

**2005 SUMMARY REPORT  
of  
Cedar Lake**

**Lake County, Illinois**

*Prepared by the*

**LAKE COUNTY HEALTH DEPARTMENT  
ENVIRONMENTAL HEALTH SERVICES  
LAKES MANAGEMENT UNIT**

3010 Grand Avenue  
Waukegan, Illinois 60085

**Adrienne Davis**  
Michael Adam  
Leonard Dane  
Shaina Keseley

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## EXECUTIVE SUMMARY

Cedar Lake is a 302-acre glacial lake in the Village of Lake Villa with a maximum depth of 44 feet. Although the Illinois Department of Natural Resources (IDNR) owns some of the lake bottom, most is privately owned. The parcel owned by the IDNR contains the Cedar Lake Bog, which is a dedicated Illinois Nature Preserve. The lake is the headwaters of the Sequoit Creek watershed, and drains to a small creek that reaches Deep Lake, which eventually flows to the Fox River/Chain O'Lakes.

The water quality in Cedar Lake has been relatively stable since 1990 with many parameters below the county medians. Total phosphorus (TP) in the epilimnion of Cedar Lake averaged 0.018 mg/L and the median for the county was 0.062 mg/L. Total suspended solid (TSS) concentrations averaged 2.4 mg/L, which is over three times lower than the county median of 7.9 mg/L. As a result of low TSS concentrations, the average Secchi depth for the season was 8.58 feet, with a considerable decrease in the Secchi depth in May corresponding to an increase in TSS. This was most likely due to the algal bloom present at the time of sampling. A Total Nitrogen to Total Phosphorus (TN:TP) ratio of 76:1 in Cedar Lake means phosphorus was highly limiting. Also using phosphorus as an indicator, the trophic state index (TSI) ranked Cedar Lake as mesotrophic with a TSIp value of 46.1. Cedar Lake ranked 7<sup>th</sup> in the county of 162 lakes for TSIp. The average conductivity reading for Cedar Lake was 0.6447 mS/cm. This is below the county median of 0.7748 mS/cm, however it has increased 9% since 2003 (0.5932 mS/cm).

Twenty-four species of plants were found during the two sampling times of June and August. In June the three most abundant species were *Chara* spp., Largeleaf Pondweed, and Eurasian Watermilfoil. This shifted slightly in August with *Chara* spp., Southern Naiad, and Eurasian Watermilfoil being the most dominant.

In 2003, the most common shoreline types were buffer (34%), wetland (25%), and woodland (14%). Approximately 97% of the shoreline classified as buffer was on developed property where the owners had allowed plants other than turfgrass to meet the shoreline. In 2003, only 4.7 % of the shoreline was eroding with the south side of the island having a noticeable shoreline loss since 1990. In 2005 the shoreline was reevaluated for erosion, and areas exhibiting little to no erosion in 2003 are now exhibiting slight to moderate erosion.

Seven species of birds were observed on Cedar Lake including an Illinois endangered species (Osprey). Mature trees, and the relatively large amount of shoreline classified as buffer, woodland, and wetland offer good habitat for a variety of wildlife. There is a great diversity of fish species (18 species) also present in the lake, which includes four Illinois threatened species and one Illinois endangered species. It is also believed that Zebra Mussels may be present in the lake. Their presence may have significant impacts on water quality and the food chain in the lake in the future. Precaution should be taken for future control of the species.

## LAKE FACTS

<b>Lake Name:</b>	Cedar Lake
<b>Historical Name:</b>	None
<b>Nearest Municipality:</b>	Lake Villa
<b>Location:</b>	T46N, R10E, Sections 32, 33
<b>Elevation:</b>	790 feet
<b>Major Tributaries:</b>	None
<b>Watershed:</b>	Fox River
<b>Sub-watershed:</b>	Sequoit Creek
<b>Receiving Water body:</b>	Deep Lake
<b>Surface Area:</b>	302 acres
<b>Shoreline Length:</b>	4.35 miles
<b>Maximum Depth:</b>	44 feet
<b>Average Depth:</b>	8.3 feet
<b>Lake Volume:</b>	2,482 acre-feet
<b>Lake Type:</b>	Glacial
<b>Watershed Area:</b>	653 acres
<b>Major Watershed Land uses:</b>	Forest and grassland, Residential, and Government and Institution
<b>Bottom Ownership:</b>	Lake Villa, Private, and State
<b>Management Entities:</b>	Lake Villa and Private
<b>Current and Historical uses:</b>	Historically it was used for fishing, hunting and resort opportunities. Currently it is used for boating (10 hp limit), swimming, fishing, and aesthetics.
<b>Description of Access:</b>	No public access, Village residents

## SUMMARY OF WATER QUALITY

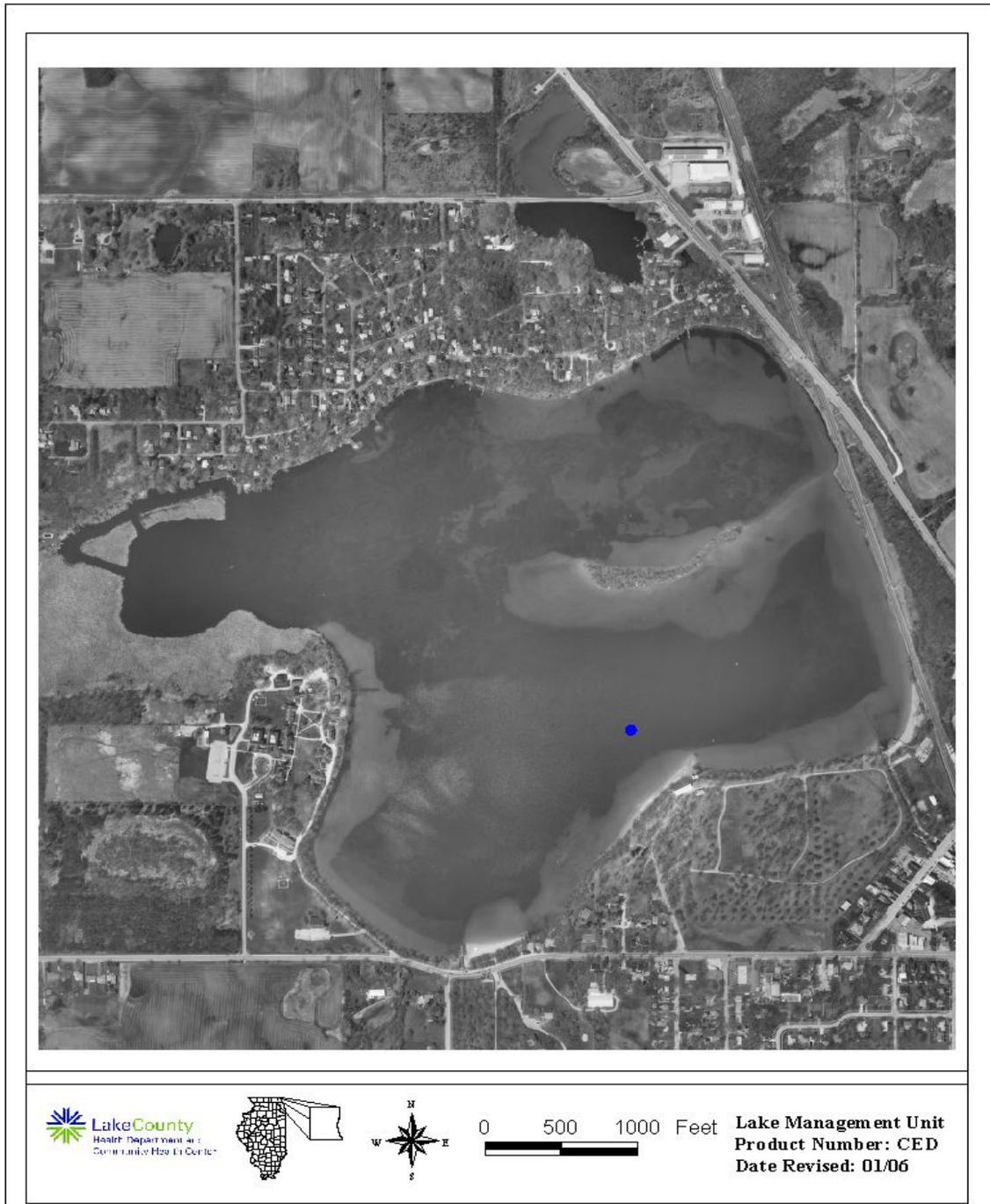
Water samples were collected from April to October in Cedar Lake at the deepest point near the center of the lake (Figure 1). Samples were taken at 3 feet below the surface and approximately 3 feet above the lake bottom (Appendix A). Water level was taken from the outflow each month during sampling. However, due to the very dry summer, the spillway was dry August through October so a total water loss could not be calculated. Although there is a staff gage back in the canal area, when water levels are low it is hard to access. A second gage is recommended that would be more easily accessible.

Stratification is typical of nutrient-enriched deep lakes like Cedar Lake. When stratified, the epilimnetic and hypolimnetic waters do not mix, and the hypolimnion typically becomes anoxic (dissolved oxygen <1 mg/L). Cedar Lake was stratified in 2005 from June through September with most of the lake having a >5.0 mg/L concentration of DO (Appendix B). This concentration (>5.0 mg/L) is considered adequate to support aquatic life, since some aquatic life, such as fish, suffer from oxygen stress below this amount. In June and July approximately 10% of the lake was anoxic and only 14% was anoxic in August and September.

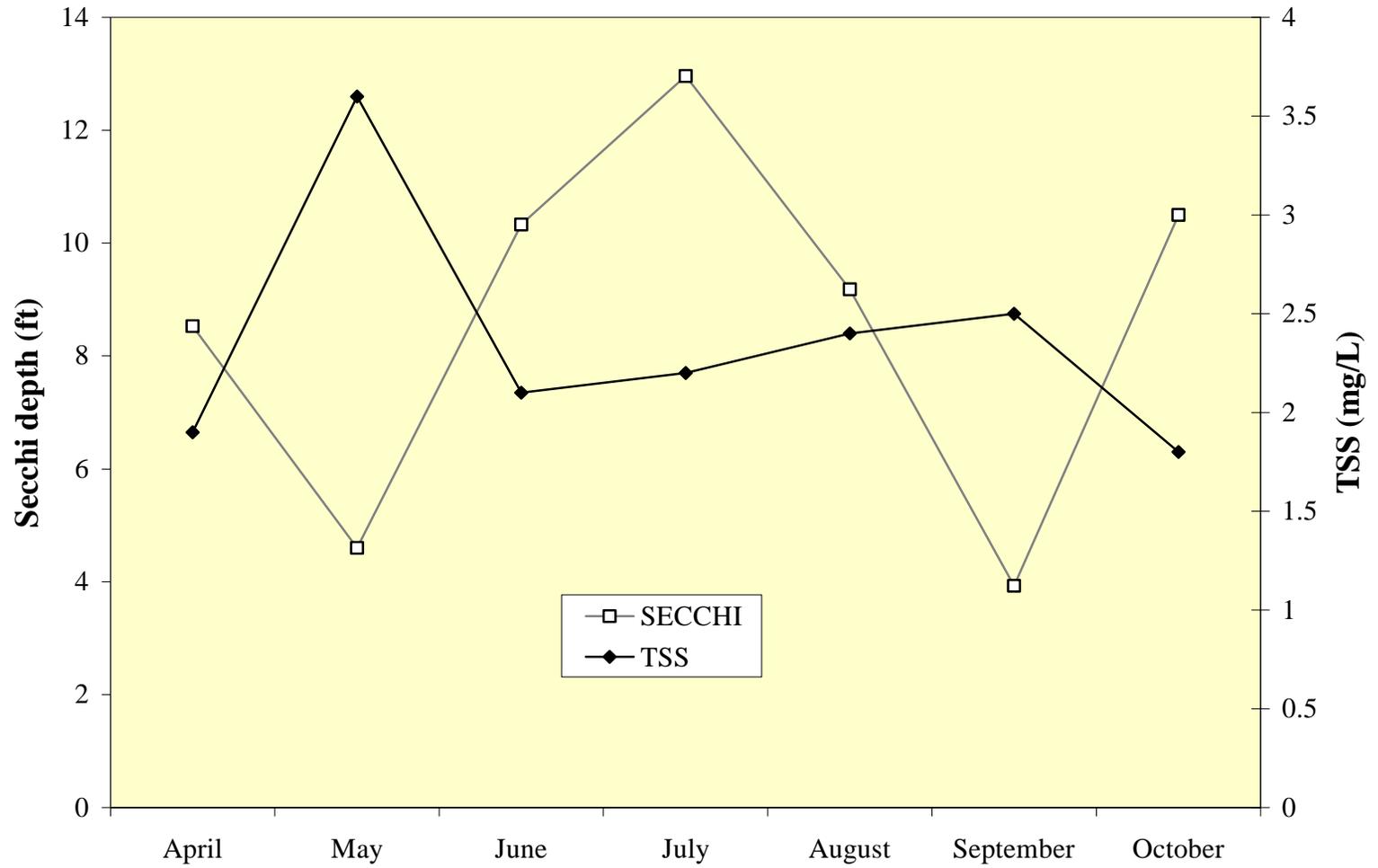
Cedar Lake has exceptional water quality (Appendix C) with many parameters below the county medians. The lake nutrient concentrations have been relatively stable since 1990. Total suspended solid (TSS) concentrations averaged 2.4 mg/L, which is over three times lower than the county median of 7.9 mg/L. 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 was high (8.58 feet). In May there was a considerable decrease in the Secchi depth corresponding to an increase in TSS (Figure 2). This was most likely due to the algal bloom present at the time of sampling. Water quality in 2003 was similar, the TSS average was 2.2 mg/L. Secchi disk readings far surpassed the county median in 2003 (3.41 feet), with an average of 12.16 feet. The average historical Secchi depth for the Lakes Management Unit (LMU) is 10.4 feet. Cedar Lake has been participating in the Volunteer Lake Management Program since 1985, providing valuable information throughout those years. It helps to fill in gaps when the LMU is not out sampling (Figure 3) and had similar Secchi depths in years the LMU samples. The average depth since 1985 is 10.3 feet.

Phosphorus is a nutrient that limits plant and algal growth, therefore any addition of phosphorus to the lake could produce algal blooms. Total phosphorus (TP) in the epilimnion of Cedar Lake averaged 0.018 mg/L (Table 1) and the median for the county was 0.063 mg/L (Appendix E). The historical average from 1990 to 2003 was 0.021 mg/L. Sources of TP may be a result of internal loading from the sediment or external sources such as the watershed (Figure 4). Phosphorus can enter a lake either internally (typically linked to sediment) or externally (point or non-point sources). Point source pollution can be from storm pipes or wastewater discharge and non-point source pollution is from groundwater runoff, which all pick up phosphorus from agricultural fields, septic systems, or impervious surfaces. The watershed is small (653 acres) and the land use within the watershed is primarily made up of forest and grassland (14%) (Figure 5). Therefore, most runoff may be filtered by the surrounding open landscape before entering the lake. Single family housing is the secondary use (11%), however potential land use changes

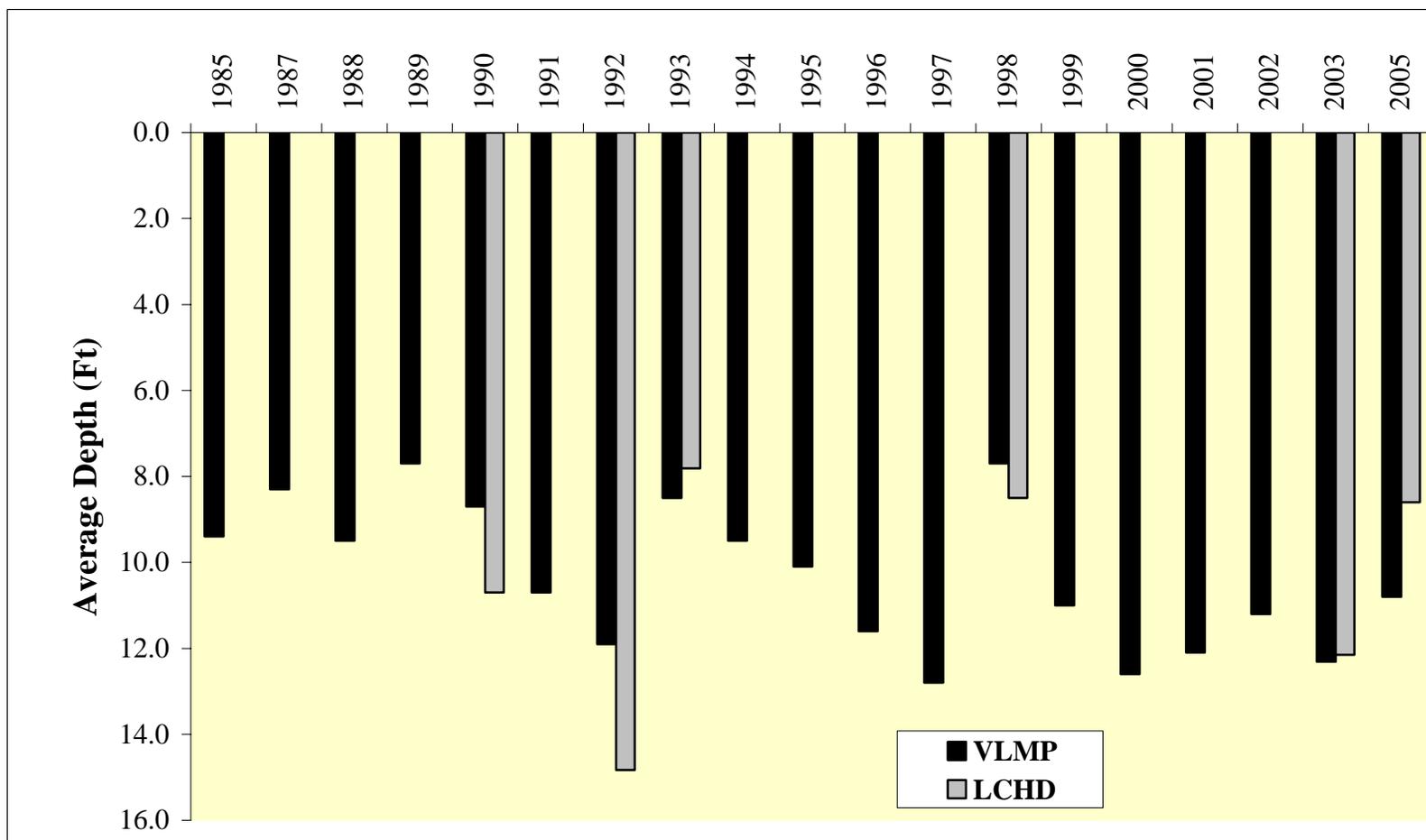
**Figure 1. Water quality sampling site on Cedar Lake, 2005.**



**Figure 2. Secchi depth vs. total suspended solid (TSS) concentrations in Cedar Lake, 2005.**



**Figure 3. Yearly Secchi depth averages from VLMP and LCHD records for Cedar Lake, 1985 to 2005.**



**Table 1. Summary of water quality data for Cedar Lake, 2005.**

2005		Epilimnion														
DATE	DEPTH	ALK	TKN	NH <sub>3</sub> -N	NO <sub>3</sub> -N	TP	SRP	TDS	Cl <sup>-</sup>	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	3	163	1.06	0.177	0.110	<0.05	<0.005	NA	94.9	1.9	388	107	8.53	0.6259	8.30	9.37
17-May	3	165	1.35	<0.1	0.069	0.029	<0.005	NA	100.0	3.6	400	111	4.60	0.6470	8.13	11.24
21-Jun	3	142	1.22	<0.1	<0.05	0.016	<0.005	NA	106.0	2.1	406	127	10.33	0.6376	8.14	8.87
19-Jul	3	136	0.98	<0.1	<0.05	0.012	<0.005	NA	117.0	2.2	406	122	12.96	0.6635	8.29	7.06
16-Aug	3	129	1.22	<0.1	<0.05	0.018	<0.005	NA	116.0	2.4	413	144	9.18	0.6400	9.05	8.59
20-Sep	3	124	1.15	<0.1	<0.05	0.015	<0.005	NA	188.0	2.5	396	122	3.93	0.6421	9.10	7.62
18-Oct	3	140	1.20	0.106	<0.05	0.02	<0.005	NA	117.0	1.8	397	112	10.50	0.6570	8.53	7.13

**Average**    143    1.17    0.141<sup>k</sup>    0.090<sup>k</sup>    0.018<sup>k</sup>    <0.005    NA    119.8    2.4    401    121    8.58    0.6447    8.51    8.55

2003		Epilimnion														
DATE	DEPTH	ALK	TKN	NH <sub>3</sub> -N	NO <sub>3</sub> -N	TP	SRP	TDS	Cl <sup>-</sup>	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	3	145	1.10	<0.1	<0.05	0.026	0.005	346	NA	1.4	371	110	15.91	0.6192	8.57	8.94
18-Jun	3	137	1.20	<0.1	<0.05	0.023	<0.005	378	NA	1.0	375	103	18.5	0.5947	9.04	8.89
23-Jul	3	120	1.13	<0.1	<0.05	0.021	<0.005	360	NA	3.0	365	118	8.69	0.5624	8.98	7.31
20-Aug	3	123	1.19	<0.1	<0.05	0.016	<0.005	318	NA	4.0	383	142	5.74	0.5814	9.16	8.92
24-Sep	3	135	1.25	<0.1	<0.05	0.020	<0.005	318	NA	1.4	367	121	11.94	0.6081	8.75	7.12

**Average**    132    1.17    <0.1    <0.05    0.021    0.005<sup>k</sup>    344    NA    2.2    372    119    12.16    0.5932    8.90    8.24

Glossary
ALK = Alkalinity, mg/L CaCO <sub>3</sub>
TKN = Total Kjeldahl nitrogen, mg/L
NH <sub>3</sub> -N = Ammonia nitrogen, mg/L
NO <sub>3</sub> -N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
TDS = Total dissolved solids, mg/L
Cl <sup>-</sup> = Chlorides, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

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

NA= Not applicable

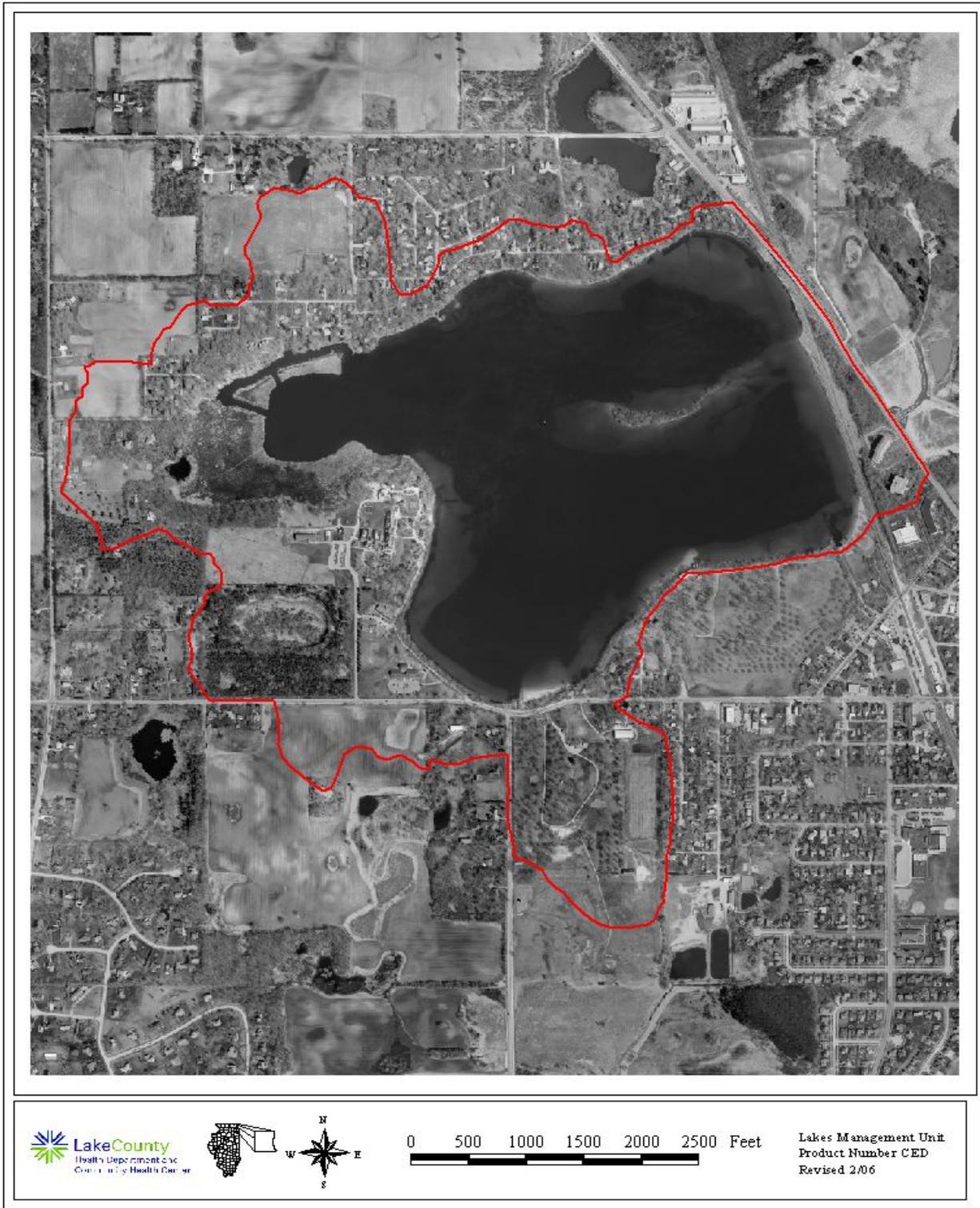
**Table 1. Continued.**

2005		Hypolimnion														
DATE	DEPTH	ALK	TKN	NH <sub>3</sub> -N	NO <sub>3</sub> -N	TP	SRP	TDS	Cl <sup>-</sup>	TSS	TS	TVS	SECCHI	COND	pH	DO
11-Apr	37	174	1.67	0.697	0.086	0.018	<0.005	NA	97.5	2.4	403	108	NA	0.6516	7.55	1.37
17-May	37	172	1.49	0.525	<0.05	0.013	<0.005	NA	98.8	1.3	393	97	NA	0.6604	7.28	2.23
21-Jun	38	181	1.91	0.939	<0.05	0.034	0.006	NA	100	1.5	403	99	NA	0.6730	6.68	10.40
19-Jul	33	186	2.11	0.996	<0.05	0.038	<0.005	NA	100	4.5	424	127	NA	0.6826	6.60	0.04
16-Aug	37	196	2.72	1.59	<0.05	0.030	<0.005	NA	100	4.1	427	128	NA	0.6885	6.64	0.06
20-Sep	37	159	1.31	<0.1	<0.05	0.029	<0.005	NA	105	4.4	393	110	NA	0.6992	6.74	0.08
18-Oct	35	155	2.18	0.766	<0.05	0.029	<0.005	NA	112	2.9	403	104	NA	0.6584	8.54	1.50
<b>Average</b>		175	1.91	0.919 <sup>k</sup>	0.086 <sup>k</sup>	0.027	0.006 <sup>k</sup>	NA	103.4	3.5	410	110	NA	0.6803	7.04	2.2393

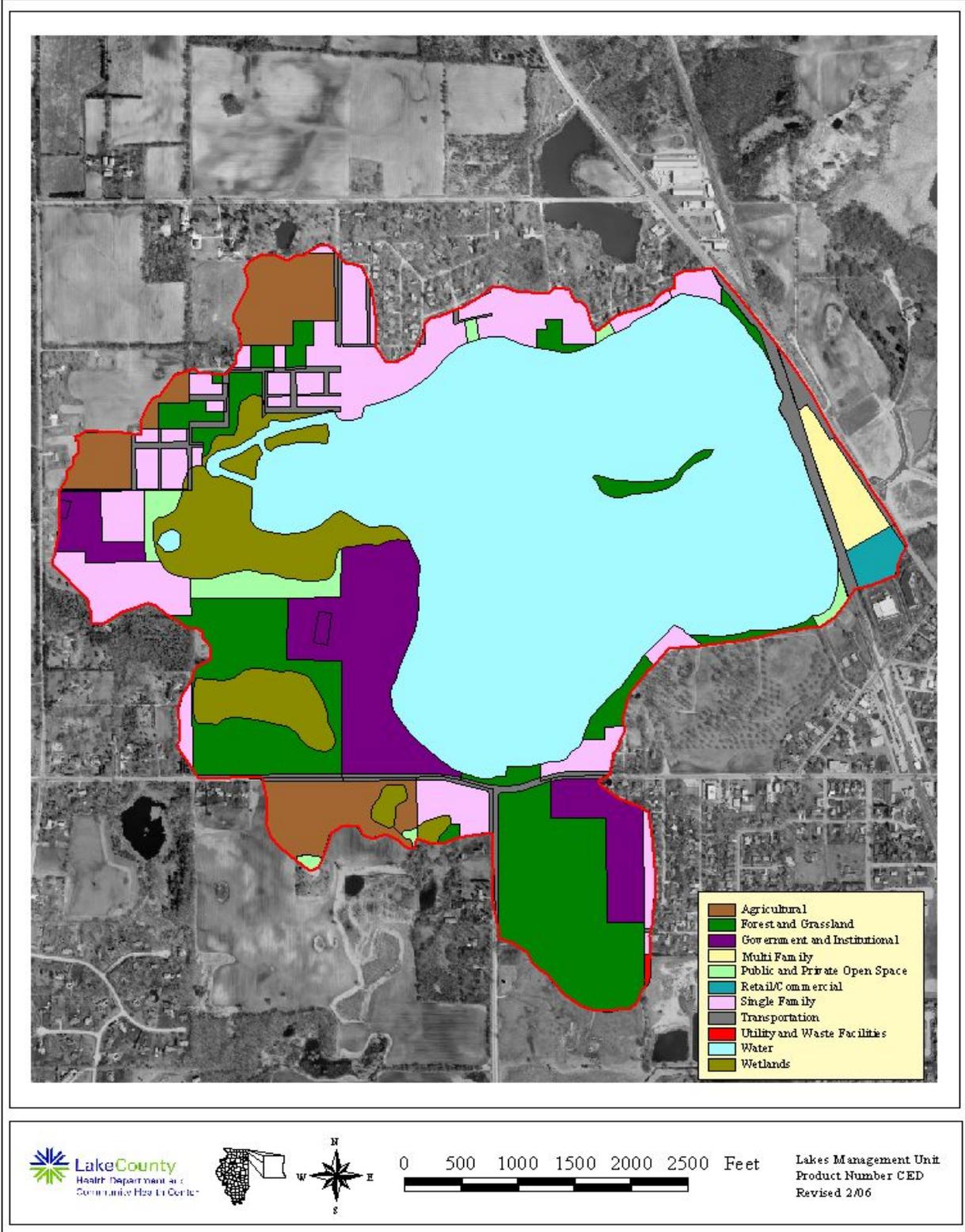
2003		Hypolimnion														
DATE	DEPTH	ALK	TKN	NH <sub>3</sub> -N	NO <sub>3</sub> -N	TP	SRP	TDS	Cl <sup>-</sup>	TSS	TS	TVS	SECCHI	COND	pH	DO
20-May	38	151	1.27	0.266	<0.05	0.027	0.006	362	NA	1.4	368	108	NA	0.6250	7.70	2.53
18-Jun	38	159	1.81	0.646	<0.05	0.090	0.044	352	NA	1.9	373	106	NA	0.6284	7.43	0.05
23-Jul	40	168	2.28	1.060	<0.05	0.054	0.008	366	NA	3.7	392	123	NA	0.6344	7.41	0.04
20-Aug	39	181	2.75	1.710	<0.05	0.088	0.042	360	NA	2.7	399	111	NA	0.6530	7.26	0.50
24-Sep	40	196	3.28	2.360	<0.05	0.093	0.055	346	NA	3.6	377	115	NA	0.6666	7.10	0.09
<b>Average</b>		171	2.28	1.208	<0.05	0.070	0.031	357	NA	2.7	382	113	NA	0.6415	7.38	0.64

Glossary
ALK = Alkalinity, mg/L CaCO <sub>3</sub>
TKN = Total Kjeldahl nitrogen, mg/L
NH <sub>3</sub> -N = Ammonia nitrogen, mg/L
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Cl <sup>-</sup> = Chlorides, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

**Figure 4. Approximate watershed delineation of Cedar Lake, 2005.**



**Figure 5. Approximate land use within the Cedar Lake watershed, 2005.**



within the watershed could adversely impact the lake. Nitrogen is also critical for the growth of algae. Nitrogen sources vary from fertilizer to human waste and sewage treatment plants, to groundwater, air, and rainfall. Total Kjeldahl nitrogen (TKN) together with nitrate concentrations are indicators of the total amount of nitrogen present in the water column. The TN:TP (total nitrogen to total phosphorus) ratio looks at which nutrient is limiting plant and algal growth in a lake. Ratios < 10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate there is enough of both nutrients for excessive algal growth. Cedar Lake had a TN:TP ratio of 76:1 which means phosphorus was highly limiting. The plant abundance on Cedar Lake also influences nutrient levels in the lake by using available phosphorus.

Conductivity readings, which are correlated with chloride concentrations, have been increasing throughout the past few years in the county. In Cedar Lake it is believed road salt was the reason for the increase because chloride concentrations detect sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts, which is what most road salt consists of. The average conductivity reading for Cedar Lake was 0.6447 mS/cm. This is below the county median of 0.7748 mS/cm, however it has increased 9% since 2003 (0.5932 mS/cm). Chloride concentrations averaged 119.8 mg/L for the season and the county median was 183.0 mg/L. A study done in Canada reported 10% of aquatic species were harmed by prolonged exposure to chloride concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were associated with chloride concentrations as low as 12 mg/l.

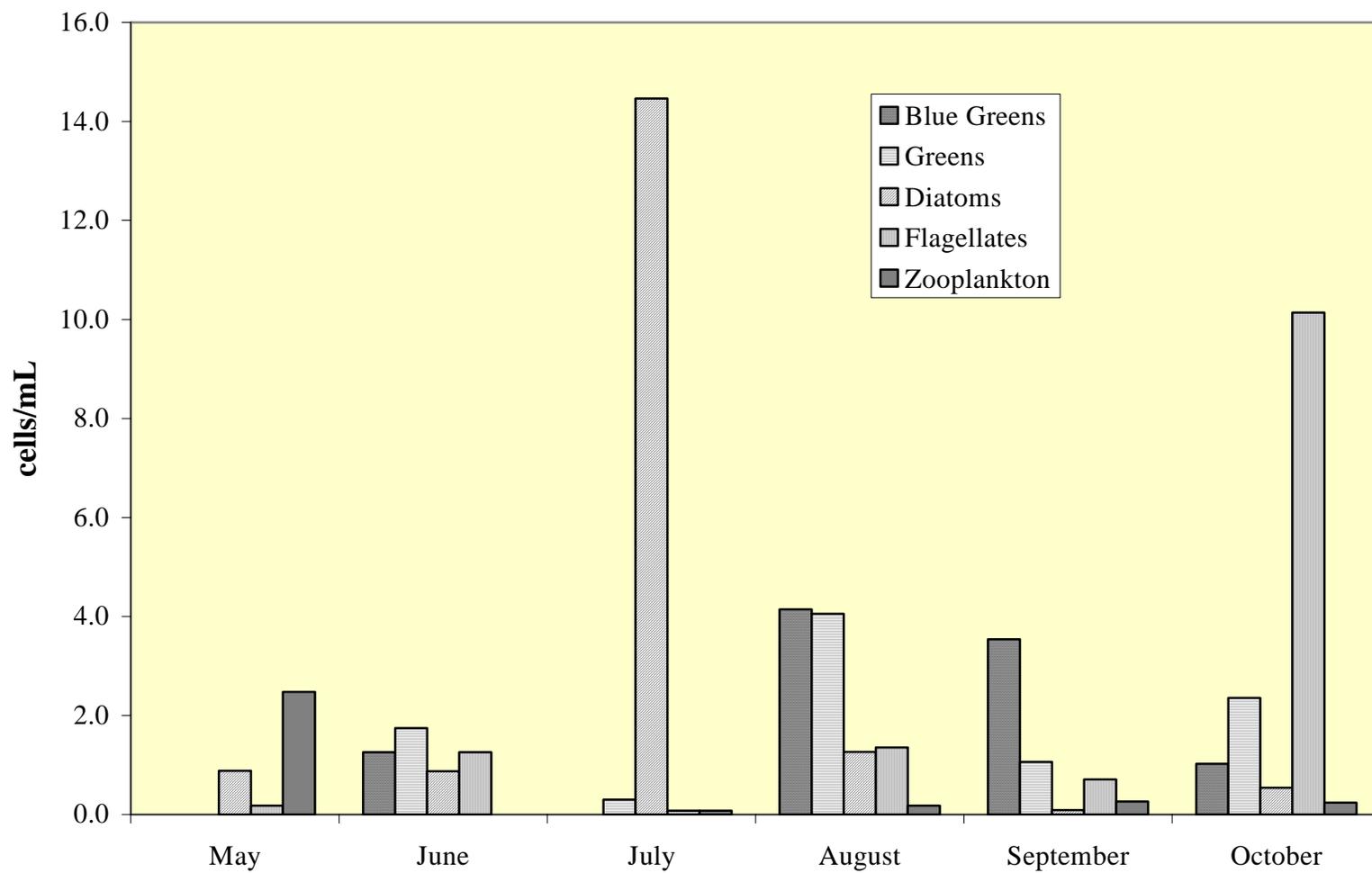
A plankton sample was collected each month from April through October at the same location water samples were taken. Plankton are microscopic plants and animals that are free-floating within the water column. Samples were collected to get a general idea of the types of algae found in the lake. The dominant species in the lake were as follows: Anabaena (blue-green), Phaeosphaera and Gloeobotrys (green), Fragilaria (diatom), and Dinobryon and Rhodomonas (flagellates) (Figure 6), with diatoms as the dominant species in July and flagellates in October.

The Illinois EPA has indices used for assessing lakes for aquatic life, swimming, and recreational use impairment. The indices are calculated using the mean trophic state index (TSI), percent macrophyte coverage, and the median nonvolatile suspended solids concentration. The TSI 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). This index can be calculated using total phosphorus values obtained at or near the surface. In 2005 Cedar Lake was mesotrophic with a TSI value of 46.1 and aquatic life, swimming, and recreational use indices all having full support. Cedar Lake ranked 7<sup>th</sup> in the county of 162 lakes for TSIp (Table 2).

## **SUMMARY OF AQUATIC MACROPHYTES**

Plant sampling was conducted twice on Cedar Lake, once in June and again in August. Sampling was based on a computer generated grid system (ArcGIS) with points spaced 60 meters apart. There were 23 species of plants present in June and August (Table 3) with species differing between the two sampling periods. There were also four species, Threadleaf

**Figure 6. Plankton counts for Cedar Lake, 2005.**



**Table 2. Lake County average TSI phosphorous (TSIp) ranking 2000-2005.**

<b>RANK</b>	<b>LAKE NAME</b>	<b>TP AVE</b>	<b>TSIp</b>
1	Windward Lake	0.0158	43.9
2	Sterling Lake	0.0162	44.3
3	Lake Minear	0.0165	44.6
4	Pulaski Pond	0.0180	45.8
5	Fourth Lake	0.0182	46.0
6	West Loon Lake	0.0182	46.0
<b>7</b>	<b>Cedar Lake</b>	<b>0.0183</b>	<b>46.1</b>
8	Third Lake	0.0190	46.6
9	Lake Carina	0.0193	46.9
10	Independence Grove	0.0194	46.9
11	Lake Kathryn	0.0200	47.3
12	Lake of the Hollow	0.0200	47.3
13	Banana Pond	0.0202	47.5
14	Cross Lake	0.0220	48.7
15	Dog Pond	0.0222	48.9
16	Sand Pond	0.0230	49.4
17	Stone Quarry Lake	0.0230	49.4
18	Bangs Lake	0.0233	49.6
19	Cranberry Lake	0.0236	49.7
20	Deep Lake	0.0240	50.0
21	Druce Lake	0.0244	50.2
22	Little Silver Lake	0.0246	50.3
23	Round Lake	0.0254	50.8
24	Lake Leo	0.0256	50.9
25	Timber Lake	0.0270	51.7
26	Dugdale Lake	0.0274	51.9
27	Peterson Pond	0.0274	51.9
28	Lake Miltmore	0.0276	52.0
29	Ames Pit	0.0278	52.1
30	East Loon Lake	0.0280	52.2
31	Lake Zurich	0.0282	52.3
32	Lake Fairfield	0.0296	53.0
33	Gray's Lake	0.0302	53.3
34	Highland Lake	0.0302	53.3
35	Hook Lake	0.0302	53.3
36	Lake Catherine (Site 1)	0.0308	53.6
37	Lambs Farm Lake	0.0312	53.8
38	Old School Lake	0.0312	53.8
39	Sand Lake	0.0316	53.9
40	Waterford Lake	0.0318	54.0
41	Potomac Lake	0.0318	54.0
42	Sullivan Lake	0.0320	54.1

**Table 2. Continued.**

<b>RANK</b>	<b>LAKE NAME</b>	<b>TP AVE</b>	<b>TSIp</b>
43	Wooster Lake	0.0324	54.3
44	Gages Lake	0.0338	54.9
45	Hendrick Lake	0.0356	55.7
46	Diamond Lake	0.0372	56.3
47	Channel Lake (Site 1)	0.0380	56.6
48	Sun Lake	0.0410	57.7
49	Lake Linden	0.0420	58.0
50	Old Oak Lake	0.0428	58.3
51	Schreiber Lake	0.0434	58.5
52	Nielsen Pond	0.0448	59.0
53	Turner Lake	0.0458	59.3
54	Seven Acre Lake	0.0460	59.4
55	Willow Lake	0.0464	59.5
56	Lucky Lake	0.0476	59.9
57	Davis Lake	0.0476	59.9
58	East Meadow Lake	0.0478	59.9
59	College Trail Lake	0.0496	60.4
60	Countryside Lake	0.0512	60.9
61	Lake Lakeland Estates	0.0524	61.2
62	Butler Lake	0.0528	61.3
63	Lake Christa	0.0530	61.4
64	West Meadow Lake	0.0530	61.4
65	Deer Lake	0.0542	61.7
66	Heron Pond	0.0545	61.8
67	Little Bear Lake	0.0550	61.9
68	Lucy Lake	0.0552	62.0
69	Lake Charles	0.0580	62.7
70	White Lake	0.0588	62.9
71	Lake Naomi	0.0616	63.6
72	Lake Tranquility S1	0.0618	63.6
73	Werhane Lake	0.0630	63.9
74	Liberty Lake	0.0632	63.9
75	Countryside Glen Lake	0.0642	64.2
76	Leisure Lake	0.0648	64.3
77	Hastings Lake	0.0664	64.7
78	St. Mary's Lake	0.0666	64.7
79	Mary Lee Lake	0.0682	65.0
80	Honey Lake	0.0690	65.2
81	Redwing Slough, Site II, Outflow	0.0718	65.8
82	North Tower Lake	0.0718	65.8
83	Lake Fairview	0.0724	65.9
84	Spring Lake	0.0726	65.9
85	ADID 203	0.0730	66.0
86	Bluff Lake	0.0734	66.1

**Table 2. Continued.**

<b>RANK</b>	<b>LAKE NAME</b>	<b>TP AVE</b>	<b>TSIp</b>
87	Long Lake	0.0761	66.6
88	Harvey Lake	0.0766	66.7
89	Broberg Marsh	0.0782	67.0
90	Echo Lake	0.0792	67.2
91	Sylvan Lake	0.0794	67.2
92	Big Bear Lake	0.0806	67.4
93	Petite Lake	0.0834	67.9
94	Lake Marie (Site 1)	0.0850	68.2
95	North Churchill Lake	0.0872	68.6
96	Grandwood Park, Site II, Outflow	0.0876	68.6
97	South Churchill Lake	0.0896	69.0
98	Rivershire Pond 2	0.0900	69.0
99	McGreal Lake	0.0914	69.3
100	International Mine and Chemical Lake	0.0948	69.8
101	Eagle Lake (Site I)	0.0950	69.8
102	Dunns Lake	0.0952	69.8
103	Lake Barrington	0.0956	69.9
104	Lochanora Lake	0.0960	70.0
105	Owens Lake	0.0978	70.2
106	Woodland Lake	0.0986	70.4
107	Island Lake	0.0990	70.4
108	Duck Lake	0.0996	70.5
109	Tower Lake	0.1000	70.6
110	Crooked Lake	0.1014	70.8
111	Fish Lake	0.1022	70.9
112	Longview Meadow Lake	0.1024	70.9
113	Lake Forest Pond	0.1074	71.6
114	Bittersweet Golf Course #13	0.1096	71.9
115	Fox Lake (Site 1)	0.1098	71.9
116	Bresen Lake	0.1126	72.3
117	Round Lake Marsh North	0.1126	72.3
118	Timber Lake S	0.1128	72.3
119	Deer Lake Meadow Lake	0.1158	72.7
120	Taylor Lake	0.1184	73.0
121	Grand Avenue Marsh	0.1194	73.1
122	Columbus Park Lake	0.1226	73.5
123	Nippersink Lake (Site 1)	0.1240	73.7
124	Grass Lake (Site 1)	0.1288	74.2
125	Lake Holloway	0.1322	74.6
126	Lakewood Marsh	0.1330	74.7
127	Summerhill Estates Lake	0.1384	75.2
128	Redhead Lake	0.1412	75.5

**Table 2. Continued.**

<b>RANK</b>	<b>LAKE NAME</b>	<b>TP AVE</b>	<b>TSIp</b>
129	Antioch Lake	0.1448	75.9
130	Forest Lake	0.1470	76.1
131	Valley Lake	0.1470	76.1
132	Slocum Lake	0.1496	76.4
133	Drummond Lake	0.1510	76.5
134	Pond-a-Rudy	0.1514	76.5
135	Lake Matthews	0.1516	76.6
136	Buffalo Creek Reservoir	0.1550	76.9
137	Pistakee Lake (Site 1)	0.1592	77.3
138	Salem Lake	0.1650	77.8
139	Half Day Pit	0.1690	78.1
140	McDonald Lake 1	0.1722	78.4
141	Lake Eleanor Site II, Outflow	0.1812	79.1
142	Lake Farmington	0.1848	79.4
143	ADID 127	0.1886	79.7
144	Lake Louise Inlet	0.1938	80.1
145	Grassy Lake	0.1952	80.2
146	Fischer Lake	0.1978	80.4
147	Dog Bone Lake	0.1990	80.5
148	Redwing Marsh	0.2072	81.1
149	Stockholm Lake	0.2082	81.1
150	Bishop Lake	0.2156	81.6
151	Hidden Lake	0.2236	82.2
152	Lake Napa Suwe (Outlet)	0.2304	82.6
153	Patski Pond (outlet)	0.2512	83.8
154	Slough Lake	0.2634	84.5
155	McDonald Lake 2	0.2706	84.9
156	Oak Hills Lake	0.2792	85.4
157	Loch Lomond	0.2954	86.2
158	Fairfield Marsh	0.3264	87.6
159	ADID 182	0.3280	87.7
160	Flint Lake Outlet	0.4996	93.8
161	Rasmussen Lake	0.5025	93.8
162	Albert Lake, Site II, outflow	1.1894	106.3

**Table 3: Aquatic plant species found in Cedar Lake, 2005.**

Water Marigold*	<i>Bidens beckii</i>
Coontail	<i>Ceratophyllum demersum</i>
Chara (Macro algae)	<i>Chara</i> spp.
American Elodea	<i>Elodea canadensis</i>
Water Stargrass	<i>Heteranthera dubia</i>
Duckweed	<i>Lemna</i> spp.
Variable Leaved Milfoil	<i>Myriophyllum aquaticum</i>
Northern Watermilfoil	<i>Myriophyllum sibiricum</i>
Eurasian Watermilfoil^	<i>Myriophyllum spicatum</i>
Slender Naiad	<i>Najas flexilis</i>
Southern Naiad	<i>Najas guadalupensis</i>
Spiny Naiad	<i>Najas marina</i>
Spatterdock	<i>Nuphar variegata</i>
White Water Lily	<i>Nymphaea tuberosa</i>
Largeleaf Pondweed	<i>Potamogeton amplifolius</i>
Curlyleaf Pondweed^	<i>Potamogeton crispus</i>
Leafy Pondweed	<i>Potamogeton foliosus</i>
Illinois Pondweed	<i>Potamogeton illinoensis</i>
Floatingleaf Pondweed	<i>Potamogeton natans</i>
Sago Pondweed	<i>Potamogeton pectinatus</i>
Whitestem Pondweed*	<i>Potamogeton praelongus</i>
Claspingleaf Pondweed	<i>Potamogeton richardsonii</i>
Fern-leaf Pondweed*	<i>Potamogeton robbinsii</i>
Flatstem Pondweed	<i>Potamogeton zosteriformis</i>
Grass-leaved Arrowhead	<i>Sagittaria graminea</i>
Bladderwort	<i>Utricularia vulgaris</i>
Eel Grass	<i>Vallisneria americana</i>
Horned Pondweed	<i>Zannichellia palustris</i>

\* **Endangered in Illinois**

^ **Exotic plant**

Pondweed, Small Pondweed, White Water Crowfoot, and Watermeal found in 2003, but not in 2005. However, there were three new species found in 2005 that were not present in 2003 (Leafy Pondweed, Grass Leaved Arrowhead, and Horned Pondweed). In June the three most abundant species were *Chara* spp. (54% of sites), Largeleaf Pondweed (35% of sites), and Eurasian Watermilfoil (29% of sites) (Table 4). This shifted a bit in August with *Chara* spp. still dominant at 46% of the sites and Southern Naiad (38% of sites) and Eurasian Watermilfoil (30% of sites) being the second and third most abundant species. Cedar Lake has a great abundance (Figure 7 and 8) and diversity of plants with three Illinois endangered species present; Fernleaf Pondweed, Water Marigold, and White-stemmed Pondweed. In 2002, the state threatened species Grass-leaved Pondweed was found, but has not been found since.

Eurasian Watermilfoil is an invasive, exotic species, which was found in the lake throughout the summer. It is scattered throughout the lake, however the more dense areas occur in the deeper part of the lake. It has been periodically controlled by the milfoil weevil, *Euhrychiopsis lecontei*, which is a native weevil that feeds exclusively on milfoil species. They feed on the stem making it difficult for the plants to move nutrients from the roots to new shoots, therefore damaging growth of the plant. Historically, the weevil was found in the lake but was not observed this year.

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 Cedar Lake was at 20 to 22 feet throughout the entire sampling season. In June plants were found at 19.5 feet (86% of the lake) and in August they were found at 14.6 feet (81% of the lake). This means plants can grow in all areas of the lake in which light penetrates. Herbicide treatments have been done by private landowners in the past, however at this time the Lakes Management Unit does not recommend an aquatic plant management plan.

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. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submersed plant species found in the lake. These numbers are averaged and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. Non-native species were counted in the FQI calculations for Lake County lakes. In 2005, Cedar Lake had an FQI of 35.6 and ranked #1 of 151 lakes in the county (Table 5). The median FQI of lakes that we have studied from 2000-2005 is 13.1.

## **SUMMARY OF SHORELINE CONDITION**

In August of 2003 an assessment was conducted to determine the condition of the shoreline at the water/land interface. Buffer (34%), wetland (25%), and woodland (14%) were the most common shoreline types. Approximately 97% of the shoreline classified as buffer was on

**Table 4a. Aquatic plant species found at the 344 sampling sites on Cedar Lake in June, 2005. The maximum depth that plants were found was 19.5 feet.**

Plant Density	Chara	Coontail	Curlyleaf Pondweed	Elodea	Eurasian Watermilfoil	Fernleaf Pondweed	Flatstem Pondweed	Floatingleaf Pondweed	Grass-leaved Arrowhead	Horned Pondweed	Illinois Pondweed	Largeleaf Pondweed
Present	81	11	16	6	46	14	17	5	3	1	16	35
Common	42	5	15	2	18	9	8	2	0	0	0	42
Abundant	30	2	1	1	5	3	3	1	0	0	0	23
Dominant	5	0	0	0	15	0	0	0	0	0	0	1
% Plant Occurrence	53.9	6.1	10.9	3.1	28.7	8.9	9.6	2.7	1.0	0.3	5.5	34.5

Plant Density	Water Marigold	Northern Watermilfoil	Claspingleaf Pondweed	Sago Pondweed	Southern Naiad	Spatterdock	Spiny Naiad	Vallisneria	Water Stargrass	White-stemmed Pondweed	White Water Lily
Present	4	4	4	44	39	0	1	29	13	22	14
Common	1	0	1	5	13	0	0	0	4	6	10
Abundant	0	0	1	1	0	1	0	0	2	1	4
Dominant	0	0	0	0	0	0	0	0	0	0	0
% Plant Occurrence	1.7	1.4	2.0	17.1	17.7	0.3	0.3	9.9	6.5	9.9	9.6

**Table 4b. Aquatic plant species found at the 344 sampling sites on Cedar Lake in August, 2005. The maximum depth that plants were found was 14.6 feet.**

Plant Density	Bladderwort	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Fernleaf Pondweed	Flatstem Pondweed	Floatingleaf Pondweed	Grass-leaved Arrowhead	Illinois Pondweed
Present	6	65	8	1	1	8	47	28	15	4	3	42
Common	1	23	5	0	0	2	16	11	6	1	0	6
Abundant	0	28	6	0	0	2	4	2	0	0	0	1
Dominant	0	20	1	0	0	0	23	0	0	0	0	0
% Plant Occurrence	2.3	45.6	6.7	0.3	0.3	4.0	30.2	13.8	7.0	1.7	1.0	16.4

Plant Density	Largeleaf Pondweed	Leafy Pondweed	Water Marigold	Sago Pondweed	Slender Naiad	Southern Naiad	Spatterdock	Spiny Naiad	Vallisneria	White-stemmed Pondweed	Water Stargrass	White Water Lily
Present	53	1	13	70	2	69	1	23	57	17	19	19
Common	17	0	1	5	0	23	1	2	23	0	4	9
Abundant	14	0	0	1	0	17	0	2	8	1	3	7
Dominant	5	0	0	0	0	6	0	0	1	0	0	1
% Plant Occurrence	29.9	0.3	4.7	25.5	0.7	38.6	0.7	9.1	29.9	6.0	8.7	12.1

**Table 4c. Distribution of rake density across all sampling sites.**

**June**

Rake Density (coverage)	# of Sites	% of Sites
No Plants	39	13
>0-10%	60	20
10-40%	66	23
40-60%	78	27
60-90%	40	14
>90%	10	3
Total Sites with Plants	254	87
Total # of Sites	293	100

**August**

Rake Density (coverage)	# of Sites	% of Sites
No Plants	46	15
>0-10%	77	26
10-40%	28	9
40-60%	32	11
60-90%	41	14
>90%	74	25
Total Sites with Plants	252	85
Total # of Sites	298	100

Figure 7. Aquatic plant sampling grid illustrating plant density on Cedar Lake, June 2005.

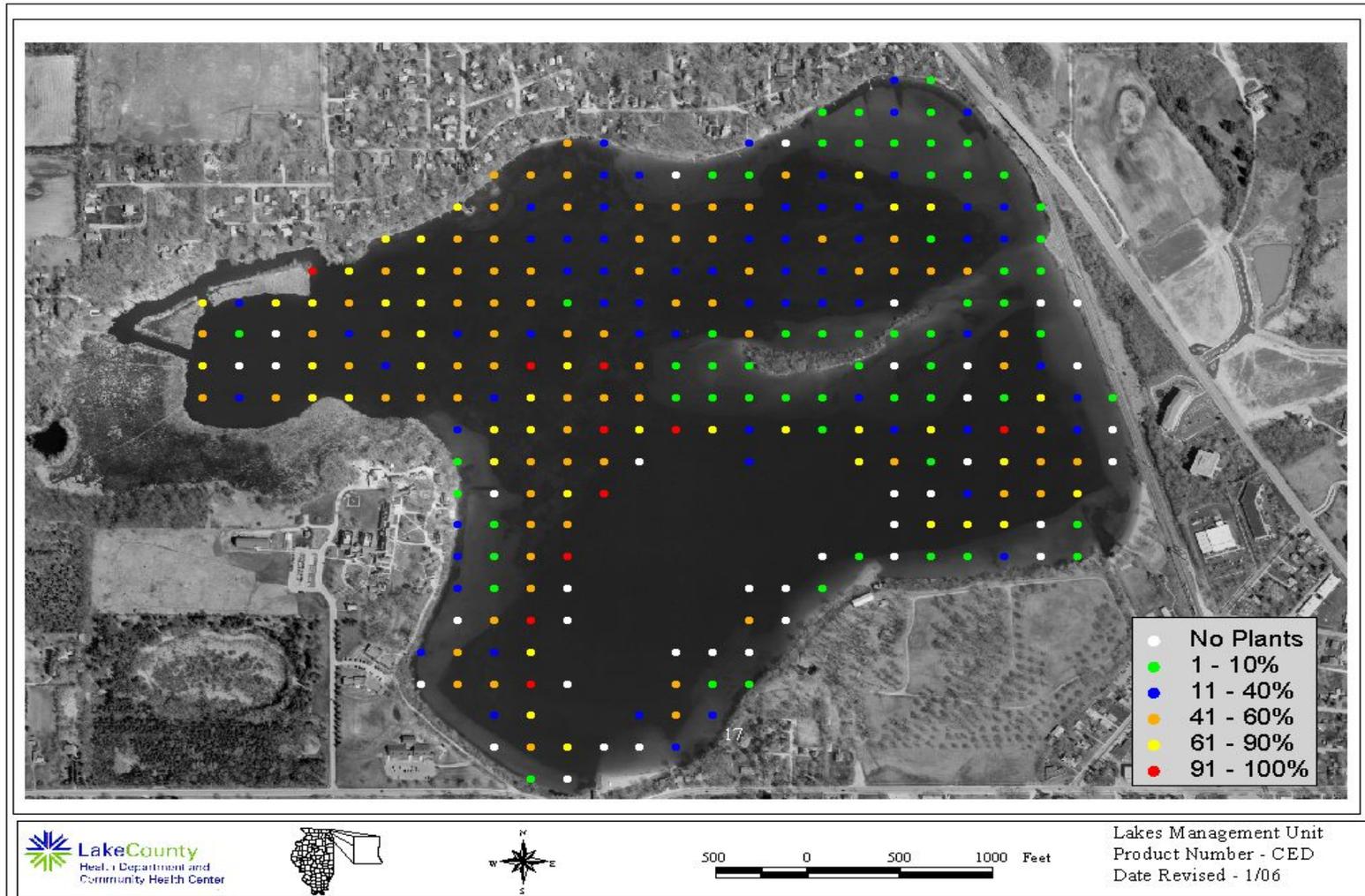
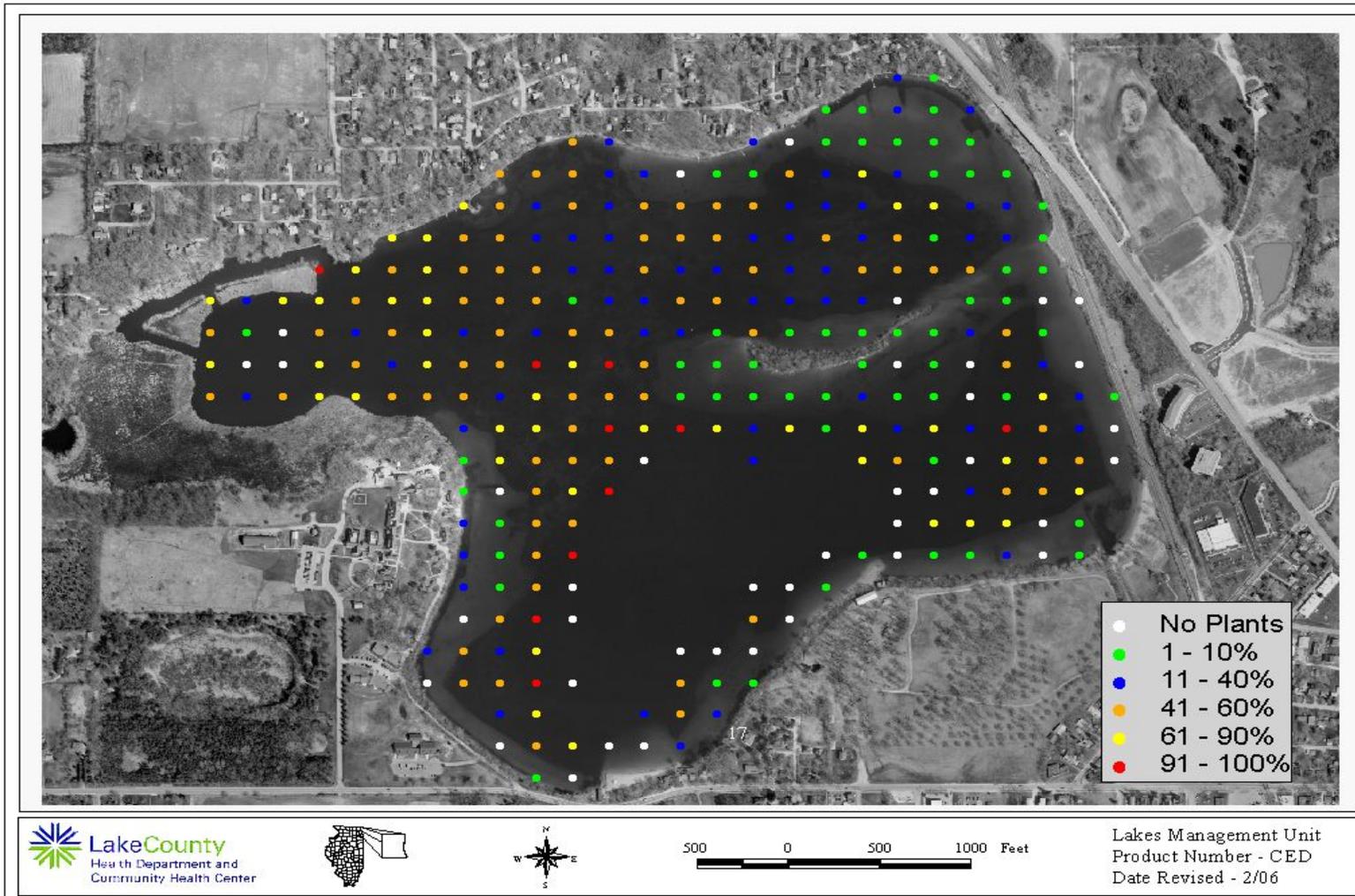


Figure 8. Aquatic plant sampling grid illustrating plant density on Cedar Lake, August 2005.



**Table 5. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/Adventives) and with native species only (native).**

<b>Rank</b>	<b>Lake Name</b>	<b>FQI (w/A)</b>	<b>FQI (native)</b>
<b>1</b>	<b>Cedar Lake</b>	<b>35.6</b>	<b>37.8</b>
2	Deep Lake	33.9	35.4
3	Round Lake Marsh North	29.1	29.9
4	East Loon Lake	28.4	29.9
5	Cranberry Lake	28.3	28.3
6	Sullivan Lake	28.2	29.7
7	Deer Lake	27.9	30.2
8	Little Silver Lake	27.9	30.0
9	Schreiber Lake	26.8	27.6
10	Redwing Slough	26.0	26.9
11	West Loon Lake	26.0	27.6
12	Timber Lake (North)	25.5	27.1
13	Cross Lake	25.2	27.8
14	Wooster Lake	25.2	26.9
15	Butler Lake	25.0	26.6
16	Lake Zurich	24.0	26.0
17	Lake of the Hollow	23.8	26.2
18	Lakewood Marsh	23.8	24.7
19	Round Lake	23.5	25.9
20	Fourth Lake	23.0	24.8
21	Druce Lake	22.8	25.2
22	Sun Lake	22.7	24.5
23	Countryside Glen Lake	21.9	22.8
24	Sterling Lake	21.8	24.1
25	Bangs Lake	21.2	23.7
26	ADID 203	20.5	20.5
27	Broberg Marsh	20.5	21.4
28	Davis Lake	20.5	21.4
29	McGreal Lake	20.2	22.1
30	Lake Kathryn	19.6	20.7
31	Third Lake	19.6	21.7
32	Owens Lake	19.3	20.2
33	Redhead Lake	19.3	21.2
34	Lake Minear	18.8	20.6
35	Turner Lake	18.6	21.2
36	Salem Lake	18.5	20.2
37	Lake Miltmore	18.4	20.3
38	Fish Lake	18.1	20.0
39	McDonald Lake 1	17.7	18.7
40	Potomac Lake	17.3	18.5
41	Hendrick Lake	17.2	19.0

**Table 5. Continued**

<b>Rank</b>	<b>Lake Name</b>	<b>FQI (w/A)</b>	<b>FQI (native)</b>
42	Duck Lake	17.1	19.1
43	Summerhill Estates Lake	17.1	18.0
44	Ames Pit	17.0	18.0
45	Seven Acre Lake	17.0	15.5
46	Grand Avenue Marsh	16.9	18.7
47	Gray's Lake	16.9	19.8
48	White Lake	16.9	18.7
49	Bresen Lake	16.6	17.8
50	Waterford Lake	16.6	17.8
51	Diamond Lake	16.3	17.4
52	Lake Barrington	16.3	17.4
53	Lake Napa Suwe	16.3	17.4
54	Windward Lake	16.3	17.6
55	Fischer Lake	16.0	18.1
56	Dog Bone Lake	15.7	15.7
57	Independence Grove	15.5	16.7
58	Long Lake	15.5	17.3
59	Tower Lake	15.2	17.6
60	Heron Pond	15.1	15.1
61	Lake Linden	15.1	16.5
62	Lake Tranquility (S1)	15.0	17.0
63	North Churchill Lake	15.0	15.0
64	Dog Training Pond	14.7	15.9
65	Island Lake	14.7	16.6
66	Highland Lake	14.5	16.7
67	Lake Fairview	14.3	16.3
68	Taylor Lake	14.3	16.3
69	Dugdale Lake	14.0	15.1
70	Eagle Lake (S1)	14.0	15.1
71	Longview Meadow Lake	13.9	13.9
72	Bishop Lake	13.4	15.0
73	Hook Lake	13.4	15.5
74	Timber Lake (South)	13.4	15.5
75	Buffalo Creek Reservoir	13.1	14.3
76	Mary Lee Lake	13.1	15.1
77	Old School Lake	13.1	15.1
78	Dunn's Lake	12.7	13.9
79	Old Oak Lake	12.7	14.7
80	Echo Lake	12.5	14.8
81	Sand Lake	12.5	14.8
82	Stone Quarry Lake	12.5	12.5

**Table 5. Continued**

<b>Rank</b>	<b>Lake Name</b>	<b>FQI (w/A)</b>	<b>FQI (native)</b>
83	Honey Lake	12.1	14.3
84	Lake Leo	12.1	14.3
85	Lambs Farm Lake	12.1	14.3
86	Pond-A-Rudy	12.1	12.1
87	Stockholm Lake	12.1	13.5
88	Lake Matthews	12.0	12.0
89	McDonald Lake 2	12.0	12.0
90	Flint Lake	11.8	13.0
91	Harvey Lake	11.8	13.0
92	Rivershire Pond 2	11.5	13.3
93	Antioch Lake	11.3	13.4
94	Lake Charles	11.3	13.4
95	Lake Naomi	11.2	12.5
96	Pulaski Pond	11.2	12.5
97	Lake Christa	11.0	12.7
98	Redwing Marsh	11.0	11.0
99	West Meadow Lake	11.0	11.0
100	Nielsen Pond	10.7	12.0
101	Lake Holloway	10.6	10.6
102	Lake Carina	10.2	12.5
103	College Trail Lake	10.0	10.0
104	Lake Lakeland Estates	10.0	11.5
105	Crooked Lake	9.8	12.0
106	Hastings Lake	9.8	12.0
107	Werhane Lake	9.8	12.0
108	Big Bear Lake	9.5	11.0
109	Little Bear Lake	9.5	11.0
110	Loch Lomond	9.4	12.1
111	Sand Pond (IDNR)	9.4	12.1
112	Columbus Park Lake	9.2	9.2
113	Sylvan Lake	9.2	9.2
114	Grandwood Park Lake	9.0	11.0
115	Lake Fairfield	9.0	10.4
116	East Meadow Lake	8.5	8.5
117	Lake Farmington	8.5	9.8
118	Lucy Lake	8.5	9.8
119	South Churchill Lake	8.5	8.5
120	Bittersweet Golf Course #13	8.1	8.1
121	Woodland Lake	8.1	9.9
122	Albert Lake	7.5	8.7
123	Banana Pond	7.5	9.2
124	Fairfield Marsh	7.5	8.7
125	Lake Eleanor	7.5	8.7

**Table 5. Continued**

<b>Rank</b>	<b>Lake Name</b>	<b>FQI (w/A)</b>	<b>FQI (native)</b>
127	Patski Pond	7.1	7.1
128	Rasmussen Lake	7.1	7.1
129	Lucky Lake	7.0	7.0
130	Lake Forest Pond	6.9	8.5
131	Leisure Lake	6.4	9.0
132	Peterson Pond	6.0	8.5
133	Countryside Lake	5.8	7.1
134	Gages Lake	5.8	10.0
135	Grassy Lake	5.8	7.1
136	Slocum Lake	5.8	7.1
137	Deer Lake Meadow Lake	5.2	6.4
138	ADID 127	5.0	5.0
139	Drummond Lake	5.0	7.1
140	IMC	5.0	7.1
141	Liberty Lake	5.0	5.0
142	Oak Hills Lake	5.0	5.0
143	Slough Lake	5.0	5.0
144	North Tower Lake	4.9	7.0
145	Forest Lake	3.5	5.0
146	Half Day Pit	2.9	5.0
147	Lochanora Lake	2.5	5.0
148	Hidden Lake	0.0	0.0
149	St. Mary's Lake	0.0	0.0
150	Valley Lake	0.0	0.0
151	Willow Lake	0.0	0.0
	<b><i>Mean</i></b>	<b>14.0</b>	<b>15.4</b>
	<b><i>Median</i></b>	<b>13.1</b>	<b>14.8</b>

developed property where the owners had allowed plants other than turfgrass to meet the shoreline. In 2003, only 4.7% of the shoreline was eroding with the south side of the island having a noticeable shoreline loss since 1990 (Figure 9). In 2005 the shoreline was reevaluated for erosion. There were areas in 2003 found to have no erosion that are now exhibiting slight to moderate erosion (Figure 10). A larger section of the island, classified with slight erosion in 2003, is now severely eroding and should be protected since it offers good wildlife habitat and will add sediment to the water column if it continues to erode. Although buffer strips are usually thought to withstand erosion, they can erode if they are not properly maintained.

In 2003 there were aggressive exotic shoreline plant species found, most notably along the east shoreline, the main island, the two small islands in the northwest corner, and along the southwest shoreline. Some exotic species found were Buckthorn, Honeysuckle, Reed Canary Grass, Common Reed, and Purple Loosestrife. These species are especially detrimental, as they can crowd out native, beneficial plants used by wildlife. Their removal is recommended.

## **SUMMARY OF WILDLIFE AND HABITAT**

Cedar Lake, as well as the IDNR Nature Preserve on the northwest lobe of the lake, is designated as an Illinois State Natural Area. Mature trees, and the relatively large amount of shoreline classified as buffer, woodland, and wetland offer good habitat for a variety of wildlife. Osprey were observed in October and are listed as Illinois endangered species. There were also other species of birds observed throughout the season to include: Chimney Swift, Canadian Geese, American Crow, Great Blue Heron, Red-winged Blackbird, White Egret, and gulls.

Cedar Lake had a great diversity of fish (18 species), which includes four Illinois threatened species and one Illinois endangered species. However, only the state endangered Blacknose Shiner and state threatened Banded Killifish were found in 2001, which was the last survey done by the IDNR. The Blackchin Shiner (state threatened) and the Iowa Darter (state threatened) have not been found in quite some time. With the fishing pressure on the lake, it was recommended that efforts should be taken to improve the Largemouth Bass and Northern Pike populations. However, close consultation with IDNR should be made due to the presence of threatened and endangered fish.

Zebra Mussels found at Lehmann Park Beach were a concern in 2003, however, there has been no report of them actually being found in the lake. It is recommended that residents educate themselves on what the species looks like and how it can be spread and remain diligent about removing plants and emptying all sources of water from boats being transferred from Cedar Lake or to any other lake.

Figure 9. Shoreline erosion on Cedar Lake, 2003.

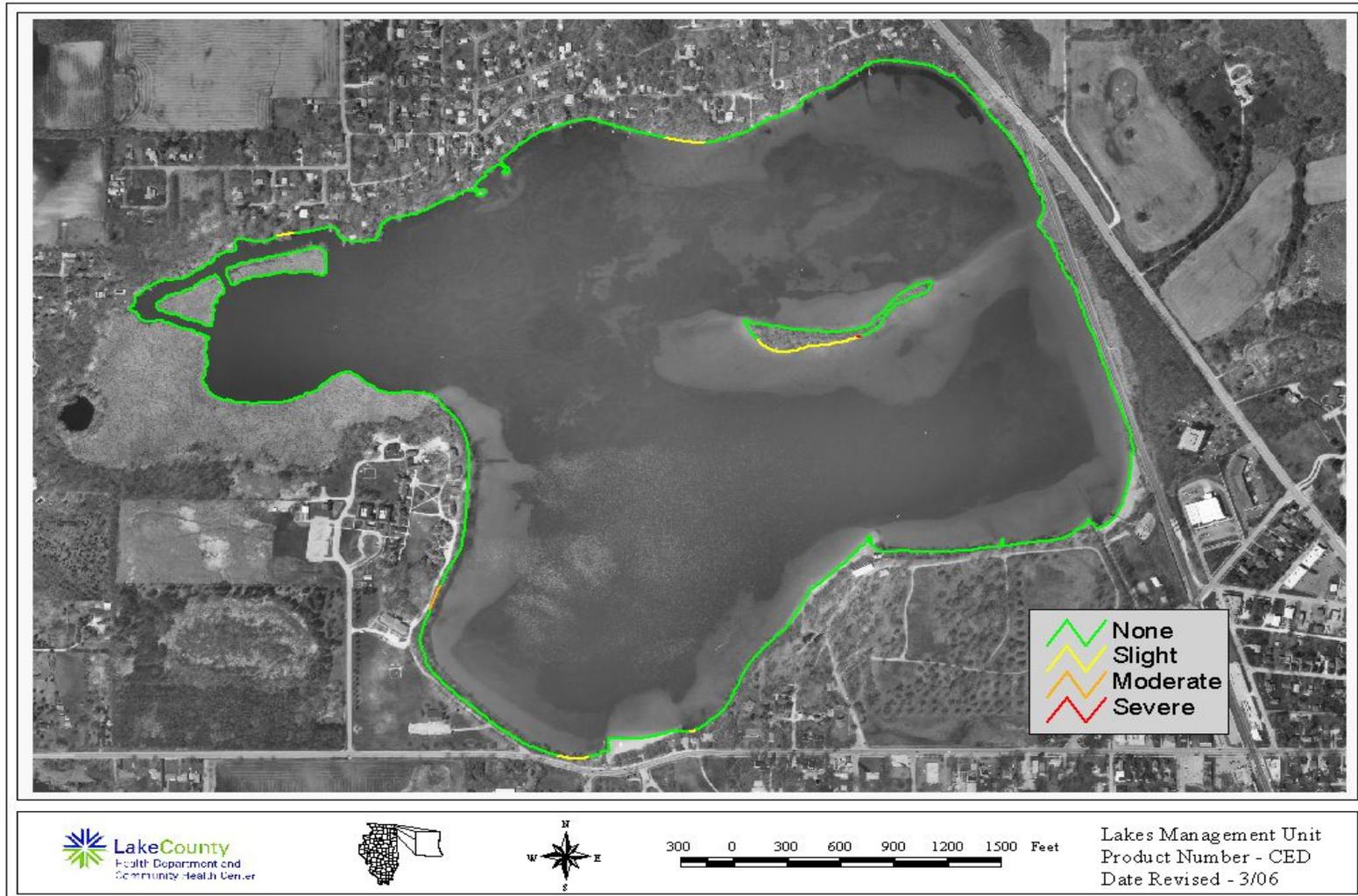
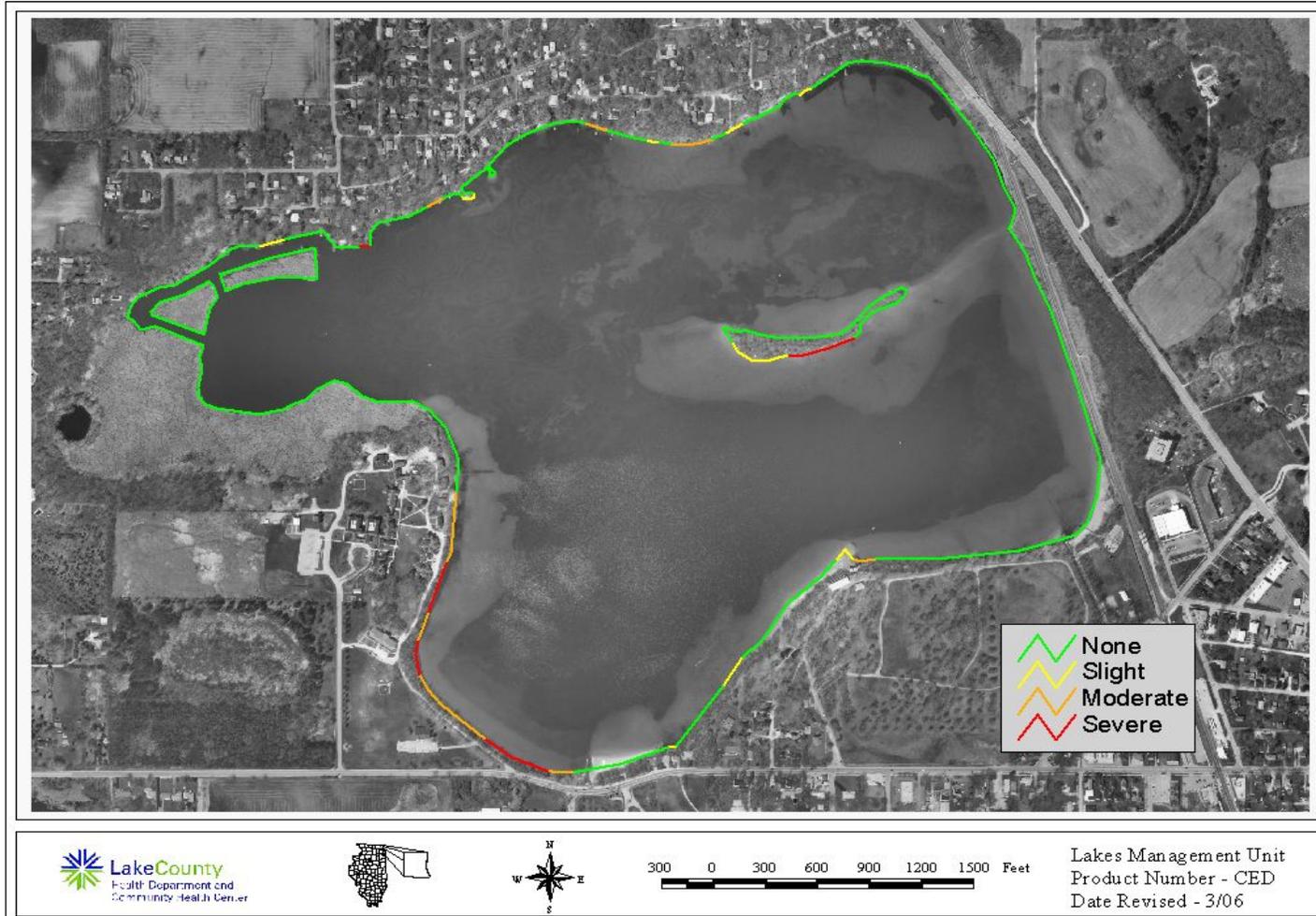


Figure 10. Shoreline erosion on Cedar Lake, 2005.



## LAKE MANAGEMENT RECOMMENDATIONS

Cedar Lake has excellent water quality and plant diversity, a relatively stable shoreline, and has been participating in the Volunteer Lake Management Program (VLMP) since 1985. This program has provided valuable data to the Lakes Management Unit and other interested parties and continued participation is recommended. However, there are some areas in which Cedar Lake can improve and there are many funding sources available for lake improvement (Appendix F).

### **Eliminate or Control Exotic Species**

To ensure the survival of the native species, the exotic species within the lake and on the shoreline should be kept under control or removed (Appendix D1).

### **Lakes with Shoreline Erosion**

Erosion around the lake has increased since the 2001 evaluation, which could be a problem if it is not controlled. Although a good portion of the shoreline is buffer, it needs to be maintained to be affective (Appendix D2).

### **Lakes with High Canada Geese Populations**

Canadian Geese were noted on the lake throughout the season and although excessive numbers were not seen, they can add nutrients (especially phosphorus) and bacteria to a lake through their feces (Appendix D3).

### **Zebra Mussels**

Zebra mussels were identified for the first time in Cedar Lake in 2003. Their presence may have significant impacts on water quality and the food chain in the lake in the future. Signage has been posted at Lehmann Park to inform lake users of the Zebra Mussel presence, and to prevent the spread of this exotic species to other inland lakes (Appendix D4).

### **Watershed Land Use Changes**

Phosphorus levels in Cedar Lake have remained relatively stable since the LMU began monitoring the lake in 1990. The watershed has a large amount of forest and grassland area which helps maintain this low level, however potential development within the watershed could adversely affect the lake. With development there is usually a loss of forest and grassland areas and an increase in impervious surfaces. This could also increase the conductivity levels in the lake, if road salt is added to these surfaces (Appendix D5).

**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 (ArcGIS 3.2) overlaid a grid pattern onto a 2004 aerial photo of Lake County and placed points 60 meters apart. 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.

### **Plankton Sampling**

Plankton was sampled at the same location as water quality samples. Using the Hydrolab DataSonde® 4a 1% light level depth (depth where the water light is 1% of the surface irradiance) was determined. A plankton net/tow, with 80µm mesh, was then lowered to the pre-determined 1% light level depth and retrieved vertically. On the way up the water column, plankton are collected within a small cup on the bottom of the tow. The collected sample was then emptied into a pre-labeled brown plastic bottle. The net was rinsed with deionized water into the bottle in order to ensure all the plankton were

collected. The sample was then transferred to a graduated cylinder to measure the amount of milliliters (mL) that the sample was. The sample was then returned to the bottle and preserved with Lugol's iodine solution (5 drops/mL). The sample bottle was then closed and stored in a cooler until returning to the lab, where it was transferred to the refrigerator until enumeration. Enumeration was performed within three months, but ideally within one month, under a microscope. Sample bottle was inverted several times to ensure proper homogenization. An automated pipette was used to retrieve 1 mL of sample, which was then placed on a Sedgewick Rafter slide. This is a microscope slide on which a rectangular chamber has been constructed, measuring 50 mm x 20 mm in area and with a depth of 1 mm. The slide was then placed under the microscope and counted at a 20X magnification. Twenty fields of view were randomly counted with all species within each field counted. Through calculations, it was determined how many of each species were in 1 mL of lake water.

### **Shoreline Assessment**

In previous years a complete assessment of the shoreline was done. However, this year we did a visual estimate to determine changes in the shoreline. The degree of shoreline erosion was categorically defined as none, slight, moderate, or severe. Below are brief descriptions of each category.

None – Includes man-made erosion control such as beach, rip-rap and sea wall.

Slight – Minimal or no observable erosion; generally considered stable; no erosion control practices will be recommended with the possible exception of small problem areas noted within an area otherwise designated as “slight”.

Moderate – Recession is characterized by past or recently eroded banks; area may exhibit some exposed roots, fallen vegetation or minor slumping of soil material; erosion control practices may be recommended although the section is not deemed to warrant immediate remedial action.

Severe – Recession is characterized by eroding of exposed soil on nearly vertical banks, exposed roots, fallen vegetation or extensive slumping of bank material, undercutting, washouts or fence posts exhibiting realignment; erosion control practices are recommended and immediate remedial action may be warranted.

### **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.**

<i>Parameter</i>	<i>Method</i>
Temperature	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Dissolved oxygen	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Nitrate nitrogen	Brucine method Standard Methods (SM) 14 <sup>th</sup> ed 419D Detection Limit = 0.05 mg/L
Ammonia nitrogen	SM 18 <sup>th</sup> ed. Electrode method, #4500 NH <sub>3</sub> -F Detection Limit = 0.1 mg/L
Total Kjeldahl nitrogen	SM 18 <sup>th</sup> ed, 4500-N <sub>org</sub> C Semi-Micro Kjeldahl, plus 4500 NH <sub>3</sub> -F Detection Limit = 0.5 mg/L
pH	Hydrolab DataSonde® 4a, or YSI 6600 Sonde® Electrometric method
Total solids	SM 18 <sup>th</sup> ed, Method #2540B
Total suspended solids	SM 18 <sup>th</sup> ed, Method #2540D Detection Limit = 0.5 mg/L
Total dissolved solids	SM 18 <sup>th</sup> ed, Method #2540C
Total volatile solids	SM 18 <sup>th</sup> ed, Method #2540E, from total solids
Alkalinity	SM 18 <sup>th</sup> ed, Method #2320B, potentiometric titration curve method
Conductivity	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Total phosphorus	SM 18 <sup>th</sup> ed, Methods #4500-P B 5 and #4500-P E Detection Limit = 0.01 mg/L
Soluble reactive phosphorus	SM 18 <sup>th</sup> ed, Methods #4500-P B 1 and #4500-P E Detection Limit = 0.005 mg/L
Clarity	Secchi disk
Color	Illinois EPA Volunteer Lake Monitoring Color Chart
Photosynthetic Active Radiation (PAR)	Hydrolab DataSonde® 4a or YSI 6600 Sonde®, LI-COR® 192 Spherical Sensor

**APPENDIX B. MULTI-PARAMETER DATA FOR CEDAR LAKE IN  
2005**

Date	Time	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 0.57
41105	124339	0.25	0.53	14.26	9.65	96.9	0.626	8.28	3540	Surface		
41105	124429	1	0.9	14.25	9.51	95.4	0.6259	8.29	3283	Surface	100%	
41105	124530	2	1.95	14.24	9.5	95.3	0.6259	8.3	937	0.2	29%	6.27
41105	124658	3	2.96	14.24	9.37	94	0.6259	8.3	1044	1.21	32%	-0.11
41105	124832	4	4.15	14.23	9.34	93.7	0.6259	8.3	863	2.4	26%	0.16
41105	125052	6	6.02	14.24	9.25	92.9	0.6262	8.3	354	4.27	11%	0.48
41105	125153	8	8.02	14.21	9.25	92.8	0.626	8.3	280	6.27	9%	0.12
41105	125328	10	9.96	14.11	9.28	92.9	0.6257	8.3	294	8.21	9%	-0.03
41105	125513	12	12.05	13.72	9.13	90.6	0.6241	8.28	127	10.3	4%	0.4
41105	125615	14	13.87	13.46	9.16	90.3	0.625	8.28	83	12.12	3%	0.23
41105	125723	16	16	12.23	8.94	85.8	0.622	8.23	91	14.25	3%	-0.04
41105	125820	18	18.05	11.86	8.94	85.1	0.6211	8.2	65	16.3	2%	0.16
41105	125944	20	20.02	11.61	8.77	83	0.6214	8.17	50	18.27	2%	0.13
41105	130113	22	22.03	11.08	8.11	75.8	0.6219	8.08	34	20.28	1%	0.19
41105	130313	24	24.01	10.96	7.67	71.5	0.622	8.01	25	22.26	1%	0.16
41105	130412	26	26.06	10.48	7.69	70.6	0.6227	7.99	10	24.31	0%	0.45
41105	130538	28	27.92	9.8	6.85	62.1	0.6237	7.92	7	26.17	0%	0.19
41105	130652	30	29.95	9.16	6.32	56.4	0.6266	7.83	4	28.2	0%	0.28
41105	130829	32	32	7.68	3.97	34.2	0.6371	7.69	1	30.25	0%	0.68
41105	131024	34	33.96	7.33	2.45	20.9	0.6423	7.6	0	32.21		
41105	131145	36	36.02	6.96	1.62	13.7	0.6505	7.54	0	34.27		
41105	131302	38	38.01	6.87	1.12	9.5	0.6527	7.56	0	36.26		
41105	131352	40	39.91	6.85	0.55	4.6	0.6533	7.53	0	38.16		

Date	Time	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 0.46
51705	115540	0.25	0.33	15.14	11.12	113.6	0.6474	8.15	4428	Surface		
51705	115656	1	0.99	15.09	11.2	114.3	0.6476	8.14	4103	Surface	100%	
51705	115808	2	1.96	15.02	11.09	113	0.6472	8.14	2152	0.21	52%	3.07
51705	115926	3	2.97	14.81	11.24	114	0.6474	8.14	1617	1.22	39%	0.28
51705	120136	4	3.97	14.66	11.12	112.4	0.6461	8.13	892	2.22	22%	0.59
51705	120314	6	6.01	14.12	11.43	114.2	0.6448	8.13	402	4.26	10%	0.39
51705	120512	8	7.97	13.64	10.68	105.6	0.6463	8.09	374	6.22	9%	0.04
51705	120648	10	9.98	13.48	10.47	103.1	0.6465	8.05	252	8.23	6%	0.2
51705	120822	12	12.01	13.25	10.12	99.2	0.6471	8.02	164	10.26	4%	0.21
51705	121004	14	14.01	13.22	9.92	97.2	0.6478	8	138	12.26	3%	0.09
51705	121126	16	16.03	13.11	9.46	92.4	0.6485	7.97	94	14.28	2%	0.19
51705	121244	18	17.98	12.92	9.1	88.6	0.6491	7.94	74	16.23	2%	0.12
51705	121350	20	19.97	12.84	8.84	85.8	0.6494	7.91	55	18.22	1%	0.15
51705	121548	22	22.05	12.64	8.43	81.6	0.6477	7.87	39	20.3	1%	0.17
51705	121712	24	24.01	12.39	7.98	76.8	0.6506	7.82	20	22.26	0%	
51705	121834	26	26	11.93	7.25	69	0.6517	7.74	15	24.25		
51705	122011	28	27.99	11.26	5.98	56	0.654	7.61	15	26.24		
51705	122121	30	29.97	10.48	5.68	52.3	0.6541	7.53	11	28.22		
51705	122305	32	31.98	9.87	4.61	41.9	0.6543	7.41	6	30.23		
51705	122437	34	33.99	9.43	3.7	33.2	0.6561	7.34	3	32.24		
51705	122557	36	36.03	9.33	3.12	28	0.6579	7.31	1	34.28		
51705	122711	37	37.03	9.26	2.23	19.9	0.6583	7.28	2	35.28		
51705	122841	38	38.02	9.21	1.45	12.9	0.6611	7.25	2	36.27		
51705	123044	40	39.85	9.18	0.77	6.9	0.6629	7.24	2	38.1		

Date	Time	Text Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light Meter	% Light Transmission	Extinction Coefficient
MMDDYYHHMMSS		feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet	Average	0.47
62105	115540	0.25	0.33	24.78	8.62	106.7	0.6383	8.16	3789	Surface		
62105	115656	1	0.99	24.73	8.74	108.2	0.6384	8.15	3714	Surface	100%	
62105	115808	2	1.96	24.71	8.77	108.3	0.6379	8.15	1949	0.21	52%	3.07
62105	115926	3	2.97	24.6	8.87	109.7	0.6376	8.14	1449	1.22	39%	0.29
62105	120136	4	3.97	24.54	8.87	109.4	0.6375	8.14	1045	2.22	28%	0.33
62105	120314	6	6.01	23.24	6.84	81.8	0.6446	7.92	833	4.26	22%	0.11
62105	120512	8	7.97	21.76	7.88	91.9	0.6386	7.95	598	6.22	16%	0.17
62105	120648	10	9.98	21.35	7.15	83.2	0.6401	7.88	366	8.23	10%	0.24
62105	120822	12	12.01	20.65	6.55	75	0.6413	7.81	242	10.26	7%	0.20
62105	121004	14	14.01	19.25	5.32	58.8	0.6486	7.59	168	12.26	5%	0.18
62105	121126	16	16.03	16.85	4.35	45.7	0.6537	7.4	117	14.28	3%	0.18
62105	121244	18	17.98	15.05	3.57	36.5	0.6602	7.23	82	16.23	2%	0.18
62105	121350	20	19.97	13.77	2.51	24.9	0.6638	7.08	56	18.22	2%	0.19
62105	121548	22	22.05	12.79	1.23	11.8	0.6647	6.97	36	20.3	1%	0.21
62105	121712	24	24.01	12.39	0.36	3.2	0.6654	6.88	20	22.26	1%	0.30
62105	121834	26	26	11.79	0.14	1.4	0.668	6.85	16	24.25	0%	0.11
62105	122011	28	27.99	11.41	0.11	1.1	0.6672	6.66	9	26.24	0%	0.29
62105	122121	30	29.97	11.1	0.09	0.7	0.6685	6.64	3	28.22	0%	0.55
62105	122305	32	31.98	10.93	0.11	0.9	0.6691	6.62	1	30.23	0%	0.55
62105	122437	34	33.99	10.84	0.07	0.8	0.6697	6.61	1	32.24	0%	0.00
62105	122557	36	36.03	10.55	0.05	0.5	0.6708	6.64	0	34.28	0%	0.00
62105	122711	38	37.03	10.4	0.05	0.1	0.673	6.68	0	35.28	0%	0.00
62105	122841	40	38.02	10.36	0.05	0.5	0.6733	6.7	0	36.27	0%	0.00

Date	Time	Text Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light Meter	% Light Transmission Average	Extinction Coefficient
MMDDYYHHMMSS		feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet		1.13
71905	105614	0.25	0.24	27.82	6.93	91.5	0.6633	8.22	3622	Surface		
71905	105845	1	1.05	27.9	6.88	90.4	0.6629	8.26	3193	Surface	100%	
71905	110127	2	1.92	27.75	7.09	92.9	0.6645	8.28	428	0.17	13%	11.82
71905	110305	3	3.14	27.35	7.06	91.8	0.6635	8.29	1477	1.39	46%	-1.02
71905	110403	4	4.03	27.22	7.16	93.1	0.6643	8.3	1271	2.28	40%	0.17
71905	110622	6	6	27.1	7.05	91.3	0.6642	8.3	843	4.25	26%	0.21
71905	110742	8	7.99	26.75	6.56	84.3	0.6648	8.27	619	6.24	19%	0.16
71905	110935	10	9.98	26.25	5.91	75.4	0.664	8.21	414	8.23	13%	0.2
71905	111036	12	12	25.45	4.97	62.4	0.6642	8.08	299	10.25	9%	0.16
71905	111232	14	13.98	23.29	3.41	41.1	0.6651	7.83	209	12.23	7%	0.18
71905	111632	16	15.96	19.47	1.29	14.5	0.669	7.4	138	14.21	4%	0.21
71905	111716	18	18.02	17.08	1.31	13.9	0.6685	7.13	106	16.27	3%	0.13
71905	111821	20	19.98	15.51	1.06	10.9	0.6697	7.09	74	18.23	2%	0.18
71905	111937	22	22.03	14.5	0.64	6.5	0.6695	7.03	48	20.28	2%	0.21
71905	112032	24	23.99	13.08	0.35	3.4	0.6704	6.96	34	22.24	1%	0.18
71905	112132	26	25.99	12.07	0.09	0.9	0.6751	6.9	13	24.24	0%	0.48
71905	112319	28	26.01	12.06	0.06	0.6	0.6754	6.86	13	24.26	0%	0
71905	112608	30	27.98	11.67	0.04	0.4	0.6765	6.65	3	26.23	0%	0
71905	112656	32	31.91	10.95	0.04	0.4	0.6813	6.59	4	30.16	0%	0
71905	112810	34	34.03	10.73	0.04	0.4	0.6834	6.61	6	32.28	0%	0
71905	113210	36	36.01	10.64	0.03	0.3	0.686	6.66	6	34.26	0%	0

Date	Time	Text Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light Meter	% Light Transmission	Extinction Coefficient
MMDDYYHHMMSS		feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet	Average	0.39
81605	111136	0.25	0.29	22.53	9.85	116.5	0.0001	8.96	3927	Surface		
81605	111230	1	1.16	25.22	8.44	105.2	0.6395	9.02	3171	Surface	100%	
81605	111415	2	2.1	25.2	8.46	105.3	0.6392	8.98	1637	0.35	52%	1.89
81605	111600	3	3.03	25.17	8.59	106.9	0.6389	9.03	1479	1.28	47%	0.11
81605	111659	4	4.02	25.14	8.49	105.6	0.6392	9.13	1049	2.27	33%	0.35
81605	112138	6	6.03	25.06	8.51	105.8	0.639	9.02	575	4.28	18%	0.3
81605	112319	8	8.08	24.55	8.22	101.2	0.6392	9.06	356	6.33	11%	0.23
81605	112507	10	10.01	24.09	7.5	91.5	0.6393	9.01	346	8.26	11%	0.01
81605	112723	12	11.97	23.96	7.43	90.5	0.6397	8.94	242	10.22	8%	0.18
81605	113016	14	14	23.9	7.09	86.3	0.64	8.89	180	12.25	6%	0.15
81605	113156	16	15.99	22.48	1.91	22.6	0.6521	8.08	112	14.24	4%	0.24
81605	113548	18	17.96	19.2	0.76	8.4	0.6632	7.49	79	16.21	2%	0.18
81605	113655	20	20	17.25	0.63	6.7	0.6629	7.51	22	18.25	1%	0.63
81605	113812	22	21.96	15.51	0.61	6.3	0.6621	7.51	6	20.21	0%	0.66
81605	113939	24	24	13.96	0.12	1.2	0.6654	7.3	15	22.25	0%	-0.45
81605	114052	26	26.09	13.34	0.09	0.9	0.666	7.14	4	24.34	0%	0.63
81605	114233	28	28.04	12.46	0.08	0.8	0.6721	6.94	1	26.29	0%	0.71
81605	114335	30	30	11.71	0.08	0.8	0.6776	6.87	0	28.25	0%	
81605	114446	32	31.98	11.28	0.08	0.8	0.6823	6.78	0	30.23	0%	
81605	114547	34	34.06	11.09	0.07	0.6	0.685	6.69	1	32.31	0%	
81605	114738	36	36.06	10.97	0.06	0.6	0.6874	6.6	0	34.31	0%	
81605	114846	38	37.96	10.88	0.05	0.6	0.6895	6.58	0	36.21	0%	

Date	Time	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 0.6
92005	102608	0.25	0.53	22.34	7.44	87.9	0.643	9.05	3558	Surface		
92005	102710	1	1.05	22.33	7.4	87.3	0.6425	9.07	3357	Surface	100%	
92005	102806	2	2	22.04	7.55	88.6	0.6419	9.09	972	0.25	29%	4.96
92005	102927	3	2.93	21.99	7.62	89.4	0.6419	9.1	1071	1.18	32%	-0.1
92005	103054	4	4	21.98	7.67	89.9	0.6419	9.12	955	2.25	28%	0.11
92005	103246	6	6	21.91	7.64	89	0.6425	9.15	597	4.25	18%	0.23
92005	103432	8	8	21.89	7.59	88.8	0.6425	9.17	370	6.25	11%	0.24
92005	103707	10	9.99	21.8	7.4	86.5	0.643	9.17	269	8.24	8%	0.16
92005	103837	12	12.03	21.58	6.41	74.5	0.6451	9.08	172	10.28	5%	0.22
92005	104036	14	14.04	21.3	5.92	68.5	0.6451	9.06	112	12.29	3%	0.21
92005	104223	16	16.1	20.88	4.94	56.7	0.647	8.96	79	14.35	2%	0.17
92005	104445	18	18.04	20.38	3.53	40.2	0.6517	8.7	55	16.29	2%	0.19
92005	104731	20	20.08	19.48	1.65	18.4	0.6585	8.14	37	18.33	1%	0.19
92005	104844	22	22.16	16.96	0.42	4.5	0.668	7.61	23	20.41	1%	0.23
92005	105055	24	24.06	14.94	0.33	3.4	0.6737	7.4	12	22.31	0%	0.34
92005	105223	26	25.99	14	0.19	1.9	0.6782	7.28	4	24.24	0%	0.57
92005	105337	28	28.01	12.92	0.17	1.7	0.6868	7.13	1	26.26	0%	0.69
92005	105443	30	30.12	12.19	0.15	1.4	0.6912	7	0	28.37	0%	0
92005	105638	32	32.06	11.95	0.11	1.1	0.6939	6.92	1	30.31	0%	0
92005	105755	34	33.98	11.73	0.09	0.9	0.6959	6.84	1	32.23	0%	0
92005	105910	36	35.95	11.57	0.08	0.8	0.698	6.77	0	34.2	0%	0
92005	110015	38	38.01	11.38	0.08	0.8	0.7013	6.69	0	36.26	0%	0
92005	110111	40	39.98	11.19	0.07	0.7	0.7063	6.61	1	38.23	0%	0

Date	Time	Text Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light Meter	% Light Transmission	Extinction Coefficient
MMDDYYHHMMSS		feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet	Average	
101805	115627	0.25	0.36	14.99	6.96	71.3	0.6579	8.48	3632	Surface		0.55
101805	115725	1	0.99	15	6.85	70.2	0.6578	8.49	3786	Surface	100%	
101805	115817	2	1.99	14.87	7	71.6	0.6576	8.51	1508	0.24	40%	3.84
101805	115911	3	3.01	14.73	7.13	72.6	0.6572	8.53	1099	1.26	29%	0.31
101805	120001	4	3.99	14.49	7.24	73.4	0.6573	8.57	877	2.24	23%	0.23
101805	120101	6	5.98	14.43	7.31	74.1	0.657	8.6	640	4.23	17%	0.16
101805	120204	8	8	14.4	7.26	73.4	0.657	8.62	401	6.25	11%	0.23
101805	120318	10	9.98	14.37	7.1	71.8	0.657	8.63	239	8.23	6%	0.26
101805	120415	12	12.01	14.35	7.17	72.5	0.6572	8.62	127	10.26	3%	0.31
101805	120530	14	13.99	14.3	7.15	72.2	0.6569	8.62	100	12.24	3%	0.12
101805	120623	16	16.01	14.25	7.19	72.5	0.6576	8.63	62	14.26	2%	0.24
101805	120727	18	18.02	14.24	7.21	72.7	0.6577	8.64	43	16.27	1%	0.18
101805	120842	20	19.99	14.17	7.32	73.7	0.6576	8.64	29	18.24	1%	0.2
101805	121029	22	21.95	14.14	7.02	70.6	0.6572	8.59	20	20.2	1%	0.19
101805	121130	24	24	14.04	6.83	68.6	0.6577	8.57	14	22.25	0%	0.17
101805	121247	26	26.03	13.92	6.22	62.2	0.6591	8.46	9	24.28	0%	0.22
101805	121336	28	28.04	13.86	5.15	51.5	0.6639	8.23	6	26.29	0%	0.2
101805	121515	30	29.96	13.55	5.59	55.6	0.6663	8.18	4	28.21	0%	0.21
101805	121615	32	32.02	13.31	4.6	45.5	0.6721	7.9	3	30.27	0%	0.14
101805	121832	34	33.98	13.01	2.6	25.5	0.6791	7.56	1	32.23	0%	0.56
101805	121954	36	36.09	12.61	0.45	4.4	0.6905	7.35	1	34.34	0%	0
101805	122136	38	37.97	11.55	0.06	0.5	0.7251	7.06	1	36.22	0%	0

**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 2000-2005 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 2000-2005 is 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 2000-2005 was 0.174 mg/L and ranged from a minimum of 0.012 mg/L in West Loon 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.  $\text{NH}_4^+$  (ammonium) is released from decomposing organic material under anoxic conditions and accumulates in the hypolimnion of thermally stratified lakes. If  $\text{NH}_4^+$  comes into contact with oxygen, it is immediately converted to  $\text{NO}_2^-$  (nitrite) which is then oxidized to  $\text{NO}_3^-$  (nitrate). Therefore, in a thermally stratified lake, levels of  $\text{NH}_4^+$  would only be elevated in the hypolimnion and levels of  $\text{NO}_3^-$  would only be elevated in the epilimnion. Both  $\text{NH}_4^+$  and  $\text{NO}_3^-$  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 ( $\text{NO}_3^-$ ,  $\text{NO}_2^-$ ,  $\text{NH}_4^+$ ) concentrations exceed 0.3 mg/L in spring, sufficient nitrogen is available to support summer algae blooms. However, low nitrogen levels do not guarantee limited algae growth the way low phosphorus levels do. Nitrogen gas in the air can dissolve in lake water and blue-green algae can "fix" atmospheric nitrogen, converting it into a usable form. Since other types of algae do not have the ability to do this, nuisance blue-green algae blooms are typically associated with lakes that are nitrogen limited (i.e., have low nitrogen levels).

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

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

### **Solids:**

Although several forms of solids (total solids, total suspended solids, total volatile solids, total dissolved solids) were measured each month by the Lakes Management Staff, total suspended solids (TSS) and total volatile solids (TVS) have the most impact on other variables and on the lake as a whole. TSS are particles of algae or sediment suspended in the water column. High TSS concentrations can result from algae blooms, sediment resuspension, and/or the inflow of turbid water, and are typically associated with low water clarity and high phosphorus concentrations in many lakes in Lake County. Low water clarity and high phosphorus concentrations, in turn, exacerbate the high TSS problem by leading to reduced plant density (which stabilize lake sediment) and increased occurrence of algae blooms. The median TSS value in epilimnetic waters in Lake County is 7.9 mg/L, ranging from below the 1 mg/L detection limit (10 lakes) 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 mg/L, ranging from 34 mg/L in Pulaski Pond to 298 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 3.17 feet. From 2000-2005, Fairfield Marsh and Patski Pond had the lowest Secchi depths (0.33 feet) and Bangs Lake had the highest (29.23 feet). As an example of the difference in Secchi depth based on plant coverage, South Churchill Lake, which had no plant coverage and large numbers of Common Carp in 2003 had an average Secchi depth of 0.73 feet (over four times lower than the county average), while Deep Lake, which had a diverse plant community and few carp had an average 2003 Secchi depth of 12.48 feet (almost four times higher than the county average).

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

#### **Alkalinity, Conductivity, Chloride, pH:**

### Alkalinity:

Alkalinity is the measurement of the amount of acid necessary to neutralize carbonate ( $\text{CO}_3^{2-}$ ) and bicarbonate ( $\text{HCO}_3^-$ ) 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 ( $\text{CaCO}_3$ ) or dolomite ( $\text{CaMgCO}_3$ ), alkalinity will be high. The median alkalinity in Lake County lakes (162 mg/L) is considered moderately hard according to the hardness classification scale of Brown, Skougstad and Fishman (1970). Because hard water (alkaline) lakes often have watersheds with fertile soils that add nutrients to the water, they usually produce more fish and aquatic plants than soft water lakes. Since the majority of Lake County lakes have a high alkalinity they are able to buffer the adverse effects of acid rain.

### Conductivity and Chloride:

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

### pH:

pH is the measurement of hydrogen ion ( $H^+$ ) activity in water. The pH of pure water is neutral at 7 and is considered acidic at levels below 7 and basic at levels above 7. Low pH levels of 4-5 are toxic to most aquatic life, while high pH levels (9-10) are not only toxic to aquatic life but may also result in the release of phosphorus from lake sediment. The presence of high plant densities can increase pH levels through photosynthesis, and lakes dominated by a large amount of plants or algae can experience large fluctuations in pH levels from day to night, depending on the rates of photosynthesis and respiration. Few, if any pH problems exist in Lake County lakes.

Typically, the flooded gravel mines in the county are more acidic than the glacial lakes as they have less biological activity, but do not usually drop below pH levels of 7. The median near surface pH value of Lake County lakes is 8.30, with a minimum of 7.06 in Deer Lake and a maximum of 10.28 in Round Lake Marsh North.

### **Eutrophication and Trophic State Index:**

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

The Trophic State Index (TSI) is an index which attaches a score to a lake based on its average

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

**Table 1. Trophic State Index (TSI).**

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

## **APPENDIX D. LAKE MANAGEMENT OPTIONS**

## ***DI. Eliminate or Control Exotic Species***

### **Option 1: Biological Control**

Biological control (bio-control) is a means of using natural relationships already in place to limit, stop, or reverse an exotic species' expansion. In most cases, insects that prey upon the exotic plants in its native ecosystem are imported. Since there is a danger of bringing another exotic species into the ecosystem, state and federal agencies require testing before any bio-control species are released or made available for purchase. Control of exotics by a natural mechanism is preferable to chemical treatments, however there are few exotics that can be controlled by biological means. Insects, being part of the same ecological system as the exotic plant (i.e., the beetles and weevils with Purple Loosestrife) are more likely to provide long-term control. Chemical treatments are usually non-selective while bio-control measures target specific plant species. Bio-control can also be expensive and labor intensive.

### **Option 2: Control by Hand**

Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. Some exotics, such as Purple Loosestrife and Reed Canary Grass, can be controlled to some degree by digging, cutting, or mowing if done early and often during the year. Digging may be required to ensure the entire root mass is removed. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. Proper disposal of excavated plants is important since seeds may persist and germinate even after several years. Once exotic plants are removed, the disturbed ground should be planted with native vegetation and closely monitored since regrowth of the removed species is common. Many exotic species, such as Purple Loosestrife, Buckthorn, and Garlic Mustard are proficient at colonizing disturbed sites. This method can be labor intensive but costs are low.

### **Option 3: Herbicide Treatment**

Chemical treatments can be effective at controlling exotic plant species, and works best on individual plants or small areas already infested with the plant. In some areas where individual spot treatments are prohibitive or impractical (i.e., large expanses of a wetland or woodland), chemical treatments may not be an option because in order to chemically treat the area, a broadcast application would be needed. Because many of the herbicides are not selective, meaning they kill all plants they contact, this may be unacceptable if native plants are found in the proposed treatment area.

Herbicides are commonly used to control nuisance shoreline vegetation by applying it to green foliage or cut stems. They provide a fast and effective way to control or eliminate nuisance vegetation by killing the root of the plant, preventing regrowth. Products are applied by either spraying or wicking (wiping) solution on plant surfaces. Spraying is used when large patches of undesirable vegetation are targeted. Herbicides are sprayed on growing foliage using a hand-held or backpack sprayer. Wicking is used when selected plants are to be removed from a group of plants. It is best to apply herbicides

when plants are actively growing, such as in the late spring/early summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions.

## ***D2. Options for Lakes with Shoreline Erosion***

### **Option 1: Install a Seawall**

Seawalls are designed to prevent shoreline erosion on lakes in a similar manner they are used along coastlines to prevent beach erosion or harbor siltation. Today, seawalls are generally constructed of steel, although in the past seawalls were made of concrete or wood (frequently old railroad ties). A new type of construction material being used is vinyl or PVC. Vinyl seawalls will not rust over time.

If installed properly and in the appropriate areas (i.e., shorelines with severe erosion) seawalls provide effective erosion control. Seawalls are made to last many years and have relatively low maintenance. However, seawalls are disadvantageous for several reasons. One of the main disadvantages is that they are expensive, since a professional contractor and heavy equipment are needed for installation. Also, if any fill material is placed in the floodplain along the shoreline, compensatory storage may also be needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling of another portion. Permits and surveys are needed whether replacing old seawall or installing a new one. Seawalls also provide little habitat for fish or wildlife. Because there is no structure for fish, wildlife, or their prey, few animals use shorelines with seawalls. In addition, poor water clarity that may be caused by resuspension of sediment from deflected wave action contributes to poor fish and wildlife habitat, since sight feeding fish and birds (i.e., bass, herons, and kingfishers) are less successful at catching prey. This may contribute to a lake's poor fishery (i.e., stunted fish populations).

### **Option 2: Install Rock Rip-Rap or Gabions**

Rip-rap is the procedure of using rocks to stabilize shorelines. Size of the rock depends on the severity of the erosion, distance to rock source, and aesthetic preferences. Generally, four to eight inch diameter rocks are used. Gabions are wire cages or baskets filled with rock. They provide similar protection as rip-rap, but are less prone to displacement. They can be stacked, like blocks, to provide erosion control for extremely steep slopes.

Rip-rap and gabions can provide good shoreline erosion control. Rocks can absorb some of the wave energy while providing a more aesthetically pleasing appearance than seawalls. If installed properly, rip-rap and gabions will last for many years. Maintenance is relatively low, however, undercutting of the bank can cause sloughing of the rip-rap and subsequent shoreline. Fish and wildlife habitat can also be provided if large (not

small) boulders are used. A major disadvantage of rip-rap is the initial expense of installation and associated permits. Installation is expensive since a licensed contractor and heavy equipment are generally needed to conduct the work. Permits are required if replacing existing or installing new rip-rap or gabions and must be acquired prior to work beginning.

### **Option 3: Create a Buffer Strip**

Another effective, more natural method of controlling shoreline erosion is to create a buffer strip with existing or native vegetation. Native plants have deeper root systems than turfgrass and thus hold soil more effectively. Native plants also provide positive aesthetics and good wildlife habitat. Allowing vegetation to naturally propagate the shoreline would be the most cost effective, depending on the severity of erosion and the composition of the current vegetation. Stabilizing the shoreline with vegetation is most effective on slopes less than 2:1 to 3:1, horizontal to vertical, or flatter. Usually a buffer strip of at least 25 feet is recommended, however, wider strips (50 or even 100 feet) are recommended on steeper slopes or areas with severe erosion problems.

Buffer strips can be one of the least expensive means to stabilize shorelines. If no permits or heavy equipment are needed (i.e., no significant earthmoving or filling is planned), the property owner can complete the work without the need of professional contractors. Once established (typically within 3 years), a buffer strip of native vegetation will require little maintenance and may actually reduce the overall maintenance of the property, since the buffer strip will not have to be continuously mowed, watered, or fertilized. Buffer strips may slow the velocity of floodwaters, thus preventing shoreline erosion. Native plants also can withstand fluctuating water levels more effectively than commercial turfgrass. In addition, many wildlife species prefer the native shoreline vegetation habitat and various species are even dependent on native shoreline vegetation for their existence. In addition to the benefits of increased wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of colors from flowers, leaves, seeds, and stems. This is not only aesthetically pleasing to people, but also benefits wildlife and the overall health of the lake's ecosystem.

There are few disadvantages to native shoreline vegetation. Certain species (i.e., cattails) can be aggressive and may need to be controlled occasionally. If stands of shoreline vegetation become dense enough, access and visibility to the lake may be compromised to some degree. However, small paths could be cleared to provide lake access or smaller plants could be planted in these areas.

### **Option 4: Install Biolog, Fiber Roll, or Straw Blanket with Plantings**

These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Biologs, fiber rolls, and straw blankets provide erosion control that secure the shoreline in the short-term and allow native plants to establish which will eventually provide long-term shoreline stabilization. They are most often made of bio-degradable materials, which break down by the time the natural

vegetation becomes established (generally within 3 years). They provide additional strength to the shoreline, absorb wave energy, and effectively filter run-off from watershed sources. They are most effective in areas where plantings alone are not effective due to existing erosion.

#### **Option 5: Install A-Jacks®**

A-Jacks® are made of two pieces of pre-cast concrete when fitted together resemble a playing jacks. These structures are installed along the shoreline and covered with soil and/or an erosion control product. Native vegetation is then planted on the backfilled area. They can be used in areas where severe erosion does not justify a buffer strip alone. The advantage to A-Jacks® is that they are quite strong and require low maintenance once installed. In addition, once native vegetation becomes established the A-Jacks® cannot be seen. A disadvantage is that installation cost can be high since labor is intensive and requires some heavy equipment. A-Jacks® need to be pre-made and hauled in from the manufacturing site.

#### **Option 6: Establish a “No Wake” Zone or No Motor Area**

Establishing a “no wake” zone or no motor area will not solve erosion problems by itself. However, since shoreline erosion is generally not caused by one specific factor, these techniques can be effective if used in combination with one or more of the techniques described above. Limiting boat activity, particularly near shorelines or in shallow areas, may also have an additional benefit by improving water quality since less sediment may be disturbed and resuspended in the water column. Less motorboat disturbance will also benefit wildlife and may encourage many species to use the lake both during spring and fall migration and for summer residence. This may add to the lake’s aesthetics and increasing recreational opportunities for some lake users.

Enforcement and public education are the primary obstacles with the “no wake” techniques. Public resistance to any regulation change may be strong, particularly if the lake is open to the public and has had no similar regulations in the past. Depending on the regulations implemented, there may be some loss of recreational use for some users, particularly powerboating. However, if the lake is large enough, certain parts of the lake (i.e., the middle or deepest) may be used for this activity without negatively influencing other uses.

### ***D3. Options for Lakes with High Canada Geese Populations***

#### **Option 1: Removal**

Since Canada Geese are considered migratory waterfowl, both state and federal laws restrict taking or harassing geese. Under the federal Migratory Bird Treaty Act, it is illegal to kill or capture geese outside a legal hunting season or to harass their nests without a permit. If removal of problematic geese is warranted or if nest and egg

destruction becomes an option, permits need to be obtained from the Illinois Department of Natural Resources (217- 782-6384) and the U.S. Fish and Wildlife Service (217-241-6700). Removing a significant portion of a problem goose population can have a positive effect on the overall health of a lake. However, if the habitat conditions still exist, more geese will likely replace any that were removed. Thus, money and time used removing geese may not be well spent unless there is a change in habitat conditions.

### **Option 2: Dispersal/Repellent Techniques**

Several techniques and products are on the market that claim to disperse or deter geese from using an area. These techniques can be divided into two categories: harassment and chemical. With both types of techniques it is important to implement any action early in the season, before geese establish territories and begin nesting. Once established, the dispersal/repellent techniques may be less effective and geese more difficult to coerce into leaving. Harassment techniques include scaring off geese with noisemakers, or chasing them off using dogs or swans. Chemical repellents may also be used with some effectiveness. New products are continually coming out that claim to rid an area of nuisance geese.

With persistence, harassment and/or use of repellants can result reduced or minimal usage of an area by geese. Fewer geese may mean less feces and cleaner yards and parks, which may increase recreational uses along shorelines. However, the effectiveness of harassment techniques is reduced over time since geese will adapt to the devices.

### **Option 3: Exclusion**

Erecting a barrier to exclude geese is another option. In addition to a traditional wood or wire fence, an effective exclusion control is to suspend netting over the area where geese are unwanted. Geese are reluctant to fly or walk into the area. A similar deterrent that is often used is a single string or wire suspended a foot or so above the ground along the length of the shoreline. This technique will not be effective if the geese are using a large area. The single string or wire method may be effective at first, but geese often learn to go around, over, or under the string after a short period of time. Excluding geese from one area will force them to another area on a different part of the same lake or another nearby lake. While this solves one property owner's problem, it creates one for another.

### **Option 4: Habitat Alteration**

One of the best methods to deter geese from using an area is through habitat alteration. Habitats that consist of mowed turfgrass to the edge of the shoreline are ideal for geese. Create a buffer strip (approximately 10-20 feet wide) between the shoreline and any mowed lawn by planting natural shoreline vegetation (i.e., bulrushes, cattails, rushes, grasses, shrubs, and trees, etc.) or allowing the vegetation to establish naturally. Aeration systems that run into the fall and winter prevent the lake from freezing, thus not forcing geese to migrate elsewhere. To alleviate this problem, turn aerators off during fall and early winter. Once the lake freezes over and the geese have left, wait a few weeks before turning the aerators on again if needed.

Altering the habitat in an area can not only make the habitat less desirable for geese, but may be more desirable for many other species of wildlife. A buffer strip has additional benefits by filtering run-off of nutrient, sediments, and pollutants and protecting the shoreline from erosion from wind, wave, or ice action. The more area that has natural vegetation, the less turfgrass needs to be constantly manicured and maintained.

#### **Option 5: Do Not Feed Waterfowl!**

There are few “good things”, if any, that come from feeding waterfowl. Birds become dependent on handouts, become semi-domesticated, and do not migrate. This causes populations to increase and concentrate, which may create additional problems such as diseases within waterfowl populations. The nutritional value in many of the “foods” (i.e., white bread) given to geese and other waterfowl are quite low. Since geese are physiologically adapted to eat a variety of foods, they can actually be harmed by filling-up on human food. Geese that are accustomed to hand feeding may become aggressive toward other geese or even the people feeding the geese.

### ***D4. Options for lakes with Zebra Mussels***

Zebra Mussels get their name from the alternating black and white striped pattern on their shells. They have spread extensively in the Great Lakes region in the past decade. They attach themselves to any solid underwater object such as boat hulls, piers, intake pipes, plants, other bivalves (mussels), and even other Zebra Mussels. Zebra Mussels originated from Eastern Europe, specifically the Black and Caspian Seas. By the mid 18<sup>th</sup> and 19<sup>th</sup> centuries they had spread to most of Europe. The mussels were believed to have been spread to this country in the mid 1980s by cargo ships that discharged their ballast water into the Great Lakes. They were first discovered in Lake St. Clair (the body of water that connects lakes Erie and Huron) in June of 1988. The mussels then spread to the rest of the Great Lakes. The first sighting in Lake Michigan was in June 1989. By 1990, Zebra Mussels had been found in all of the Great Lakes. By 1991 they had made their way into the adjacent waters of the Great Lakes such as the Illinois River, which eventually led to their spread into the Mississippi River and all the way down to the Gulf of Mexico. Other states in the Midwest have also experienced Zebra Mussel infestations of their inland lakes. Southeastern Wisconsin has about a dozen lakes infested and Michigan has about 100 infested lakes. Even though they are a fresh water mussel they have also been found in brackish (slightly saline) water and they can even live out of the water for up to 10 days at high humidity and cool temperatures. At average summer temperatures, Zebra Mussels can survive out of water for an average of five days.

The Zebra Mussels reproductive cycle allows for rapid expansion of the population. A mature female can produce up to 40,000 eggs in a cycle and up to one million in a season. Eggs hatch within a few days and young larvae (called veligers) are free floating for up to 33 days, carried along on water currents. This allows for the distribution of larvae to uninfested areas, which accelerates their spread. The larvae attach themselves by a

filamentous organ (called a byssus) near their foot. Once attached to a solid surface, larvae develop into a double shelled adult within three weeks and are capable of reproduction in a year. Zebra Mussels can live as long as five years and have an average life span of about 3.5 years. The adults are typically about the size of a thumb nail but can grow as large as 2 inches in diameter. Colonies can reach densities of 30,000 - 70,000 mussels per square meter.

Due to their quick life cycle and explosive growth rate, Zebra Mussels can quickly edge out native mussel species. Negative impacts on native bivalve populations include interference with feeding, habitat, growth, movement, and reproduction. Some native species of bivalves have been found with 10,000 Zebra Mussels attached to them. Many of these native, rare, threatened and endangered bivalve species may not be able to survive if Zebra Mussels populations continue to expand. The impact that the mussels have on fish populations is not fully understood. However, they feed on phytoplankton (algae), which is also a major food source for planktivorous fish, such as Bluegill. These fish, in turn, are a food source for piscivorous fish (fish eating fish), such as Largemouth Bass and Northern Pike. Concern has also arisen over the concentration of pollutants found in Zebra Mussels. Mussels are filter feeders, taking up water and sediment containing pollutants, which then builds to high concentrations in their tissue (bioaccumulation). Due to the large number of mussels that are consumed by fish, concentrations of pollutants are even higher in the fish (biomagnification), which are potentially consumed by humans.

In addition to the ecological impacts, there are also many economical concerns. Zebra Mussels have caused major problems for industrial complexes located on the Great Lakes and associated bodies of water. Mussels can clog water intakes of power plants, public water supplies, and other industrial facilities. This can reduce water flow (by as much as two-thirds) to heat exchangers, condensers, fire fighting equipment, and air conditioning systems. Zebra Mussels can infest inboard motor intakes and can actually grow inside the motor, causing considerable damage. Navigational buoys have sunk due to the weight of attached mussels. Corrosion of concrete and steel, which can lead to loss of structural integrity, can occur from long-term mussel attachment. A Michigan-based paper company recently reported that it had spent 1.4 million dollars in removing only 400 cubic yards of Zebra Mussels. It has been estimated that billions of dollars have been incurred in removal efforts and in damage to factories, water supply companies, power plants, ships, and the fishing industry. There are several methods of control, which include both removal and eradication. Many are site specific, so control methods are often dictated by the situation. These control methods include chemical molluscicides, manual removal, thermal irritation, acoustical vibration, toxic and non-toxic coatings, CO<sub>2</sub> injection, and ultraviolet light. Additionally, several biological controls are being investigated. However, there is currently no widespread/whole lake control practice that would be effective without harming other wildlife.

Surprisingly, some positive impacts have been observed from Zebra Mussel infestations. They are capable of filtering one liter of water per day. This water often contains sediment and phytoplankton, which contribute to turbidity. As a result, large infestations

have brought about significant improvements in water clarity in some lakes. Due to severe mussel infestations, Lake Erie water clarity has increased four to six times what it was before Zebra Mussels invaded the lake (in addition to improvements as a result of pollution control measures). This has resulted in deeper penetration of light and an expansion of aquatic plant populations, something that has not been seen for decades. In turn, the increased plant growth is providing better fish habitat and better fishing. Unfortunately, the negative ecological and economical impacts associated with Zebra Mussels far outweigh any positive benefits.

Here are some tips from the Great Lakes Sea Grant Network that can help prevent the spread of Zebra Mussels:

- Flush clean water (tap) through the cooling system of your motor to rinse out any larvae.
- Drain all bilge water, live wells, bait buckets, and engine compartments. Make sure water is not trapped in your trailer.
- Always inspect your boat and boat trailer carefully before transporting.
- In their earlier stages, attached Zebra Mussels may not be easily seen. Pass your hand across the bottom of the boat - if it feels grainy, it is probably covered with mussels. Don't take a chance; clean them off by scraping or blasting.
- Full grown Zebra Mussels can be easily seen but cling stubbornly to surfaces. Carefully scrape the hull (or trailer), or use a high pressure spray (250 psi) to dislodge them. Or leave your boat out of the water for at least 10-14 days, preferably two weeks. The mussels will die and drop off.
- Dispose of the mussels in a trash barrel or other garbage container. Don't leave them on the shore where they could be swept back into the lake or foul the area.
- Before you leave the boat launch site, remove from the boat trailer any plant debris where tiny Zebra Mussels may be entangled.
- Always use extra caution when transporting bait fish from one lake to another. You could be carrying microscopic veligers. To be safe, do not take water from one lake to another.
- Certain polymer waxes discourage zebra Mussels from attaching. But check your hull periodically because the mussels cling to drain holes and speedometer brackets.

## ***D5. Options for Watershed Nutrient Reduction***

The two key nutrients for plant and algae growth are nitrogen and phosphorus. Fertilizers used for lawn and garden care have significant amounts of both. The three numbers on the fertilizer bag identify the percent of nitrogen, phosphorus and potash in the fertilizer mixture. For example, a fertilizer with the numbers 5-10-5 has 5% nitrogen, 10% phosphorus and 5% potash. Fertilizers considered low in phosphorus (the second number) have a number of 5 or lower. A lower concentration of phosphorus applied to a lawn will result in a smaller concentration of phosphorus in stormwater runoff. An established lawn will not be negatively affected by a lower phosphorus rate. However, for areas with new seeding or new sod, the homeowner would still want to use a fertilizer formulated for encouraging growth until the lawn is established. A simple soil test can determine the correct type and amount of fertilizer needed for the soil. Knowing this, homeowners can avoid applying the wrong type or amount of fertilizer.

### **Option 1. Buffer Strips**

Buffer strips of unmowed native vegetation at least 25 feet wide along the shoreline can slow nutrient laden runoff from entering a lake. It can help prevent shoreline erosion and provide habitat beneficial for wildlife. Different plant mixes can be chosen to allow for more aesthetically pleasing buffer strips and tall species can be used to deter waterfowl from congregating along the shore. Initially the cost of plants can be expensive, however, over time less maintenance is required for the upkeep of a buffer strip.

### **Option 2. Lake Friendly Lawn and Garden Care Practices – Phosphorus Reduction**

- a. Compost yard waste instead of burning. Ashes from yard waste contain nutrients and are easily washed into a lake.
- b. Avoid dumping yard waste along or into a ditch, pond, lake, or stream. As yard waste decomposes, the nutrients are released directly into the water, or flushed to the lake via the ditch.
- c. Avoid applying fertilizer up to the water's edge. Leave a buffer strip of at least 25 feet of unfertilized yard before the shoreline.
- d. Avoid applying fertilizers when heavy rains are expected, or over-watering the ground after applying fertilizer.
- e. When landscaping, keep site disturbance to a minimum, especially the removal of vegetation and exposure of bare soil. Exposed soil can easily erode.
- f. When landscaping, seed or plant exposed soil and cover it with mulch as soon as possible to minimize erosion and runoff.
- g. Use lawn and garden chemicals sparingly, or do not use them at all.

### **Option 3. Street Sweeping**

Street sweeping has been used in communities to help prevent debris from clogging stormsewer drains, but it also benefits lakes by removing excess phosphorus, sand, silt and other pollutants. Leftover sand and salt applied to streets has been found to contain

higher concentrations of silt, phosphorus and trace metals than new sand and salt mixes. If a municipality does not manage the lake, the lake management entity may be able to offer the village or city extra payment for sweeping streets closest to the lake.

#### **Option 4: Reduce Stormwater Volume from Impervious Surfaces**

The quality and quantity of runoff directly affects the lake's water quality. With continued growth and development in Lake County, more impervious surfaces such as parking lots and buildings contribute to the volume of stormwater runoff. Runoff picks up pollutants such as nutrients and sediment as it moves over land or down gutters. A faster flow rate and higher volume can result in erosion and scouring, adding sediment and nutrients to the runoff.

Roof downspouts should be pointed away from driveways and foundations and toward lawns or planting beds where water can soak into the soil. A splash block directly below downspouts helps prevent soil erosion. If erosion still occurs, a flexible perforated plastic tubing attached to the downspout can dissipate the water flow.

#### **Option 5: Required Practices for Construction**

Follow the requirements in the Watershed Development Ordinance (WDO) concerning buffer strips. Buffer strips can slow the velocity of runoff and trap sediment and attached nutrients. Setbacks, buffer strips and erosion control features, when done properly, will help protect the lake from excessive runoff and associated pollutants. Information about the contents of the ordinance can be obtained through Lake County Planning and Development, (847) 360-6330.

#### **Option 6. Organize a Local Watershed Organization**

A watershed organization can be instrumental in circulating educational information about watersheds and how to care for them. Often a galvanized organization can be a stronger working unit and a stronger voice than a few individuals. Watershed residents are the first to notice problems in the area, such as a lack of erosion control at construction sites. This organization would be an advocate for the watershed, and members could voice their concerns about future development impacts to local officials. This organization could educate the community about how phosphorus (and other pollutants) affect lakes and can help people implement watershed controls. Several types of educational outreaches can be used together for best results. These include: community newsletters, newspaper articles, local cable and radio station announcements. In some cases fundraising may be utilized to secure more funding for a project. could include a ban of motorized traffic in certain areas or ban the use of motors entirely, however this could be hard to enforce without hiring law enforcement personnel. This would work best for lakes with shallow areas that have a large phosphorus source in the sediment.

### **Option 7. Discourage Waterfowl from Congregating**

Waterfowl droppings (feces) can be a source of phosphorus (and bacteria) to the water, especially if they are congregating in large numbers along beaches and/or other nearshore areas. The annual nutrient load from two Canada Geese can be greater than the annual nutrient load from residential areas (Gremlin and Malone, 1986). These birds prefer habitat with short plants or no plants, such as lawns mowed to the water's edge and beaches. Waterfowl avoid areas with tall, dense vegetation through which they are unable to see predators. Tactics to discourage waterfowl from congregating in large groups include scare devices, a buffer strip of tall plants along the shoreline, and discouraging people from feeding geese and ducks. Signage could be erected at public parks/beaches discouraging people from feeding waterfowl. A template is available from Lakes Management Unit.

**APPENDIX E. WATER QUALITY STATISTICS FOR ALL LAKE  
COUNTY LAKES**

## 2000 - 2005 Water Quality Parameters, Statistics Summary

	ALK (oxic) <=3ft 2000-2005		ALK (anoxic) 2000-2005	
Average	<b>167.0</b>		<b>205</b>	
Median	<b>162.0</b>		<b>194</b>	
Minimum	<b>64.9</b>	<b>IMC</b>	<b>103</b>	<b>Heron Pond</b>
Maximum	<b>330.0</b>	<b>Flint Lake</b>	<b>470</b>	<b>Lake Marie</b>
STD	<b>42.2</b>		<b>53</b>	
n =	<b>803</b>		<b>265</b>	

	Cond (oxic) <=3ft 2000-2005		Cond (anoxic) 2000-2005	
Average	<b>0.8536</b>		<b>0.9606</b>	
Median	<b>0.7748</b>		<b>0.8210</b>	
Minimum	<b>0.2305</b>	<b>White Lake</b>	<b>0.3031</b>	<b>White Lake</b>
Maximum	<b>6.8920</b>	<b>IMC</b>	<b>7.4080</b>	<b>IMC</b>
STD	<b>0.5203</b>		<b>0.7611</b>	
n =	<b>808</b>		<b>265</b>	

	NO3-N (oxic) <=3ft 2000-2005		NH3-N (anoxic) 2000-2005	
Average	<b>0.480</b>		<b>2.296</b>	
Median	<b>0.116</b>		<b>1.560</b>	
Minimum	<b>&lt;0.05</b>	<b>*ND</b>	<b>&lt;0.1</b>	<b>*ND</b>
Maximum	<b>9.670</b>	<b>South Churchill Lake</b>	<b>18.400</b>	<b>Taylor Lake</b>
STD	<b>1.019</b>		<b>2.483</b>	
n =	<b>808</b>		<b>265</b>	

\*ND = Many lakes had non-detects (69%)

\*ND = 21% Non-detects from 32 different lakes

Only compare lakes with detectable concentrations to the statistics above

	pH (oxic) <=3ft 2000-2005		pH (anoxic) 2000-2005	
Average	<b>8.31</b>		<b>7.11</b>	
Median	<b>8.30</b>		<b>7.13</b>	
Minimum	<b>7.06</b>	<b>Deer Lake</b>	<b>5.80</b>	<b>Third Lake</b>
Maximum	<b>10.28</b>	<b>Round Lake Marsh North</b>	<b>8.48</b>	<b>Heron Pond</b>
STD	<b>0.46</b>		<b>0.41</b>	
n =	<b>807</b>		<b>265</b>	

	All Secchi 2000-2005	
Average	<b>4.39</b>	
Median	<b>3.17</b>	
Minimum	<b>0.33</b>	<b>Fairfield Marsh, Patski Pond</b>
Maximum	<b>29.23</b>	<b>Bangs Lake</b>
STD	<b>3.65</b>	
n =	<b>740</b>	

81 of 161 lakes had anoxic conditions  
 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

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## 2000 - 2005 Water Quality Parameters, Statistics Summary continued

TKN (oxic) <=3ft 2000-2005			TKN (anoxic) 2000-2005		
Average	<b>1.457</b>		Average	<b>3.067</b>	
Median	<b>1.220</b>		Median	<b>2.270</b>	
Minimum	<b>&lt;0.5</b>	<b>*ND</b>	Minimum	<b>&lt;0.5</b>	<b>*ND</b>
Maximum	<b>10.300</b>	<b>Fairfield Marsh</b>	Maximum	<b>21.000</b>	<b>Taylor Lake</b>
STD	<b>0.831</b>		STD	<b>2.467</b>	
n =	<b>808</b>		n =	<b>265</b>	
*ND = 5% Non-detects from 19 different lakes			*ND = 5% Non-detects from 7 different lakes		

TP (oxic) <=3ft 2000-2005			TP (anoxic) 2000-2005		
Average	<b>0.098</b>		Average	<b>0.320</b>	
Median	<b>0.063</b>		Median	<b>0.174</b>	
Minimum	<b>&lt;0.01</b>	<b>From 5 Lakes</b>	Minimum	<b>0.012</b>	<b>West Loon Lake</b>
Maximum	<b>3.880</b>	<b>Albert Lake</b>	Maximum	<b>3.800</b>	<b>Taylor Lake</b>
STD	<b>0.168</b>		STD	<b>0.412</b>	
n =	<b>795</b>		n =	<b>265</b>	
*ND = 0.1% Non-detects from 5 different lakes (Bangs, Cedar, Carina, Minear, & Stone Quarry)					

TSS (all) <=3ft 2000-2005			TVS (oxic) <=3ft 2000-2005		
Average	<b>15.3</b>		Average	<b>136.0</b>	
Median	<b>7.9</b>		Median	<b>132.0</b>	
Minimum	<b>&lt;0.1</b>	<b>*ND</b>	Minimum	<b>34.0</b>	<b>Pulaski Pond</b>
Maximum	<b>165.0</b>	<b>Fairfield Marsh</b>	Maximum	<b>298.0</b>	<b>Fairfield Marsh</b>
STD	<b>20.3</b>		STD	<b>40.4</b>	
n =	<b>815</b>		n =	<b>758</b>	
*ND = 2% Non-detects from 10 different lakes			No 2002 IEPA Chain Lakes		

TDS (oxic) <=3ft 2000-2004			CL (anoxic) 2004-2005		
Average	<b>470</b>		Average	<b>277</b>	
Median	<b>454</b>		Median	<b>102</b>	
Minimum	<b>150</b>	<b>Lake Kathryn, White</b>	Minimum	<b>53</b>	<b>Banana Pond</b>
Maximum	<b>1340</b>	<b>IMC</b>	Maximum	<b>2390</b>	<b>IMC</b>
STD	<b>169</b>		STD	<b>489</b>	
n =	<b>745</b>		n =	<b>66</b>	
No 2002 IEPA Chain Lakes, Data from 00-04.					

CL (oxic) <=3ft 2004-2005		
Average	<b>243.8</b>	
Median	<b>183.0</b>	
Minimum	<b>51.7</b>	<b>Heron Pond</b>
Maximum	<b>2760.0</b>	<b>IMC</b>
STD	<b>339.4</b>	
n =	<b>197</b>	



## **APPENDIX F. GRANT PROGRAM OPPORTUNITES**

**Table F1. A list of potential grant opportunities**

Grant Program Name	Funding Source	Funding Focus			Cost Share	Typical Award
		Water Quality	Flooding	Habitat		
Challenge Grant Program	USFWS			X	>50%	<\$10,000
Chicago Wilderness Small Grants Program	CW			X	None	\$15,000
Conservation 2000 (C2000)	IDNR			X	None	\$10,000 to \$500,000
Conservation Reserve Program	NRCS			X	Land	Variable
Five Star Challenge Grant	NFWF			X	None	\$5,000 to \$20,000
Flood Mitigation Assistance Program	IEMA		X		25%	\$200,000
Habitat Restoration Program for the Fox Watershed	LCSWCD			X	25%	<\$1,000K
Illinois Clean Lakes Program (ICLP)	IEPA	X			>50%	\$5,000 to \$30,000
Illinois Clean Energy Community Foundation	ICECF			X	None	Variable
Lakes Education Assistance Grant Program (LEAP)	IEPA	X			None	\$500
Northeast Illinois Wetland Conservation Account	USFWS	X		X	>50%	\$600 to \$200,000
Partners for Fish and Wildlife Program	USFWS			X	>50%	\$3,000
Section 206: Aquatic Ecosystem Restoration	USACE			X	35%	<\$1,000,000
Section 319: Non-Point Source Management Program	IEPA	X		X	>40%	Variable
STAG Grants	LCSMC	X			None	Variable
Stream Cleanup And Lakeshore Enhancement (SCALE)	IEPA	X			None	\$2,000
Streambank Stabilization and Restoration Program (SSRP)	LCSWCD	X		X	25%	Variable
Unincorporated Lake County Drainage Fund	LCPBD		X		>50%	\$5,000 to \$10,000
Wildlife Habitat Incentives Program	NRCS			X	Land	Variable
Watershed Management Board	LCSMC	X	X	X	>50%	\$5K to \$10K
Wetland Reserve Program	NRCS			X	Land	Variable

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

## **Table F2. Grant Contacts**

### **Chicago Wilderness (CW)**

Elizabeth McCance, Director of Conservation Programs

Phone: (312) 580-2138

E-mail: [emccance@chicagowilderness.org](mailto:emccance@chicagowilderness.org)

<http://www.chicagowilderness.org/>

### **Illinois Clean Energy Community Foundation (ICECF)**

2 N. LaSalle Street

Suite 950

Chicago, IL 60602

Phone: (312) 372-5191

Fax: (312) 372-5190

<http://www.illinoiscleanenergy.org/>

### **Illinois Department of Natural Resources (IDNR)**

One Natural Resources Way

Springfield, IL 62702-1271

Phone: (217) 782-9740

<http://dnr.state.il.us/orep/C2000>

### **Illinois Emergency Management Agency (IEMA)**

110 East Adams Street

Springfield, Illinois 62701

Phone: (217) 785-0229

<http://www.state.il.us/iema/index.htm>

### **Illinois Environmental Protection Agency (IEPA)**

Bureau of Water - Surface Water Section

1021 North Grand Avenue East

P.O. Box 19276

Springfield, Illinois 62794-9276

Telephone: (217) 782-3362

Fax: (217) 785-1225

<http://www.epa.state.il.us/water/financial-assistance/non-point.html>

**Lake County Planning, Building, and Development Department (LCPBD)**

18 N. County Street  
Waukegan, IL 60085  
Phone: (847) 377-2875  
Fax: (847) 782-3016

**Lake County Soil and Water Conservation District (LCSWCD)**

100 N. Atkinson Road  
Suite 102A  
Grayslake, IL 60030  
Phone: (847)-223-1056  
Fax: (847)-223-1127  
<http://www.lakeswcd.org/>

**Lake County Stormwater Management Commission (LCSMC)**

333-B Peterson Road  
Libertyville, IL 60048  
Phone: (847) 918-5260  
Fax: (847) 918-9826  
<http://www.co.lake.il.us/smc>

**National Fish and Wildlife Foundation (NFWF)**

Attn: Five Star Restoration Program  
1120 Connecticut Avenue N.W., Suite 900  
Washington, DC 20036  
Phone: (202) 857-0166  
Fax: (202) 857-0162  
<http://nfwf.org/programs/5star-rfp.htm>

**Natural Resources Conservation Service (NRCS)**

Wildlife Habitat Incentives Program Coordinator  
USDA Natural Resources Conservation Service  
1902 Fox Drive  
Champaign, IL 61820  
Phone: (217) 398-5267  
<http://www.nrcs.usda.gov/programs/whip/>

**United States Army Corps of Engineers (USACE)**

111 N. Canal Street  
Chicago, Illinois 60606-7206  
Telephone: (312)-846-5333  
Fax: (312)-353-2169  
<http://www.lrc.usace.army.mil/>

**United States Fish and Wildlife Service (USFWS)**

Chicago Field Office  
1250 South Grove Avenue, Suite 103  
Barrington, IL 60010  
Phone: (847)-381-2253  
Fax: (847)-381-2285

**Other Related Contacts**

*Catalog of Federal Funding Sources for Watershed Protection Web Site*  
<http://cfpub.epa.gov/fedfund/>

*Fox River Ecosystem Partnership (FREP)*  
<http://foxriverecosystem.org/>

*North American Wetlands Conservation Act Grants Program*  
<http://birdhabitat.fws.gov/NAWCA/grants.htm>

*North American Wetland Conservation Act Programs*  
<http://birdhabitat.fws.gov/NAWCA/grants.htm>

*U.S. Fish and Wildlife Foundation*  
<http://www.nfwf.org/>