

**2005 SUMMARY REPORT
of
Cranberry Lake**

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Cranberry Lake is located in Avon Township at the corner of Hainesville Road and Washington Street in the Village of Hainesville (T45N, R10E, Section 28, NE ¼). The lake is a glacial pothole that is nearly round in shape except for a shallow north-south arm off of the east side, which has very little open water. The lake is totally surrounded by a wide Cattail fringe that is slowly encroaching on the north and east sides, and has a shallow shelf (1-7 feet) extending far out into the lake where the depth then increases quickly. Ownership of Cranberry Lake changed hands in 2004, with responsibilities shifting from Deer Point Homes to the Village of Hainesville. Access to the lake is limited to a small path through the Cattails on the northeast side, which makes a canoe the only suitable watercraft, although access is not permitted to anyone at this time.

Water clarity in the lake averaged 10.5 feet, which was similar to the readings taken in 2000, and is still well above the county median (3.2 feet). Total suspended solids (TSS) concentration also remained relatively steady, with only a slight increase in the average (1.2 mg/L, 2000; 1.5 mg/L, 2005). TSS was still well below the county median of 7.9 mg/L. Average total phosphorus (TP) concentration (1.65 mg/L in the epilimnion) remained the same as in 2000 (0.024 mg/L). The epilimnetic dissolved oxygen (DO) average concentration dropped slightly, from 7.38 mg/L in 2000, to 7.00 mg/L in 2005. This drop is minimal and is not of concern. The average hypolimnetic DO concentration increased from 0.16 mg/L 2001 to 1.42 mg/L in 2005.

A new plant sampling technique was employed this year using a grid system with points 60 meters apart. Plant sampling was performed in both June and August in order to determine the aquatic plant community composition and abundance. Plant diversity declined from June of 2000 to June of 2005, with 16 species in 2000 and 12 species in 2005. Floatingleaf Pondweed, Largeleaf Pondweed, Slender Naiad, and Threadleaf Pondweed were the species present in June 2000, but not in June 2005. Plant diversity also declined from August 2000, to August 2005, and there was also a species shift. Largeleaf Pondweed, Spiny Naiad, Threadleaf Pondweed and Variable Leaved Pondweed were observed in August 2000, but not in August 2005. Small Bladderwort and Soft Bulrush were observed in August 2005, but not in the previous August 2000 sampling. These changes in both June and August were probably due to natural annual variation and the drought-like conditions in 2005.

Shoreline conditions have remained the same, with no recorded erosion. This is due to the large buffer strip left between the surrounding developments and the lake. Shoreline invasive plant species are present, but actions are presently being taken to control at least one species (Buckthorn). The wetland area surrounding the lake provides good habitat for many birds and small mammals.

LAKE FACTS

Lake Name:	Cranberry Lake
Historical Name:	None
Nearest Municipality:	Village of Hainesville
Location:	T45N, R10E, Section 28
Elevation:	800 feet
Major Tributaries:	None (Headwaters of the Round Lake drainage basin)
Watershed:	Fox River
Sub-watershed:	Squaw Creek (Long Lake) Watershed
Receiving Waterbody:	Highland Lake
Surface Area:	17.5 acres
Shoreline Length:	0.76 miles
Maximum Depth:	18.5 feet
Average Depth (est.):	9.25 feet
Lake Volume (est.):	163.8 acre-feet
Lake Type:	Glacial Pothole
Watershed Area (est.):	122.5 acres
Major Watershed Land Uses:	Multi-family housing, Wetland
Bottom Ownership:	Village of Hainesville
Management Entities:	Village of Hainesville
Current and Historical Uses:	Historically used for fishing and waterfowl hunting. Currently used for aesthetic enjoyment.
Description of Access:	No public access

SUMMARY OF WATER QUALITY

Cranberry Lake has a relatively small watershed (Figure 1). The lake receives runoff from a primarily residential watershed, with substantial sections of forest/grassland and wetland (Figure 2). The large amount of impervious surfaces that are associated with residential areas (rooftops, driveways, and roads) increase the amount of direct stormwater runoff into a lake. The large buffer area of wetland/forest-grassland between development and the lake allow filtering of nutrients and solids from stormwater before it reaches the lake. The retention time, (the approximate time it takes a molecule of water to cycle through the lake) is approximately 1.2 years (430.2 days) (Table 1).

Water samples were taken once a month at the deepest location in the lake, from May to September (Figure 3). Two samples were taken; one from the upper water layer (epilimnion) and one from the lower water layer (hypolimnion). They were analyzed for nutrients, solids concentration and other physical parameters. The epilimnion sample was taken from three feet each month, while the hypolimnion sample varied from 14-15 feet deep, as these samples are always taken three feet above the bottom, and the water level fluctuated throughout the season (Appendix A). Cranberry Lake was divided into these different layers from May until September, with the strongest thermal stratification occurring in August. Thermal stratification is measured in relative thermal resistance to mixing (RTRM). RTRM values that fall below 20 generally allow water within the entire waterbody to mix freely, while values of 20 and higher generally do not allow layers to mix. The size of this strongly stratified layer usually increases throughout the summer. This was the case in Cranberry Lake.

The average epilimnetic dissolved oxygen (DO) concentration was 7.00 mg/L (Table 2), with the highest reading in May, and the lowest in June. The average hypolimnetic DO concentration was 1.42 mg/L, with the highest reading also in May (6.40 mg/L) and the lowest reading also in June (0.12 mg/L). The hypoxic layer (where DO drops below 5.0 mg/L) was below approximately 12 feet in June, 10 feet in July, 8 feet in August, and 10 feet in September. All water below these levels lacked adequate oxygen supply for most aquatic life. Because a bathymetric map does not exist for Cranberry Lake, we are unable to calculate the volume of water affected by these low DO levels. This pattern of decreased oxygen content as the summer progresses is normal. Water holds less oxygen as it heats up. Also, as organisms start to die and fall to the bottom to decay, more oxygen is used to breakdown the dead material. Anoxic conditions (<1 mg/L DO) occurred in the hypolimnion from June through September (Appendix C).

Suspended solids are made up of any type of solid particles in the water column, including algal cells and sediment. The median epilimnetic total suspended solid (TSS) concentration for Cranberry Lake during the 2005 study was 1.5 mg/L. This is similar to the median concentration in 2000 (1.2 mg/L) and over four times lower than the County median (Appendix E). Cranberry Lake also has the lowest TSS concentration in the Long Lake watershed. This is mainly due to the lake sitting at the top of the watershed.

Figure 1. Approximate watershed delineation for Cranberry Lake, 2005.



Figure 2. Approximate land use within the Cranberry Lake watershed, 2005.

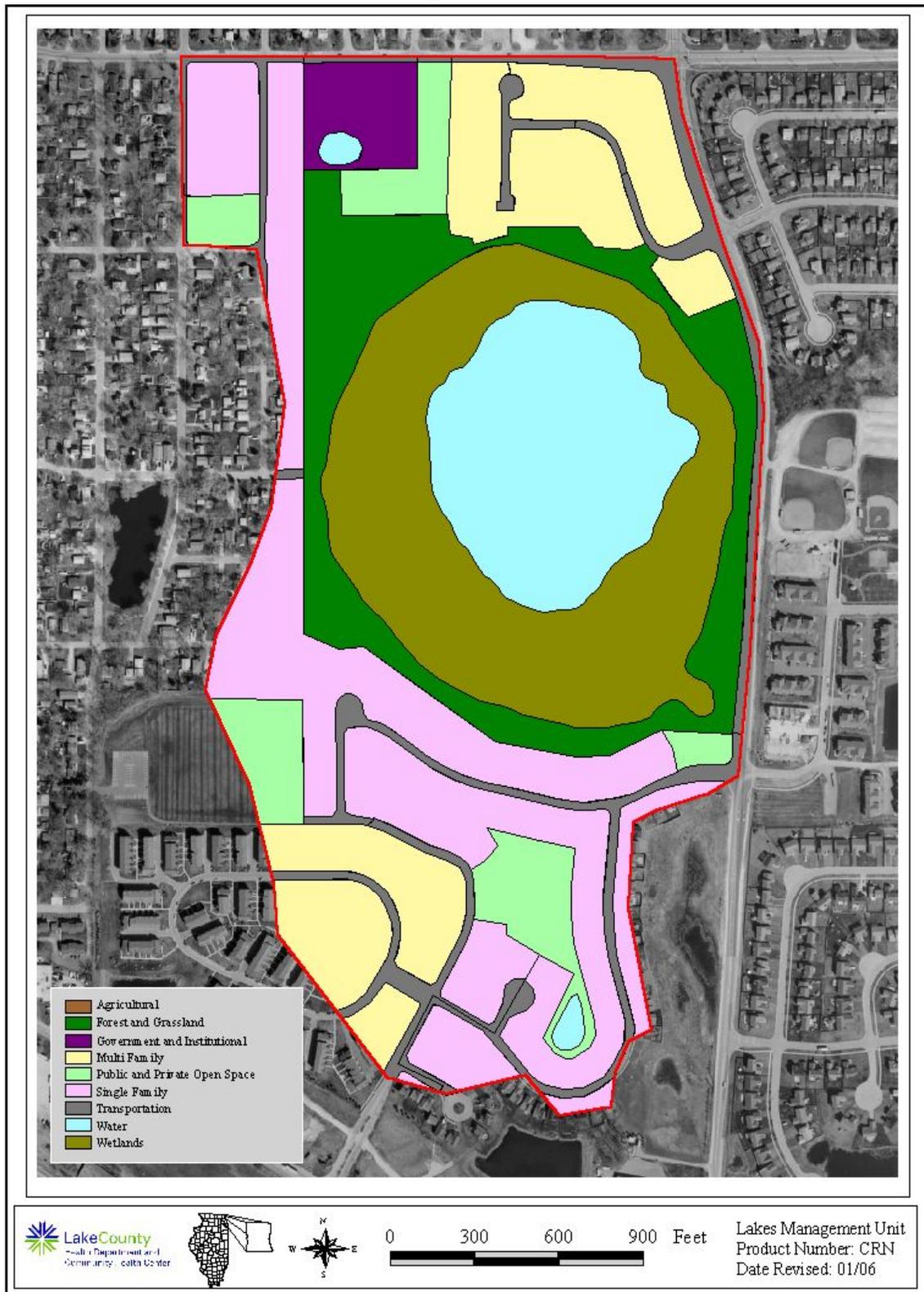


Figure 3. Water quality sampling point on Cranberry Lake, 2005.

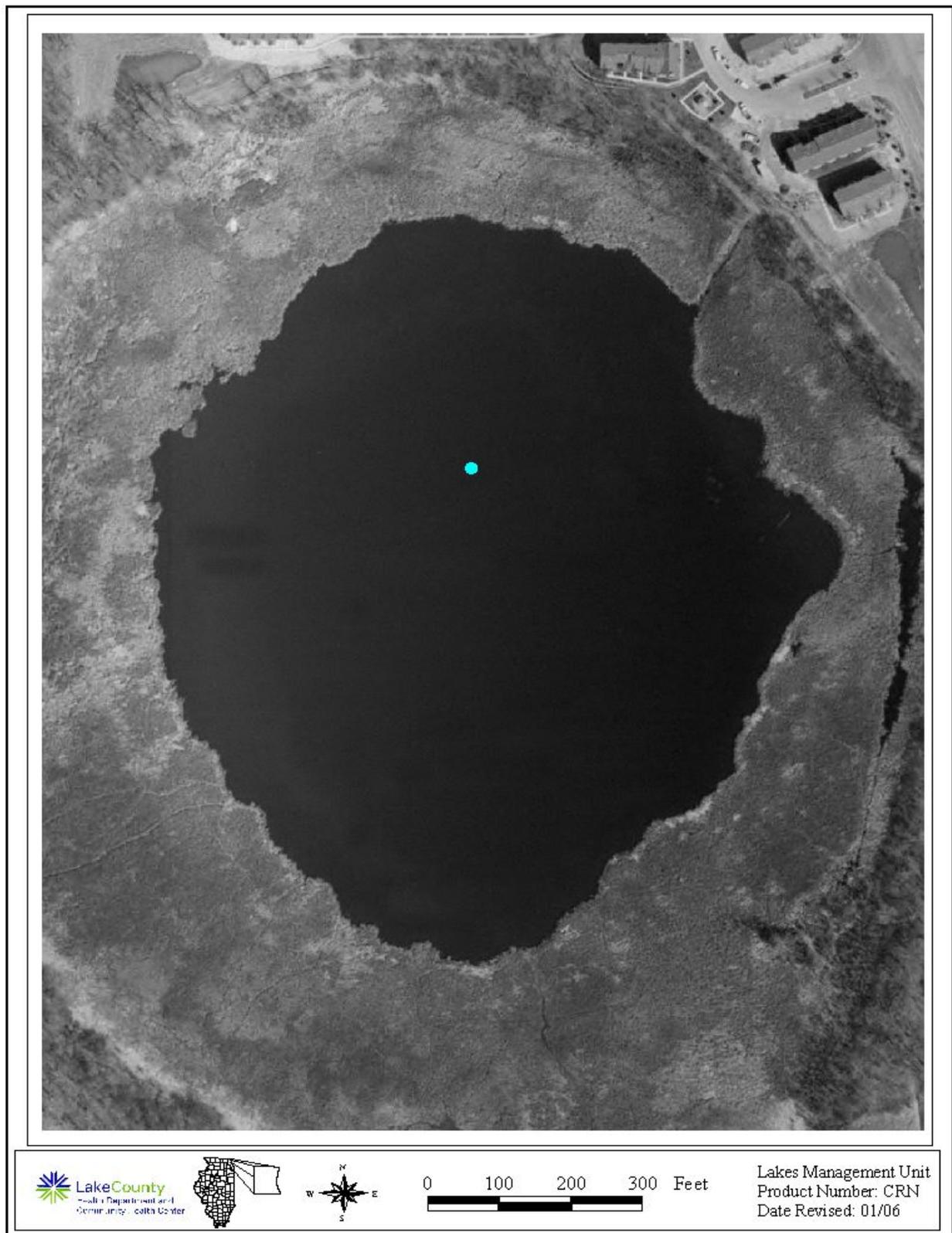


Table 2. Water quality data for Cranberry Lake, 2000 and 2005.

2005		Eplimmion														
DATE	DEPTH	ALK	TKN	NH3-N	NO3-N	TP	SRP	TDS	Cl ⁻	TSS	TS	TVS	SECCHI	COND	pH	DO
10-May	3	139	1.31	<0.1	<0.05	0.032	<0.005	NA	72.3	2.2	320	84	8.86	0.5081	7.82	8.06
14-Jun	3	136	1.40	<0.1	<0.05	0.015	<0.005	NA	76.9	1.1	334	99	11.32	0.5362	7.62	5.88
12-Jul	3	147	2.54	<0.1	<0.05	0.019	<0.005	NA	82.9	1.1	399	147	12.14	0.5684	7.44	7.79
9-Aug	3	159	1.43	<0.1	<0.05	0.029	<0.005	NA	86.3	1.5	384	114	9.80	0.6002	8.42	6.64
13-Sep	3	154	1.33	<0.1	<0.05	0.023	<0.005	NA	87.2	<1.0	383	120	10.49	0.5994	8.25	6.65
Average		147	1.60	<0.1	<0.05	0.024	<0.005	NA	81.1	1.5 ^k	364	113	10.52	0.5625	7.91	7.00

2000		Eplimmion														
DATE	DEPTH	ALK	TKN	NH3-N	NO3-N	TP	SRP	TDS	Cl ⁻	TSS	TS	TVS	SECCHI	COND	pH	D.O.
2-May	3	120	1.22	<0.1	0.057	0.034	<0.005	265	NA	1.0	259	93	7.71	0.4018	8.37	10.40
6-Jun	3	109	1.27	<0.1	0.059	0.020	<0.005	252	NA	0.6	268	122	13.55	0.3768	7.87	9.50
12-Jul	3	98	0.80	<0.1	0.063	0.018	<0.005	220	NA	0.7	251	104	12.47	0.3449	7.63	7.20
8-Aug	3	108	1.20	<0.1	<0.05	0.013	<0.005	244	NA	1.6	263	108	11.25	0.3669	7.79	7.00
5-Sep	3	120	1.39	0.139	<0.05	0.037	<0.005	258	NA	2.0	283	110	9.84	0.4140	7.31	2.80
Average		111	1.18	0.139 ^k	0.060 ^k	0.024	<0.005	248	NA	1.2	265	107	10.96	0.3809	7.79	7.38

Glossary

ALK = Alkalinity, mg/L CaCO₃
TKN = Total Kjeldahl nitrogen, mg/L
NH₃-N = Ammonia nitrogen, mg/L
NO₃-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
TDS = Total dissolved solids, mg/L
Cl⁻ = Chloride ions, 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

Note: "k" denotes that the actual value is known to be less than the value presented.
NA = Not Applicable

Table 2. Continued.

2005		Hypolimnion														
DATE	DEPTH	ALK	TKN	NH3-N	NO3-N	TP	SRP	TDS	Cl ⁻	TSS	TS	TVS	SECCHI	COND	pH	DO
10-May	14	141	1.21	<0.1	<0.05	0.020	<0.005	NA	72.0	1.7	317	82	NA	0.5040	7.22	6.40
14-Jun	14	146	1.91	<0.1	<0.05	0.045	<0.005	NA	72.6	8.4	335	92	NA	0.5279	6.56	0.12
12-Jul	15	164	1.32	0.205	<0.05	0.153	<0.005	NA	71.2	23.0	377	123	NA	0.5788	6.54	0.18
9-Aug	15	201	3.15	1.500	<0.05	0.152	0.079	NA	74.0	8.6	387	108	NA	0.6023	6.01	0.19
13-Sep	15	198	3.10	1.020	<0.05	0.120	0.031	NA	72.9	10.0	392	108	NA	0.6628	6.50	0.20
Average		170	2.14	0.908 ^k	<0.05	0.098	0.055 ^k	NA	72.5	10.3	362	103	NA	0.5752	6.57	1.42

2000		Hypolimnion														
DATE	DEPTH	ALK	TKN	NH3-N	NO3-N	TP	SRP	TDS	Cl ⁻	TSS	TS	TVS	SECCHI	COND	pH	DO
2-May	17	130	1.49	0.22	0.058	0.037	<0.005	268	NA	2.3	284	96	NA	0.4156	7.27	0.60
6-Jun	18	161	3.26	2.09	0.129	0.326	0.214	298	NA	9.2	313	140	NA	0.4739	6.73	0.04
12-Jul	17	185	6.37	4.80	<0.05	0.511	0.412	316	NA	11	331	125	NA	0.5104	6.40	0.01
8-Aug	16	193	6.00	4.72	<0.05	0.396	0.367	316	NA	8	326	110	NA	0.5289	6.33	0.03
5-Sep	15	189	5.98	5.17	<0.05	0.489	0.449	300	NA	9.4	334	106	NA	0.5510	6.55	0.1
Average		172	4.62	3.40	0.094 ^k	0.352	0.360 ^k	300	NA	8.0	318	115	NA	0.4960	6.66	0.16

Glossary

ALK = Alkalinity, mg/L CaCO₃
TKN = Total Kjeldahl nitrogen, mg/L
NH₃-N = Ammonia nitrogen, mg/L
NO₃-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
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TVS = Total volatile solids, mg/L
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COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

Note: "k" denotes that the actual value is known to be less than the value presented.

NA = Not Applicable

Cranberry Lake drains into Highland Lake, which had a TSS concentration of 3.3 mg/L in 2001. Highland Lake drains into Round Lake, which had a TSS concentration of 3.5 mg/L in 2003. The water eventually drains into Long Lake, which had a TSS concentration of 4.18 mg/L in 2005 (Table 3). Due to low TSS (and lack of excessive algal growth), Secchi disk depth was also good on Cranberry Lake (Figure 4). The average Secchi disk depth on Cranberry Lake was 10.5 feet (Lake County median is 3.2 feet). This is a slight decrease since 2000 sampling, when the average Secchi depth was 11.0 feet. The deepest Secchi reading of 2005 was in July (12.1 feet), while the lowest was in May (8.9 feet). Secchi depths decrease as you go down the watershed, which is directly related to the increase in TSS concentration as you go down the watershed. Highland Lake had an average Secchi depth of 6.6 feet in 2001, and Long Lake had an average Secchi depth of 4.2 feet in 2005 (Table 2).

Conductivity is the measure of ions within water. The higher the conductivity, the more ions and the better the water can conduct electricity. In Cranberry Lake, average epilimnetic conductivity was 0.5625 mS/cm. This was a 48% increase from 2000 when the epilimnion average was 0.3809 mS/cm. Most likely, this increase is from the accumulation of road salts used during winter road management. While this is an increase for Cranberry Lake, it is still below the county median (0.7748 mS/cm). Almost all the lakes in the county are experiencing these increases in conductivity for the same reason. In relation to conductivity is the chlorine ion (Cl^-). The median Cl^- concentration in the county is 183.0 mg/L, but Cranberry Lake has less than half this concentration (81.1 mg/L). Conductivity and Cl^- concentrations, as well as alkalinity, increased from the beginning to the end of the sampling season. This was most likely due to the overall drop in water volume throughout the summer, with a 2.5-foot decrease from May to August. When there is a drop in water level, constituents within the lake is concentrated into a smaller volume, and even though inputs did not increase due to the drought-like conditions in 2005, constituent levels are elevated in the remaining water.

As with TSS concentration, conductivity and Cl^- concentrations increase as you travel down the Long Lake watershed. Highland Lake had a conductivity average of 0.5560 mS/cm in 2001, but this has most likely increased to approximately 0.6500 mS/cm based on a 1996 concentration of 0.4080 mS/cm and the fact that all lake in the County are experiencing continual conductivity increases every year. Long Lake had an average conductivity concentration of 1.0821 mS/cm in 2005, which was an increase from 0.9430 mS/cm in 2001. Cl^- concentrations are most likely experiencing similar increases, because Cl^- concentrations are positively correlated to conductivity concentrations. Long Lake had a Cl^- concentration of 251 mg/L in 2005, which again shows an increase as you move down the watershed. Unfortunately, 2005 is the first year that Cl^- concentration was monitored, so values cannot be compared to lakes sampled in the past.

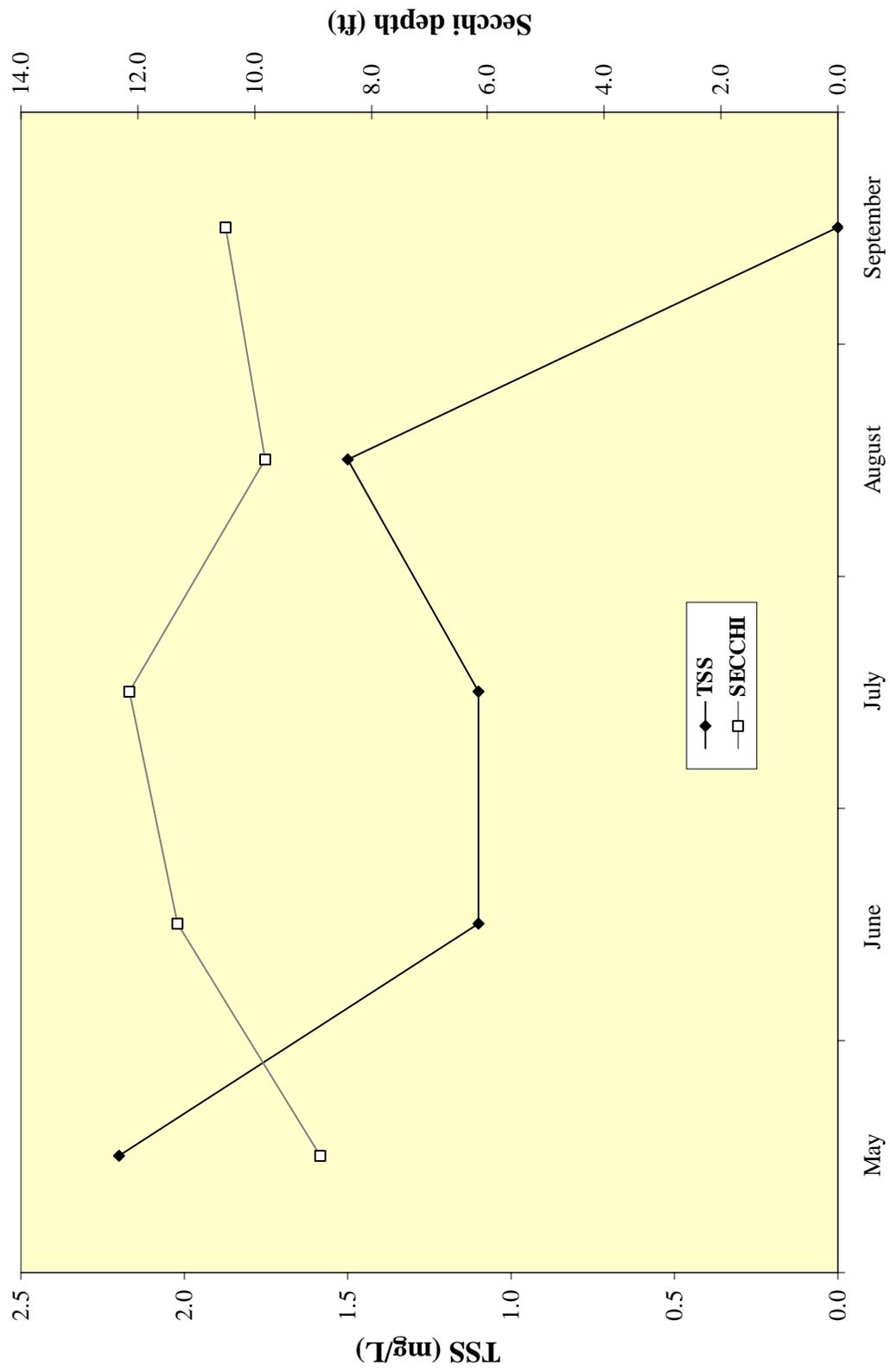
Table 3. Comparison of epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus, and conductivity readings in the Long Lake watershed (Cranberry Lake, Highland Lake, Round Lake, and Long Lake).

Year	Cranberry Lake	Cranberry Lake	Highland Lake	Highland Lake	Round Lake	Round Lake	Round Lake	Round Lake	Long Lake	Long Lake	Long Lake	Long Lake
	2000	2005	1996	2001	1991	1995	1999	2003	1991	1996	2001	2005
Secchi (feet)	10.96	10.52	7.98	6.58	5.20	7.44	10.32	6.25	2.81	2.44	4.11	4.18
TSS (mg/L)	1.2	1.5	2.4	3.3	5.4	3.4	2.7	3.5	23.6	13.9	9.7	10.9
TP (mg/L)	0.024	0.024	0.023	0.030	0.031	0.024	0.015	0.025	0.063	0.086	0.092	0.076
Conductivity (milliSiemens/cm)	0.3809	0.5625	0.4080	0.5560	NA	0.6290	0.8364	1.073	NA	0.5222	0.9430	1.0821

Direction of Watershed Flow



**Figure 4. Total suspended solid (TSS) concentrations vs. Secchi depth for Cranberry Lake, 2005.
September TSS <1.0 mg/L detection limit.**



Another aspect of water quality is the nutrients within a waterbody, especially nitrogen (N) and phosphorus (P). These are the two nutrients that can limit plant and algal growth. Carbon and light are the other factors that control plant and algal growth, but these are not normally limiting. Nutrient concentrations in Cranberry Lake were close to the county medians. Average total kjeldahl nitrogen (TKN) concentrations in the epilimnion (1.60 mg/L) and in the hypolimnion (2.14 mg/L) were slightly higher, and slightly lower than the county medians. Average total phosphorus (TP) concentrations in both the epilimnion (0.024 mg/L) and the hypolimnion (0.098 mg/L) were lower than the respective county median. Neither TKN nor TP has changed since the 2000 study. In order to compare the availability of N and P, a ratio of total nitrogen to total phosphorus is used (TN:TP). 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. Cranberry Lake has a TN:TP ratio of 69:1, which means that it is highly P limited. This means that any additions of phosphorus, even small influxes, could result in drastic increases in algal biomass. These low levels of phosphorus, along with a healthy aquatic plant population, help keep algal growth to a minimum.

Another way to look at phosphorus levels and how they affect productivity of the lake is to use a Trophic State Index (TSI) based on phosphorus (TSIp). TSIp values are commonly used to classify and compare lake productivity levels (trophic state). The higher the phosphorus levels the greater the amount of algal biomass, which leads to a higher TSIp and corresponding trophic state. Based on a TSIp value of 50, Cranberry Lake is classified as eutrophic (≥ 50 , <70 TSI). A eutrophic lake is defined as a productive system that has above average nutrient levels and high algal biomass (growth). However, this definition does not hold completely true for Cranberry Lake. The eutrophic classification was due to slightly elevated phosphorus levels. These elevated levels did not cause high algal biomass, which TSIp trophic states are partially based (Cranberry Lake TSIp was borderline). Based on a Secchi TSI of 43, Cranberry Lake is classified as mesotrophic (moderately productive). Overall, the trophic state of the lake is borderline between eutrophic and mesotrophic and is dependent on which parameter is used to calculate the TSI. Based on the phosphorus TSI, Cranberry Lake ranks 19th out of 162 lakes studied by the LMU between 2000-2005 (Table 4). This illustrates the good quality of Cranberry Lake.

TSI values along with other water quality parameters can be used to make other analyses based on use impairment indexes established by the Illinois Environmental Protection Agency (IEPA). Most water quality standard impairment assessments were listed as *None*. However, widespread aquatic vegetation was the source of impairments based on excessive plant growth (*High* use impairment), and exotic species (*Slight* use impairment). Furthermore, based on IEPA indices, Cranberry Lake is listed as providing *Partial* support for Recreational Use and *Full* support of Swimming and Aquatic Life Use. Based on these indices, this lake is listed as providing *Full* Overall Use support.

Table 4. Lake County average TSI phosphorous (TSIp) ranking, 2000-2005.

RANK	LAKE NAME	TP AVE	TSIp
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
7	Cedar Lake	0.0183	46.1
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 Training 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 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
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 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
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 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
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

SUMMARY OF AQUATIC MACROPHYTES

An aquatic plant (macrophyte) survey was conducted in June and August of 2005. These study times allowed us to determine plant growth at the beginning of the growing season, as well as at the end. In previous years, the sampler, with the goal of covering most of the lake and finding all species present, chose sampling sites randomly. While this method worked well, a new sampling technique was implemented this year. Sampling sites were based on a grid system created by mapping software (ArcGIS), with each site located 60 meters apart. On Cranberry Lake, there were 20 sampling sites in both June and August sampling (Figure 5a; Figure 5b). Overall, there were a total of 11 plant species found in June, with the most common species being *Chara spp.*, which is a macroalgae (found at 60 % of the sampling sites). Flatstem Pondweed was the second most common species (found at 50 % of the sampling sites) (Table 5a). In August, a total of 16 plant species were found. The most common species was Common Bladderwort (found at 70 % of the sampling sites), with White Water Lily as the second most common (found at 65% of the sampling sites) (Table 5c). Plants need at least 1% of surface light levels in order to survive. In June, plants were found down to depths of 12.5 feet, which relates to the 1% light level of 15 feet. In August, the 1% light level was around 11.5 feet, which also relates well to the 12.5-foot depth at which plants were found. Coontail was the only species of plant found below 10 feet. Out of the 20 sampling sites, plants were found at 19 (95%) in both June and August (Table 5d). There is also a decent sized Watershield population on the lake (found at 5% of sample sites), which is a rare species in Lake County. Approximately 45% of Cranberry Lake is topped out with vegetation, meaning the plants reached the lake's surface. Overall, the lake had approximately 65% plant coverage. This amount of plants is one reason that water clarity is so high in the lake. A majority of the nutrients are taken up by macrophytes, leaving a small amount for plankton growth. This results in low algal densities, which could cloud the water. Ideally, a lake should have 35-45% plant coverage, according to the IDNR. If Cranberry Lake reduced some of its plant coverage, there may be a better chance for a fishery to establish. However, due to the natural high organic nature of the lake, present plant coverage is fine and reduction is not recommended (Table 6).

Some species of plants were of great interest due to their rarity. Humped Bladderwort is considered rare and has never been officially documented within Lake County, except in Cranberry Lake. As the summer progressed, occurrence of Humped Bladderwort increased (Table 5a). It was found at two of the sites in June and by August it was found at 25% of sampling sites. There was another plant species that was found in Cranberry Lake that is on the Illinois endangered species list; Small Bladderwort. Great care should be taken to preserve the well being of this rare, highly desirable plant. Other species, such as Largeleaf Pondweed, Common Bladderwort, Flatstem Pondweed and Small Pondweed were more common and are considered desirable. These desirable native plants kept problematic species such as Coontail (35-50% of sample sites), and Northern Watermilfoil (57% of sample sites) under control. Another positive attribute of Cranberry Lake is the absence of Eurasian Watermilfoil (EWM). Many lakes throughout the county are infested with this problematic exotic, invasive plant. This makes containing the spread from one lake to another very difficult.

Figure 5a. Aquatic plant sampling grid that illustrates plant density in June on Cranberry Lake, 2005.

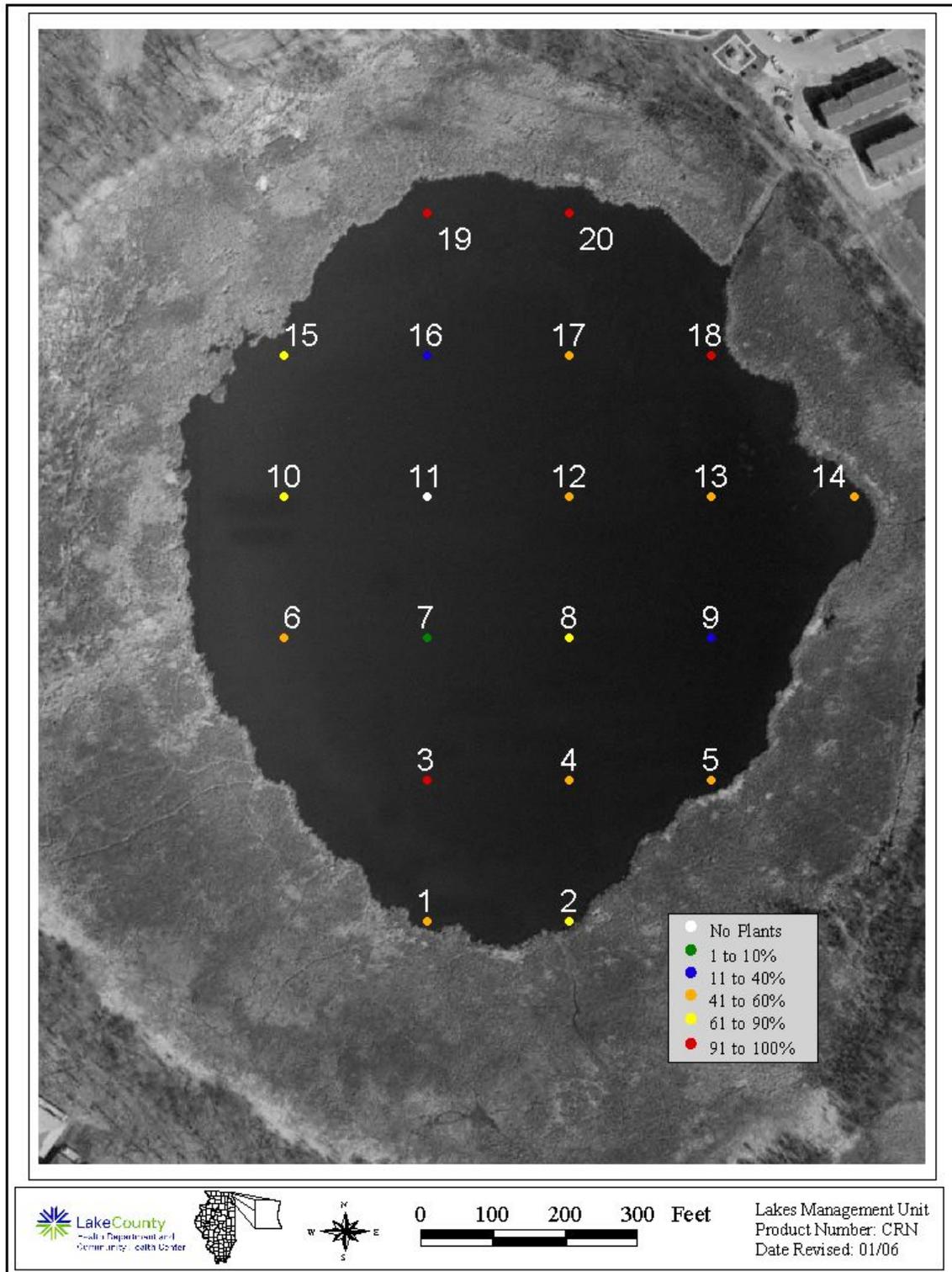


Figure 5b. Aquatic plant sampling grid that illustrates plant density in August on Cranberry Lake, 2005.

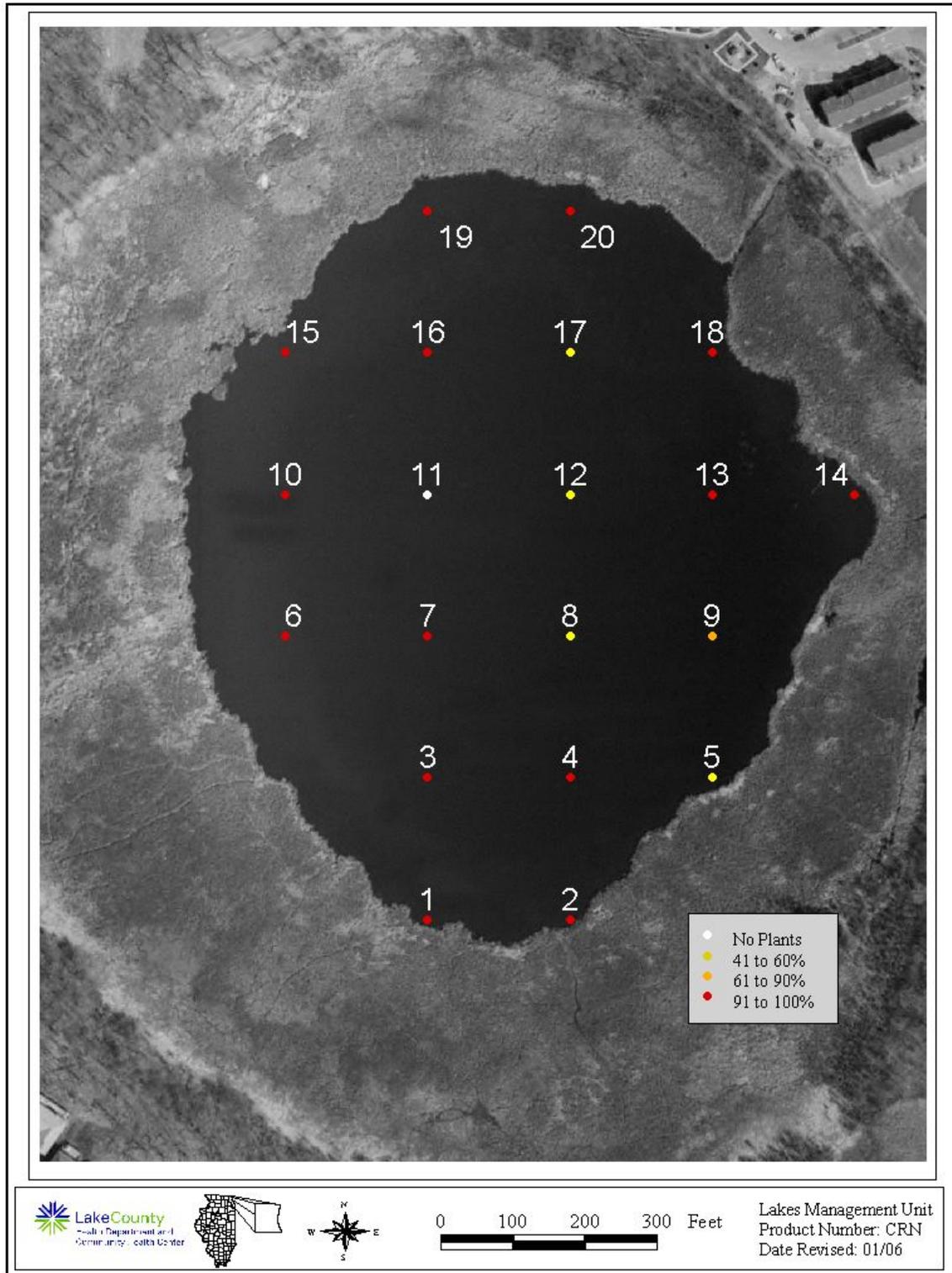


Table 5a. Aquatic plant species found at the 20 sampling sites on Cranberry Lake in June 2005. Maximum depth that plants were found was 14 feet.

June Plant Density	Common Bladderwort	Humped Bladderwort	Chara	Coontail	Flatstem Pondweed	Illinois Pondweed	Northern Milfoil	Sago Pondweed	Small Pondweed	Spatterdock	Watershield	White Water Lily
Present	4	1	4	2	7	3	4	1	1	2	0	5
Common	3	1	2	2	3	0	0	0	0	3	0	3
Abundant	0	0	2	3	0	0	0	0	0	1	1	1
Dominant	0	0	4	0	0	0	0	0	0	0	0	0
% Plant Occurrence	35	10	60	35	50	15	20	5	5	30	5	45

Table 5b. Distribution of rake density across all sampling sites in June.

June Rake Density (coverage)	# of Sites	% of Sites
No Plants	1	5
>0-10%	1	5
10-40%	2	10
40-60%	8	40
60-90%	4	20
>90%	4	20
Total Sites with Plants	19	95
Total # of Sites	20	100

Table 5c. Aquatic plant species found at the 20 sampling sites on Cranberry Lake in August 2005. Maximum depth that plants were found was 12.5 feet.

August								
Plant Density	Common Bladderwort	Humped Bladderwort	Small Bladderwort	Chara	Coontail	Flatstem Pondweed	Floatingleaf Pondweed	Illinois Pondweed
Present	6	4	1	1	3	6	1	10
Common	7	1	0	2	1	0	0	1
Abundant	1	0	0	3	0	0	0	0
Dominant	0	0	0	1	6	0	0	0
% Plant Occurrence	70	25	5	35	50	30	5	55

Plant Density	Leafy Pondweed	Northern Milfoil	Sago Pondweed	Slender Naid	Softstem Bulrush	Spatterdock	Watershield	White Water Lily
Present	1	0	1	1	2	2	0	4
Common	1	1	2	0	0	3	0	4
Abundant	0	0	0	0	0	1	0	2
Dominant	0	0	0	0	0	2	1	3
% Plant Occurrence	10	5	15	5	10	40	5	65

Table 5d. Distribution of rake density across all sampling sites in August.

August		
Rake Density (coverage)	# of Sites	% of Sites
No Plants	1	5
>0-10%	0	0
10-40%	0	0
40-60%	1	5
60-90%	4	20
>90%	14	70
Total Sites with Plants	19	95
Total # of Sites	20	100

If Cranberry Lake undergoes some type of development (walking trails, fishing and observations piers, etc.), usage will undoubtedly increase. Therefore, precautions should be taken to prevent introduction of EWM and other invasive species such as Curlyleaf Pondweed and Zebra Mussels into Cranberry Lake. Only non-motorized boating should be allowed, if any boating is allowed at all.

Plant diversity declined from June of 2000 to June of 2005, with 16 species in 2000 and 12 species in 2005. Floatingleaf Pondweed, Largeleaf Pondweed, Slender Naiad, and Threadleaf Pondweed were the species that were seen in June 2000, but not in June 2005. Plant diversity also declined from August 2000, to August 2005, and there was also a species shift. Largeleaf Pondweed, Spiny Naiad, Threadleaf Pondweed and Variable Leaved Pondweed were observed in August 2000, but not in August 2005. Small Bladderwort and Soft Bulrush were observed in August 2005, but not in the previous August 2000 sampling. These changes in both June and August were probably due to natural annual variation and the drought-like conditions in 2005.

Plankton are microscopic plants and animals that are free-floating within the water column. Samples were collected during water quality testing and analyzed for species content (See Appendix A for methods). Cranberry Lake had low algal counts from May to August, and then experienced a spike in blue-green algae in September (Figure 6). Blue-green algae are actually bacterial, and certain species can be toxic when in high amounts. The amounts found in September were not dangerous and the spike was most likely due to nutrients being utilized from decaying plants.

Floristic Quality Index (FQI) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. 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 (Nichols, 1999). Each floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. 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 also included in the FQI calculations for Lake County lakes. The average FQI for 2000-2005 Lake County lakes is 13.1. Cranberry Lake had a FQI of 28.3 in 2005, which ranked it 5th out of the 151 lakes recorded (Table 7). This is a decrease since the 2000 survey was conducted, when the FQI was 37.2. The change in aquatic plant sampling procedure is most likely the main reason for this decrease, although there is often a natural plant community composition variation from year to year. Because this lake is one of the sentinel lakes in Lake County, the Lakes Management Unit plans to sample the lake annually from 2006-2009. This should give a better perspective on what is occurring in the aquatic plant community.

Table 6. Aquatic plant species found in Cranberry Lake, 2005.

Water Shield	<i>Brasenia schreberi</i>
Coontail	<i>Ceratophyllum demersum</i>
Chara (Macro alga)	<i>Chara spp.</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>
Small Pondweed	<i>Potamogeton pusillus</i>
Flatstem Pondweed	<i>Potamogeton zosteriformis</i>
Northern Watermilfoil	<i>Myriophyllum sibiricum</i>
Slender Naiad	<i>Najas flexilis</i>
Spatterdock	<i>Nuphar variegata</i>
White Water Lily	<i>Nymphaea tuberosa</i>
Softstem Bulrush	<i>Scirpus validus</i>
Humped Bladderwort	<i>Utricularia gibba</i>
Small Bladderwort*	<i>Utricularia minor</i>
Common Bladderwort	<i>Utricularia vulgaris</i>

* **Endangered in Illinois**

SUMMARY OF SHORELINE CONDITION

The water-cattail interface does not experience erosion problems that other, more distinct shorelines have. A major concern with regard to the “shoreline” on Cranberry Lake is the continual encroachment of cattails (Figure 7). Cranberry Lake is at an elevated risk of encroachment due to the expansive, shallow shelf around the perimeter of the lake. The current extent of the cattails should be maintained and expansion should not be allowed. Prescribed burning was performed in 2000 that removed a portion of the cattails, but since then *Phragmites*, another invasive species, has spread. Another invasive shoreline species that needs to be controlled/eliminated is Purple Loosestrife. Controlling these invasive species will help to slow the gradual filling in of the shallow areas of Cranberry Lake.

Cranberry Lake was turned over from Deer Point Homes to the Village of Hainesville in 2004. Deer Point homes built the Cranberry Lake subdivision, and owned the lake and surrounding land from 2001-2004. The Village is currently looking into the best preservation and restoration practices for the lake and surrounding wetland area. A current plan to remove Buckthorn started in the winter of 2005, and will continue each winter for three years, with a third of the shoreline covered each year. Past control of Buckthorn has been attempted, but because all trees were not removed, resprouting

occurred. This is common when trying to control Buckthorn because birds can spread the seeds from any remaining trees, and resprouting can occur if cut stumps are not treated with an herbicide like glyphosphate. If a decision is made to control Purple Loosestrife, there are many options, from chemical control (low density of plants) to biological control with beetles (high density of plants).

SUMMARY OF WILDLIFE AND HABITAT CONDITION

Wildlife observations were made during sampling in May and June. Several species of birds were observed, including Wood Ducks, Swans, Geese, Gold Finch, Morning Doves and Swallows. American Toads and Snapping Turtles were also seen. The healthy populations of cattails provide good habitat for the variety of bird species. Additionally, there are several shrub areas that provide habitat for smaller bird and mammal species. Purple Loosestrife and Buckthorn have been noted in several areas around the lake, and are seldom used by wildlife for food or shelter. They should be eliminated before they spread and displace other native and more desirable plant species. The elimination of Buckthorn has already begun, as stated above. Also stated above, due to the low DO levels in the lake, the presence of a quality game fishery may be limited. However, Cranberry Lake may contain important non-game fish species including those that are threatened or endangered. A fishery study would need to be conducted in order to determine the condition of the fishery in Cranberry Lake.

Other interesting organisms found in Cranberry Lake were weevil species *Euhrychiopsis lecontei* and *Phytobius leucogaster*. Commonly known as the Watermilfoil Weevils. These are herbivorous insects that feed exclusively on milfoil (Northern and Eurasian). Due to recent surveys, the weevils have been documented on 18 lakes throughout Lake County. Commercially, *Euhrychiopsis lecontei* is used as a biocontrol method to combat Eurasian Watermilfoil.

Overall, the habitat around Cranberry Lake is good, and provides for many wildlife species. This is mainly due to the excellent buffer left around the lake when the surrounding homes were constructed. This buffer renders great habitat as well as benefiting water quality.

Figure 6. Results from plankton counts for Cranberry Lake, 2005.

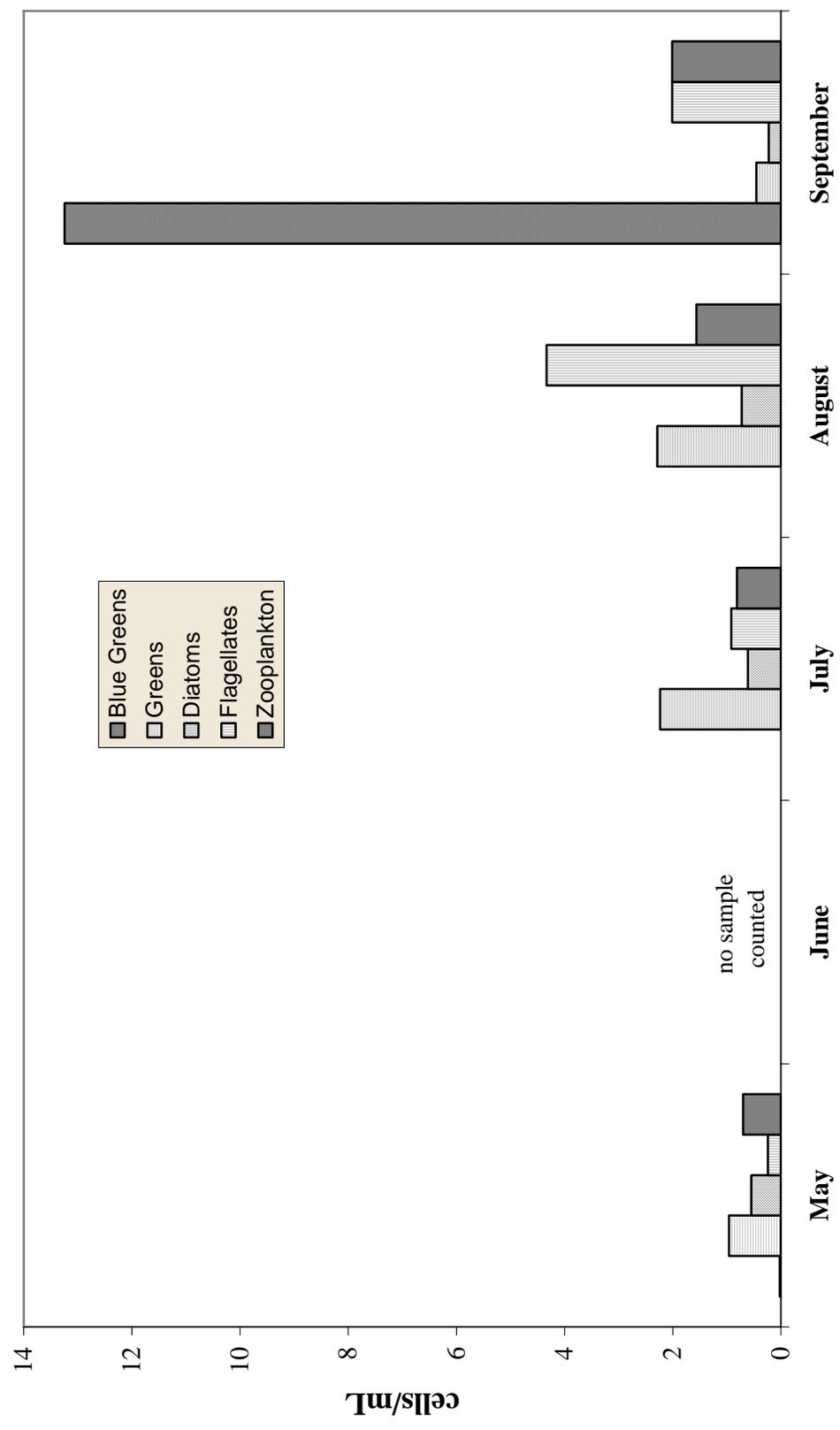


Table 7. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/Adventives) and with native species only (native).

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	35.6	37.8
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	Lake Zurich	24.0	26.0
16	Lake of the Hollow	23.8	26.2
17	Lakewood Marsh	23.8	24.7
18	Round Lake	23.5	25.9
19	Fourth Lake	23.0	24.8
20	Druce Lake	22.8	25.2
21	Sun Lake	22.7	24.5
22	Countryside Glen Lake	21.9	22.8
23	Sterling Lake	21.8	24.1
24	Butler Lake	21.4	23.1
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
42	Duck Lake	17.1	19.1

Table 7. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
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
83	Honey Lake	12.1	14.3

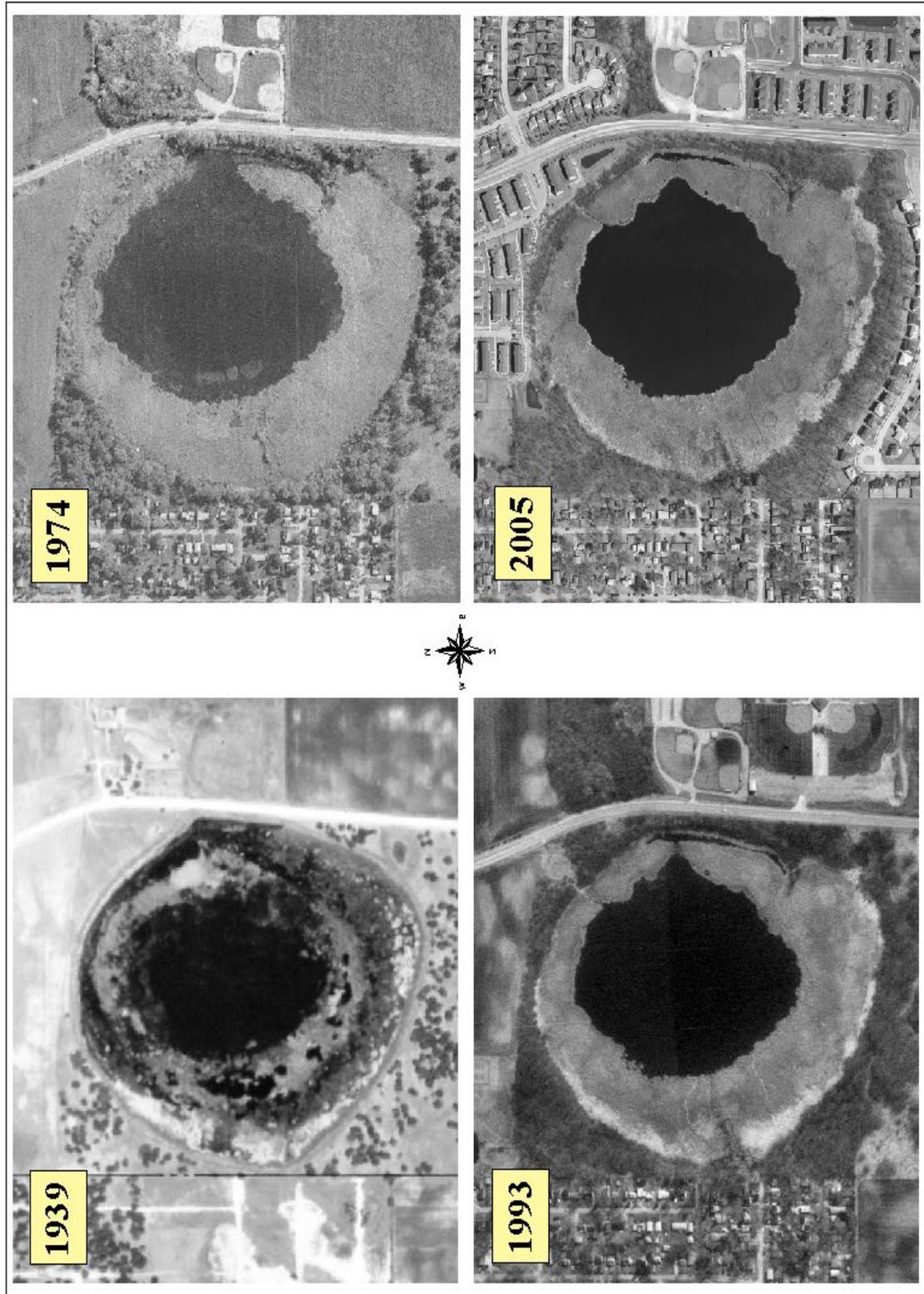
Table 7. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
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 7. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
126	Lake Louise	7.5	8.7
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
	<i>Mean</i>	14.0	15.4
	<i>Median</i>	13.1	14.8

Figure 7. Historic comparison of the encroaching cattail fringe on Cranberry Lake.



LAKE MANAGEMENT RECOMMENDATIONS

There are many positive aspects to Cranberry Lake. Water quality is good, with high water clarity and relatively low TKN and TP concentrations. Aquatic plant diversity is also good, with rare species being a highlight. A great buffer zone exists between the development around the lake and the lake itself. Although there are some exotic shoreline plant species within this buffer, overall it creates a good habitat area for birds, amphibians and reptiles. This buffer zone also stabilizes the bank and therefore inhibits any shoreline erosion from occurring.

✿ **Watershed nutrient reduction**

There has been a lot of development on the lake in the past five years since LMU's last sampling period (2000). The impact of this development has been minimal on the lake, with the exception of increased conductivity and Cl⁻ concentrations. This is probably due to the precautions put in place by the developer and the large buffer strip surrounding the lake that was not disturbed. This preservation should continue in the future, and should implement better use of road salts in the surrounding subdivisions. It is assumed that road salt is needed for winter road management, but there are ways to reduce lake inputs. (See Appendix D1 for more details)

✿ **Low dissolved oxygen concentrations**

Epilimnetic DO concentrations were fairly consistent throughout the sampling season and remained above the adequate level (5.0 mg/L). However, during June, August and September, concentrations neared this critical number (Figure 2a; Table 1a). There is no ideal solution for this problem due to the nature of Cranberry Lake. It's shallow morphology, high plant density and highly organic bottom create a high oxygen demand. Historically there have been fish kills, and the lake may experience more of these in the future. This is due to the stress caused by the low DO concentrations. While there are options available to increase the DO concentration in a lake system, all of them would have adverse effects on Cranberry Lake. The nature of the lake allows it to hold a small fish community composed of smaller fish species. In order to increase the fish capacity, many of the lake's positive aspects would be sacrificed.

✿ **Creating a bathymetric map**

The creation of a bathymetric map on Cranberry Lake would allow, among other things, the calculation of how much water volume is experiencing low DO concentrations. With new technology available through the LMU, it is possible to create a detailed depth contour map that includes the calculation of plant density throughout the lake (See Appendix D2 for more details).

✿ **Assess your lake's fishery**

Performing a fishery assessment is recommended for Cranberry Lake. With a history of fish kills, and low DO concentrations, it would be beneficial to know what species inhabit the lake (See Appendix D3 for more details).

✿ **Eliminate or control exotic species**

As mentioned previously, the effort already being put forth by the Village of Hainesville to control the Buckthorn surrounding the lake is commendable. Actions such as this will result in the control or elimination of exotic species. Cattails, Phragmites, and Purple Loosestrife are also present around the shoreline and plans should be implemented to control their distribution as well (See Appendix D4 for more details).

✿ **Participate in the Volunteer Lake Monitoring Program**

Detailed ecosystem information is vital to understanding the workings of a lake. The more data collected, the better a lake can be understood. Data can be used to create and implement a conservation and/or restoration plan. While the LMU does collect a lot of data during the years the lake is studied, gaps can be filled with data collected by volunteers. The Volunteer Lake Management Program (VLMP) is a program that relies on volunteers to gather a variety of information on their chosen lake. An example of data that a volunteer can collect is water depth, by installing and monitoring a staff gauge (See Appendix D5 for more details).

**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 th ed 419D Detection Limit = 0.05 mg/L
Ammonia nitrogen	SM 18 th ed. Electrode method, #4500 NH ₃ -F Detection Limit = 0.1 mg/L
Total Kjeldahl nitrogen	SM 18 th ed, 4500-N _{org} C Semi-Micro Kjeldahl, plus 4500 NH ₃ -F Detection Limit = 0.5 mg/L
pH	Hydrolab DataSonde® 4a, or YSI 6600 Sonde® Electrometric method
Total solids	SM 18 th ed, Method #2540B
Total suspended solids	SM 18 th ed, Method #2540D Detection Limit = 0.5 mg/L
Total dissolved solids	SM 18 th ed, Method #2540C
Total volatile solids	SM 18 th ed, Method #2540E, from total solids
Alkalinity	SM 18 th ed, Method #2320B, potentiometric titration curve method
Conductivity	Hydrolab DataSonde® 4a or YSI 6600 Sonde®
Total phosphorus	SM 18 th ed, Methods #4500-P B 5 and #4500-P E Detection Limit = 0.01 mg/L
Soluble reactive phosphorus	SM 18 th 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 CRANBERRY
LAKE IN 2005.**

Date		Time		Text		Depth		Temp		DO		SpCond		pH		PAR		Depth of		% Light		Extinction	
MM	DD	YY	HH	MM	SS	feet	feet	øC	øC	mg/l	Sat	mS/cm	mS/cm	Units	Units	æE/s/mý	æE/s/mý	feet	feet	Average	Average	Coefficient	Coefficient
51005	83251	0.25	17.96	0.43	8.17	89.40	0.5085	7.91	3451	Surface	0.97447543	Surface	100%										
51005	83402	1	17.96	1.02	8.07	88.30	0.5085	7.87	3283	Surface		100%											
51005	83534	2	17.92	2.01	8.09	88.40	0.5085	7.83	946	0.26		29%										4.79	
51005	83639	3	17.90	2.97	8.06	88.10	0.5081	7.82	526	1.22		16%										0.61	
51005	83740	4	17.82	3.98	8.26	90.10	0.5079	7.84	573	2.23		17%										-0.08	
51005	83915	6	17.55	6.00	7.97	86.50	0.5081	7.80	191	4.25		6%										0.54	
51005	84123	8	11.16	8.00	9.92	93.60	0.5058	7.66	103	6.25		3%										0.31	
51005	84243	10	10.25	10.01	9.39	86.70	0.5019	7.52	64	8.26		2%										0.24	
51005	84407	12	9.69	11.98	8.11	74.00	0.5034	7.37	28	10.23		0.9%										0.42	
51005	84545	14	9.49	14.01	6.40	58.10	0.5040	7.22	12	12.26		0.4%										0.42	
51005	84753	16	9.30	15.99	2.92	26.40	0.5073	7.05	5	14.24		0.2%										0.44	

Date		Time		Text		Depth		Temp		DO		SpCond		pH		PAR		Depth of		% Light		Extinction	
MM	DD	YY	HH	MM	SS	feet	feet	øC	øC	mg/l	Sat	mS/cm	mS/cm	Units	Units	æE/s/mý	æE/s/mý	feet	feet	Average	Average	Coefficient	Coefficient
61405	84536	0.25	25.26	0.82	6.00	76.00	0.5356	7.66	2583	Surface	0.43638513	Surface	100%										
61405	84719	1	25.30	1.59	5.79	73.40	0.5359	7.64	1702	Surface		100%											
61405	84846	2	25.31	2.18	5.91	75.10	0.5361	7.63	2888	0.43		170%										-1.23	
61405	85011	3	25.31	2.95	5.88	74.70	0.5361	7.62	142	1.20		8%										3.91	
61405	85147	4	25.31	4.04	5.77	73.20	0.5360	7.62	742	2.29		44%										-1.52	
61405	85353	6	24.96	6.11	5.63	71.00	0.5347	7.57	98	4.36		6%										0.98	
61405	85559	8	19.52	8.05	4.84	54.90	0.5183	7.22	41	6.30		2%										0.45	
61405	85817	10	16.23	10.01	2.06	21.90	0.5155	6.93	39	8.26		2%										0.03	
61405	90115	12	12.88	12.11	0.18	1.70	0.5167	6.68	20	10.36		1.2%										0.32	
61405	90317	14	11.69	14.08	0.12	1.10	0.5266	6.56	34	12.33		2%										-0.27	
61405	90520	16	10.53	15.99	0.10	1.00	0.5409	6.46	5	14.24		0.3%										1.00	

Date	Time	Text	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Light Meter	% Light	Extinction
MMDDYY	HHMMSS	feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet	Average	Coefficient	
71205	84632	0.25	0.25	25.15	8.05	100.60	0.5681	7.46	661	Surface	100%	0.98448861	
71205	84652	1	1.00	25.16	8.14	101.30	0.5680	7.45	665	Surface	100%		
71205	84712	2	2.00	25.16	7.97	99.60	0.5678	7.43	194	0.25	29%	4.93	
71205	84747	3	3.04	25.16	7.79	97.30	0.5681	7.43	125	1.29	19%	0.42	
71205	84835	4	4.01	25.16	7.87	98.30	0.5678	7.43	90	2.26	14%	0.34	
71205	85006	6	5.98	24.42	5.80	71.50	0.5608	7.25	49	4.23	7%	0.31	
71205	85119	8	7.97	22.19	2.46	29.10	0.5395	7.09	34	6.22	5%	0.18	
71205	85429	10	10.05	19.58	0.23	2.50	0.5299	6.83	17	8.30	3%	0.33	
71205	85533	12	12.05	15.68	0.18	1.90	0.5230	6.77	8	10.30	1.2%	0.38	
71205	85651	14	13.98	12.52	0.18	1.70	0.5498	6.60	0	12.23	0.0%		
71205	85745	16	16.06	10.65	0.18	1.70	0.6105	6.46	7	14.31	1.1%		

Date	Time	Text	Depth	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Light Meter	% Light	Extinction
MMDDYY	HHMMSS	feet	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	feet	Average	Coefficient	
80905	83202	0.25	0.32	26.39	6.79	86.70	0.6016	8.33	2930	Surface	100%		
80905	83247	1	1.05	26.38	6.69	85.40	0.6010	8.34	2869	Surface	100%		
80905	83334	2	2.03	26.38	6.71	85.60	0.6005	8.37	869	0.28	30%	4.27	
80905	83519	3	2.96	26.38	6.64	84.80	0.6000	8.42	657	1.21	23%	0.30	
80905	83627	4	3.99	26.38	6.62	84.50	0.5997	8.44	401	2.24	14%	0.48	
80905	83836	6	5.98	25.36	3.07	38.40	0.5951	7.77	201	4.23	7%	0.35	
80905	84024	8	8.06	24.03	0.96	11.80	0.5841	7.59	134	6.31	5%	0.19	
80905	84155	10	9.96	21.39	0.36	4.20	0.5647	7.18	60	8.21	2%	0.42	
80905	84345	12	12.02	16.63	0.25	2.60	0.5626	6.62	11	10.27	0.4%	0.82	
80905	84443	14	14.02	13.44	0.19	1.90	0.5917	6.35	0	12.27	0.0%		
80905	84640	16	15.95	11.18	0.21	1.90	0.6712	6.09	0	14.20	0.0%		
80905	84721	18	18.02	10.59	0.17	1.50	0.7217	5.94	0	16.27	0.0%		

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
MMDDYY	HHMMSS	MMDDYY	HHMMSS	MMDDYY	HHMMSS											
91305	83259	91305	83259	0.25	0.28	24.32	6.55	80.90	0.6009	8.18	738	Surface				
91305	83410	91305	83410	1	1.02	24.34	6.42	79.40	0.6007	8.17	643	Surface	100%			
91305	83514	91305	83514	2	2.03	24.34	6.54	80.90	0.6000	8.21	211	0.28	33%	3.98		
91305	83615	91305	83615	3	3.04	24.33	6.65	82.10	0.5993	8.25	123	1.29	19%	0.53		
91305	83701	91305	83701	4	4.04	24.31	6.83	84.40	0.5992	8.30	100	2.29	16%	0.21		
91305	83809	91305	83809	6	6.05	24.10	4.45	54.80	0.6038	7.92	65	4.30	10%	0.21		
91305	83924	91305	83924	8	8.02	22.42	1.12	13.40	0.5962	7.54	38	6.27	6%	0.27		
91305	84032	91305	84032	10	10.02	20.76	0.43	5.00	0.5942	7.26	20	8.27	3%	0.32		
91305	84223	91305	84223	12	12.04	17.81	0.29	3.10	0.5927	6.82	5	10.29	0.8%	0.69		
91305	84344	91305	84344	14	14.01	14.60	0.22	2.20	0.6193	6.58	1	12.26	0.2%	0.82		
91305	84447	91305	84447	16	16.02	12.19	0.18	1.70	0.7178	6.40	1	14.27	0.2%	0.00		

APPENDIX C. INTERPRETING YOUR LAKES 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. NH_4^+ (ammonium) is released from decomposing organic material under anoxic conditions and accumulates in the hypolimnion of thermally stratified lakes. If NH_4^+ comes into contact with oxygen, it is immediately converted to NO_2^- (nitrite) which is then oxidized to NO_3^- (nitrate). Therefore, in a thermally stratified lake, levels of NH_4^+ would only be elevated in the hypolimnion and levels of NO_3^- would only be elevated in the epilimnion. Both NH_4^+ and NO_3^- can be used as a nitrogen source by aquatic plants and algae. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen plus ammonium. Adding the concentrations of TKN and nitrate together gives an indication of the amount of total nitrogen present in the water column. If inorganic nitrogen (NO_3^- , NO_2^- , NH_4^+) concentrations exceed 0.3 mg/L in spring, sufficient nitrogen is available to support summer algae blooms. However, low nitrogen levels do not guarantee limited algae growth the way low phosphorus levels do. Nitrogen gas in the air can dissolve in lake water and blue-green algae can "fix" atmospheric nitrogen, converting it into a usable form. Since other types of algae do not have the ability to do this, nuisance blue-green algae blooms are typically associated with lakes that are nitrogen limited (i.e., have low nitrogen levels).

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

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

Solids:

Although several forms of solids (total solids, total suspended solids, total volatile solids, total dissolved solids) were measured each month by the Lakes Management Staff, total suspended solids (TSS) and total volatile solids (TVS) have the most impact on other variables and on the lake as a whole. TSS are particles of algae or sediment suspended in the water column. High TSS concentrations can result from algae blooms, sediment resuspension, and/or the inflow of turbid water, and are typically associated with low water clarity and high phosphorus concentrations in many lakes in Lake County. Low water clarity and high phosphorus concentrations, in turn, exacerbate the high TSS problem by leading to reduced plant density (which stabilize lake sediment) and increased occurrence of algae blooms. The median TSS value in epilimnetic waters in Lake County is 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 (CO_3^-) and bicarbonate (HCO_3^-) ions in the water, and represents the buffering capacity of a body of water. The alkalinity of lake water depends on the types of minerals in the surrounding soils and in the bedrock. It also depends on how often the lake water comes in contact with these minerals.

If a lake gets groundwater from aquifers containing limestone minerals such as calcium carbonate (CaCO_3) or dolomite (CaMgCO_3), alkalinity will be high. The median alkalinity in Lake County lakes (162 mg/L) is considered moderately hard according to the hardness classification scale of Brown, Skougstad and Fishman (1970). Because hard water (alkaline) lakes often have watersheds with fertile soils that add nutrients to the water, they usually produce more fish and aquatic plants than soft water lakes. Since the majority of Lake County lakes have a high alkalinity they are able to buffer the adverse effects of acid rain.

Conductivity and Chloride:

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

pH:

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

Typically, the flooded gravel mines in the county are more acidic than the glacial lakes as they have less biological activity, but do not usually drop below pH levels of 7. The median near surface pH value of Lake County lakes is 8.30, 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	≤ 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	≥ 70	> 0.096	< 1.64

APPENDIX D. LAKE MANAGEMENT OPTIONS.

D1. 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.

Option 7. Motor Boat Restrictions for Shallow Lakes

To reduce resuspension of phosphorus from the sediment, communities that have a shallow lake or large shallow areas in their lake may want to restrict motorized boating. The action of a spinning prop in shallow areas can disturb the sediment. Flocculent sediment particles can release loosely attached phosphorus into the water. Restrictions 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 8. 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.

D2. Option for Creating a Bathymetric Map

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information about the physical features of the lake, such as depth, surface area, volume, etc. This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some bathymetric maps for lakes in Lake County do exist, but they are frequently old, outdated and do not accurately represent the current features of the lake. Maps can be created by the Lake County Health Department - Lakes Management Unit (LMU). LMU recently purchased a BioSonics DT-X™ Echosounder. With this equipment the creation of an accurate bathymetric map of almost any size lake in the county is possible. Costs vary, but can range from \$2,000-5,000 depending on lake size.

D3. Option to Assess Your Lake's Fisheries

Many lakes have a fish-stocking program in which fish are stocked every year or two to supplement fish species already occurring in the lake or to introduce additional fish species into the system. However, few lakes that participate in stocking check the progress or success of these programs with regular fish surveys. Lake managers should have information about whether or not funds delegated to fish stocking are being well spent, and it is difficult to determine how stocked fish species are surviving and reproducing or how they are affecting the rest of the fish community without a comprehensive fish assessment.

A simple, inexpensive way to collect information on the status of a fishery is to sample anglers and evaluate the types, numbers and sizes of fish caught by anglers actively involved in recreational fishing on the lake. Such information provides insight on the status of fish populations in the lake, as well as a direct measure of the quality of fishing and the fishing experience. However, the numbers and types of fish sampled by anglers are limited, focusing on game and catchable-sized fish. Thus, in order to obtain a comprehensive assessment of the fish community, including non-game fish species, more quantitative methods such as gill netting, trap netting, seining, trawling, angling (hook and line fishing) and electroshocking must be employed. Each method has its advantages and limitations, and frequently multiple gears are employed. The best gear and sampling methods depend on the target species and life stage, the types of information desired, and the environment to be sampled.

Typically, fish populations are monitored annually. The best time of year depends on the sampling method, the target fish species, and the types of data to be collected. In many lakes and regions, the best time to sample fish is during the fall turnover period after thermal stratification breaks down and the lake is completely mixed because (1) young-of-year (YOY) and age 1+ (one year or older) fish of most target species should be present and vulnerable to most standard collection gear, including seines, trap nets and electroshockers; (2) species that dwell in the hypolimnion during the summer may be more vulnerable to capture during fall overturn; and (3) lower water temperatures in the fall can help reduce sampling-related mortality. Sampling locations are also species, life stage, and gear dependent. As with sampling methods and time, locations should be selected to maximize capture efficiency for the target species of interest and provide the greatest gain in information for the least amount of sampling effort.

The Illinois Department of Natural Resources (IDNR) will perform a fish survey at no charge on most public and some private water bodies. In order to determine if your lake is eligible for a survey by the IDNR, contact Frank Jakubecik, Fisheries Biologist, at (815) 675-2319. If a lake is not eligible for an IDNR fish survey or if a more comprehensive survey is desired, contact the Lakes Management Unit for a list of consultants.

D4. Options to 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 and the 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 is common. This can be labor intensive however, costs are low. Many exotic species, such as purple loosestrife, buckthorn, and garlic mustard are proficient at colonizing disturbed sites.

Option 3: Herbicide Treatment

Chemical treatments can be effective at controlling exotic plant species. However, chemical treatment 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.

D5. Participate in the Volunteer Lake Monitoring Program

In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection Agency (Illinois EPA) to gather fundamental information on Illinois' inland lakes, and to provide an educational program for citizens.

Annually, approximately 165 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 300 citizen volunteers. The volunteers are primarily lake shore residents, lake owners/managers, members of environmental groups, public water supply personnel, and citizens with interest in a particular lake.

The VLMP relies on volunteers to gather a variety of information on their chosen lake. The primary measurement is Secchi disk transparency or Secchi depth. Analysis of the Secchi disk measurement provides an indication of the general water quality condition of the lake, as well as the amount of usable habitat available for fish and other aquatic life.

Microscopic plants and animals, water color, and suspended sediments are factors that interfere with light penetration through the water column and lessen the Secchi disk depth. As a rule, one to three times the Secchi depth is considered the lighted or euphotic zone of the lake. In this region of the lake there is enough light to allow plants to survive and produce oxygen. Water below the lighted zone can be expected to have little or no dissolved oxygen. Other observations such as water color, suspended algae and sediment, aquatic plants, and odor are also recorded. The sampling season is May through October with volunteer measurements taken twice a month. After volunteers have completed one year of the basic monitoring program, they are qualified to participate in the Expanded Monitoring Program. In the expanded program, selected volunteers are trained to collect water samples that are shipped to the Illinois EPA laboratory for analysis of total and volatile suspended solids, total phosphorus, nitrate-nitrite nitrogen and ammonia nitrogen. Other parameters that are part of the expanded program include dissolved oxygen, temperature, and zebra mussel monitoring. Additionally, chlorophyll *a* monitoring has been added to the regiment for selected lakes.

For information, please contact:

VLMP Regional Coordinator:
Holly Hudson
Northeastern Illinois Planning Commission
233 S. Wacker Drive, Suite 880
Chicago, IL 60606
(312) 386-8700

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	167.0		Average	205	
Median	162.0		Median	194	
Minimum	64.9	IMC	Minimum	103	Heron Pond
Maximum	330.0	Flint Lake	Maximum	470	Lake Marie
STD	42.2		STD	53	
n =	803		n =	265	

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

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

*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	8.31		Average	7.11	
Median	8.30		Median	7.13	
Minimum	7.06	Deer Lake	Minimum	5.80	Third Lake
Maximum	10.28	Round Lake Marsh North	Maximum	8.48	Heron Pond
STD	0.46		STD	0.41	
n =	807		n =	265	

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

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	
Average	1.457	
Median	1.220	
Minimum	<0.5	*ND
Maximum	10.300	Fairfield Marsh
STD	0.831	
n =	808	

*ND = 5% Non-detects from 19 different lakes

	TKN (anoxic) 2000-2005	
Average	3.067	
Median	2.270	
Minimum	<0.5	*ND
Maximum	21.000	Taylor Lake
STD	2.467	
n =	265	

*ND = 5% Non-detects from 7 different lakes

	TP (oxic) <=3ft 2000-2005	
Average	0.098	
Median	0.063	
Minimum	<0.01	From 5 Lakes
Maximum	3.880	Albert Lake
STD	0.168	
n =	795	

*ND = 0.1% Non-detects from 5 different lakes
(Bangs, Cedar, Carina, Minear, & Stone Quarry)

	TP (anoxic) 2000-2005	
Average	0.320	
Median	0.174	
Minimum	0.012	West Loon Lake
Maximum	3.800	Taylor Lake
STD	0.412	
n =	265	

	TSS (all) <=3ft 2000-2005	
Average	15.3	
Median	7.9	
Minimum	<0.1	*ND
Maximum	165.0	Fairfield Marsh
STD	20.3	
n =	815	

*ND = 2% Non-detects from 10 different lakes

	TVS (oxic) <=3ft 2000-2005	
Average	136.0	
Median	132.0	
Minimum	34.0	Pulaski Pond
Maximum	298.0	Fairfield Marsh
STD	40.4	
n =	758	

No 2002 IEPA Chain Lakes

	TDS (oxic) <=3ft 2000-2004	
Average	470	
Median	454	
Minimum	150	Lake Kathryn, White
Maximum	1340	IMC
STD	169	
n =	745	

No 2002 IEPA Chain Lakes, Data from 00-04.

	CL (anoxic) 2004-2005	
Average	277	
Median	102	
Minimum	53	Banana Pond
Maximum	2390	IMC
STD	489	
n =	66	

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



APPENDIX F. GRANT PROGRAM 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
IEEMA = 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