2011 SUMMARY REPORT
of
East Loon Lake

Lake County, Illinois

Prepared by the

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LAKE FACTS

Lake Name:	East Loon Lake
Historical Name:	None
Nearest Municipality:	Village of Antioch
Location:	T46N, R10E, Sections 16 and 21
Elevation:	772.15 feet mean sea level
Major Tributaries:	Sun Lake Drain and West Loon Lake
Watershed:	Fox River
Sub-watershed:	Sequoit Creek
Receiving Waterbody:	Lake Marie – Fox River Chain O Lakes
Surface Area:	187.4 acres
Shoreline Length:	8.1 miles
Maximum Depth:	26.0 feet
Average Depth:	6.8 feet
Lake Volume:	1166.16 acre-feet
Lake Type:	Glacial
Watershed Area:	5258.9 acres
Major Watershed Land Uses:	Single Family, Public and Private Open Space, 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:	No public access

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 East Loon Lake. Similar 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 East Loon Lake at the deepest point near the center of the lake (Figure 1). Samples were taken at three feet below the surface and approximately three feet above the lake bottom (Appendix A). Water level was taken from the north corner of the seawall along East shore. A fluctuation in lake levels was observed during the sampling season. Data from the Lake County Stormwater Management Commission's Lindenhurst rain gauge was correlated to rain events and lake levels increases. Over the sample period May to September the lake level decreased 5.56 inches. The highest water level occurred in May and the lowest level in July. East Loon Lake level appears to be greatly influenced by rain events, the most significant increase in lake level occurred from in August with an increase in lake level by 6.0 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).

East Loon Lake has above average water quality (Appendix C) with many parameters below the county medians. The lake nutrient concentrations remained relatively stable since 2003 and some parameters notably improved since 2010. Total suspended solid (TSS) concentrations averaged 4.9 mg/L in 2011, which is nearly half the county median (7.9 mg/L) and 30% lower than the 2010 concentration (7.0 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 for the season (4.08 feet) was higher than the county median (2.95 feet; Figure 2). Although the water clarity is good, it is dramatically lower than the 2011 average Secchi depth in West Loon Lake (16.97 feet), however, these two lakes are different in several ways. First, 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. Zebra mussels favor the substrate in West Loon Lake and are much more abundant in West Loon Lake than East Loon Lake. The size of the watershed feeding the lake relative to the lakes size is also an important factor in determining the amount of pollutants in the lake. East Loon Lake has a large watershed (5258.9 acres) that delivers sediment and other suspended solids to East Loon Lake with each rain event; compared to West Loon Lake's relatively small watershed (1135.8 acres).

Stratification is typical of nutrient-enriched deep lakes like East 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 in June through September in 2011. Dissolved oxygen (DO) concentrations became anoxic in the hypolimnion June through September. The maximum volume experiencing anoxia was

approximately 25% (DO concentrations <1.0 mg/L below 10 feet in July), thus there are no apparent DO problems in East 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 amount.

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 East Loon Lake has ranged from 0.028 mg/L in 1998 and 2003 to 0.052 mg/L in 2010. The 2011 concentration averaged 0.040 mg/L (Table 1), which is nearly a third lower than the county median (0.066 mg/L) (Appendix D). This was a 23% decrease from the 2010 TP average of 0.052 mg/L. This is a significant reduction, concentrations exceeding 0.050 mg/l are considered impaired by the Illinois Environmental Protection Agency (IEPA) and can support nuisance algae blooms and dense aquatic plant communities. 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 2011 TKN for East Loon Lake was 1.03 mg/L, which was slightly lower than the county median of 1.18 mg/L, and the lowest concentration since 1998 (0.98 mg/L). The TN:TP (total nitrogen to total phosphorus) ratio looks at which nutrient is limiting plant and algal growth in a lake. East Loon Lake had a TN:TP ratio of 26:1 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 lakes 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 East Loon Lake was eutrophic with a TSI value of 57.2. East Loon Lake ranked 45th in the county of 162 lakes for TSIp (Table 2). In 2010, East Loon Lake was also classified as eutrophic with a TSIp of 61.1.

Conductivity readings in East Loon Lake have decreased slightly compared to past years (Table 2). The 2011 average for conductivity was 0.7544 milliSiemens/cm, slightly below the county median of 0.8320 mS/cm. Conductivity concentrations in the lake were highest in May and decreased throughout the summer, with the exception of July; when the parameter was more concentrated and the lake level was the lowest. Indicating that spring runoff was a major contributor to these concentrations and that over the sampling season a flushing effect occurred. One of the most common dissolved solids is road salt used in winter road deicing. Most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. East Loon Lake 2011 average chloride concentration was 144 mg/L. One of the most common sources of chlorides is road salt used in winter road maintenance washed into the lake from storm events.

SUMMARY OF AQUATIC MACROPHYTES

Plant sampling was conducted twice on East Loon Lake in 2011, once in June and again in August. There were 28 species of plants present (Table 3) with several species differing between the two sampling periods. White Water Crowfoot was only present in June while Floatingleaf Pondweed, Grass-leaved Arrowhead, Northern Milfoil, Slender Naiad, Small Pondweed, and Vallisneria were documented in August only. In June the three most abundant species were Curlyleaf Pondweed (CLP, 58%), Watermeal (51%) and Eurasian Watermilfoil (EWM, 39%) (Table 5). The plant community shifted by August (Table 4) with Watermeal as the dominant species (70%), Coontail the second most abundant (59%), and White Water Lily (53%) as the third most abundant species.

EWM and CLP are invasive, exotic species, and were found in the lake throughout the summer. East Loon Lake has an aggressive aquatic plant management program. Using funds from the Special Service Area 8 (SSA8), East Loon Lake utilizes both herbicidal treatment and mechanical harvesting. Loon Lakes Management Association (LLMA) employs two people seasonally to operate an Aquarius harvester. The harvester is used to create access lanes to the main part of the lake and to remove problematic EWM. Harvesting began in late June and ended by mid September, harvesting occurred only where water depths were greater than four feet, except near boat ramps. Since 2009, the LLMA has supplemented herbicidal treatments to further reduce EWM populations. In 2011 three areas dominated by EWM were selected to receive liquid 2-4d treatments totaling 22.6 acres. Extensive herbicide treatments generally cause an overall decline in water quality, clarity, and species diversity. Diversity is also important for fish habitat. East Loon Lake harbors three Illinois endangered and threatened fish species Blacknose Shiner, Blackchin Shiner, and Banded Killifish these species depend on diverse dense aquatic plants. In addition, the endangered plant species Grass-leaved Pondweed has been found in East Loon Lake. To evaluate the effectiveness of the herbicide treatment area a comparison of the 29 sites pretreatment (2008) and post treatment (2011) were analyzed (Tables 5-8). In June 2008 only eight species were present and the dominant species was EWM at 86%. In June 2011 these same sites had 18 species present and EWM density was reduced by 36%. CLP populations significantly increased from 25% in 2008 to 86% in 2011 within the treatment areas. While the entire East Loon Lake CLP populations only increase from 34% in 2008 to 58% in 2011. CLP reaches maturity in midsummer, typically June in Lake County when our natives are starting to emerge. This allows the plant to get a head start and outcompete native plants in the spring. In August the plant species varied from 2008 and 2011 within the treatment areas. Floatingleaf Pondweed, Sago Pondweed, and Vallisineria were only present in 2008, with a total of 18 species. The most dominate species was EWM at 96%. In 2011 there were 19 species; including Bladderwort, American Lotus, and Small Pondweed. Watermeal and Coontail were the dominant species 93% and 86%, respectively. Flatstem Pondweed (68%) and EWM (68%) were also abundant. Overall within the treatment areas there was a significant reduction in EWM and an increase in plant diversity early in the season. The 2011 plant community also had an increase in desirable aquatic plant species, specifically American Lotus and Small Pondweed. However there was a notable increase in CLP specifically within the treatment areas (Figures 3-7).

Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a lake. 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 East Loon Lake ranged from 14 feet in July to 6 feet in August. In June submerged aquatic plants were found at 12 feet and 10 feet in August.

Floristic quality index (FQI; Swink and Wilhelm 1994) is an assessment tool designed to evaluate the closeness the flora of an area is 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. The median FQI of lakes that we have studied from 2000-2011 was 14.3. In 2011, East Lake had an FQI of 37.0 and ranked #2 of 158 lakes in the county (Table 9). This was an increase from the 2008 FQI of 30.6.

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

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

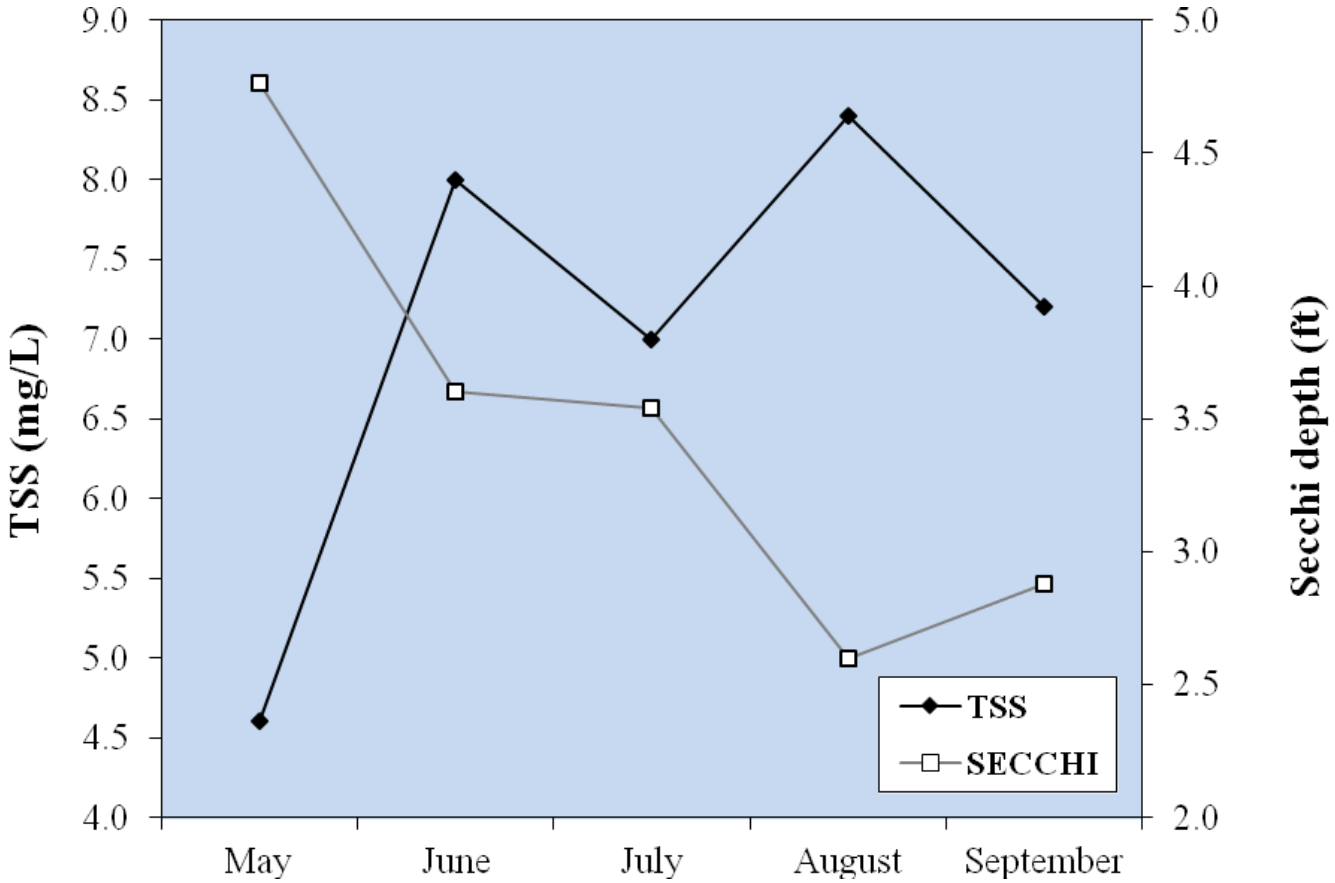

Table 1. Summary of water quality data for East Loon Lake, 2008, 2010, and 2011.

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	168	0.83	<0.1	<0.05	0.030	<0.005	154	NA	4.0	496	99	5.5	0.8219	8.18	9.54
21-Jun	3	158	0.91	<0.1	<0.05	0.040	<0.005	149	NA	3.9	483	111	5.55	0.7587	8.67	9.82
19-Jul	3	159	1.22	<0.1	<0.05	0.034	<0.005	163	NA	5.0	512	115	3.40	0.8136	8.77	8.15
16-Aug	3	149	1.19	<0.1	<0.05	0.043	<0.005	122	NA	6.6	432	110	2.30	0.6626	8.52	9.91
20-Sep	3	162	0.99	<0.1	<0.05	0.051	<0.005	131	NA	4.8	451	115	3.65	0.7152	7.9	6.83
	Average	159	1.03	<0.1	<0.05	0.040	<0.005	144	NA	4.9	475	110	4.08	0.7544	8.41	8.85

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	171	0.80	0.116	<0.05	0.042	<0.005	143	NA	4.6	496	121	4.76	0.7870	8.38	11.44
15-Jun	3	159	1.25	<0.1	0.087	0.069	<0.005	134	NA	8.0	469	116	3.60	0.7487	8.51	9.24
20-Jul	3	167	1.27	<0.1	<0.05	0.047	<0.005	132	NA	7.0	462	116	3.54	0.7625	8.59	7.01
17-Aug	3	158	1.33	<0.1	<0.05	0.039	<0.005	119	NA	8.4	431	106	2.60	0.6990	8.6	7.39
20-Sep	3	169	1.24	<0.1	<0.05	0.062	<0.005	131	NA	7.2	465	119	2.88	0.7560	8.4	6.22
	Average	165	1.18	0.116[k]	0.087[k]	0.052	<0.005	132	NA	7.0	465	116	3.48	0.7506	8.50	8.26

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	183	0.76	<0.1	<0.05	0.034	<0.005	183	NA	3.0	538	93	9.35	0.9594	8.52	9.37
17-Jun	3	161	0.96	<0.1	<0.05	0.045	<0.005	157	NA	3.2	499	100	6.73	0.8486	8.23	7.72
15-Jul	3	145	0.96	<0.1	<0.05	0.043	<0.005	137	NA	3.2	441	89	6.27	0.7547	8.54	8.38
19-Aug	3	152	1.12	<0.1	<0.05	0.042	<0.005	142	NA	6.1	469	113	4.36	0.7539	8.64	8.14
16-Sep	3	150	1.29	<0.1	<0.05	0.082	<0.005	139	NA	7.7	454	100	5.25	0.7573	8.15	7.22
	Average	158	1.02	<0.1	<0.05	0.049	<0.005	152	NA	4.6	480	99	6.39	0.8148	8.42	8.17

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	22	168	0.756	<0.1	<0.05	0.036	<0.005	151	NA	4.2	486	96	NA	0.8245	8.29	9.39
21-Jun	22	180	1.21	0.526	<0.05	0.335	0.276	153	NA	6.2	513	124	NA	0.7852	7.47	0.30
19-Jul	21	192	1.95	1.120	<0.05	0.598	0.490	146	NA	5.0	512	110	NA	0.8033	7.29	0.23
16-Aug	22	199	2.34	1.620	<0.05	0.581	0.503	150	NA	3.1	495	85	NA	0.8062	7.06	0.23
20-Sep	21	206	3.31	2.560	<0.05	0.729	0.629	150	NA	8.2	508	108	NA	0.8216	6.99	0.29
	Average	189	1.91	1.185[k]	<0.05	0.456	0.475	150	NA	5.3	503	105	NA	0.8082	7.42	2.09

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	19	180	0.955	<0.1	<0.05	0.037	0.013	151	NA	3.6	519	120	NA	0.8409	8.05	4.63
15-Jun	20	190	1.17	0.368	0.134	0.203	0.132	150	NA	5.5	511	106	NA	0.8578	7.84	0.27
20-Jul	19	209	1.94	1.140	<0.05	0.461	0.392	153	NA	4.0	516	121	NA	0.8783	7.22	0.21
17-Aug	18	201	1.8	0.956	<0.05	0.280	0.256	152	NA	4.2	529	131	NA	0.8710	7.31	0.20
20-Sep	18	181	1.70	0.638	<0.05	0.168	0.087	137	NA	11.0	487	122	NA	0.8539	7.48	0.31
	Average	192	1.51	0.776[k]	0.134[k]	0.230	0.176	149	NA	5.7	512	120	NA	0.8604	7.58	1.12

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	21	187	1.03	0.308	<0.05	0.176	0.116	180	NA	4.0	539	95	NA	0.9560	7.72	0.30
17-Jun	22	188	1.43	0.548	<0.05	0.265	0.215	187	NA	3.0	579	120	NA	0.9782	7.74	0.19
15-Jul	22	193	1.80	0.916	<0.05	0.466	0.404	183	NA	2.6	569	121	NA	0.9811	7.66	0.19
19-Aug	21	212	2.84	1.930	<0.05	0.920	0.709	183	NA	4.3	584	120	NA	0.9853	7.43	0.18
16-Sep	20	215	3.22	2.340	<0.05	0.990	0.836	181	NA	4.8	578	117	NA	1.0070	7.23	0.21
	Average	199	2.06	1.208	<0.05	0.563	0.456	183	NA	3.7	570	115	NA	0.9815	7.56	0.21

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 203 sample sites on East Loon Lake, June 2011. Maximum depth that plants were found was 12.0 feet.

Plant Density	American Lotus	American Pondweed	Common Bladderwort	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Giant Duckweed
Absent	159	154	132	151	82	42	106	117	80	96	133
Present	1	4	16	3	14	22	45	17	31	31	25
Common	0	1	12	5	35	24	9	14	32	28	2
Abundant	0	1	0	1	23	28	0	9	13	5	0
Dominant	0	0	0	0	6	44	0	3	4	0	0
% Plant Occurrence	0.5%	3.0%	13.8%	4.4%	38.4%	58.1%	26.6%	21.2%	39.4%	31.5%	13.3%

Plant Density	Grass-leaved Pondweed	Illinois Pondweed	Largeleaf Pondweed	Sago Pondweed	Southern Naiad	Spadderdock	Star Duckweed	Watermeal	Water Stargrass	White Water Crowfoot	White Water Lily
Absent	157	153	155	103	158	157	125	56	156	126	89
Present	3	6	2	32	2	2	24	41	3	18	26
Common	0	1	3	18	0	1	11	38	0	15	27
Abundant	0	0	0	6	0	0	0	24	1	0	17
Dominant	0	0	0	1	0	0	0	1	0	1	1
% Plant Occurrence	1.5%	3.4%	2.5%	28.1%	1.0%	1.5%	17.2%	51.2%	2.0%	16.7%	35.0%

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

Rake Density (Coverage)	# of Sites	%
No plants	12	5.9
>0 to 10%	9	4.4
>10 to 40%	20	9.9
>40 to 60%	31	15.3
>60 to 90%	31	15.3
>90%	57	28.1
Total Sites with Plants	148	72.9
Total # of Sites	203	100.0

Table 4. Aquatic vegetation species found at the 203 sampled sites on East Loon Lake, August 2011. Maximum depth that plants were found was 17.0 feet.

Plant Density	American Lotus	American Pondweed	Common Bladderwort	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Floatingleaf Pondweed	Giant Duckweed	Grass-leaved Arrowhead
Absent	158	152	142	151	40	155	103	136	81	101	154	139	157
Present	0	3	5	2	26	4	30	13	33	29	1	19	2
Common	0	3	8	2	41	0	22	8	14	22	3	1	0
Abundant	1	1	4	2	15	0	4	1	17	6	1	0	0
Dominant	0	0	0	2	37	0	0	1	14	1	0	0	0
% Plant Occurrence	0.5%	3.4%	8.4%	3.9%	58.6%	2.0%	27.6%	11.3%	38.4%	28.6%	2.5%	9.9%	1.0%

Plant Density	Grass-leaved Pondweed	Illinois Pondweed	Largeleaf Pondweed	Northern Watermilfoil	Sago Pondweed	Slender Naiad	Small Pondweed	Southern Naiad	Spadderdock	Star Duckweed	Vallisneria	Watermeal	Water Stargrass	White Water Lily
Absent	155	144	149	158	129	155	155	152	156	97	153	17	141	52
Present	3	5	7	1	14	3	2	3	2	40	4	35	12	22
Common	1	10	1	0	13	1	1	4	1	21	2	62	6	35
Abundant	0	0	2	0	3	0	1	0	0	1	0	29	0	19
Dominant	0	0	0	0	0	0	0	0	0	0	0	16	0	31
% Plant Occurrence	2.0%	7.4%	4.9%	0.5%	14.8%	2.0%	2.0%	3.4%	1.5%	30.5%	3.0%	70.0%	8.9%	52.7%

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

Rake Density (Coverage)	# of Sites	%
No plants	5	2.5
>0 to 10%	18	8.9
>10 to 40%	17	8.4
>40 to 60%	32	15.8
>60 to 90%	23	11.3
>90%	64	31.5
Total Sites with Plants	154	75.9
Total # of Sites	203	100.0

Table 5. Aquatic vegetation species found at the 29 sampling sites on East Loon Lake within the treatment areas, June 2008.

Plant Density	Chara	Coontail	Curlyleaf	Eurasian Watermilfoil	Giant Duckweed	Illinois Pondweed	Watermeal	White Water Lily
Absent	21	21	21	4	25	26	26	24
Present	0	3	4	2	3	2	2	4
Common	3	3	1	6	0	0	0	0
Abundant	2	0	1	2	0	0	0	0
Dominant	2	1	1	14	0	0	0	0
% Plant Occurrence	25.0%	25.0%	25.0%	85.7%	10.7%	7.1%	7.1%	14.3%

Table 5a. Distribution of rake density across all sampling sites

Rake Density (Coverage)	# of Sites	%
No plants	0	0.0
>0 to 10%	1	3.6
>10 to 40%	5	17.9
>40 to 60%	3	10.7
>60 to 90%	2	7.1
>90%	17	60.7
Total Sites with Plants	28	100.0
Total Sites	28	17.8

Table 6. Aquatic vegetation species found at the 29 sampling sites on East Loon Lake within the Treatment Areas, June 2011.

Plant Density	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Giant Duckweed	Illinois Pondweed
Absent	27	16	4	23	24	14	18	25	27
Present	1	3	4	4	1	4	4	3	0
Common	0	7	4	1	2	7	5	0	1
Abundant	0	2	8	0	1	2	1	0	0
Dominant	0	0	8	0	0	1	0	0	0
% Plant Occurrence	3.6%	42.9%	85.7%	17.9%	14.3%	50.0%	35.7%	10.7%	3.6%

Plant Density	Largeleaf Pondweed	American Lotus	Sago Pondweed	Southern Naiad	Star Duckweed	White Water Crowfoot	Watermeal	Water Stargrass	White Water Lily
Absent	24	27	22	27	23	25	14	27	22
Present	1	1	4	1	4	2	7	1	3
Common	3	0	1	0	1	1	5	0	3
Abundant	0	0	1	0	0	0	2	0	0
Dominant	0	0	0	0	0	0	0	0	0
% Plant Occurrence	14.3%	3.6%	21.4%	3.6%	17.9%	10.7%	50.0%	3.6%	21.4%

Table 6a. Distribution of rake density across all sampling sites

Rake Density (Coverage)	# of Sites	%
No plants	3	10.7
>0 to 10%	4	14.3
>10 to 40%	3	10.7
>40 to 60%	10	35.7
>60 to 90%	2	7.1
>90%	6	21.4
Total Sites with Plants	25	89.3
Total Sites	28	15.9

Table 7. Aquatic vegetation species found at the 29 sampling sites on East Loon Lake within the Treatment Areas, August 2008.

Plant Density	American Pondweed	Chara	Coontail	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Floatingleaf Pondweed	Illinois Pondweed
Absent	25	21	16	24	27	1	27	27	24
Present	1	3	5	3	1	3	1	1	2
Common	2	0	4	1	0	2	0	0	2
Abundant	0	3	3	0	0	3	0	0	0
Dominant	0	1	0	0	0	19	0	0	0
% Plant Occurrence	10.7%	25.0%	42.9%	14.3%	3.6%	96.4%	3.6%	3.6%	14.3%

Plant Density	Largeleaf Pondweed	Sago Pondweed	Slender Naiad	Spatterdock	Star Duckweed	Vallisneria	Watermeal	Water Stargrass	White Water Lily
Absent	25	23	27	27	26	23	13	24	15
Present	3	4	1	1	2	4	11	3	13
Common	0	1	0	0	0	1	2	1	0
Abundant	0	0	0	0	0	0	2	0	0
Dominant	0	0	0	0	0	0	0	0	0
% Plant Occurrence	10.7%	17.9%	3.6%	3.6%	7.1%	17.9%	53.6%	14.3%	46.4%

Table 7a. Distribution of rake density across all sampling sites

Rake Density (Coverage)	# of Sites	%
No plants	0	0.0
>0 to 10%	0	0.0
>10 to 40%	0	0.0
>40 to 60%	4	14.3
>60 to 90%	2	7.1
>90%	22	78.6
Total Sites with Plants	28	100.0
Total Sites	28	17.8

Table 8. Aquatic vegetation species found at the 29 sampling sites on East Loon Lake within the Treatment Areas, August 2011.

Plant Density	American Pondweed	Bladderwort	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Flatstem Pondweed	Giant Duckweed
Absent	27	27	26	4	27	24	27	9	9	26
Present	1	1	1	9	1	2	1	11	8	1
Common	0	0	1	9	0	1	0	4	8	1
Abundant	0	0	0	3	0	1	0	1	3	0
Dominant	0	0	0	3	0	0	0	3	0	0
% Plant Occurrence	3.6%	3.6%	7.1%	85.7%	3.6%	14.3%	3.6%	67.9%	67.9%	7.1%

Plant Density	Illinois Pondweed	Largeleaf Pondweed	American Lotus	Small Pondweed	Southern Naiad	Star Duckweed	Watermeal	Water Stargrass	White Water Lily
Absent	23	22	27	25	26	19	2	26	13
Present	3	3	0	1	2	7	9	2	4
Common	2	1	0	1	0	2	15	0	7
Abundant	0	2	1	1	0	0	1	0	4
Dominant	0	0	0	0	0	0	1	0	0
% Plant Occurrence	17.9%	21.4%	3.6%	10.7%	7.1%	32.1%	92.9%	7.1%	53.6%

Table 8a. Distribution of rake density across all sampling sites

Rake Density (Coverage)	# of Sites	%
No plants	0	0.0
>0 to 10%	3	10.7
>10 to 40%	9	32.1
>40 to 60%	9	32.1
>60 to 90%	5	17.9
>90%	2	7.1
Total Sites with Plants	28	100.0
Total Sites	28	17.8

Figure 3. Aquatic plant sampling illustrating plant density on East Loon Lake, June 2011.

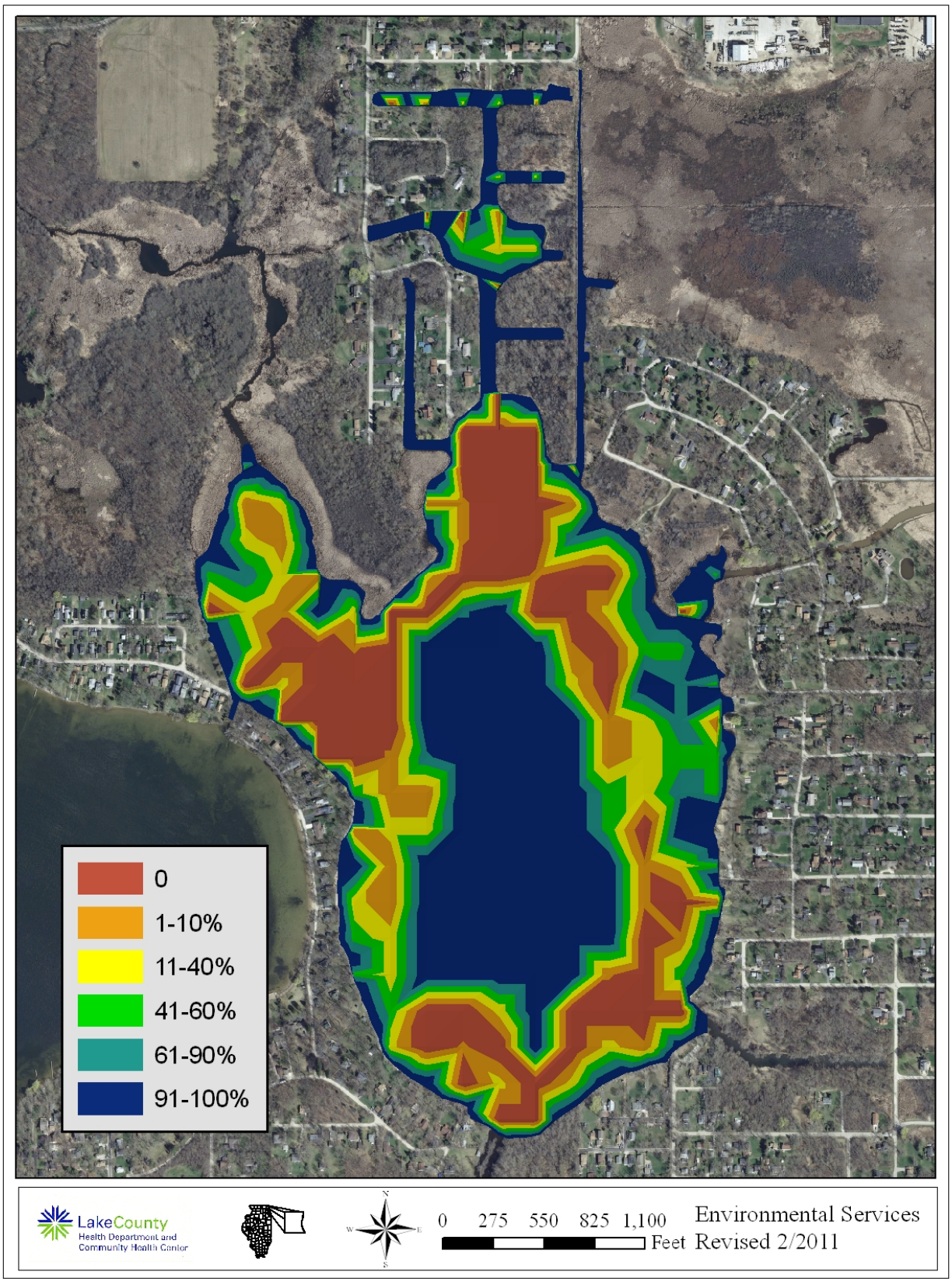

Figure 4. Aquatic plant sampling illustrating plant density on East Loon Lake, August 2011.

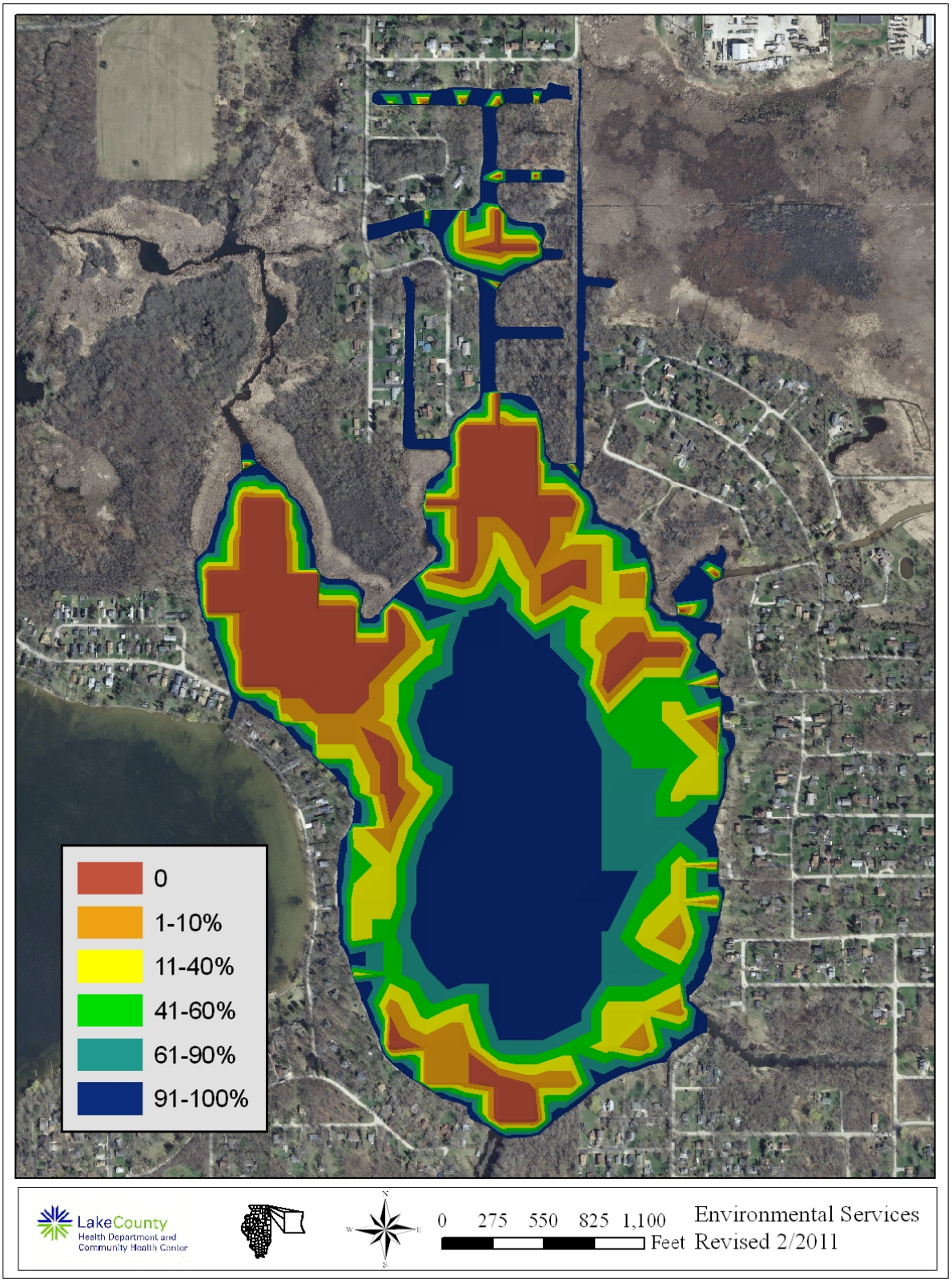

Figure 5. Aquatic plant sampling illustrating Eurasian Watermilfoil on East Loon Lake, June 2011.

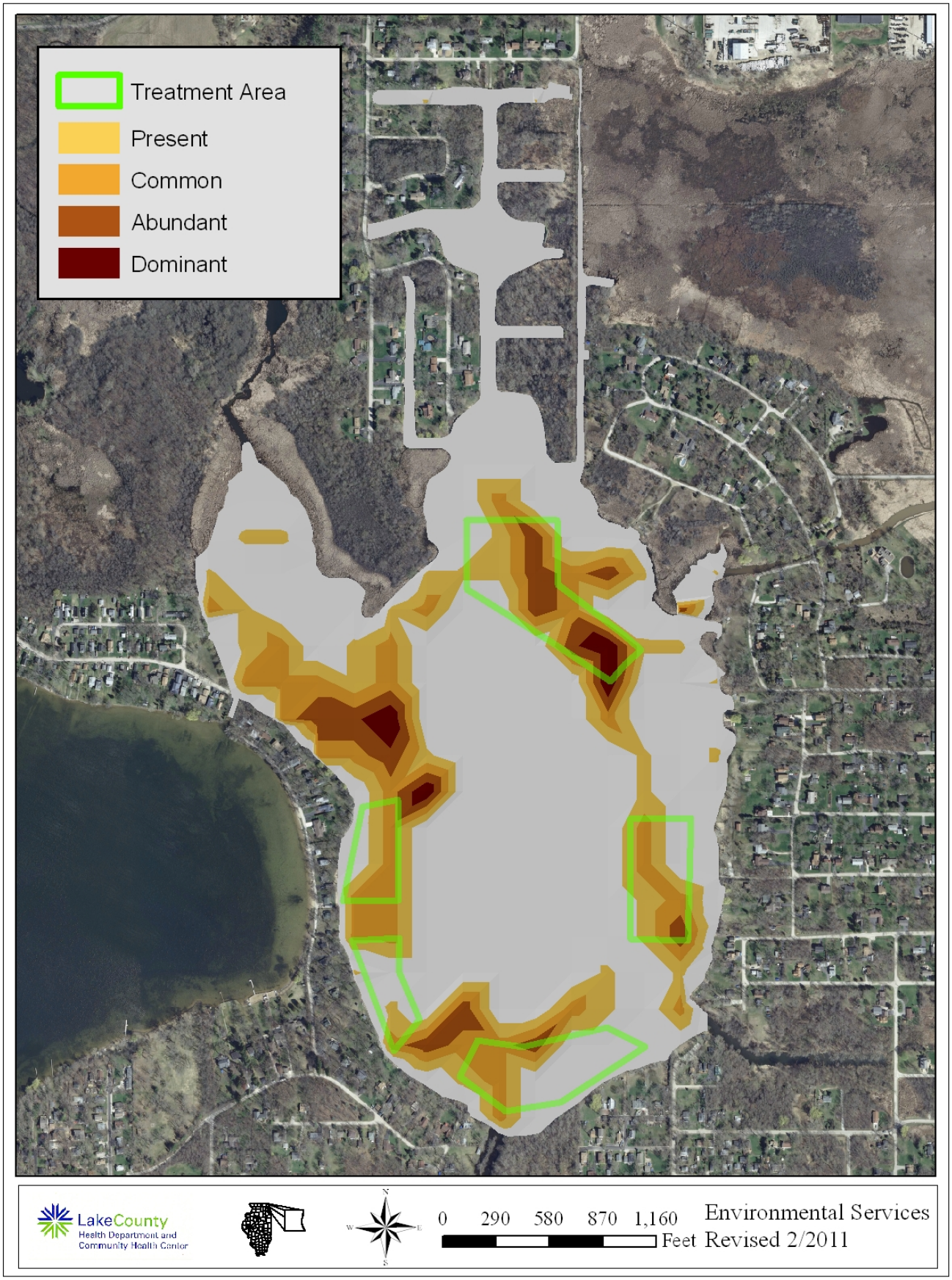

Figure 6. Aquatic plant sampling illustrating Eurasian Watermilfoil on East Loon Lake, August 2011.

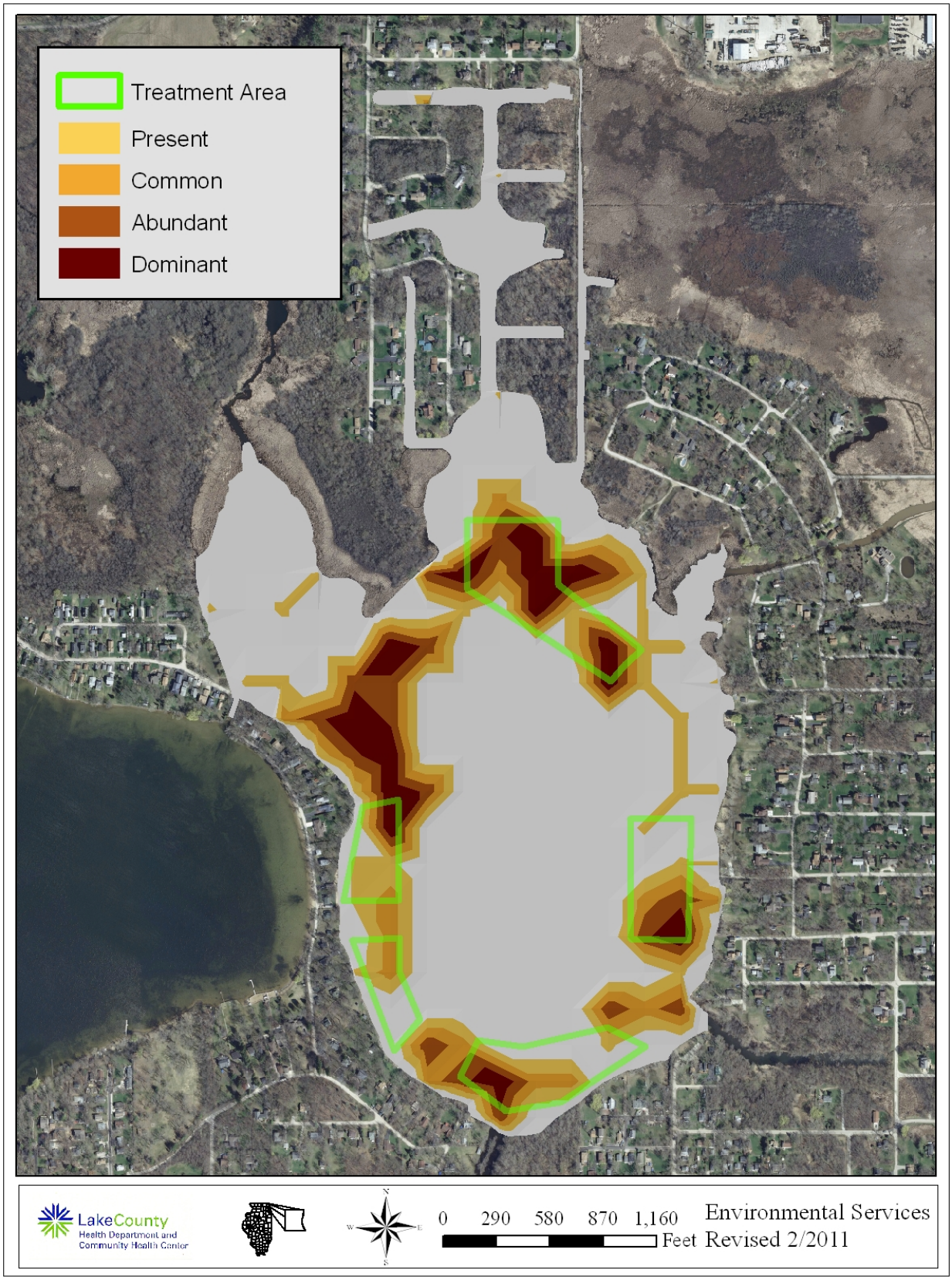

Figure 7. Aquatic plant sampling illustrating Curlyleaf Pondweed on East Loon Lake, June 2011.

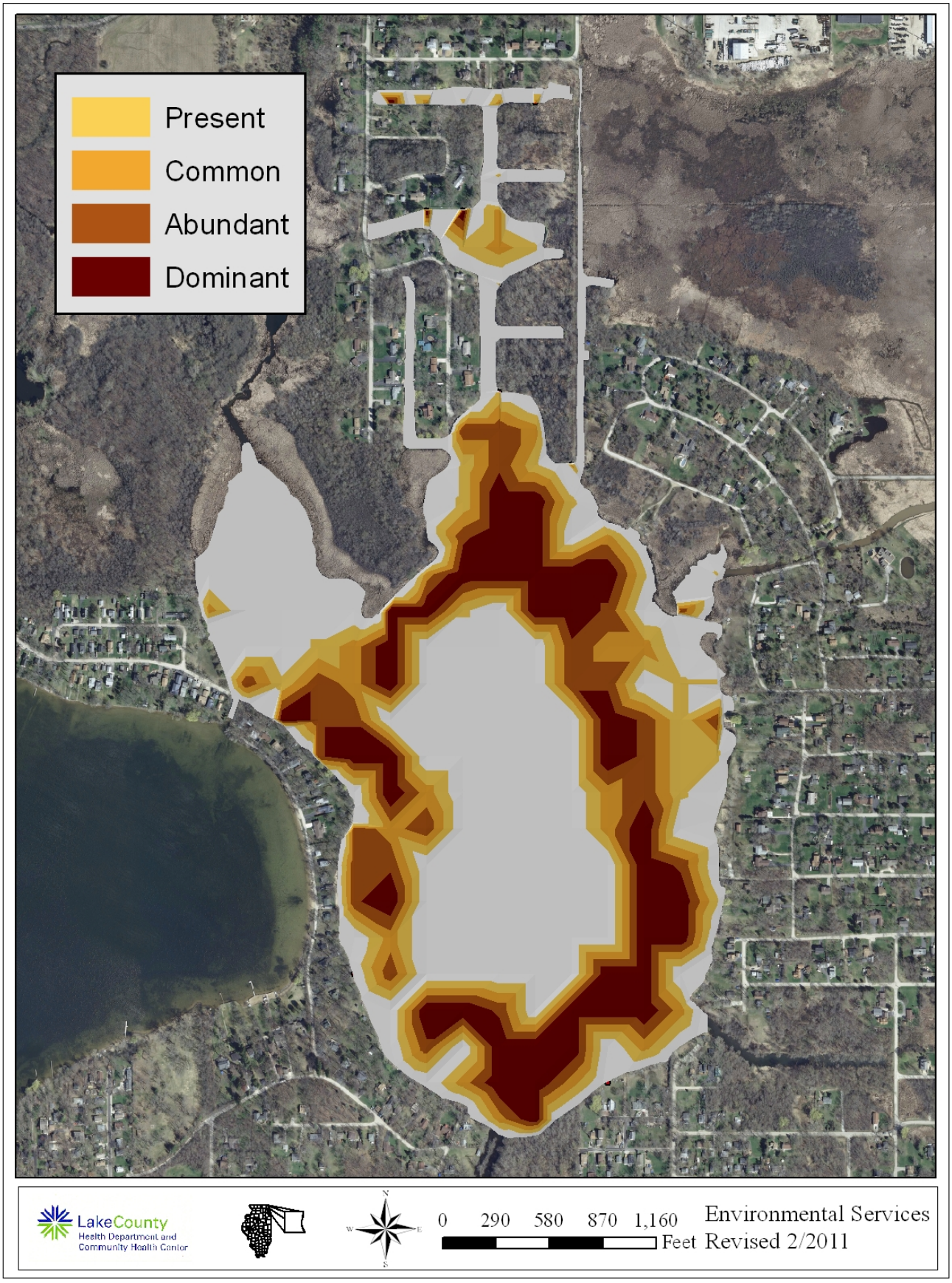

Table 9. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/Adventives) and with native species only (native).

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 9. 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 9. 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

East 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	0.30
51711	0.25	0.33	12.59	9.60	92.9	0.8222	7.52	3336	Surface	100%	
51711	1	0.96	12.58	9.52	92.2	0.8218	8.02	3134	Surface	100%	
51711	2	2.07	12.58	9.54	92.3	0.8218	8.13	1168	0.400	37%	2.47
51711	3	3.07	12.58	9.54	92.4	0.8219	8.18	648	1.400	21%	0.42
51711	4	4.03	12.57	9.53	92.2	0.8218	8.2	690	2.360	22%	-0.03
51711	6	5.97	12.56	9.59	92.7	0.8217	8.23	295	4.300	9%	0.20
51711	8	7.99	12.56	9.58	92.7	0.8222	8.23	124	6.320	4%	0.14
51711	10	9.99	12.55	9.65	93.3	0.8221	8.25	59	8.320	2%	0.09
51711	12	12.03	12.54	9.65	93.3	0.8223	8.26	31	10.360	1.0%	0.06
51711	14	14.00	12.55	9.66	93.4	0.8224	8.27	16	12.330	0.5%	0.05
51711	16	16.03	12.53	9.74	94.2	0.8245	8.29	9	14.360	0.3%	0.04
51711	18	17.97	12.49	9.83	94.9	0.8251	8.32	4	16.300	0.1%	0.05
51711	20	20.06	12.35	9.64	92.8	0.8282	8.31	2	18.390	0.1%	0.04
51711	22	22.08	12.23	9.39	90.2	0.8245	8.29	1	20.410	0.0%	0.03
51711	24	24.01	11.86	8.5	80.9	0.8231	8.12	1	22.340	0.0%	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	0.56
62111	0.25	0.24	23.4	9.5	116.1	0.7585	8.64	3078	Surface	100%	
62111	1	0.96	23.38	9.76	119	0.7587	8.67	3001	Surface	100%	
62111	2	1.96	23.33	9.8	120	0.7586	8.67	993	0.290	33%	3.81
62111	3	3.04	23.34	9.82	120	0.7587	8.67	545	1.370	18%	0.44
62111	4	3.99	23.24	9.77	119	0.7592	8.66	339	2.320	11%	0.20
62111	6	5.98	22.25	5.21	62.2	0.7791	8.08	122	4.310	4%	0.24
62111	8	7.98	20.58	5.78	66.9	0.7597	8.11	54	6.310	1.8%	0.13
62111	10	9.98	19.28	5.82	65.7	0.7763	7.94	29	8.310	1.0%	0.07
62111	12	11.95	18.48	4.59	50.9	0.7707	7.81	13	10.280	0.4%	0.08
62111	14	13.98	16.23	3.06	32.4	0.7712	7.69	8	12.310	0.3%	0.04
62111	16	15.99	14.44	1.44	14.6	0.7745	7.58	5	14.320	0.2%	0.03

East Loon 11

62111	18	17.99	13.43	0.56	5.6	0.7803	7.5	3	16.320	0.1%	0.03
62111	20	20.06	13.13	0.32	3.2	0.7835	7.49	2	18.390	0.1%	0.02
62111	22	22.03	12.88	0.3	2.9	0.7852	7.47	1	20.360	0.0%	0.03
62111	24	23.99	12.68	0.27	2.7	0.7882	7.44	0	22.320		

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 Average	Extinction Coefficient 0.23
71911	0.25	0.26	28.89	8.22	110	0.8139	8.78	1162	Surface	100%	
71911	1	1.04	28.87	8.24	111	0.8140	8.77	168	Surface	100%	
71911	2	2.04	28.84	8.24	110	0.8139	8.77	72	0.370	43%	2.29
71911	3	3	28.78	8.15	109	0.8136	8.77	87	1.330	52%	-0.14
71911	4	4	28.6	7.93	106	0.8143	8.74	195	2.330	116%	-0.35
71911	6	5.93	27.4	5.08	66.3	0.8168	8.43	91	4.260	54%	0.18
71911	8	8.02	25.24	2.17	27.2	0.8136	8.01	29	6.350	17%	0.18
71911	10	10.07	22.47	0.38	4.5	0.8030	7.75	9	8.400	5.4%	0.14
71911	12	12.07	19.04	0.26	2.9	0.7836	7.58	4	10.400	2.4%	0.08
71911	14	13.96	16.52	0.26	2.7	0.7789	7.51	1	12.290	0.6%	0.11
71911	16	16.28	14.68	0.26	2.6	0.7923	7.47	1	14.610	0.6%	0.00
71911	18	17.93	13.82	0.25	2.5	0.7948	7.42	1	16.260	0.6%	0.00
71911	20	20.05	13	0.23	2.3	0.8033	7.31	1	18.380	0.6%	0.00
71911	22	22.04	12.90	0.23	2.2	0.8032	7.26	0	20.370	0.0%	
71911	24	23.950	12.86	0.22	2.2	0.805	7.20	0	22.280	0.0%	

East Loon 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 Average	Extinction Coefficient 0.75
81611	0.5	0.32	24.53	10	124	0.6628	8.53	3554	Surface	100%	
81611	1	1.01	24.34	10.15	125	0.6627	8.55	3486	Surface	100%	
81611	2	2.00	24.19	9.99	122	0.6626	8.53	1149	0.330	33%	3.36
81611	3	3.00	24.05	9.91	121	0.6626	8.52	373	1.330	11%	0.85
81611	4	4.08	23.96	9.74	119	0.6629	8.50	142	2.410	4%	0.40
81611	6	6.04	23.80	8.53	104	0.6646	8.28	42	4.370	1.2%	0.28
81611	8	8.01	23.55	6.53	79	0.6672	8.07	14	6.340	0.4%	0.17
81611	10	10.04	23.22	4.05	48.7	0.6934	7.76	5	8.370	0.1%	0.12

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81611	12	12.03	22.25	0.35	4.1	0.7036	7.46	2	10.360	0.1%	0.09
81611	14	13.96	19.38	0.27	3.0	0.7782	7.34	0	12.290		
81611	16	16.05	16.64	0.24	2.6	0.7911	7.31	0	14.380		
81611	18	18.04	15.00	0.24	2.4	0.7942	7.25	0	16.370		
81611	20	20.10	13.94	0.23	2.3	0.8038	7.09	0	18.430		
81611	22	22.01	13.63	0.23	2.2	0.8062	7.06	0	20.340		
81611	24	23.98	13.44	0.23	2.2	0.8084	7.02	0	22.310		

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	0.53	
92011	0.25	0.36	17.72	6.93	74.7	0.7153	7.91	3370	Surface	100%		
92011	1	1.05	17.71	6.9	74.4	0.7153	7.91	3258	Surface	100%		
92011	2	2.03	17.69	6.89	74.3	0.7153	7.90	856	0.360	26%	3.71	
92011	3	3.06	17.68	6.83	73.7	0.7152	7.90	380	1.390	12%	0.58	
92011	4	4.02	17.69	6.87	74	0.7165	7.90	213	2.350	7%	0.25	
92011	6	6.00	17.67	6.78	73.1	0.7152	7.90	67	4.330	2.1%	0.27	
92011	8	8.00	17.67	6.76	72.8	0.7154	7.89	27	6.330	0.8%	0.14	
92011	10	10.05	17.67	6.71	72.4	0.7154	7.88	11	8.380	0.3%	0.11	
92011	12	12.04	17.66	6.50	70	0.7156	7.86	5	10.370	0.2%	0.08	
92011	14	14.00	17.63	5.48	59	0.7174	7.74	2	12.330	0.1%	0.07	
92011	16	16.00	17.47	3.30	35.4	0.7217	7.57	1	14.330	0.03%	0.05	
92011	18	18.05	17.05	0.73	7.7	0.7404	7.38	1	16.380	0.03%	0.00	
92011	20	20.02	15.3	0.30	3.1	0.8167	7.04	0	18.350			0.29
92011	22	22.06	14.6	0.27	2.7	0.8264	6.94	0	20.390			
92011	24	24.01	13.57	0.25	2.4	0.8463	6.81	0	22.340			

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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