readings, one additional parameter, chlorides, was collected. Chloride concentrations help determine if road salt is the primary chloride source as most road salt is composed of sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. The seasonal average for chlorides in West

Loon Lake in 2011 was 102 mg/L. The chloride concentrations increased slightly from 2010 (99 mg/L).

SUMMARY OF AQUATIC MACROPHYTES

Aquatic plant sampling was conducted on West Loon Lake in July 2011. There were 743 points generated based on a computer grid system with points 30 meters apart. Typically larger lakes, like West Loon Lake are sampled using a 60 meter grid. The 30 meter grid was applied to West Loon Lake in 2010. This increases the accuracy of the survey by reducing the impact of the deep contours of the lake. In 2011 aquatic plants existed at 359 sites and found at a maximum depth of 15 feet (Table 4). There were 24 species present that included two exotic invasive species (Curlyleaf Pondwed, Eurasian Watermilfoil (EWM)) and one macro-algae (Chara). Unlike the 2010 survey Northern Watermilfoil, Small Pondweed, and Spatterdock were not documented. This could be an artifact the sampling period: once in midseason 2011(July) and twice in 2010 early and late summer (June and August). A truly healthy aquatic plant community contains a large number of plant species that provide different types of habitat and structure to the lake. Aquatic plant coverage had a minimal increase from August 2010 (47%) to July 2011 (48%) (Figure 3). The most abundant species in 2011 was Water Stargrass occurring at 34% of the sampling sites. EWM (18%), Flatstem Pondweed (16%), and Vallisneria (16%) were also common. The 2011 EWM populations declined from the 2010 June and August sampling event (25%, and 21%, respectively). The Lake County Forest Preserve owns approximately 22% percent of the bottom of West Loon Lake totaling 106 aquatic plant sampling sites (Table 5). Similar to 2010 Water Stargrass (31%) was dominant within the LCFP sample sites present however the density was reduced in 2011 (23%). With the 30 meter grid in consecutive sampling years (2010 and 2011) the Eurasian Watermilfoil populations remained constant at 18%. While the Illinois Pondweed (4%) and Variable Pondweed (5%) density was reduced from 2010 (9% and 12%, respectively). Variable Pondweed is a State listed threatened species.

The diversity and extent of plant populations can be influenced by a variety of factors. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow. When the light level in the water column falls below 1% of the surface light level, plants can no longer grow. The 1% light level in West Loon Lake ranged from the 32 foot depth in May to 18 feet in September. In 2011 plants were documented at a maximum depth of 15.0 feet this was also the maximum depth in 2003. A healthy aquatic plant population is critical to good lake health and provides important wildlife habitat and food sources. If managed aquatic plants provide many water quality benefits such as sediment stabilization and competition with algae for available resources

Floristic quality index (FQI; Swink and Wilhelm 1994) is an assessment tool designed to evaluate the closeness the flora of an area to that of undisturbed conditions. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). Non-native species were counted in the FQI calculations for Lake County lakes. In 2011, West Loon Lake had an FQI of 33.7 and ranked #3 of 158 lakes in the county (Table 6). The median FQI of lakes that we have studied from 2000-2011 is 14.3. West Loon Lake had a FQI of 34.3 in 2010.

Figure 1. Water quality sampling site on West Loon Lake, 2011.

Figure 2. Secchi depth vs. total suspended solid (TSS) concentrations in West Loon Lake, 2011.

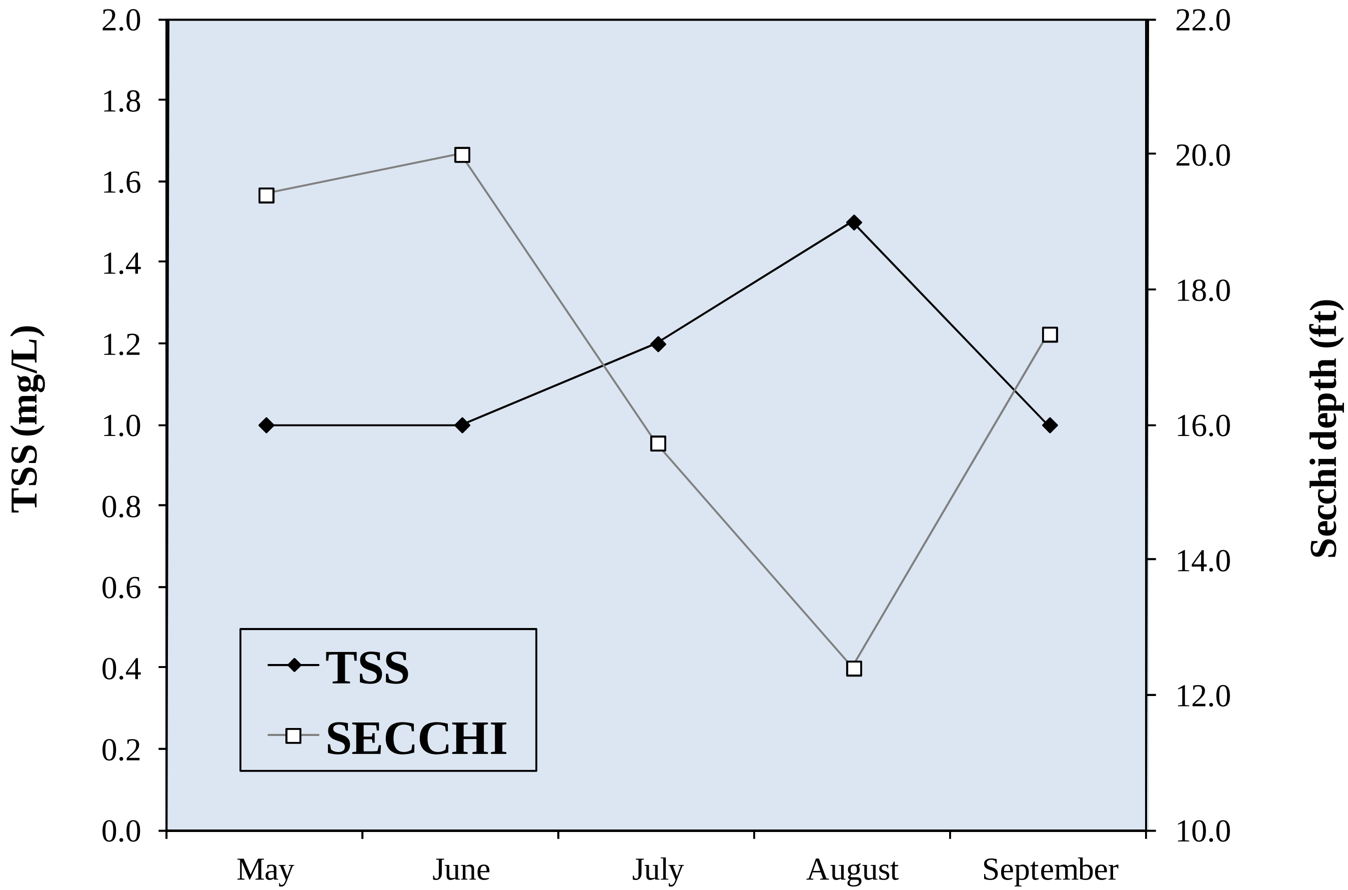

Table 1. Summary of water quality data for West Loon Lake, 2003, 2008, 2010, and 2011.

2011	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
17-May	3	160	0.58	<0.1	0.054	0.014	<0.005	105	NA	<1.0	394	88	19.40	0.6639	8.25	9.53
21-Jun	3	158	0.47	<0.1	<0.05	0.016	<0.005	103	NA	<1.0	380	89	20.00	0.6231	8.58	9.20
19-Jul	3	142	0.51	<0.1	<0.05	0.014	<0.005	108	NA	1.2	385	91	15.73	0.6148	8.92	9.23
16-Aug	3	125	0.51	<0.1	<0.05	0.020	<0.005	95	NA	1.5	359	92	12.40	0.5558	8.84	8.81
20-Sep	3	126	0.46	<0.1	<0.05	0.012	<0.005	98	NA	<1.0	352	95	17.34	0.5642	8.63	7.94
	Average	142	0.51	<0.1	0.054[k]	0.015	<0.005	102	NA	1.1[k]	374	91	16.97	0.6044	8.64	8.94

2010	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
18-May	3	165	0.57	<0.1	0.051	0.013	<0.005	102	NA	<1.0	387	78	23.50	0.6563	8.26	9.98
15-Jun	3	156	0.55	<0.1	0.133	0.015	<0.005	98	NA	1.0	380	89	17.90	0.6439	8.49	8.01
20-Jul	3	148	0.55	<0.1	0.053	0.013	<0.005	100	NA	<1.0	369	95	14.90	0.6364	8.74	7.57
17-Aug	3	133	0.55	<0.1	<0.05	0.013	<0.005	96	NA	1.5	362	103	10.25	0.6040	8.75	8.03
20-Sep	3	137	0.52	<0.1	<0.05	0.016	<0.005	97	NA	1.2	364	99	18.00	0.6111	8.67	8.18
	Average	148	0.55	<0.1	0.079[k]	0.014	<0.005	99	NA	1.2[k]	372	93	16.91	0.6303	8.58	8.35

2008	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	3	167	0.58	<0.1	<0.05	<0.01	<0.005	125	NA	<1.0	421	83	24.77	0.7588	8.43	9.52
17-Jun	3	163	1.12	0.424	0.080	<0.01	<0.005	116	NA	2.4	419	95	14.60	0.7262	8.47	8.49
15-Jul	3	151	0.69	<0.1	<0.05	0.015	<0.005	107	NA	1.5	407	100	14.63	0.6698	8.66	8.46
19-Aug	3	143	0.55	<0.1	<0.05	0.014	<0.005	109	NA	1.4	404	112	14.47	0.6500	8.71	8.54
16-Sep	3	137	0.65	<0.1	<0.05	0.012	<0.005	109	NA	1.1	394	111	14.73	0.6489	8.41	7.34
	Average	152	0.72	0.424[k]	0.080[k]	0.014[k]	<0.005	113	NA	1.6[k]	409	100	16.64	0.6907	8.54	8.47

2003	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N[*]	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
7-May	3	168	0.83	<0.1	<0.05	0.018	<0.005	NA	353	2.5	392	96	9.19	0.6602	8.44	9.47
4-Jun	3	170	0.90	<0.1	<0.05	0.020	<0.005	NA	373	2.2	399	107	11.98	0.6695	8.54	9.20
9-Jul	3	151	0.77	<0.1	<0.05	0.021	<0.005	NA	374	1.5	387	104	12.47	0.6324	8.46	7.03
6-Aug	3	150	0.73	<0.1	<0.05	0.020	<0.005	NA	342	1.5	385	104	12.27	0.6358	8.67	7.54
10-Sep	3	151	0.69	<0.1	<0.05	0.012	<0.005	NA	358	1.3	382	117	13.91	0.6435	8.59	8.62
	Average	158	0.79	<0.1	<0.05	0.018	<0.005	NA	360	1.8	389	106	11.96	0.6483	8.54	8.37

Table 1. Continued

2011	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
17-May	36	161	0.63	0.127	0.092	0.036	<0.005	105	NA	1.0	401	106	NA	0.6675	7.86	6.72
21-Jun	36	171	1.08	0.449	<0.05	0.204	0.138	104	NA	5.6	403	89	NA	0.6408	7.38	0.27
19-Jul	36	176	1.1	0.308	<0.05	0.232	0.164	104	NA	6.0	417	102	NA	0.6515	7.30	0.25
16-Aug	36	190	1.74	1.100	<0.05	0.309	0.257	105	NA	2.9	410	86	NA	0.6595	7.10	0.24
20-Sep	36	198	2.25	1.960	<0.05	0.425	0.371	104	NA	4.3	416	81	NA	0.6785	6.95	0.25
	Average	179	1.36	0.789	0.059[k]	0.241	0.233	104	NA	4.0	409	93	NA	0.6596	7.32	1.55

2010	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
18-May	36	185	1.62	0.775	<0.05	0.272	0.176	104	NA	9.2	426	99	NA	0.6762	7.92	1.61
15-Jun	35	176	1.22	0.486	0.091	0.163	0.115	102	NA	4.2	406	94	NA	0.6790	7.69	0.25
20-Jul	36	193	1.69	1.110	<0.05	0.388	0.323	102	NA	2.0	417	96	NA	0.7021	7.30	0.20
17-Aug	36	201	2.35	1.910	<0.05	0.452	0.441	103	NA	2.8	431	109	NA	0.7020	7.34	0.13
20-Sep	35	206	2.60	2.080	<0.05	0.470	0.406	103	NA	10.0	429	101	NA	0.7220	7.33	0.26
	Average	192	1.90	1.272	0.091[k]	0.349	0.292	103	NA	5.6	422	100	NA	0.6963	7.52	0.49

2008	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	35	174	0.857	0.349	0.059	0.013	<0.005	124	NA	<1.0	437	95	NA	0.7600	7.69	2.23
17-Jun	36	178	0.644	<0.1	<0.05	0.083	0.051	125	NA	3.6	462	108	NA	0.7721	7.45	0.22
15-Jul	37	186	1.36	0.633	<0.05	0.200	0.142	125	NA	3.9	488	128	NA	0.7759	7.38	0.19
19-Aug	35	200	1.83	1.090	<0.05	0.294	0.223	126	NA	3.3	481	123	NA	0.7753	7.18	0.19
16-Sep	36	211	2.78	2.060	<0.05	0.434	0.329	127	NA	4.9	475	109	NA	0.7995	7.09	0.20
	Average	190	1.49	1.033[k]	0.059[k]	0.205	0.186[k]	125	NA	3.9[k]	469	113	NA	0.7766	7.36	0.61

2003	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N[*]	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
7-May	33	168	0.75	<0.1	<0.05	0.012	<0.005	NA	340	2.6	391	102	NA	0.6643	7.55	0.71
4-Jun	36	177	1.51	0.526	<0.05	0.09	0.043	NA	388	2.5	401	103	NA	0.6782	7.50	0.11
9-Jul	33	189	1.93	0.928	<0.05	0.143	0.097	NA	382	3.3	410	121	NA	0.6733	7.34	0.06
6-Aug	34	192	1.78	0.929	<0.05	0.149	0.078	NA	391	3.5	417	112	NA	0.6966	7.36	0.08
10-Sep	33	215	3.03	2.310	<0.05	0.259	0.236	NA	411	4.2	413	124	NA	0.7068	7.2	0.06
	Average	188	1.80	1.173[k]	<0.05	0.131	0.114[k]	NA	382	3.2	406	112	NA	0.6838	7.39	0.20

Table 1. Glossary

Glossary	
ALK = Alkalinity, mg/L $CaCO_3$	Cl^- = Chloride ions, 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_3-N = Nitrate + Nitrite nitrogen, mg/L	TVS = Total volatile solids, mg/L
TP = Total phosphorus, mg/L	SECCHI = Secchi Disk Depth, ft.
SRP = Soluble reactive phosphorus, mg/L	COND = Conductivity, milliSiemens/cm
TDS = Total dissolved solids, mg/L	DO = Dissolved oxygen, mg/L

Note: "k" denotes that the actual value is known to be less than the value presented.
NA = Not Applicable
* = Prior to 2006 only Nitrate was analyzed

Table 2. Lake County average TSI phosphorous (TSIp) ranking 2000-2011.

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Indpendence Grove	0.0130	41.14
4	Lake Zurich	0.0135	41.68
5	Druce Lake	0.0140	42.00
6	**West Loon**	**0.0152**	**43.00**
7	Windward Lake	0.0160	44.13
8	Sand Pond (IDNR)	0.0165	44.57
9	Cedar Lake	0.0170	45.00
10	Pulaski Pond	0.0180	45.83
11	Gages Lake	0.0200	47.00
12	Banana Pond	0.0200	47.35
13	Lake Kathryn	0.0200	47.35
14	Lake Minear	0.0200	47.35
15	Highland Lake	0.0202	47.49
16	Lake Miltmore	0.0210	48.00
17	Timber Lake (North)	0.0210	48.05
18	Cross Lake	0.0220	48.72
19	Dog Training Pond	0.0220	48.72
20	Sun Lake	0.0220	48.72
21	Cranberry Lake	0.0230	49.00
22	Deep Lake	0.0230	49.36
23	Lake of the Hollow	0.0230	49.36
24	Round Lake	0.0230	49.36
25	Stone Quarry Lake	0.0230	49.36
26	Little Silver Lake	0.0250	50.57
27	Bangs Lake	0.0260	51.00
28	Lake Leo	0.0260	51.13
29	Dugdale Lake	0.0270	51.68
30	Peterson Pond	0.0270	51.68
31	Fourth Lake	0.0360	53.00
32	Lake Fairfield	0.0300	53.20
33	Third Lake	0.0300	53.33
34	Lake Catherine	0.0310	53.67
35	Lambs Farm Lake	0.0310	53.67
36	Old School Lake	0.0310	53.67
37	Grays Lake	0.0310	54.00
38	Hendrick Lake	0.0340	55.00
39	Honey Lake	0.0340	55.00
40	Sand Lake	0.0380	56.00
41	Diamond Lake	0.0370	56.22
42	Sullivan Lake	0.0370	56.22
43	Channel Lake	0.0380	56.60
44	Ames Pit	0.0390	56.98
45	East Loon	0.0400	57.00
46	Schreiber Lake	0.0400	57.34

Table 2. Continued.

RANK	LAKE NAME	TP AVE	TSIp
47	Waterford Lake	0.0400	57.34
48	Hook Lake	0.0410	57.70
49	Duck Lake	0.0430	58.39
50	Nielsen Pond	0.0450	59.04
51	Seven Acre Lake	0.0460	59.36
52	Turner Lake	0.0460	59.36
53	Willow Lake	0.0460	59.36
54	East Meadow Lake	0.0480	59.97
55	Lucky Lake	0.0480	59.97
56	Old Oak Lake	0.0490	60.27
57	College Trail Lake	0.0500	60.56
58	Hastings Lake	0.0520	61.13
59	Lake Lakeland Estates	0.0520	61.13
60	Butler Lake	0.0530	61.40
61	West Meadow Lake	0.0530	61.40
62	Little Bear Lake	0.0550	61.94
63	Lucy Lake	0.0550	61.94
64	Lake Linden	0.0570	62.45
65	Lake Napa Suwe	0.0570	62.45
66	Lake Charles	0.0580	62.70
67	Lake Christa	0.0580	62.70
68	Owens Lake	0.0580	62.70
69	Briarcrest Pond	0.0580	63.00
70	Lake Naomi	0.0620	63.66
71	Lake Tranquility (S1)	0.0620	63.66
72	Liberty Lake	0.0630	63.89
73	Werhane Lake	0.0630	63.89
74	Countryside Glen Lake	0.0640	64.12
75	Davis Lake	0.0650	64.34
76	Lake Fairview	0.0650	64.34
77	Leisure Lake	0.0650	64.34
78	Tower Lake	0.0660	64.56
79	St. Mary's Lake	0.0670	64.78
80	Mary Lee Lake	0.0680	65.00
81	Wooster Lake	0.0690	65.00
82	Crooked Lake	0.0700	65.41
83	Lake Helen	0.0720	65.82
84	Grandwood Park Lake	0.0720	66.00
85	ADID 203	0.0730	66.02
86	Bluff Lake	0.0730	66.02
87	Spring Lake	0.0730	66.02
88	Harvey Lake	0.0770	66.79
89	Broberg Marsh	0.0780	66.97
90	Countryside Lake	0.0780	67.00
91	Sylvan Lake	0.0790	67.16
92	Big Bear Lake	0.0810	67.52

Table 2. Continued.

RANK	LAKE NAME	TP AVE	TSIp
93	Redwing Slough	0.0822	67.73
94	Petite Lake	0.0830	67.87
95	Forest Lake	0.0820	68.00
96	Lake Marie	0.0850	68.21
97	Potomac Lake	0.0850	68.21
98	Timber Lake (South)	0.0850	68.21
99	White Lake	0.0862	68.42
100	Grand Ave Marsh	0.0870	68.55
101	North Churchill Lake	0.0870	68.55
102	McDonald Lake 1	0.0880	68.71
103	North Tower Lake	0.0880	68.71
104	Long Lake	0.0850	69.00
105	Rivershire Pond 2	0.0900	69.04
106	South Churchill Lake	0.0900	69.04
107	McGreal Lake	0.0910	69.20
108	Deer Lake	0.0940	69.66
109	Dunn's Lake	0.0950	69.82
110	Eagle Lake (S1)	0.0950	69.82
111	International Mine and Chemical Lake	0.0950	69.82
112	Valley Lake	0.0950	69.82
113	Fish Lake	0.0960	69.97
114	Lochanora Lake	0.0960	69.97
115	Island Lake	0.0990	70.41
116	Woodland Lake	0.0990	70.41
117	Nippersink Lake	0.1000	70.56
118	Longview Meadow Lake	0.1020	70.84
119	Lake Barrington	0.1050	71.26
120	Lake Forest Pond	0.1070	71.53
121	Bittersweet Golf Course #13	0.1100	71.93
122	Fox Lake	0.1100	71.93
123	Middlefork Savannah Outlet 1	0.1120	72.00
124	Osprey Lake	0.1110	72.06
125	Bresen Lake	0.1130	72.32
126	Round Lake Marsh North	0.1130	72.32
127	Deer Lake Meadow Lake	0.1160	72.70
128	Taylor Lake	0.1180	72.94
129	Columbus Park Lake	0.1230	73.54
130	Lake Nipperink	0.1240	73.66
131	Echo Lake	0.1250	73.77
132	Grass Lake	0.1290	74.23
133	Lake Holloway	0.1320	74.56
134	Redhead Lake	0.1410	75.51
135	Antioch Lake	0.1450	75.91
136	Slocum Lake	0.1500	76.40
137	Lakewood Marsh	0.1510	76.50
138	Pond-A-Rudy	0.1510	76.50

Table 2. Continued.

RANK	LAKE NAME	TP AVE	TSIp
139	Lake Matthews	0.1520	76.59
140	Buffalo Creek Reservoir	0.1550	76.88
141	Middlefork Savannah Outlet 2	0.1590	77.00
142	Pistakee Lake	0.1590	77.24
143	Grassy Lake	0.1610	77.42
144	Salem Lake	0.1650	77.78
145	Half Day Pit	0.1690	78.12
146	Lake Eleanor	0.1810	79.11
147	Lake Farmington	0.1850	79.43
148	Lake Louise	0.1850	79.43
149	ADID 127	0.1890	79.74
150	Patski Pond	0.1970	80.33
151	Dog Bone Lake	0.1990	80.48
152	Summerhill Estates Lake	0.1990	80.48
153	Redwing Marsh	0.2070	81.05
154	Stockholm Lake	0.2082	81.13
155	Bishop Lake	0.2160	81.66
156	Ozaukee Lake	0.2200	81.93
157	Hidden Lake	0.2240	82.19
158	McDonald Lake 2	0.2250	82.28
159	Fischer Lake	0.2280	82.44
160	Oak Hills Lake	0.2790	85.35
161	Loch Lomond	0.2950	86.16
162	Heron Pond	0.2990	86.35
163	Rollins Savannah 1	0.3070	87.00
164	Fairfield Marsh	0.3260	87.60
165	ADID 182	0.3280	87.69
166	Slough Lake	0.3860	90.03
167	Flint Lake Outlet	0.5000	93.76
168	Rasmussen Lake	0.5030	93.85
169	Rollins Savannah 2	0.5870	96.00
170	Albert Lake, Site II, outflow	1.1894	106.26
171	Almond Marsh	1.9510	113.00

Table 3. Aquatic vegetation species found at the 743 sampling sites, on West Loon Lake July 2011. Maximum depth that plants were found was 15.0 feet.

Plant Density	American Pondweed	Bladderwort	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Floatingleaf Pondweed	Grass-leaved Arrowhead	Giant Duckweed
Absent	687	742	667	691	733	735	720	611	621	737	741	742
Present	28	1	32	31	10	4	11	88	83	4	2	1
Common	19	0	25	8	0	3	5	32	28	2	0	0
Abundant	9	0	13	5	0	1	2	9	10	0	0	0
Dominant	0	0	6	8	0	0	5	3	1	0	0	0
% Plant Occurrence	7.5%	0.1%	10.2%	7.0%	1.3%	1.1%	3.1%	17.8%	16.4%	0.8%	0.3%	0.1%

Plant Density	Illinois Pondweed	Largeleaf Pondweed	Sago Pondweed	Slender Naiad	Southern Naiad	Star Duckweed	Vallisneria	Variable Pondweed	White Crowfoot	Watermeal	Water Stargrass	White Water Lily
Absent	690	736	693	705	742	738	622	692	725	728	493	696
Present	43	7	26	23	1	2	61	48	15	8	42	34
Common	10	0	15	11	0	2	52	3	3	5	25	9
Abundant	0	0	4	4	0	1	7	0	0	2	69	4
Dominant	0	0	5	0	0	0	1	0	0	0	114	0
% Plant Occurrence	7.1%	0.9%	6.7%	5.1%	0.1%	0.7%	16.3%	6.9%	2.4%	2.0%	33.6%	6.3%

Table 3a. Distribution of rake density across all sampling sites

Rake Density (Coverage)	# of Sites	%
No plants	384	51.7
>0 to 10%	63	8.5
>10 to 40%	50	6.7
>40 to 60%	93	12.5
>60 to 90%	37	5.0
>90%	116	15.6
Total Sites with Plants	359	48.3
Total Lake Coverage	743	100.0

Table 4. Aquatic vegetation species found at the 106 sampling sites on Lake County Forest Preserve Property, on West Loon Lake July 2011. Maximum depth that plants were found was 11.0 feet.

Plant Density	American Pondweed	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Floatingleaf Pondweed	Illinois Pondweed
Absent	98	101	102	104	105	100	87	88	105	102
Present	2	1	3	2	0	3	12	14	1	3
Common	3	2	0	0	1	1	5	2	0	1
Abundant	3	1	0	0	0	1	2	2	0	0
Dominant	0	1	1	0	0	1	0	0	0	0
% Plant Occurrence	7.5%	4.7%	3.8%	1.9%	0.9%	5.7%	17.9%	17.0%	0.9%	3.8%

Plant Density	Sago Pondweed	Slender Naiad	Star Duckweed	Vallisneria	Variable Pondweed	White Crowfoot	Watermeal	Water Stargrass	White Water Lily
Absent	99	100	105	86	101	104	102	82	103
Present	2	5	1	6	5	1	3	2	2
Common	2	1	0	11	0	1	1	2	1
Abundant	2	0	0	2	0	0	0	4	0
Dominant	1	0	0	1	0	0	0	16	0
% Plant Occurrence	6.6%	5.7%	0.9%	18.9%	4.7%	1.9%	3.8%	22.6%	2.8%

Table 4a. Distribution of rake density across all sampling sites

Rake Density (Coverage)	# of Sites	%
No plants	70	66.0
>0 to 10%	4	3.8
>10 to 40%	4	3.8
>40 to 60%	3	2.8
>60 to 90%	3	2.8
>90%	22	20.8
Total Sites with Plants	36	34.0
Total Lake Coverage	106	22.9

Aquatic vegetation species found at the 106 sampling sites on Lake County Forest Preserve Property, on West Loon Lake August 2010. Maximum depth that plants were found was 12.5 feet.

Plant Density	American Pondweed	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Floatingleaf Pondweed	Illinois Pondweed
Absent	95	102	93	105	105	103	87	100	103	96
Present	7	3	9	1	1	1	13	5	3	9
Common	4	1	2	0	0	2	4	1	0	1
Abundant	0	0	2	0	0	0	2	0	0	0
Dominant	0	0	0	0	0	0	0	0	0	0
% Plant Occurrence	10.4%	3.8%	12.3%	0.9%	0.9%	2.8%	17.9%	5.7%	2.8%	9.4%

Plant Density	Northern Watermilfoil	Sago Pondweed	Slender Naiad	Southern Naiad	Star Duckweed	Vallisneria	Variable Pondweed	Watermeal	Water Stargrass	White Water Lily
Absent	99	95	102	102	104	79	93	101	73	104
Present	7	8	3	3	2	9	9	4	5	2
Common	0	3	1	1	0	14	4	1	8	0
Abundant	0	0	0	0	0	4	0	0	4	0
Dominant	0	0	0	0	0	0	0	0	16	0
% Plant Occurrence	6.6%	10.4%	3.8%	3.8%	1.9%	25.5%	12.3%	4.7%	31.1%	1.9%

Distribution of rake density across all sampling sites

Rake Density (Coverage)	# of Sites	%
No plants	71	67.0
>0 to 10%	1	0.9
>10 to 40%	8	7.5
>40 to 60%	9	8.5
>60 to 90%	5	4.7
>90%	12	11.3
Total Sites with Plants	35	33.0
Total Lake Coverage	106	22.3

Figure 3. Aquatic plant sampling illustrating plant density on West Loon Lake, July 2011.

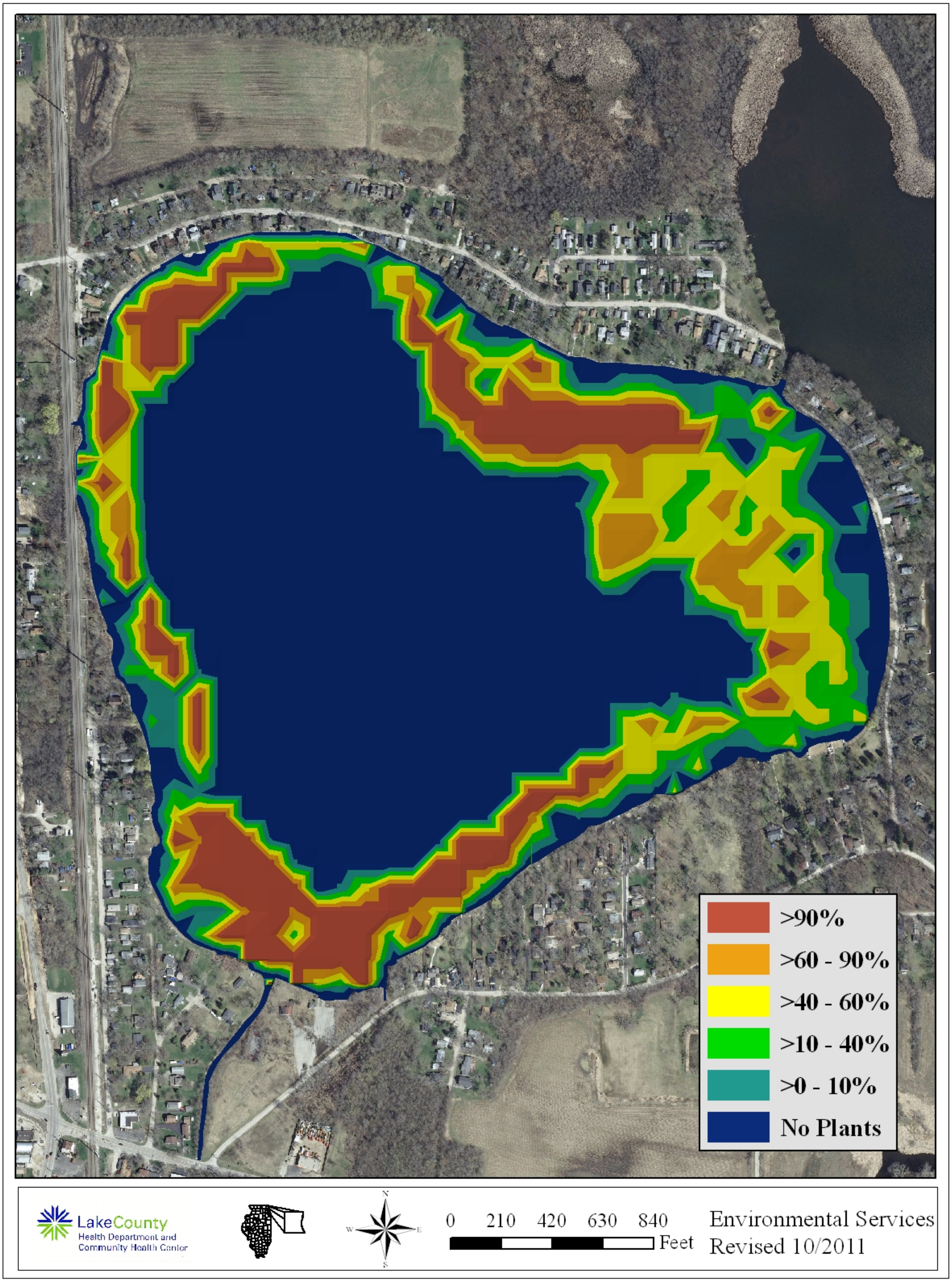

Figure 4. Aquatic plant sampling illustrating Eurasian Watermilfoil density on West Loon Lake, July 2011.

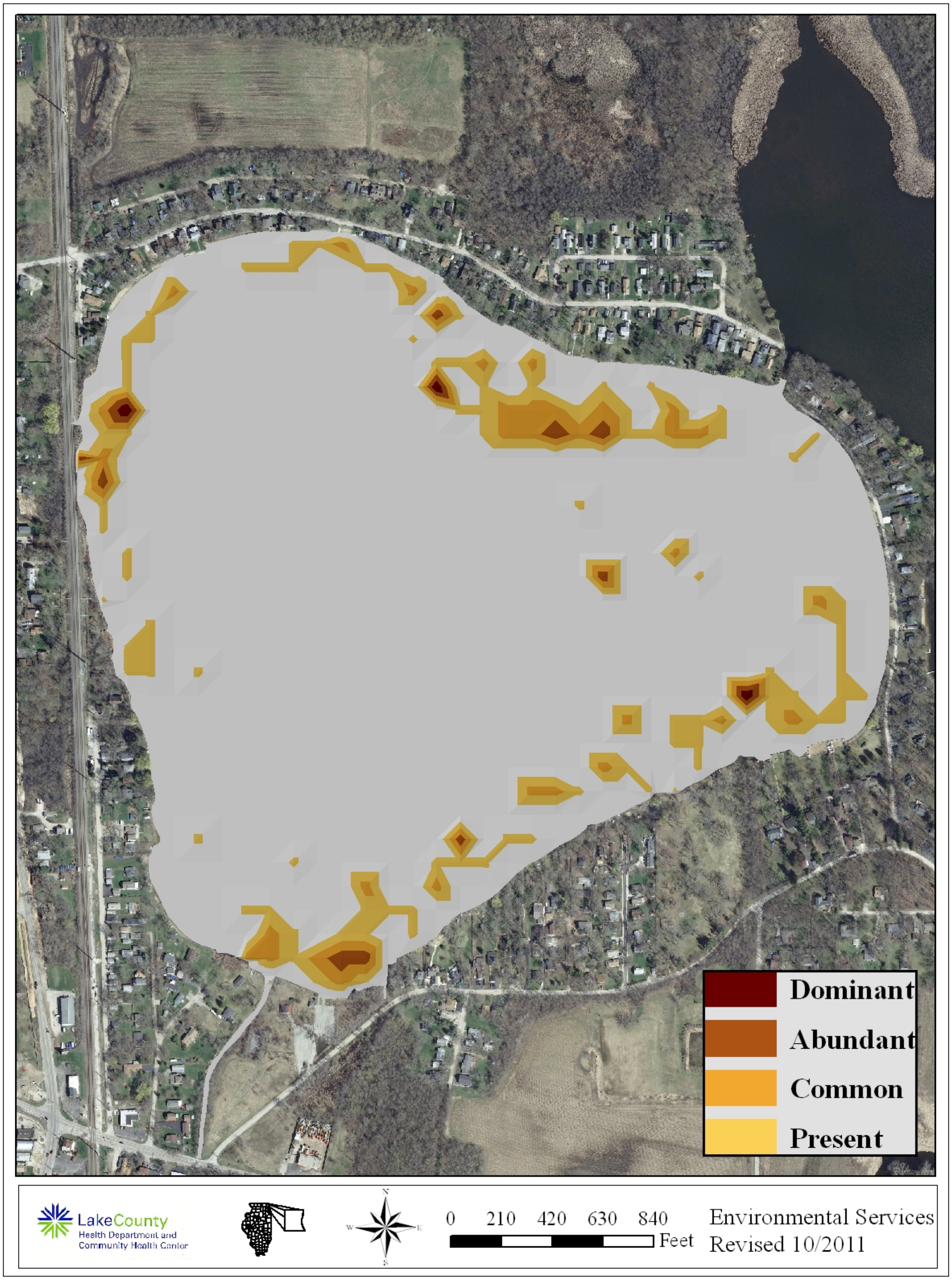

Figure 5. Aquatic plant sampling illustrating Water Stargrass density on West Loon Lake, July 2011.

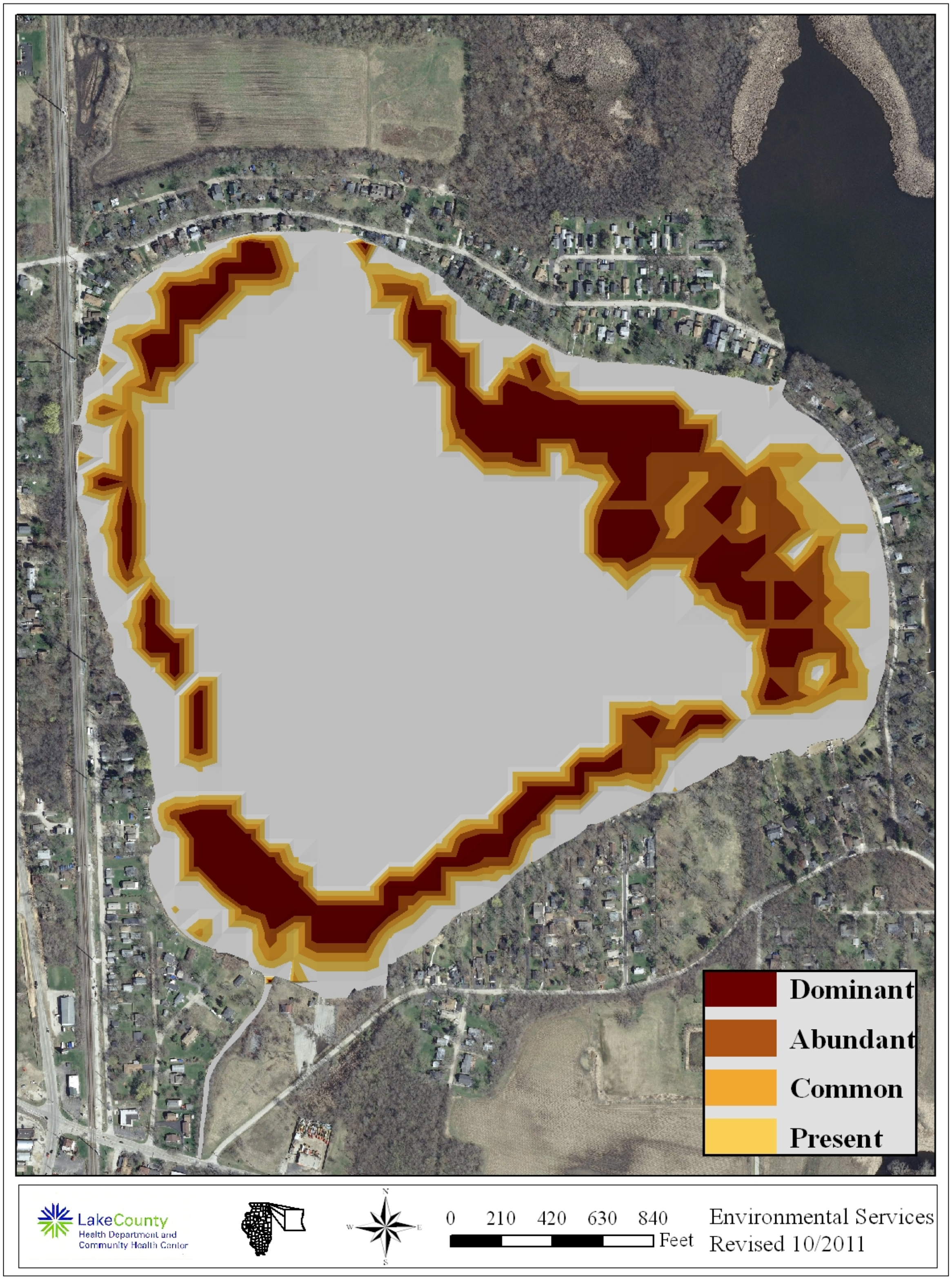

Table 6. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/Adventives) and with native species only (native).

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	38.4	37.0
2	East Loon Lake	37	35.6
3	**West Loon Lake**	**33.7**	**32.3**
4	Little Silver	31.6	29.6
5	Deep Lake	31.2	29.7
6	Round Lake Marsh North	29.9	29.1
7	Cranberry Lake	28.9	28.0
8	Sullivan Lake	28.5	26.9
9	Independence Grove	27.5	24.6
10	Fourth Lake	27.1	24.7
11	Lake Zurich	27.1	24.3
12	Bangs Lake	26.9	25.2
13	Sterling Lake	26.9	24.5
14	Sun Lake	26.1	24.3
15	Round Lake	25.9	23.5
16	Honey Lake	25.1	23.3
17	Lake of the Hollow	24.8	23.0
18	Schreiber Lake	24.8	23.9
19	Lakewood Marsh	24.7	23.8
20	Redwing Slough	24.0	25.8
21	Deer Lake	23.5	24.4
22	Butler Lake	23.1	21.4
23	Duck Lake	22.9	21.1
24	Countryside Glen Lake	22.8	21.9
25	Cross Lake	22.4	24.2
26	McGreal Lake	22.1	20.2
27	Druce Lake	21.8	19.1
28	Third Lake	21.7	13.2
29	Broberg Marsh	21.4	20.5
30	Davis Lake	21.4	21.4
31	Fish Lake	21.2	19.3
32	Redhead Lake	21.2	19.3
33	Turner Lake	21.2	18.6
34	Wooster Lake	21.1	19.4
35	Timber Lake (North)	20.9	23.4
36	Lake Kathryn	20.7	19.6
37	ADID 203	20.5	20.5
38	Salem Lake	20.2	18.5
39	Old Oak Lake	19.1	18.0
40	Grandwood Park Lake	19.0	17.2
41	Highland Lake	18.9	16.7
42	Lake Miltmore	18.7	16.8
43	Lake Helen	18.0	18.0
44	Bresen Lake	17.8	16.6
45	Potomac Lake	17.8	17.8
46	Hendrick Lake	17.7	17.7
47	Lake Barrington	17.7	16.7
48	Long Lake	17.7	15.8
49	Rollins Savannah 2	17.7	17.7
50	Windward Lake	17.6	16.3
51	Diamond Lake	17.4	16.3
52	Almond Marsh	17.3	16.3
53	Osprey Lake	17.3	15.5
54	Owens Lake	17.3	16.3

Table 6. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
55	Forest Lake	17.0	15.9
56	Lake Tranquility (S1)	17.0	15.0
57	McDonald Lake 1	16.7	17.7
58	Island Lake	16.6	14.7
59	Countryside Lake	16.3	15.2
60	Grand Avenue Marsh	16.3	14.3
61	Lake Fairview	16.3	15.2
62	Lake Nippersink	16.3	14.3
63	Taylor Lake	16.3	14.3
64	Grays Lake	16.1	16.1
65	White Lake	16.0	17.0
66	Dog Training Pond	15.9	14.7
67	Dog Bone Lake	15.7	15.7
68	Ames Pit	15.5	13.4
69	Seven Acre Lake	15.5	17.0
70	Dugdale Lake	15.1	14.0
71	Eagle Lake (S1)	15.1	14.0
72	Heron Pond	15.1	15.1
73	Mary Lee Lake	15.1	13.1
74	Old School Lake	15.1	13.1
75	Bishop Lake	15	13.4
76	Hastings Lake	15.0	17.0
77	North Churchill Lake	15.0	15.0
78	Timber Lake (South)	14.7	12.7
79	Buffalo Creek Reservoir	14.3	13.1
80	Lake Carina	14.3	12.1
81	Lake Leo	14.3	12.1
82	Lambs Farm Lake	14.3	12.1
83	Crooked Lake	14.0	16.0
84	Dunn's Lake	13.9	12.7
85	Lake Minear	13.9	11.0
86	Lake Napa Suwe	13.9	11.7
87	Longview Meadow Lake	13.9	13.9
88	Summerhill Estates Lake	13.9	12.7
89	Stockholm Lake	13.5	12.1
90	Antioch Lake	13.4	11.3
91	Hook Lake	13.4	11.3
92	Lake Charles	13.4	11.3
93	Rivershire Pond 2	13.3	11.5
94	Flint Lake	13.0	11.8
95	Harvey Lake	13.0	11.8
96	Briarcrest Pond	12.5	11.2
97	Gages Lake	12.5	10.2
98	Lake Naomi	12.5	11.2
99	McDonald Lake 2	12.5	12.5
100	Pulaski Pond	12.5	11.2
101	Rollins Savannah 1	12.5	12.5
102	Stone Quarry Lake	12.5	12.5
103	Loch Lomond	12.1	9.4
104	Pond-A-Rudy	12.1	12.1
105	Grassy Lake	12.0	12.0
106	Lake Matthews	12.0	12.0
107	Nielsen Pond	12.0	10.7
108	Werhane Lake	12.0	9.8
109	Lake Lakeland Estates	11.5	10.0
110	Big Bear Lake	11.0	9.5
111	Fischer Lake	11.0	9.0

Table 6. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
112	Little Bear Lake	11.0	9.5
113	Redwing Marsh	11	11.0
114	Tower Lake	11.0	11.0
115	West Meadow Lake	11.0	11.0
116	Lake Holloway	10.6	10.6
117	Lake Fairfield	10.4	9.0
118	Lake Louise	10.4	9.0
119	Sand Lake	10.4	8.0
120	College Trail Lake	10.0	10.0
121	Valley Lake	9.9	9.9
122	Woodland Lake	9.9	8.1
123	Lake Christa	9.8	8.5
124	Lake Farmington	9.8	8.5
125	Lucy Lake	9.8	8.5
126	Banana Pond	9.2	7.5
127	Columbus Park Lake	9.2	9.2
128	Sylvan Lake	9.2	9.2
129	Waterford Lake	9.2	9.2
130	Leisure Lake	9.0	6.4
131	Albert Lake	8.7	7.5
132	Fairfield Marsh	8.7	7.5
133	Lake Eleanor	8.7	7.5
134	Ozaukee Lake	8.7	6.7
135	East Meadow Lake	8.5	8.5
136	Lake Forest Pond	8.5	6.9
137	Peterson Pond	8.5	6.0
138	South Churchill Lake	8.5	8.5
139	Bittersweet Golf Course #13	8.1	8.1
140	Lake Linden	8.0	8.0
141	IMC Lake	7.1	5.0
142	Patski Pond	7.1	7.1
143	Rasmussen Lake	7.1	7.1
144	Slocum Lake	7.1	5.8
145	Lucky Lake	7.0	7.0
146	Deer Lake Meadow Lake	6.4	5.2
147	ADID 127	5.0	5.0
148	Half Day Pit	5.0	2.9
149	Liberty Lake	5.0	5.0
150	Lochanora Lake	5.0	2.5
151	Oak Hills Lake	5.0	5.0
152	Sand Pond (IDNR)	5.0	3.5
153	Slough Lake	5.0	5.0
154	Echo Lake	0.0	0.0
155	Hidden Lake	0.0	0.0
156	North Tower Lake	0.0	0.0
157	St. Mary's Lake	0.0	0.0
158	Willow Lake	0.0	0.0
	Mean	**15.2**	**14.1**
	Median	**14.3**	**13.1**

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

West Loon Lake 2011 Multiparameter data

Date MMDDYY	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	0.13
51711	0.25	0.30	12.9	9.56	93.1	0.6642	8.27	1411	Surface	100%	
51711	1	1.05	12.93	9.56	93.2	0.6639	8.26	1218.0	Surface	100%	
51711	2	2.17	12.93	9.53	92.9	0.6640	8.25	500	0.500	41%	1.78
51711	3	3.03	12.95	9.53	92.9	0.6639	8.25	222	1.360	18%	0.60
51711	4	4.00	12.94	9.51	92.8	0.6640	8.25	207	2.330	17%	0.03
51711	6	5.99	12.94	9.50	92.7	0.6639	8.25	360	4.320	30%	-0.13
51711	8	8.03	12.94	9.50	92.6	0.6667	8.25	191	6.360	16%	0.10
51711	10	10.03	12.94	9.49	92.5	0.6639	8.25	166	8.360	14%	0.02
51711	12	12.09	12.94	9.48	92.4	0.6639	8.25	146	10.420	12%	0.01
51711	14	14.01	12.92	9.45	92.1	0.6639	8.25	173	12.340	14%	-0.01
51711	16	15.97	12.92	9.43	91.9	0.6637	8.25	141	14.300	12%	0.01
51711	18	18.00	12.91	9.41	91.7	0.6639	8.25	91	16.330	7%	0.03
51711	20	19.99	12.88	9.40	91.6	0.6638	8.25	79	18.320	6%	0.01
51711	22	21.99	12.85	9.29	90.4	0.6637	8.23	63	20.320	5%	0.01
51711	24	24.01	12.84	9.30	90.5	0.6637	8.23	54	22.340	4%	0.01
51711	26	26.02	12.83	9.26	90.1	0.6636	8.24	38	24.350	3.1%	0.01
51711	28	28.14	12.66	9.11	88.3	0.6635	8.2	31	26.470	2.5%	0.01
51711	30	30.07	12.33	8.81	84.7	0.6651	8.17	25	28.400	2.1%	0.01
51711	32	32.03	11.98	8.43	80.4	0.665	8.12	21	30.360	1.7%	0.01
51711	34	33.93	11.65	7.96	75.4	0.6668	8.04	15	32.260	1.2%	0.01
51711	36	36.01	10.83	6.72	62.5	0.6675	7.86	12	34.340	1.0%	0.01
51711	38	38.08	10.35	5	45.9	0.6687	7.71	9	36.410	0.7%	0.008

Date MMDDYY	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	0.29
62111	0.25	0.27	23.78	8.96	110.1	0.0008	8.71	4233	Surface	100%	
62111	1	1.03	23.7	9.18	112.8	0.6232	8.62	3764	Surface	100%	
62111	2	2.06	23.69	9.19	112.8	0.6226	8.58	1092	0.390	29%	3.17
62111	3	3.04	23.52	9.20	112.6	0.6231	8.58	1112	1.370	30%	-0.01

West Loon 11

62111	4	4.01	23.51	9.20	112.6	0.6232	8.57	948	2.340	25%	0.07
62111	6	6.06	23.19	9.22	112.2	0.6233	8.55	535	4.390	14%	0.13
62111	8	7.95	23.01	9.12	110.6	0.6235	8.50	473	6.280	13%	0.02
62111	10	9.97	22.1	8.70	103.7	0.6254	8.40	428	8.300	11%	0.01
62111	12	11.99	21.27	8.44	99.0	0.6232	8.33	253	10.320	7%	0.05
62111	14	13.94	20.67	7.96	92.2	0.6241	8.26	214	12.270	6%	0.01
62111	16	15.95	19.69	7.32	83.2	0.6269	8.12	154	14.280	4%	0.02
62111	18	17.98	17.84	6.45	70.6	0.6286	7.97	112	16.310	3%	0.02
62111	20	20.03	16.07	6.20	65.4	0.6287	7.89	91	18.360	2%	0.01
62111	22	22.00	14.79	5.74	58.9	0.6308	7.81	70	20.330	1.9%	0.01
62111	24	23.99	13.94	4.63	46.7	0.6325	7.72	54	22.320	1.4%	0.01
62111	26	26.07	13.47	3.59	35.8	0.6326	7.63	42	24.400	1.1%	0.01
62111	28	27.87	13.24	2.91	28.8	0.6336	7.58	33	26.200	0.9%	0.01
62111	30	30.00	12.97	2.64	26.0	0.6335	7.52	24	28.330	0.6%	0.01
62111	32	31.84	12.35	1.03	10.0	0.6358	7.46	19	30.170	0.5%	0.01
62111	34	34.03	11.82	0.37	3.6	0.6392	7.4	14	32.360	0.4%	0.01
62111	36	35.93	11.66	0.27	2.6	0.6408	7.38	9	34.260	0.2%	0.01
62111	38	37.99	11.53	0.25	2.4	0.6419	7.37	5	36.320	0.1%	0.02

Date MMDDYY	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	0.23
71911	0.25	0.31	29.12	8.82	118.8	0.6156	8.91	3397	Surface	100%	
71911	1	1.09	29.13	9.13	122.9	0.615	8.92	628	Surface	100%	
71911	2	2.05	28.94	9.22	123.6	0.6146	8.92	152	0.380	24%	3.73
71911	3	2.91	28.88	9.23	123.8	0.6148	8.92	144	1.240	23%	0.04
71911	4	4.05	28.65	9.26	123.6	0.6143	8.91	82	2.380	13%	0.24
71911	6	6.04	28.61	9.22	123	0.6141	8.90	99	4.370	16%	-0.04
71911	8	8.02	28.59	9.19	122.6	0.6142	8.90	107	6.350	17%	-0.01
71911	10	10.02	28.15	9	119.1	0.6179	8.81	149	8.350	24%	-0.04
71911	12	12.03	26.69	8.22	105.9	0.6189	8.69	195	10.360	31%	-0.03
71911	14	14.05	25.27	6.9	86.7	0.6272	8.43	156	12.380	25%	0.02
71911	16	15.99	22.62	5.72	68.4	0.6332	8.05	128	14.320	20%	0.01
71911	18	18.01	19.7	4.46	50.4	0.6367	7.79	70	16.340	11%	0.04
71911	20	19.97	17.79	1.66	18	0.6416	7.56	47	18.300	7.5%	0.02
71911	22	22.09	16.73	0.88	9.3	0.6394	7.46	29	20.420	4.6%	0.02

Date MMDDYY	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
71911	24	23.97	15.26	1.36	14	0.6405	7.46	20	22.300	3.2%	0.02
71911	26	26.06	14.31	0.83	8.4	0.6411	7.4	15	24.390	2.4%	0.01
71911	28	28	13.5	0.39	3.9	0.6405	7.35	11	26.330	1.8%	0.01
71911	30	30.05	12.76	0.55	5.3	0.6417	7.35	8	28.380	1.3%	0.01
71911	32	32.03	12.42	0.46	4.5	0.6439	7.33	4	30.360	0.6%	0.02
71911	34	33.98	12.2	0.28	2.7	0.6468	7.32	1	32.310	0.2%	0.04
71911	36	35.99	11.93	0.25	2.4	0.6515	7.3	1	34.320	0.2%	0.00
71911	38	38	11.59	0.23	2.2	0.6588	7.27	1	36.330	0.2%	0.00

Date MMDDYY	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	0.21
81611	0.5	0.28	25.22	8.73	108.9	0.5560	8.83	3799	Surface	100%	
81611	1	1.09	25.23	8.81	110	0.5559	8.83	3722	Surface	100%	
81611	2	2.05	25.19	8.82	110.1	0.5560	8.84	1553	0.380	42%	2.30
81611	3	3.05	25.12	8.81	109.8	0.5558	8.84	1085	1.380	29%	0.26
81611	4	4.06	25.11	8.78	109.4	0.5557	8.84	834	2.390	22%	0.11
81611	6	6.05	25.09	8.75	109	0.5555	8.83	514	4.380	14%	0.11
81611	8	8.05	25.07	8.67	107.9	0.5556	8.83	343	6.380	9%	0.06
81611	10	9.93	25.02	8.52	105.9	0.5553	8.82	218	8.260	6%	0.05
81611	12	12.04	24.89	8.15	101.1	0.5534	8.80	139	10.370	4%	0.04
81611	14	14.04	24.73	7.56	93.5	0.5540	8.74	94	12.370	3%	0.03
81611	16	16.08	24.55	6.61	81.5	0.5554	8.61	58	14.410	2%	0.03
81611	18	18.05	22.63	2.06	24.5	0.6052	7.93	39	16.380	1.0%	0.02
81611	20	20.13	20.22	2.23	25.3	0.6341	7.71	26	18.460	0.7%	0.02
81611	22	21.99	18.39	0.69	7.6	0.6402	7.52	17	20.320	0.5%	0.02
81611	24	24.02	16.77	0.36	3.8	0.6443	7.45	4	22.350	0.1%	0.06
81611	26	25.99	14.76	0.26	2.7	0.6433	7.41	1	24.320	0.03%	0.06
81611	28	28.04	13.49	0.25	2.5	0.6451	7.37	1	26.370	0.03%	0.00
81611	30	30.02	12.66	0.25	2.4	0.6508	7.28	0	28.350		
81611	32	32.01	12.31	0.24	2.3	0.6544	7.21	0	30.340		
81611	34	34.01	12.05	0.24	2.3	0.6596	7.12	0	32.340		
81611	36	36.02	11.98	0.24	2.3	0.6595	7.1	0	34.350		
81611	38	38.02	11.83	0.23	2.2	0.6618	7.05	0	36.350		

	Text								Depth of		

West Loon 11

Date MMDDYY	Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	0.37
92011	0.25	0.3	19	8.3	91.9	0.5641	8.60	3978	Surface	100%	
92011	1	1	18.99	7.96	88.1	0.5640	8.61	3874	Surface	100%	
92011	2	2.05	19	7.97	88.2	0.5642	8.62	1094	0.380	28%	3.33
92011	3	2.96	19	7.94	87.9	0.5642	8.63	1151	1.290	30%	-0.04
92011	4	4.07	18.94	7.96	88	0.5640	8.63	1087	2.400	28%	0.02
92011	6	6.11	18.93	7.93	87.7	0.5644	8.63	466	4.440	12%	0.19
92011	8	8.00	18.92	7.9	87.3	0.5639	8.62	418	6.330	11%	0.02
92011	10	9.99	18.92	7.84	86.7	0.5640	8.62	243	8.320	6%	0.07
92011	12	12.02	18.91	7.77	85.8	0.5644	8.61	176	10.350	5%	0.03
92011	14	14.00	18.91	7.68	84.9	0.5641	8.61	131	12.330	3%	0.02
92011	16	16.06	18.9	7.6	83.9	0.5647	8.60	84	14.390	2%	0.03
92011	18	18.01	18.88	7.46	82.4	0.5645	8.58	61	16.340	2%	0.02
92011	20	20.03	18.83	7.26	80.1	0.5649	8.55	41	18.360	1.1%	0.02
92011	22	22.09	18.54	5.97	65.5	0.5766	8.38	31	20.420	0.8%	0.01
92011	24	24.11	17.24	3.94	42.1	0.6417	7.72	13	22.440	0.3%	0.04
92011	26	25.98	15.97	0.72	7.5	0.647	7.45	6	24.310	0.2%	0.03
92011	28	28	14.20	0.32	3.2	0.6536	7.32	1	26.330	0.03%	0.07
92011	30	29.84	12.81	0.27	2.6	0.6646	7.15	0	28.170		
92011	32	31.94	12.38	0.27	2.6	0.6708	7.05	0	30.270		
92011	34	34.04	12.18	0.25	2.4	0.6748	6.99	0	32.370		
92011	36	36.05	12.04	0.25	2.4	0.6785	6.95	0	34.380		
92011	38	38.08	11.76	0.25	2.3	0.6869	6.87	0	36.410		

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 2000-2009 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 2000-2009 was 0.063 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 2000-2009 was 0.167 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 was 7.9 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 2000-2009, Ozaukee Lake had the lowest Secchi depths (0.25 feet) and West Loon Lake had the highest (24.77 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 was 8.34, with a minimum of 7.07 in Bittersweet #13 Lake and a maximum of 10.40 in Summerhill Estates Lake.

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

2000 - 2011 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2011	
Average	**165**	
Median	**160**	
Minimum	**65**	**IMC**
Maximum	**330**	**Flint Lake**
STD	**42**	
n =	**842**	

	ALKanoxic 2000-2011	
Average	**199**	
Median	**190**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**52**	
n =	**241**	

	Condoxic <=3ft00-2011	
Average	**0.8642**	
Median	**0.7821**	
Minimum	**0.2260**	**Schreiber Lake**
Maximum	**6.8920**	**IMC**
STD	**0.5273**	
n =	**841**	

	Condanoxic 2000-2011	
Average	**0.9953**	
Median	**0.8320**	
Minimum	**0.3210**	**Lake Kathyrn, Schreiber Lake**
Maximum	**7.4080**	**IMC**
STD	**0.7929**	
n =	**241**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2011	
Average	**0.516**	
Median	**0.198**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.059**	
n =	**841**	

*ND = Many lakes had non-detects (75.0%)
Only compare lakes with detectable
concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	NH3-Nanoxic 2000-2011	
Average	**2.135**	
Median	**1.360**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.405**	
n =	**241**	

*ND = 22.0% Non-detects from 34 different lakes

	pHoxic <=3ft00-2011	
Average	**8.35**	
Median	**8.35**	
Minimum	**7.07**	**Bittersweet #13**
Maximum	**10.40**	**Summerhill Estates**
STD	**0.46**	
n =	**840**	

	pHanoxic 2000-2011	
Average	**7.31**	
Median	**7.27**	
Minimum	**6.24**	**Banana Pond**
Maximum	**9.16**	**White Lake**
STD	**0.42**	
n =	**241**	

	All Secchi 2000-2011	
Average	**4.39**	
Median	**2.95**	
Minimum	**0.25**	**McDonald 2/Ozaukee/Rollins 2**
Maximum	**20.34**	**Lake Carina**
STD	**3.43**	
n =	**767**	

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2000 - 2011 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2011	
Average	**1.511**	
Median	**1.180**	
Minimum	**<0.1**	***ND**
Maximum	**41.200**	**Almond Marsh**
STD	**1.740**	
n =	**842**	

*ND = 3.6% Non-detects from 14 different lakes

	TKNanoxic 2000-2011	
Average	**2.823**	
Median	**2.120**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.345**	
n =	**241**	

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

	TPoxic <=3ft00-2011	
Average	**0.114**	
Median	**0.066**	
Minimum	**<0.01**	***ND**
Maximum	**7.270**	**Almond Marsh**
STD	**0.307**	
n =	**842**	

*ND = 2.1% Non-detects from 7 different lakes

	TPanoxic 2000-2011	
Average	**0.313**	
Median	**0.181**	
Minimum	**0.012**	**Independence Grove**
Maximum	**3.800**	**Taylor Lake**
STD	**0.404**	
n =	**241**	

	TSSall <=3ft00-2011	
Average	**16.6**	
Median	**8.6**	
Minimum	**<0.1**	***ND**
Maximum	**220.0**	**Rollins 2**
STD	**23.4**	
n =	**848**	

*ND = 0.9% Non-detects from 8 different lakes

	TVSoxic <=3ft00-2011	
Average	**127.2**	
Median	**122.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**1090.0**	**Almond Marsh**
STD	**53.0**	
n =	**797**	

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 <=3ft00-2010	
Average	**193**	
Median	**128**	
Minimum	**3.5**	**Schreiber Lake**
Maximum	**2390**	**IMC**
STD	**313**	
n =	**174**	

	CLoxic <=3ft00-2011	
Average	**183**	
Median	**145**	
Minimum	**2.7**	**Schreiber Lake**
Maximum	**2760**	**IMC**
STD	**212**	
n =	**638**	

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 2000-2011 (n=1398).

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

LCHD Environmental Services ~ 12/12/2011

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