2007 SUMMARY REPORT
of
Sand Pond

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Sand Pond is a 20-acre glacial lake located in Illinois Beach State Park in northern Lake County. The pond empties into Kellogg Creek and eventually into Lake Michigan. It is used by the public for fishing and aesthetics.

Sand Pond is listed as an ADID (advanced identification) wetland by the U.S. Environmental Protection Agency and an Illinois Natural Areas Inventory (INAI) by the state of Illinois. This indicates the lake and the surrounding natural environment have potential for high quality aquatic resources based on water quality and hydrology values.

Water clarity was best in June (9.20 feet) and poorest in September (6.07 feet), averaging 7.42 feet in 2007, which is down slightly from the 2000 average of 7.58 feet. The slight decrease in water clarity from 2000 was a result of an increase in total suspended solids (TSS) in the water column during 2007. The average TSS was 2.8 mg/L while in 2000 the average was 1.6 mg/L. Both of these values were below the county median of 8.0 mg/L.

The Lake County median conductivity reading was 0.8038 milliSiemens/cm (mS/cm). During 2007, the Sand Pond average epilimnetic conductivity reading was lower, at 0.8002 mS/cm. This was a 37% increase from the 2000 average of 0.5856 mS/cm. In addition, the Cl^- concentration (146 mg/L) in Sand Pond was slightly lower than the Lake County median of 158 mg/L during 2007. The 2007 average total phosphorus (TP) concentration in Sand Pond (0.017 mg/L) was lower than the Lake County median of 0.063 mg/L. The average TP has decreased from 2000 when the average was 0.023 mg/L.

Sand Pond had a dense but limited aquatic plant community. A total of only two plant species and one macro-algae were found. Eurasian Watermilfoil (EWM) was found at 94% of the sampling sites, *Chara* spp. was found at 28% of the sampling sites, and Sago Pondweed was found at 6% of the sampling sites. Species composition had decreased since 2000 when five aquatic plant species and one macro-algae were found. In 2000 EWM and *Chara* spp. were also the most common aquatic plants.

In 2007 the shoreline was surveyed to determine areas of erosion. Based on the 2007 assessment 89% of the shoreline had no erosion and 11% had slight erosion. The erosion occurred where the fishing access areas were located around the lake.

Sand Pond provides excellent habitat for a variety of birds, mammals, and other wildlife. The habitat was due to being located in a rural setting with the shoreline mainly undeveloped and the abundance of prairie and forest in the area. It is very important that the natural areas around the lake be maintained to provide the appropriate habitat for wildlife species in the future. The Sand Pond fishery was managed extensively by the Illinois Department of Natural Resources through the stocking of Rainbow Trout as “put and take” and Channel Catfish as “put, grow, and take”.

LAKE FACTS

Lake Name:	Sand Pond
Historical Name:	None
Nearest Municipality:	Zion
Location:	T 46N, R 12E, Sections 14 & 15
Elevation:	590.0 feet
Major Tributaries:	None
Watershed:	Lake Michigan
Sub-watershed:	Kellogg Creek
Receiving Waterbody:	Kellogg Creek
Surface Area:	19.7 acres
Shoreline Length:	0.7 miles
Maximum Depth:	9.6 feet
Average Depth:	4.8 feet (estimated)
Lake Volume:	94.6 acre-feet (estimated)
Lake Type:	Borrow Pit
Watershed Area:	36.9 acres
Major Watershed Land Uses:	Public and Private Open Space
Bottom Ownership:	State of Illinois
Management Entities:	Illinois Department of Natural Resources
Current and Historical Uses:	Fishing
Description of Access:	Public access via Illinois Beach State Park

SUMMARY OF WATER QUALITY

Water samples were collected monthly from May through September at the deepest point in the lake (Figure 1, Appendix A). Sand Pond was sampled at depths of three feet and 6 to 7 feet depending on water level and the samples were analyzed for various water quality parameters (Appendix C).

Sand Pond was weakly stratified in May and June and mixed throughout the rest of the season due to the lake being shallow and easily mixed by wind. Thermal stratification is when a lake divides into an upper, warm water layer (epilimnion) and a lower, cold-water layer (hypolimnion). When stratified, the epilimnetic and hypolimnetic waters do not mix, and the hypolimnion typically experiences anoxic conditions (where DO concentrations drop below 1 mg/L. The concentrations from the epilimnion were similar to the hypolimnion, therefore only the data from the epilimnion will be discussed.

A dissolved oxygen (DO) concentration of 5.0 mg/L is considered adequate to support a sunfish/bass fishery, since these fish can suffer oxygen stress below this amount. DO concentrations at the surface were above 5.0 mg/L throughout the season (Appendix B). Anoxic conditions (<1 mg/L) existed only in June at the bottom. Sand Pond has an aerator which was not working properly during 2007. It was suspected the diffusers were clogged since there was minimal water movement around the diffusers. Based on the DO concentrations found in 2000 and 2007 by Lakes Management Unit (LMU), the aeration system in Sand Pond may not be necessary. If the aerator is in operation in 2008, maintenance on the equipment is strongly recommended.

Secchi disk depth (water clarity) averaged 7.42 feet during 2007 and 7.58 feet during 2000 (Table 1). Both of these readings were above the Lake County median of 3.28 feet (Appendix E). The slight decrease in water clarity from 2000 was a result of an increase in total suspended solids (TSS) in the water column during 2007. TSS is composed of nonvolatile suspended solids, non-organic clay or sediment materials, and volatile suspended solids, algae and other organic matter. In 2007 the average TSS was 2.8 mg/L while in 2000 the average was 1.6 mg/L. Both of these values were below the county median of 8.0 mg/L.

Another factor affecting water clarity was the amount of nutrients in the water. Typically, lakes are either phosphorus (P) or nitrogen (N) limited. This means one of the nutrients is in short supply and any addition of that nutrient to the lake will result in an increase of plant and/or algal growth. Most lakes in Lake County are phosphorus limited. To compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) was used. Ratios less than or equal to 10:1 indicate nitrogen is limiting, ratios greater than or equal to 15:1 indicate phosphorus is limiting, and ratios greater than 10:1, but less than 15:1 indicate there are enough of both nutrients to facilitate excess algae or plant growth. Sand Pond had a TN:TP ratio of 43:1 in 2000 and 62:1 in 2007, indicating the lake was phosphorous limited. Nitrogen, as well as carbon, naturally occur in high concentrations and come from a variety of sources (soil, air, etc.), which are more difficult to control than sources of phosphorus. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon. The total phosphorus (TP) concentration in 2007 averaged lower than the

Figure 1. Access and water quality sampling site on Sand Pond, 2007.

Table 1. Water quality data for Sand Pond, 2000 and 2007.

2007	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
15-May	3	178	0.83	<0.1	<0.05	0.022	<0.005	156	NA	3.3	495	77	6.43	0.8870	8.60	8.93
19-Jun	3	134	0.79	<0.1	<0.05	<0.010	<0.005	142	NA	2.2	434	82	9.20	0.7550	8.59	5.49
17-Jul	3	142	0.83	<0.1	<0.05	0.019	<0.005	150	NA	2.6	452	87	7.22	0.7990	8.54	9.41
14-Aug	3	139	0.83	<0.1	<0.05	0.012	<0.005	147	NA	2.4	439	88	8.20[a]	0.7810	8.41	9.39
18-Sep	3	162	0.81	<0.1	<0.05	0.013	<0.005	136	NA	3.5	446	91	6.07	0.7790	8.43	15.25
	Average	151	0.81	<0.1	<0.05	0.017[k]	<0.005	146	NA	2.8	453	85	7.42[b]	0.8002	8.51	9.69

2000	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
22-May	3	129	1.15	<0.1	0.060	0.023	<0.005	NA	318	1.5	350	115	5.02	0.5522	9.1	11.37
26-Jun	3	109	0.91	<0.1	0.051	0.020	<0.005	NA	314	0.6	349	96	8.60[a]	0.5414	8.83	5.55
24-Jul	3	154	0.82	<0.1	0.064	0.023	<0.005	NA	378	2.1	370	82	7.78	0.6102	7.71	4.89
28-Aug	3	165	0.88	<0.1	<0.05	0.030	<0.005	NA	367	2.8	389	98	7.58	0.6381	8.55	8.20
25-Sep	3	139	0.94	<0.1	<0.05	0.019	<0.005	NA	324	0.9	344	78	8.92[a]	0.5863	8.55	9.3
	Average	139	0.94	<0.1	0.058[k]	0.023	<0.005	NA	340	1.6	360	94	7.58[b]	0.5856	8.55	7.86

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_2+NO_3-N = Nitrate + Nitrite nitrogen, mg/L
NO_3-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
Cl^- = Chloride, mg/L
TDS = Total dissolved solids, 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

a = Secchi depth was obstructed by the bottom
b = Secchi disk was on the bottom at least one month and therefore the average could have been deeper
k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed

Table 1. Continued.

2007	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
15-May	6	179	0.88	<0.1	<0.05	0.026	<0.005	156	NA	7	496	81	NA	0.8860	8.59	8.77
19-Jun	7	137	0.80	<0.1	<0.05	0.013	<0.005	142	NA	1.8	438	81	NA	0.8280	7.95	2.57
17-Jul	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14-Aug	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
18-Sep	6	162	0.85	<0.1	<0.05	0.012	<0.005	133	NA	3.4	447	86	NA	0.7790	8.37	15.05
	Average	159	0.84	<0.1	<0.05	0.017	<0.005	144	NA	4.1	460	83	NA	0.8310	8.30	8.80

2000	**Hypolimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	Cl^-	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
22-May	7	132	1.27	<0.1	0.165	0.023	<0.005	NA	320	6.5	353	114	NA	0.5452	8.55	8.81
26-Jun	6	125	0.89	<0.1	0.051	0.018	<0.005	NA	338	1.4	366	85	NA	0.5779	8.46	4.42
24-Jul	7	151	0.95	<0.1	0.066	0.023	<0.005	NA	380	2.3	376	88	NA	0.6088	7.58	4.89
28-Aug	7	167	0.93	0.127	0.068	0.03	<0.005	NA	384	3.6	391	92	NA	0.6566	7.46	0.57
25-Sep	7	138	0.88	<0.1	<0.05	0.018	<0.005	NA	330	1.1	353	98	NA	0.5863	8.56	9.49
	Average	143	0.98	0.127	0.097[k]	0.022	0.010[k]	NA	350	3.0	368	95	NA	0.5950	8.12	5.64

Glossary

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

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed

Lake County median of 0.063 mg/L. Sand Pond's average TP (0.017 mg/L) had decreased since 2000 when the average was 0.023 mg/L.

Phosphorus can be released from sediment through biological or mechanical processes, or from plant or algae cells as they die. This typically occurs in lakes like Sand Pond that only weakly stratify, therefore phosphorus attached to bottom sediment or released from dying algae/plant cells can be easily distributed throughout the water column. Phosphorus taken up from sediments through plant roots is distributed through the plant to its leaves and stem. However, when plants die and decompose, large amounts of phosphorus are released back into the water column. The decomposition of the dense beds of EWM may have released phosphorus.

There could be external sources affecting Sand Pond's water quality as well, such as stormwater from the 36.91 acres within its watershed (Figure 2). Public and private open space (48%) and transportation (3%) were the only land uses within the watershed (Figure 3). Even though transportation was only 3% of the landuse, it contributes 25% of the estimated runoff. The retention time (the amount of time it takes for water entering a lake to flow out of it again) was calculated to be approximately 10.24 years (Table 2).

Total phosphorous can be used to calculate the trophic state index (TSIp), which classifies lakes according to the overall level of nutrient enrichment. The TSIp score falls within the range of one of four categories: hypereutrophic, eutrophic, mesotrophic and oligotrophic. Hypereutrophic lakes are those with excessive nutrients, nuisance algae growth reminiscent of "pea soup," and have a TSI score greater than 70. Lakes with a TSI score of 50 or greater are classified as eutrophic or nutrient rich and are productive lakes in terms of aquatic plants and/or algae. Mesotrophic and oligotrophic lakes have lower nutrient levels. These are very clear lakes, with little algal growth. Most lakes in Lake County are eutrophic. The trophic state of Sand Pond, in terms of the phosphorus concentration during 2000, was mesotrophic with a TSIp score of 49.4. In 2007 the trophic remained mesotrophic with a lower TSIp score of 41.4, ranking Sand Pond 4^{th} out of 163 lakes in Lake County (Table 3).

The Illinois Environmental Protection Agency (IEPA) has assessment indices to classify Illinois lakes for their ability to support aquatic life and recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations (TSIp), and aquatic plant coverage. According to this index, Sand Pond provides *Full* support of aquatic life and recreational activities. The lake provides *Full* overall use.

Conductivity is a measurement of water's ability to conduct electricity and is correlated with chloride (Cl^-) concentrations (Figure 4). Compared to lakes in undeveloped areas, lakes with residential and/or urban land uses in their watershed often have higher conductivity readings and higher Cl^- concentrations because of the use of road salts. Stormwater runoff from impervious surfaces, such as roads and parking lots, can deliver high concentrations of Cl^- to nearby waterbodies. The Lake County median conductivity reading was 0.8038 milliSiemens/cm (mS/cm). During 2007, the Sand Pond average conductivity reading was similar (0.8002 mS/cm). This was a 37% increase from the 2000 average of 0.5856 mS/cm. In addition, the Cl^- concentration in Sand Pond was slightly lower than the Lake County median of 158 mg/L during 2007, with an average of 146 mg/L. A study done in Canada reported 10% of aquatic species

Figure 2. Approximate watershed delineation for Sand Pond, 2007.

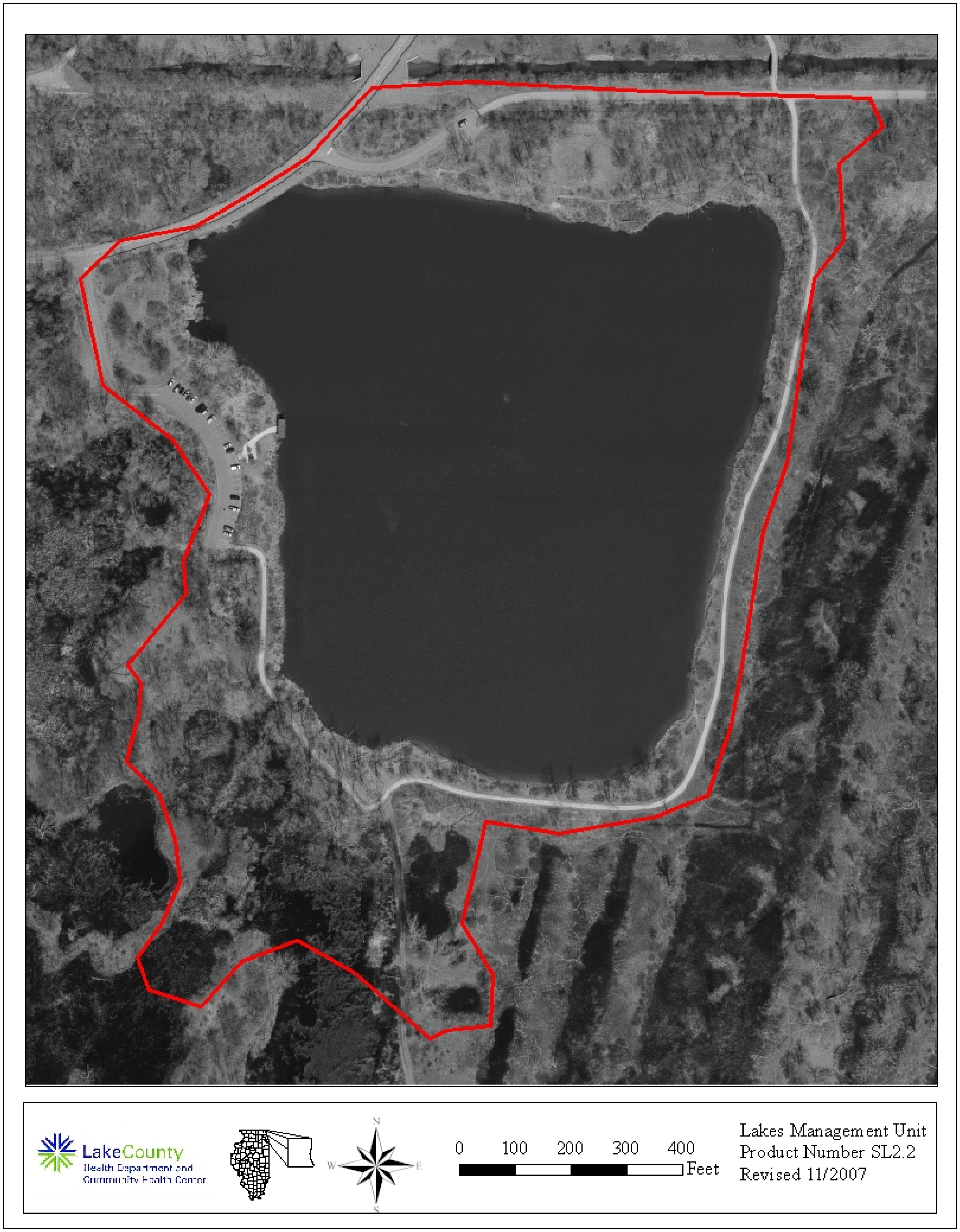


Figure 3. Approximate land use within the Sand Pond watershed, 2007.

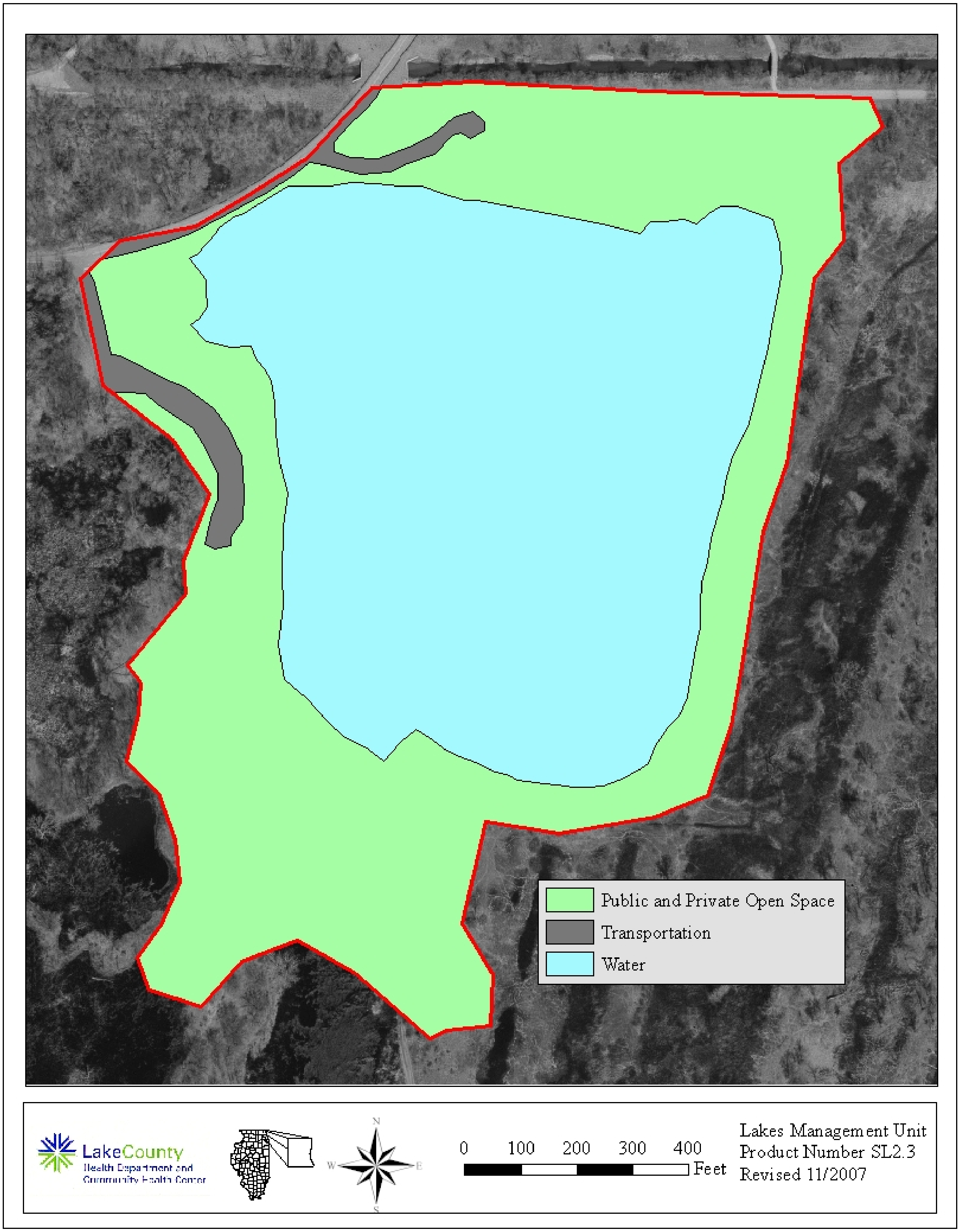


Table 2. Approximate land uses and retention time for Sand Pond, 2007.

Land Use	Acreage	% of Total
Public and Private Open Space	16.86	45.7%
Transportation	1.02	2.8%
Water	19.03	51.6%
Total Acres	**36.91**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Public and Private Open Space	16.86	0.15	7.0	74.5%
Transportation	1.02	0.85	2.4	25.5%
Water	19.03	0.00	0.0	0.0%
TOTAL	**36.91**		**9.3**	100.0%

Lake volume	**95.56**	**acre-feet**
Retention Time (years)= lake volume/runoff	**10.24**	**years**
	3737.41	**days**

Table 3. Lake County average TSI phosphorous (TSIp) ranking 2000-2007.

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Independence Grove	0.0114	39.24
4	**Sand Pond (IDNR)**	**0.132**	**41.36**
5	Cedar Lake	0.0157	41.60
6	Windward Lake	0.0158	43.95
7	Pulaski Pond	0.0180	45.83
8	Timber Lake (North)	0.0180	45.83
9	Fourth Lake	0.0182	45.99
10	West Loon Lake	0.0182	45.99
11	Lake Kathyrn	0.0200	47.35
12	Lake of the Hollow	0.0200	47.35
13	Banana Pond	0.0202	47.49
14	Lake Minear	0.0204	47.63
15	Bangs Lake	0.0212	48.17
16	Cross Lake	0.0220	48.72
17	Dog Pond	0.0222	48.85
18	Stone Quarry Lake	0.0230	49.36
19	Cranberry Lake	0.0234	49.61
20	Deep Lake	0.0240	49.98
21	Druce Lake	0.0244	50.22
22	Little Silver Lake	0.0246	50.33
23	Round Lake	0.0254	50.80
24	Lake Leo	0.0256	50.91
25	Dugdale Lake	0.0274	51.89
26	Peterson Pond	0.0274	51.89
27	Lake Miltmore	0.0276	51.99
28	East Loon Lake	0.0280	52.20
29	Lake Zurich	0.0282	52.30
30	Lake Fairfield	0.0296	53.00
31	Gray's Lake	0.0302	53.29
32	Highland Lake	0.0302	53.29
33	Hook Lake	0.0302	53.29
34	Lake Catherine (Site 1)	0.0308	53.57
35	Lambs Farm Lake	0.0312	53.76
36	Old School Lake	0.0312	53.76
37	Sand Lake	0.0316	53.94
38	Sullivan Lake	0.0320	54.13
39	Lake Linden	0.0326	54.39
40	Countryside Lake	0.0332	54.66
41	Gages Lake	0.0338	54.92
42	Hendrick Lake	0.0344	55.17
43	Third Lake	0.0346	55.24
44	Diamond Lake	0.0372	56.30
45	Channel Lake (Site 1)	0.0380	56.60
46	Ames Pit	0.0390	56.98

Table 3. Continued.

RANK	LAKE NAME	TP AVE	TSIp
47	White Lake	0.0408	57.63
48	Sun Lake	0.0410	57.70
49	Potomac Lake	0.0424	58.18
50	Duck Lake	0.0426	58.25
51	Old Oak Lake	0.0428	58.32
52	Deer Lake	0.0434	58.52
53	Schreiber Lake	0.0434	58.52
54	Nielsen Pond	0.0448	58.98
55	Turner Lake	0.0458	59.30
56	Seven Acre Lake	0.0460	59.36
57	Willow Lake	0.0464	59.48
58	Lucky Lake	0.0476	59.85
59	Davis Lake	0.0476	59.85
60	East Meadow Lake	0.0478	59.91
61	College Trail Lake	0.0496	60.45
62	Lake Lakeland Estates	0.0524	61.24
63	Butler Lake	0.0528	61.35
64	West Meadow Lake	0.0530	61.40
65	Heron Pond	0.0545	61.80
66	Little Bear Lake	0.0550	61.94
67	Lucy Lake	0.0552	61.99
68	Lake Christa	0.0576	62.60
69	Lake Charles	0.0580	62.70
70	Crooked Lake	0.0608	63.38
71	Waterford Lake	0.0610	63.43
72	Lake Naomi	0.0616	63.57
73	Lake Tranquility S1	0.0618	63.62
74	Werhane Lake	0.0630	63.89
75	Liberty Lake	0.0632	63.94
76	Countryside Glen Lake	0.0642	64.17
77	Lake Fairview	0.0648	64.30
78	Leisure Lake	0.0648	64.30
79	Tower Lake	0.0662	64.61
80	Wooster Lake	0.0663	64.63
81	St. Mary's Lake	0.0666	64.70
82	Mary Lee Lake	0.0682	65.04
83	Hastings Lake	0.0684	65.08
84	Honey Lake	0.0690	65.21
85	Spring Lake	0.0726	65.94
86	ADID 203	0.0730	66.02
87	Bluff Lake	0.0734	66.10
88	Harvey Lake	0.0766	66.71
89	Broberg Marsh	0.0782	67.01
90	Echo Lake	0.0792	67.19
91	Sylvan Lake	0.0794	67.23
92	Big Bear Lake	0.0806	67.45

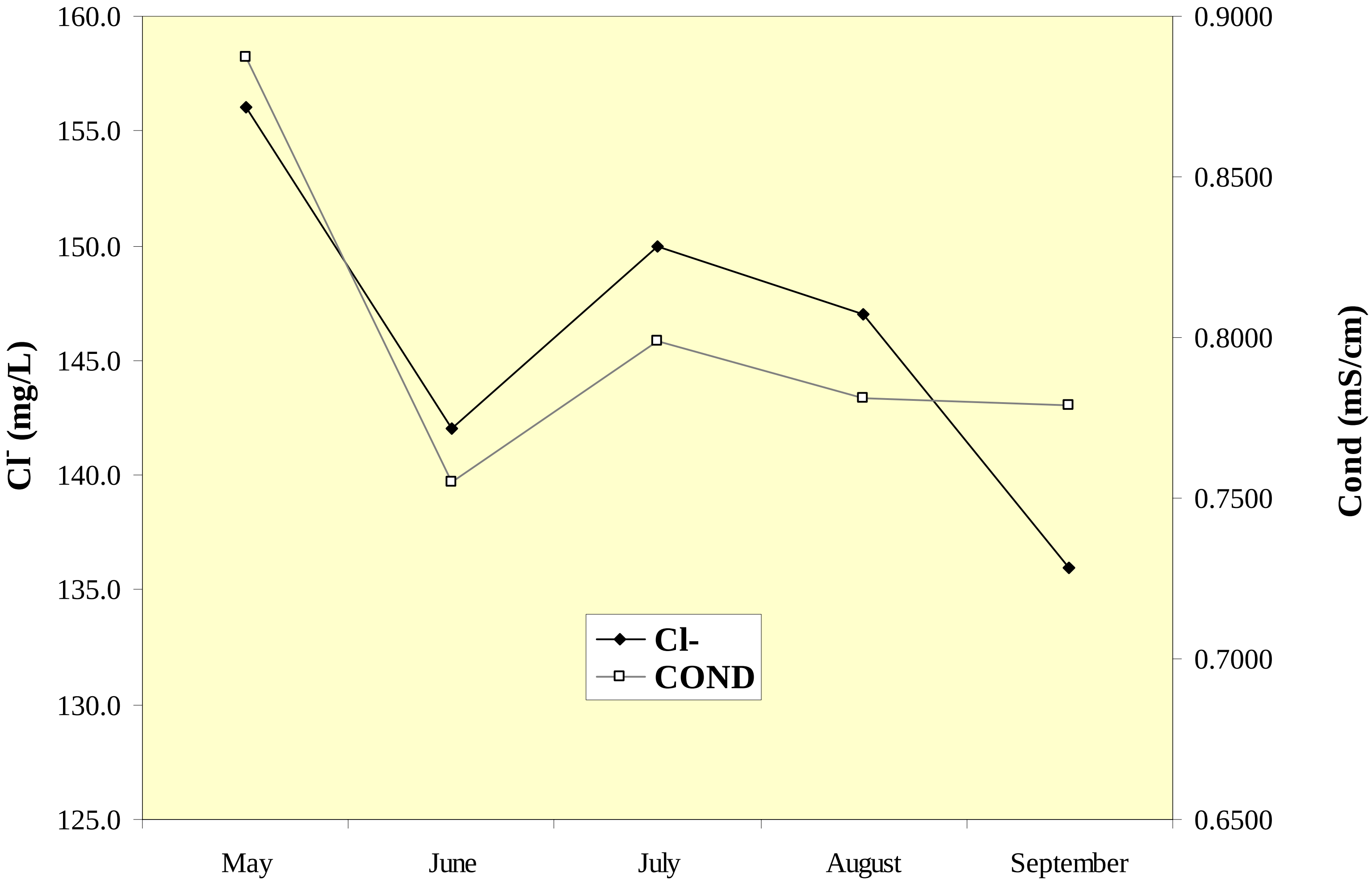
Table 3. Continued.

RANK	LAKE NAME	TP AVE	TSIp
93	Petite Lake	0.0834	67.94
94	Timber Lake (South)	0.0848	68.18
95	Lake Marie (Site 1)	0.0850	68.21
96	North Churchill Lake	0.0872	68.58
97	Grand Avenue Marsh	0.0874	68.61
98	Grandwood Park, Site II, Outflow	0.0876	68.65
99	North Tower Lake	0.0878	68.68
100	South Churchill Lake	0.0896	68.97
101	Rivershire Pond 2	0.0900	69.04
102	McGreal Lake	0.0914	69.26
103	International Mine and Chemical Lake	0.0948	69.79
104	Eagle Lake (Site I)	0.0950	69.82
105	Valley Lake	0.0950	69.82
106	Dunns Lake	0.0952	69.85
107	Fish Lake	0.0956	69.91
108	Lochanora Lake	0.0960	69.97
109	Owens Lake	0.0978	70.23
110	Woodland Lake	0.0986	70.35
111	Island Lake	0.0990	70.41
112	McDonald Lake 1	0.0996	70.50
113	Longview Meadow Lake	0.1024	70.90
114	Long Lake	0.1029	70.96
115	Lake Barrington	0.1053	71.31
116	Redwing Slough, Site II, Outflow	0.1072	71.56
117	Lake Forest Pond	0.1074	71.59
118	Bittersweet Golf Course #13	0.1096	71.88
119	Fox Lake (Site 1)	0.1098	71.90
120	Osprey Lake	0.1108	72.04
121	Bresen Lake	0.1126	72.27
122	Round Lake Marsh North	0.1126	72.27
123	Deer Lake Meadow Lake	0.1158	72.67
124	Taylor Lake	0.1184	72.99
125	Columbus Park Lake	0.1226	73.49
126	Nippersink Lake (Site 1)	0.1240	73.66
127	Grass Lake (Site 1)	0.1288	74.21
128	Lake Holloway	0.1322	74.58
129	Lakewood Marsh	0.1330	74.67
130	Summerhill Estates Lake	0.1384	75.24
131	Redhead Lake	0.1412	75.53
132	Forest Lake	0.1422	75.63
133	Antioch Lake	0.1448	75.89
134	Slocum Lake	0.1496	76.36
135	Drummond Lake	0.1510	76.50
136	Pond-a-Rudy	0.1514	76.54
137	Lake Matthews	0.1516	76.56
138	Buffalo Creek Reservoir	0.1550	76.88

Table 3. Continued.

RANK	LAKE NAME	TP AVE	TSIp
139	Pistakee Lake (Site 1)	0.1592	77.26
140	Salem Lake	0.1650	77.78
141	Half Day Pit	0.1690	78.12
142	Lake Eleanor Site II, Outflow	0.1812	79.13
143	Lake Farmington	0.1848	79.41
144	ADID 127	0.1886	79.71
145	Lake Louise Inlet	0.1938	80.10
146	Grassy Lake	0.1952	80.20
147	Dog Bone Lake	0.1990	80.48
148	Redwing Marsh	0.2072	81.06
149	Stockholm Lake	0.2082	81.13
150	Bishop Lake	0.2156	81.63
151	Hidden Lake	0.2236	82.16
152	Fischer Lake	0.2278	82.43
153	Lake Napa Suwe (Outlet)	0.2304	82.59
154	Patski Pond (outlet)	0.2512	83.84
155	Oak Hills Lake	0.2792	85.36
156	Loch Lomond	0.2954	86.18
157	McDonald Lake 2	0.3254	87.57
158	Fairfield Marsh	0.3264	87.61
159	ADID 182	0.3280	87.69
160	Slough Lake	0.4134	91.02
161	Flint Lake Outlet	0.4996	93.75
162	Rasmussen Lake	0.5025	93.84
163	Albert Lake, Site II, outflow	1.1894	106.3

Figure 4. Chloride (Cl^-) concentration vs. conductivity for Sand Pond, 2007



were harmed by prolonged exposure to chloride concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were associated with chloride concentrations as low as 12 mg/l. Therefore, lakes can be negatively impacted by the high Cl^- concentrations. Since the pond has a small watershed, reduction of road salt usage or the use of road salt alternatives may have a significant affect on the conductivity readings and chloride concentrations in the water.

SUMMARY OF AQUATIC MACROPHYTES

An aquatic plant (macrophyte) survey was conducted in July of 2007. Sampling sites were based on a grid system created by mapping software (ArcMap), with each site located 30 meters apart for a total of 86 sites. However, only 71 of the sites were sampled due to the abundance and uniform distribution of Eurasian Water Milfoil (EWM). Sixty-nine of the sites sampled had plants (Figure 5), which were found at a maximum depth of 10.3 feet (Table 4a, b). Overall, a total of two plant species and one macro-algae were found (Table 5). EWM was found at 94% of the sampling sites, *Chara* spp. was found at 28% of the sampling sites, and Sago Pondweed was found at 6% of the sampling sites. Species composition was greater in 2000 when five aquatic plant species and one macro-algae were found. In 2000 EWM and *Chara* spp. were also the most common aquatic plants. EWM competes with native plants, eventually crowding them out. Exotic species provide little or poor natural diversity, in addition to limited use by wildlife therefore, removal or control is recommended. To maintain a healthy sunfish/bass fishery, the optimal plant coverage is 30% to 40% across the lake bottom. It was calculated that approximately 97% of the lake bottom was covered by plants.

On October 3, 2007 the perimeter of Sand Pond was treated with 150 pounds of Navigate®, a contact herbicide, to control the EWM. According to the Illinois Department of Natural Resources (IDNR) fisheries biologist, when the aerator is working, the water column is clouded up and keeps the EWM from becoming so abundant. In 2007, the aerator was not working properly with little or no agitation, which allowed the 1% light level to reach the bottom of the lake the entire summer. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a specific lake. Aquatic plants will not photosynthesize in water depths with less than 1% of the available sunlight. It is recommended that if herbicides are used in the future they be applied earlier in the year.

The 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. 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 indicate that there were large numbers 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 2000-2007 Lake County lakes was 13.6 (Table 6). Sand Pond had a FQI of 3.5, which is a decrease from 2000 when the FQI was 4.2. However, there are a few potential reasons for this decline. First off, the aquatic plant sampling procedure has changed. Secondly,

Figure 5. Aquatic plant sampling grid that illustrates plant density on Sand Pond, July 2007.

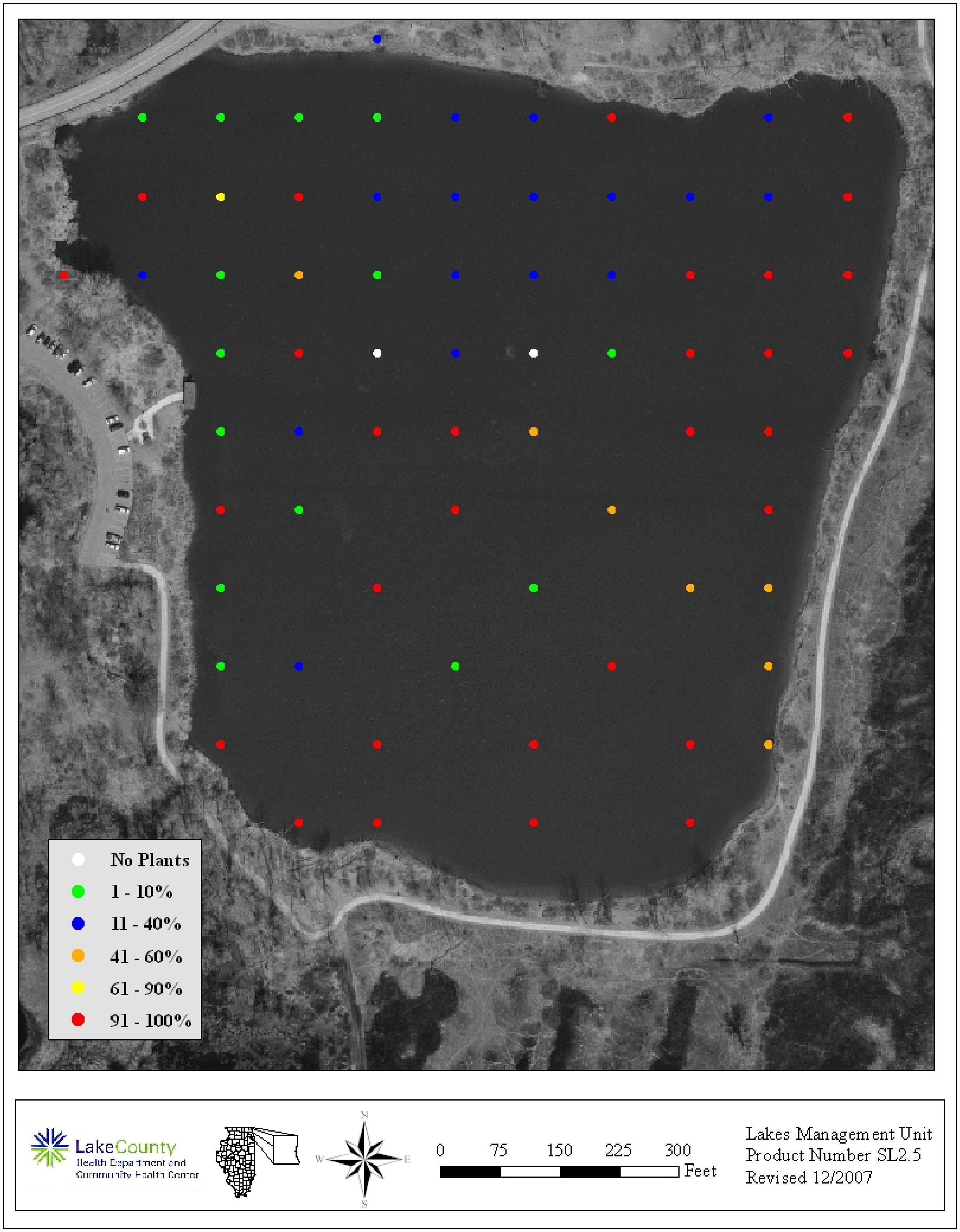


Table 4a. Aquatic plant species found at the 71 sampling sites on Sand Pond, July 2007.
Maximum depth that plants were found was 10.3 feet.

Plant Density	Chara	Eurasian Watermilfoil	Sago Pondweed
Absent	51	4	67
Present	11	14	3
Common	4	17	1
Abundant	5	7	0
Dominant	0	29	0
% Plant Occurrence	28.2%	94.4%	5.6%

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

Rake Density (Coverage)	# of Sites	%
No plants	2	2.8
>0 to 10%	14	19.7
>10 to 40%	17	23.9
>40 to 60%	7	9.9
>60 to 90%	1	1.4
>90%	30	42.3
Total Sites with Plants	69	97.2
Total # of Sites	71	100.0

Table 5. Aquatic plant species found in Sand Pond in 2007.

Chara (Macro algae)	*Chara* spp.
Eurasian Watermilfoil^	*Myriophyllum spicatum*
Sago Pondweed	*Potamogeton pectinatus*

^ Exotic plant

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

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	35.1	37.3
2	Deep Lake	33.9	35.4
3	Cranberry Lake	30.1	31.0
4	Round Lake Marsh North	29.1	29.9
5	East Loon Lake	28.4	29.9
6	Sullivan Lake	28.2	29.7
7	Deer Lake	28.2	29.7
8	Little Silver Lake	27.9	30.0
9	Schreiber Lake	26.8	27.6
10	West Loon Lake	26.0	27.6
11	Cross Lake	25.2	27.8
12	Independence Grove	24.6	27.5
13	Sterling Lake	24.5	26.9
14	Bangs Lake	24.5	26.2
15	Lake Zurich	24.0	26.0
16	Lakewood Marsh	23.8	24.7
17	Lake of the Hollow	23.8	26.2
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	Butler Lake	21.4	23.1
24	Duck Lake	21.1	22.9
25	Wooster Lake	20.8	22.6
26	Timber Lake (North)	20.8	22.8
27	Davis Lake	20.5	21.4
28	Broberg Marsh	20.5	21.4
29	ADID 203	20.5	20.5
30	McGreal Lake	20.2	22.1
31	Lake Kathryn	19.6	20.7
32	Redhead Lake	19.3	21.2
33	Owens Lake	19.3	20.2
34	Fish Lake	19.3	21.2
35	Turner Lake	18.6	21.2
36	Salem Lake	18.5	20.2
37	Lake Miltmore	18.4	20.3
38	Hendrick Lake	17.7	17.7
39	Summerhill Estates Lake	17.1	18.0
40	Seven Acre Lake	17.0	15.5
41	Gray's Lake	16.9	19.8
42	Third Lake	16.8	18.7
43	Lake Barrington	16.7	17.7
44	Bresen Lake	16.6	17.8

Table 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
45	Windward Lake	16.3	17.6
46	Lake Napa Suwe	16.3	17.4
47	Diamond Lake	16.3	17.4
48	Long Lake	16.1	18.0
49	Dog Bone Lake	15.7	15.7
50	Redwing Slough	15.6	16.6
51	Osprey Lake	15.5	17.3
52	Lake Fairview	15.2	16.3
53	Heron Pond	15.1	15.1
54	North Churchill Lake	15.0	15.0
55	Lake Tranquility (S1)	15.0	17.0
56	Island Lake	14.7	16.6
57	Dog Training Pond	14.7	15.9
58	Highland Lake	14.5	16.7
59	Taylor Lake	14.3	16.3
60	Grand Avenue Marsh	14.3	16.3
61	Eagle Lake (S1)	14.0	15.1
62	Dugdale Lake	14.0	15.1
63	Longview Meadow Lake	13.9	13.9
64	Hook Lake	13.4	15.5
65	Bishop Lake	13.4	15.0
66	Ames Pit	13.4	15.5
67	Old School Lake	13.1	15.1
68	McDonald Lake 2	13.1	14.3
69	Mary Lee Lake	13.1	15.1
70	Buffalo Creek Reservoir	13.1	14.3
71	White Lake	12.7	14.7
72	Timber Lake (South)	12.7	14.7
73	Old Oak Lake	12.7	14.7
74	Dunn's Lake	12.7	13.9
75	Stone Quarry Lake	12.5	12.5
76	Sand Lake	12.5	14.8
77	Hastings Lake	12.5	14.8
78	Echo Lake	12.5	14.8
79	Stockholm Lake	12.1	13.5
80	Pond-A-Rudy	12.1	12.1
81	Lambs Farm Lake	12.1	14.3
82	Lake Leo	12.1	14.3
83	Lake Carina	12.1	14.3
84	Honey Lake	12.1	14.3
85	Lake Matthews	12.0	12.0
86	Harvey Lake	11.8	13.0
87	Flint Lake	11.8	13.0
88	Rivershire Pond 2	11.5	13.3
89	Lake Linden	11.3	11.3
90	Lake Charles	11.3	13.4

Table 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
91	Antioch Lake	11.3	13.4
92	Pulaski Pond	11.2	12.5
93	Lake Naomi	11.2	12.5
94	West Meadow Lake	11.0	11.0
95	Tower Lake	11.0	11.0
96	Redwing Marsh	11.0	11.0
97	Lake Minear	11.0	13.9
98	Nielsen Pond	10.7	12.0
99	Lake Holloway	10.6	10.6
100	Countryside Lake	10.5	12.1
101	Crooked Lake	10.2	12.5
102	Lake Lakeland Estates	10.0	11.5
103	College Trail Lake	10.0	10.0
104	Valley Lake	9.9	9.9
105	Werhane Lake	9.8	12.0
106	Little Bear Lake	9.5	11.0
107	Big Bear Lake	9.5	11.0
108	Loch Lomond	9.4	12.1
109	Sylvan Lake	9.2	9.2
110	Columbus Park Lake	9.2	9.2
111	Lake Fairfield	9.0	10.4
112	Grandwood Park Lake	9.0	11.0
113	Fischer Lake	9.0	11.0
114	McDonald Lake 1	8.9	10.0
115	South Churchill Lake	8.5	8.5
116	Lucy Lake	8.5	9.8
117	Lake Farmington	8.5	9.8
118	Lake Christa	8.5	9.8
119	East Meadow Lake	8.5	8.5
120	Woodland Lake	8.1	9.9
121	Bittersweet Golf Course #13	8.1	8.1
122	Lake Louise	7.5	8.7
123	Lake Eleanor	7.5	8.7
124	Fairfield Marsh	7.5	8.7
125	Banana Pond	7.5	9.2
126	Albert Lake	7.5	8.7
127	Slough Lake	7.1	7.1
128	Rasmussen Lake	7.1	7.1
129	Patski Pond	7.1	7.1
130	Lucky Lake	7.0	7.0
131	Lake Forest Pond	6.9	8.5
132	Leisure Lake	6.4	9.0
133	Peterson Pond	6.0	8.5
134	Slocum Lake	5.8	7.1
135	Grassy Lake	5.8	7.1
136	Gages Lake	5.8	10.0

Table 6. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
137	Deer Lake Meadow Lake	5.2	6.4
138	Oak Hills Lake	5.0	5.0
139	Liberty Lake	5.0	5.0
140	IMC Lake	5.0	7.1
141	Drummond Lake	5.0	7.1
142	ADID 127	5.0	5.0
143	**Sand Pond (IDNR)**	**3.5**	**5.0**
144	Forest Lake	3.5	5.0
145	Half Day Pit	2.9	5.0
146	Lochanora Lake	2.5	5.0
147	Willow Lake	0.0	0.0
148	Waterford Lake	0.0	0.0
149	St. Mary's Lake	0.0	0.0
150	Potomac Lake	0.0	0.0
151	North Tower Lake	0.0	0.0
152	Hidden Lake	0.0	0.0
	Mean	**13.6**	**14.9**
	Median	**12.5**	**14.3**

plant community compositions can vary from year to year, and EWM could be outcompeting some of the native species.

SUMARY OF SHORELINE CONDITION

The roadside seawall on the pond's east side was used to measure the water level of the lake each month. Lakes with stable water levels potentially have less shoreline erosion problems. The water level in Sand Pond fluctuated, dropping 10.5 inches from June to July and then coming up 8.25 inches from August to September, with a net decrease of 2.25 inches in 2007. The rise in water level was a result of large rains that fell across Lake County during the months of August and September. The Lake Management Unit (LMU) recorded 5.5 inches of rain between the August and September sampling events at the Illinois Beach SwimCast station along the Lake Michigan shore at Illinois Beach State Park South.

An assessment was conducted to determine areas of erosion along the shoreline of Sand Pond. Based on the assessment 89% of the shoreline had no erosion and 11% had slight erosion (Figure 6). The erosion occurred where the fishing access areas were located around the lake. These areas should be monitored for future erosion.

SUMMARY OF WILDLIFE AND HABITAT

Visual wildlife observations were made on a monthly basis during water quality and plant sampling activities. A wide variety of animals were noted on and around Sand Pond in 2007 (Table 7), due to the good wildlife habitat. The habitat consisted mainly of prairie and forest. It is very important the natural areas around the lake be maintained to provide the appropriate habitat for wildlife species in the future.

Fish stocking has been occurring for the past 17 years in Sand Pond, with Rainbow Trout and Channel Catfish being stocked yearly. The Rainbow Trout were managed as a "put and take" fishery with catchable size fish (10 – 11 inches) stocked in the spring and the fall. The Channel Catfish were managed for "put, grow, and take". In 2007, approximately 5000 fingerling Largemouth Bass were also stocked. The sport fish regulations for Sand Pond include two pole and line fishing only, daily bag limit of six Channel Catfish, a 15 inch minimum size limit and daily bag limit of one Largemouth Bass, and Rainbow Trout season is closed in the spring and fall to allow the stocked fish to get acclimated.

The IDNR did a fishery assessment in 2007 with a total of 100 fish collected representing 10 species. The most abundant species was Bluegill (36%) followed by Largemouth Bass (20%), Black Crappie (15%), and Channel Catfish (11%). This was a slight change from the previous assessment done in 1997 when a total of 146 fish collected among 11 species. Black Crappie was the most abundant (27%) followed by Largemouth Bass (21%) and Yellow Perch (19%). Other species collected during the surveys were Pumpkinseed, Hybrid Sunfish, Green Sunfish, White Crappie, Northern Pike, Common Carp, Golden Shiner, White Sucker, and Central Mudminnow.

Figure 6. Shoreline erosion on Sand Pond, 2007.

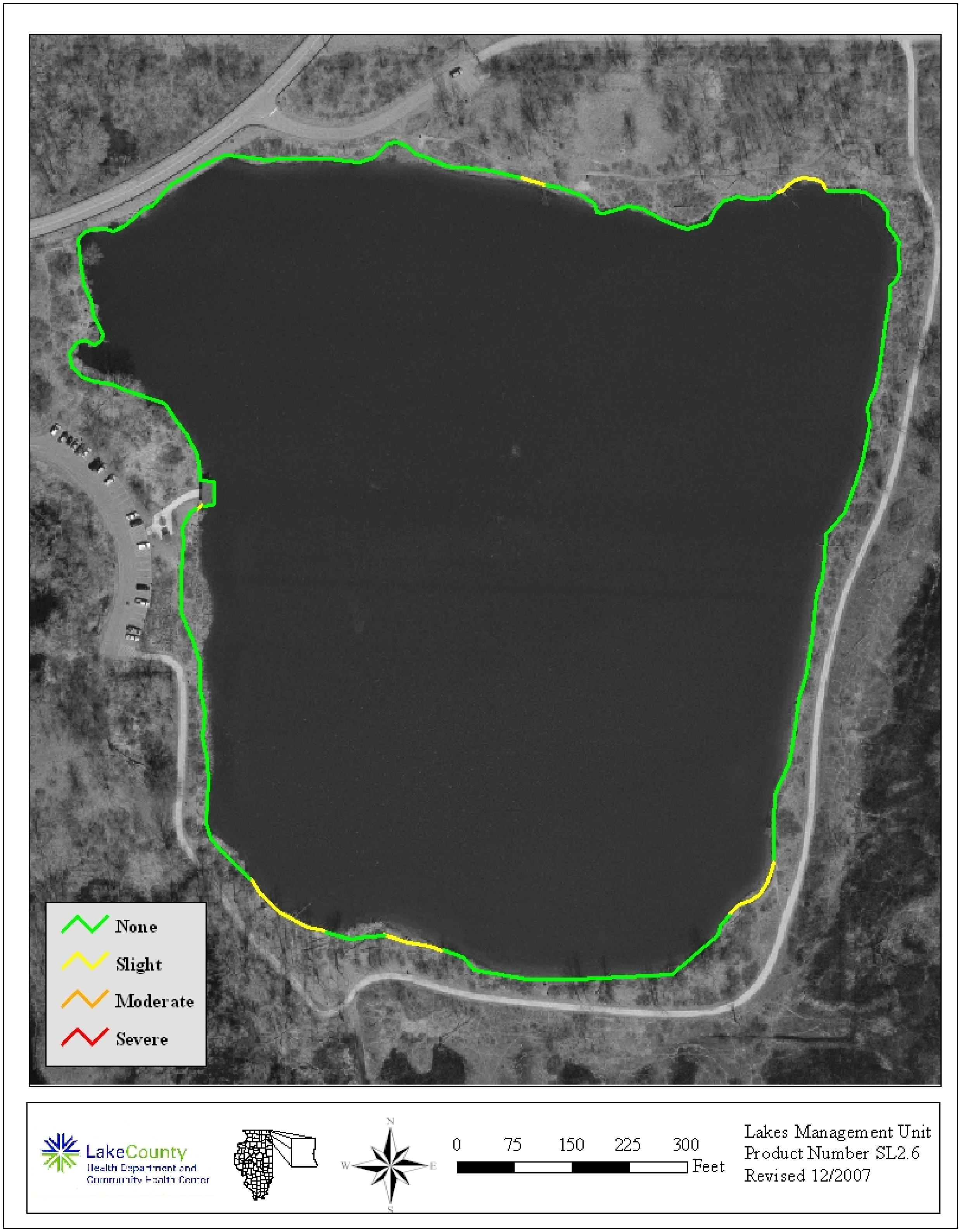


Table 7. Wildlife species observed on and around Sand Pond, May – September 2007.

Birds	
Canada Goose	*Branta canadensis*
American Robin	*Turdus migratorius*
Red-winged Blackbird	*Agelaius phoeniceus*
Northern Cardinal	*Cardinalis cardinalis*
Mammals	
White-tailed Deer	*Odocoileus virginianus*
Amphibians	
American Toad	*Bufo americanus*
Bull Frog	*Rana catesbeiana*
Fish	
Common Carp	*Cyprinus carpio*

LAKE MANAGEMENT RECOMMENDATIONS

The water quality parameters of Sand Pond were below the averages of other lakes the LMU monitored lakes in the county. The land surrounding Sand Pond is owned and managed by the IDNR, is undeveloped, and is a good refuge for many wildlife species. To improve the quality of Sand Pond, the LMU has the following recommendations.

- **Creating a Bathymetric Map**

  A bathymetric (depth contour) map is an essential tool in effective lake management since it provides information on the morphometric features such as depth, surface area, volume, etc. Sand Pond does have an old bathymetric map, but an updated map with volumetric calculations is recommended. Maps can be created by the LMU (Appendix D1).

- **Reduce Conductivity and Chloride Concentrations**

  The average conductivity reading for Sand Pond has increased by 37% since 2000. Although the chloride concentration was below the county median, it was still high enough to potentially have an impact on aquatic life. The use of road salts for winter road management is a major contributor to chloride concentrations and conductivity. Proper application procedures and alternative methods can be used to keep these concentrations under control (Appendix D2).

- **Participate in the Volunteer Lake Monitoring Program (VLMP)**

  To track future water quality trends, it is recommended the lake become enrolled in the Volunteer Lake Monitoring Program (VMLP), which trains a volunteer to measure the Secchi disk readings on a bimonthly basis from April to October (Appendix D3). In addition to the VMLP, a staff gauge should be installed to monitor the lake level each month.

- **Aquatic Plant Management**

  A key to a healthy lake is a well-balanced aquatic plant population. Aquatic plants compete with algae for nutrients and stabilize bottom substrate, which in turn improves water clarity. Putting together a good aquatic plant management plan should not be rushed. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. Follow up is critical for an aquatic plant management plan to achieve long-term success. A good aquatic plant management plan considers both the short and long-term needs of the lake (Appendix D4). EWM, an exotic species, was found in Sand Pond during the 2007 sampling season. The aquatic plant management plan should include control of EWM.

- **Low dissolved oxygen concentrations**

  Anoxic conditions (<1 mg/L) existed only in June at the bottom. Sand Pond has an aerator which was not working properly during 2007. It was suspected the diffusers were clogged since there was minimal water movement around the diffusers. Based on the DO concentrations found in 2000 and 2007 by the LMU, the aeration system in Sand Pond may not be necessary. The goal of the aerator should be re-evaluated and if the aerator is in operation in 2008, maintenance on the equipment is strongly recommended (Appendix D5).

- **<u>Grant program opportunities</u>**

  There are opportunities to receive grants to help accomplish some of the management recommendations listed above (Appendix F).

APPENDIX A. METHODS FOR FIELD DATA COLLECTION AND LABORATORY ANALYSES

Water Sampling and Laboratory Analyses

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

Plant Sampling

In order to randomly sample each lake, mapping software (ArcMap 9.1) overlaid a grid pattern onto a 2006 aerial photo of Lake County and placed points 60 or 30 meters apart, depending on lake size. Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At designated sampling sites, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, plant coverage was assessed for overall abundance. Then plants were individually identified and placed in categories based on coverage. Plants that were not found on the rake but were seen in the immediate vicinity of the boat at the time of sampling were also recorded. Plants difficult to identify in the field were placed in plastic bags and identified with plant keys after returning to the office. The depth of each sampling location was measured either by a hand-held depth meter, or by pushing the rake straight down and measuring the depth along the rope or rake handle. One-foot increments were marked along the rope and rake handle to aid in depth estimation.

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.

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

APPENDIX B. MULTI-PARAMETER DATA FOR SAND POND IN 2007.

Sand Pond 2007 Multiparameter data

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.76
5/15/2007		0.5	0.488	19.43	8.91	97.1	0.886	8.52	3527.0	Surface		
5/15/2007		1	1.014	19.45	8.95	97.6	0.886	8.55	3566.8	Surface	100%	
5/15/2007		2	1.968	19.44	8.93	97.4	0.887	8.59	947.2	0.298	27%	4.45
5/15/2007		3	2.961	19.41	8.93	97.3	0.887	8.60	591.6	1.291	17%	0.36
5/15/2007		4	3.993	19.40	8.93	97.3	0.886	8.61	405.2	2.323	11%	0.16
5/15/2007		5	5.057	19.39	8.91	97.0	0.886	8.61	201.5	3.387	6%	0.21
5/15/2007		6	5.993	19.23	8.77	95.2	0.886	8.59	161.9	4.323	5%	0.05
5/15/2007		7	6.893	16.00	8.79	89.3	0.890	8.46	126.2	5.223	4%	0.05
5/15/2007		8	8.027	15.59	7.71	77.7	0.890	8.32	109.2	6.357	3%	0.02

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.50
6/19/2007		0.5	0.504	25.55	5.56	68.1	0.756	8.61	3358.8	Surface		
6/19/2007		1	1.006	25.59	5.68	69.6	0.755	8.58	3425.3	Surface	100%	
6/19/2007		2	2.000	25.60	5.56	68.2	0.755	8.59	962.9	0.330	28%	3.85
6/19/2007		3	2.989	25.61	5.49	67.3	0.755	8.59	834.0	1.319	24%	0.11
6/19/2007		4	4.003	25.60	5.32	65.2	0.756	8.59	668.5	2.333	20%	0.09
6/19/2007		5	4.979	25.59	5.18	63.5	0.756	8.59	448.8	3.309	13%	0.12
6/19/2007		6	5.961	23.93	3.75	44.6	0.784	8.25	464.2	4.291	14%	-0.01
6/19/2007		7	7.075	21.40	2.57	29.2	0.828	7.95	278.1	5.405	8%	0.09
6/19/2007		8	7.990	20.16	2.39	26.5	0.850	7.84	221.6	6.320	6%	0.04
6/19/2007		9	9.003	19.04	1.71	18.5	0.869	7.70	147.2	7.333	4%	0.06
6/19/2007		10	10.022	18.82	0.40	4.4	0.866	7.59	51.7	8.352	2%	0.13

Date	Time	Text Depth	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter	% Light	Extinction

MMDDYY	HHMMSS	feet								feet	Transmission	Coefficient
											Average	0.63
7/17/2007		0.5	0.502	24.33	9.44	113.1	0.799	8.54	978.4	Surface		
7/17/2007		1	1.009	24.38	9.44	113.2	0.799	8.54	945.7	Surface	100%	
7/17/2007		2	2.018	24.38	9.43	113.0	0.799	8.54	265.7	0.348	97%	3.65
7/17/2007		3	3.012	24.38	9.41	112.8	0.799	8.54	184.2	1.342	27%	0.27
7/17/2007		4	4.036	24.37	9.35	112.1	0.799	8.53	145.0	2.366	19%	0.10
7/17/2007		5	5.004	24.36	9.01	107.9	0.789	8.51	81.8	3.334	15%	0.17
7/17/2007		6	6.080	24.29	7.71	92.2	0.803	8.39	44.5	4.410	8%	0.14
7/17/2007		7	7.007	23.94	4.62	55.0	0.810	8.15	36.2	5.337	5%	0.04
7/17/2007		8	8.006	23.73	3.33	39.4	0.814	8.01	33.5	6.336	4%	0.01

		Text	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light		
Date	Time	Depth	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	Meter	% Light	Extinction
MMDDYY	HHMMSS	feet								feet	Transmission	Coefficient
											Average	0.44
8/14/2007		0.5	0.491	26.35	9.14	113.6	0.781	9.00	2127.1	Surface		
8/14/2007		1	1.015	26.35	9.39	116.7	0.781	8.53	1776.6	Surface	100%	
8/14/2007		2	2.017	26.35	9.33	116.0	0.790	8.45	896.5	0.347	84%	1.97
8/14/2007		3	2.997	26.33	9.39	116.7	0.781	8.41	688.4	1.327	42%	0.20
8/14/2007		4	4.022	26.31	9.57	118.9	0.780	8.41	396.8	2.352	32%	0.23
8/14/2007		5	5.098	26.27	9.69	120.3	0.780	8.43	186.4	3.428	19%	0.22
8/14/2007		6	6.024	26.22	9.73	120.6	0.779	8.43	226.4	4.354	9%	-0.04
8/14/2007		7	7.058	26.12	9.63	119.2	0.779	8.43	160.6	5.388	11%	0.06

		Text	Dep25	Temp	DO	DO%	SpCond	pH	PAR	Depth of Light		
Date	Time	Depth	feet	øC	mg/l	Sat	mS/cm	Units	æE/s/mý	Meter	% Light	Extinction
MMDDYY	HHMMSS	feet								feet	Transmission	Coefficient
											Average	0.55
9/18/2007		0.5	0.569	18.80	15.79	169.8	0.565	8.79	3193.7	Surface		
9/18/2007		1	1.145	18.77	15.32	164.7	0.779	8.49	3073.8	Surface	100%	
9/18/2007		2	2.038	18.73	15.29	164.3	0.780	8.46	1214.6	0.368	96%	2.52
9/18/2007		3	3.075	18.68	15.25	163.8	0.779	8.43	115.3	1.405	38%	1.68
9/18/2007		4	3.975	18.62	15.13	162.2	0.779	8.41	552.5	2.305	4%	-0.68
9/18/2007		5	4.973	18.57	15.16	162.4	0.779	8.39	326.3	3.303	17%	0.16

9/18/2007	6	5.970	18.45	15.05	160.7	0.779	8.37	258.7	4.300	10%	0.05
9/18/2007	7	7.015	18.33	14.97	159.5	0.778	8.35	168.6	5.345	8%	0.08
9/18/2007	8	7.996	18.30	14.75	157.2	0.779	8.34	120.8	6.326	5%	0.05

APPENDIX C. INTERPRETING YOUR LAKE'S WATER QUALITY DATA.

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

The following pages will discuss the different water quality parameters measured by Lake County Health Department staff, how these parameters relate to each other, and why the measurement of each parameter is important. The median values (the middle number of the data set, where half of the numbers have greater values, and half have lesser values) of data collected from Lake County lakes from 2000-2005 will be used in the following discussion.

Temperature and Dissolved Oxygen:

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

Monthly temperature profiles were established on each lake by measuring water temperature every foot (lakes ≤ 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	≥40<50	>0.012 ≤ 0.024	≥6.56<13.12
Eutrophic	≥50<70	>0.024 ≤ 0.096	≥1.64<6.56
Hypereutrophic	≥70	>0.096	< 1.64

APPENDIX D. LAKE MANAGEMENT OPTIONS.

D1. 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.

D2. Options to Reduce Conductivity and Chloride Concentrations

Road salt (sodium chloride) is the most commonly used winter road de-icer. While recent advances in the technology of salt spreaders have increased the efficiency to allow more even distribution, the effect to the surrounding environment has come into question. Whether it is used on highways for public safety or on your sidewalk and driveway to ensure your own safety, the main reason for road salt's popularity is that it is a low cost option. However, it could end up costing you more in the long run from the damages that result from its application.

Excess salt can effect soil and in turn plant growth. This can lead to the die-off of beneficial native plant species that cannot tolerate high salt levels, and lead to the increase of non-native, and/or invasive species that can.

Road salts end up in waterways either directly or through groundwater percolation. The problem is that animals do not use chloride and therefore it builds up in a system. This can lead to decreases in dissolved oxygen, which can lead to a loss of biodiversity.

The Lakes Management Unit monitors the levels of salts in surface waters in the county by measuring conductivity and chloride concentrations (which are correlated to each other). There has been an overall increase in salt levels that has been occurring over the past couple of decades. These increases could have detrimental effects on plants, fish and animals living and using the water.

What can you do to help maintain or reduce chloride levels?

Option 1. Proper Use on Your Property

Ultimately, the less you use of any product, the better. Physically removing as much snow and ice as possible before applying a de-icing agent is the most important step. Adding more products before removing what has already melted can result in over application, meaning unnecessary chemicals ending up in run-off to near by streams and lakes.

Option 2. Examples of Alternatives

While alternatives may contain chloride, they tend to work faster at lower temperatures and therefore require less application to achieve the same result that common road salt would.

Calcium, Magnesium or Potassium Chloride

- Aided by the intense heat evolved during its dissolution, these are used as ice-melting compounds.

Calcium Magnesium Acetate (CMA)

- Mixture of dolomic lime and acetic acid; can also be made from cheese whey and may have even better ice penetration.
- Benefits: low corrosion rates, safe for concrete, low toxicity and biodegradable, stays on surfaces longer (fewer applications necessary).
- Multi-Purpose: use straight, mix with sodium chloride, sand or as a liquid
- Negatives: slow action at low temperatures, higher cost.

Agricultural Byproducts

- Usually mixed with calcium chloride to provide anti-corrosion properties.
- Lower the freezing point of the salt they are added to.
- as a pre-wetting (anti-ice) agent, it's like a Teflon treatment to which ice and snow will not stick.

Local hardware and home improvement stores should carry at least one salt alternative. Some names to look for: Zero Ice Melt Jug, Vaporizer, Ice Away, and many others. Check labels or ask a sales associate before you buy in order to ensure you are purchasing a salt alternative.

Option 3. Talk to Your Municipality About Using an Alternative

Many municipalities are testing or already using alternative products to keep the roads safe. Check with your municipality and encourage the use of these products.

D3. 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. Approximately 165 lakes (of 3,041 lakes in Illinois) are sampled annually by approximately 300 volunteers. The volunteers are lakeshore residents, lake owners/managers, members of environmental groups, public water supply personnel, and/or 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 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 zone of the lake. In this region of the lake there is enough light to allow plants to grow 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, 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:

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D4. Options for Aquatic Plant Management

Option 1: Aquatic Herbicides

Aquatic herbicides are the most common method to control nuisance vegetation/algae. When used properly, they can provide selective and reliable control. Products cannot be licensed for use in aquatic situations unless there is less than a 1 in 1,000,000 chance of any negative effects on human health, wildlife, and the environment. Prior to herbicide application, licensed applicators should evaluate the lake's vegetation and, along with the lake's management plan, choose the appropriate herbicide and treatment areas, and apply the herbicides during appropriate conditions (i.e., low wind speed, DO concentration, temperature).

When used properly, aquatic herbicides can be a powerful tool in management of excessive vegetation. Often, aquatic herbicide treatments can be more cost effective in the long run compared to other management techniques. The fisheries and waterfowl populations of the lake would benefit greatly due to an increase in quality habitat and food supply. Dense stands of plants would be thinned out and improve spawning habitat and food source availability for fish. By implementing a good management plan with aquatic herbicides, usage opportunities of the lake would increase.

The most obvious drawback of using aquatic herbicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error can make them unsafe and bring about undesired outcomes. If not properly used, aquatic herbicides can remove too much vegetation from the lake. Another problem associated with removing too much vegetation is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. After the initial removal, there is a possibility for regrowth of vegetation. Upon regrowth, weedy plants such as Eurasian Watermilfoil and Coontail quickly reestablish, form dense stands, and prevent the growth of desirable species. This causes a decrease in plant biodiversity. Over-removal, and possible regrowth of nuisance vegetation that may follow will drastically impair recreational use of the lake.

Option 2: Mechanical Harvesting

Mechanical harvesting involves the cutting and removal of nuisance aquatic vegetation by large specialized boats with underwater cutting bars. The total removal or over removal (neither of which should never be the plan of any management entity) of plants by mechanical harvesting should never be attempted. To avoid complete or over removal, the management entity should have a harvesting plan that determines where and how much vegetation is to be removed.

Mechanical harvesting can be a selective means to reduce stands of nuisance vegetation in a lake. Typically, plants cut low enough to restore recreational use and limit or prevent regrowth. This practice normally improves habitat for fish and other aquatic organisms.
High initial investment, extensive maintenance, and high operational costs have led to decreased use. Mechanical harvesters cannot be used in less than 2-4 feet of water (depending on draft of the harvester) and cannot maneuver well in tight places. The harvested plant material must be disposed of properly to a place that can accommodate large quantities of plants and prevent any from washing back into the lake. Fish, mussels, turtles and other aquatic organisms are commonly caught in the harvester and injured or even removed from the lake in the harvesting process. After the initial removal, there is a possibility for vegetation regrowth. If complete/over removal does occur several problems can result. One problem is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. Another problem with mechanical harvesting, even if properly done, is that it can be a nonselective process.

Option 3: Hand Removal

Hand removal of excessive aquatic vegetation is a commonly used management technique. Hand removal is normally used in small ponds/lakes and limited areas for selective vegetation removal. Areas surrounding piers and beaches are commonly targeted areas. Typically tools such as rakes and cutting bars are used to remove vegetation. Hand removal is a quick, inexpensive, and selective way to remove nuisance vegetation. There are few negative attributes to hand removal. One negative implication is labor. Depending on the extent of infestation, removal of a large amount of vegetation can be quite tiresome. Another drawback can be disposal. Finding a site for numerous residents to dispose of large quantities of harvested vegetation can sometimes be problematic.

Option 4: Water Milfoil Weevil

Euhrychiopsis lecontei (*E. lecontei*) is a biological control organism used to control Eurasian Watermilfoil (EWM). *E. lecontei* is a native weevil, which feeds exclusively on milfoil species. It is stocked as a biocontrol and is commonly referred to as the Eurasian Watermilfoil weevil.

Currently, the LCHD-Lakes Management Unit has documented weevils in 35 Lake County lakes. Many of these lakes have seen declines in EWM densities in recent years. Weevils are stocked in known quantities to achieve a density of 1-4 weevils per stem. As weevil populations expand, EWM populations may decline. After EWM declines, weevil populations decline and do not feed on any other aquatic plants. Currently only one company, EnviroScience Inc., has a stocking program (called the MiddFoil® process). The program includes evaluation of EWM densities, of current weevil populations (if any), stocking, monitoring, and restocking as needed.

If control with milfoil weevils were successful, the quality of the lake would be improved. Native plants could start to recolonize, and the fishery of the lake would improve due to more balanced predation and higher quality habitat. Waterfowl would benefit due to increased food sources and availability of prey. Use of milfoil weevils does have some drawbacks. Control using the weevil has been inconsistent in many cases. Also, milfoil control using weevils may not work well on plants in deep water. Furthermore, weevils do not work well in areas where plants are continuously disturbed by activities such as powerboats, swimming, harvesting or herbicide use. One of the most prohibitive aspects to weevil use is price. Typically weevils are stocked to achieve a density of 1-4 weevils per stem. This translates to 500-3000 weevils per acre.

Option 5: Reestablishing Native Aquatic Vegetation

Revegetation should only be done when existing nuisance vegetation, such as Eurasian Watermilfoil, are under control using one of the above management options. If the lake has poor clarity due to excessive algal growth or turbidity, these problems must be addressed before a revegetation plan is undertaken. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis.

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. There are few negative impacts to revegetating a lake. One possible drawback is the possibility of new vegetation expanding to nuisance levels and needing control. However, this is an unlikely outcome. Another drawback could be the high costs of extensive revegetation with imported plants.

D5. Options for Low Dissolved Oxygen Concentrations

Option 1: Aeration via Artificial Circulation

The principal effect of artificial circulation is to raise the DO content throughout the lake. This is accomplished by circulating the entire water column to the surface, where atmospheric oxygen can diffuse into surface waters. While the vertical movement of water is usually achieved by releasing compressed air at some depth, little oxygen increase is actually achieved through direct diffusion from bubbles (King, 1970; Smith et al. 1975).

These systems can improve DO concentrations in the water column to help prevent fish kills and increase habitat for aquatic life. Algal blooms may be controlled through aeration and internal loading of phosphorus can theoretically be decreased through increased circulation. Artificial circulation in winter can help alleviate low oxygen conditions when the systems are able to keep about 2-3% of the lake's surface free from snow and ice cover (Wirth, 1988).

Aeration systems should be started just after spring/fall turnover to avoid mixing anoxic water from the hypolimnion with surface waters that can cause DO concentrations in the entire water column to fall below the amount needed for fish survival. Internal phosphorus loading from the sediment may actually increase as temperature at the sediment-water interface is raised in the circulation process. If nutrient-rich waters are brought to the surface by the circulating water, algae and plant growth can become a greater nuisance. For shallow lakes where light is not a limiting factor, algae populations may not decrease. Depending on the size and type of the compressor(s), seasonal or annual electrical costs may run in the hundreds or thousands of dollars.

<u>Option 2. Reduce Lake Phosphorus Concentrations</u>

If a lake has an overabundance of plants and algae, severe oxygen losses can occur when they die and decompose. Reducing phosphorus concentrations can decrease algal populations and (possibly) plant populations. Phosphorus entering lakes from the watershed is more difficult to control. Watershed controls may not reduce phosphorus in the lake for years, and if the lake receives high concentrations of phosphorus from the watershed, treatments could be short-lived.

<u>Option 3. Snow Removal from Ice-Covered Lakes</u>

Although aquatic plants do die back in the fall, a lake's primary source of oxygen in the winter is from submersed aquatic plants and algae as they photosynthesize. A layer of snow over ice prevents sunlight from penetrating through the ice and reaching the plants, slowing or even stopping this process. Snow five or more inches deep will block virtually all light from passing through. If the photosynthetic process is halted for too long, the demand for oxygen may deplete the supply. To help increase the oxygen supply, snow should be removed from the ice. This seems to work better in lakes dominated by plants rather than algal blooms in the summer, as plant dominated lakes seem to have more oxygen than lakes dominated by algae. In cases where snow removal helped, about 30% or more of the lake's surface area was cleared. Plowing was done in alternating strips rather than clearing large areas, which cut down on the need to stockpile the snow.

Snowplowing with a vehicle can clear 30% of the surface area of the lake in less than a day. Villages, Park Districts and Association’s may already own the equipment and thus, the staff hourly rate costs could be minimal. In situations where no other oxygen sources will be made available for a prolonged period of time (such as weeks of heavy snow cover and continued cold weather), snow removal can be a quick and an effective option. Although snow removal has helped in cases where 30% or more of the surface area was cleared, it is difficult to be sure how much snow removal would be necessary. Safety issues and subsequent liability are of primary concern. The ice would need to be able to support someone with a snow blower (for small areas) or a truck with a snowplow. Also, piling snow on the ice can cause unstable ice conditions due to variations in weight distribution. If snowplowing companies were hired, the cost would increase dramatically.

Option 4. Increasing Lake Depth

As a general rule of thumb, at least 25% of the lake or pond should be 10 feet deep or deeper to minimize winter fish kills in the Lake County region. However, if the watershed delivers more than an eighth of an inch of sediment per year to the lake, this may not be a practical option. This option will not guarantee the prevention of winter fish kills as many factors control oxygen consumption. Prices are normally based on cubic yards of sediment removed, and can vary widely.

Option 5. Aquatic Plant Management

Plants use dissolved oxygen at night during respiration, a process necessary to produce food for plant growth. A lake with nuisance plant populations could suffer dissolved oxygen losses at night as the plants respire. Reducing the plant coverage to 30% - 40% of the lake's surface area may help this situation.

Option 6. Reduce Organic Matter

Decomposition of organic matter by bacteria can consume large quantities of oxygen. The addition of bacteria products and enzymes may reduce the amount of organic matter in the sediment, which could lessen the oxygen demand.

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

2000 - 2007 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2007	
Average	**167.3**	
Median	**162.0**	
Minimum	**64.9**	**IMC**
Maximum	**330.0**	**Flint Lake**
STD	**42.0**	
n =	**803**	

	ALKanoxic 2000-2007	
Average	**200**	
Median	**193**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**48**	
n =	**253**	

	Condoxic <=3ft00-2007	
Average	**0.8856**	
Median	**0.8038**	
Minimum	**0.2542**	**Broberg Marsh**
Maximum	**6.8920**	**IMC**
STD	**0.5243**	
n =	**802**	

	Condanoxic 2000-2007	
Average	**1.0035**	
Median	**0.8340**	
Minimum	**0.3210**	**Lake Kathyrn**
Maximum	**7.4080**	**IMC**
STD	**0.7787**	
n =	**252**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2007	
Average	**0.515**	
Median	**0.150**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.082**	
n =	**808**	

*ND = Many lakes had non-detects (74.5%)
Only compare lakes with detectable
concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	NH3-Nanoxic 2000-2007	
Average	**2.070**	
Median	**1.340**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.296**	
n =	**252**	

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

	pHoxic <=3ft00-2007	
Average	**8.31**	
Median	**8.31**	
Minimum	**7.07**	**Bittersweet #13**
Maximum	**10.28**	**Round Lake Marsh North**
STD	**0.44**	
n =	**797**	

	pHanoxic 2000-2007	
Average	**7.22**	
Median	**7.21**	
Minimum	**6.24**	**Banana Pond**
Maximum	**8.48**	**Heron Pond**
STD	**0.41**	
n =	**252**	

	All Secchi 2000-2007	
Average	**4.57**	
Median	**3.28**	
Minimum	**0.33**	**Fairfield Marsh, Patski Pond**
Maximum	**21.33**	**Bangs Lake**
STD	**3.81**	
n =	**750**	

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2000 - 2007 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2007	
Average	**1.457**	
Median	**1.220**	
Minimum	**<0.1**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.830**	
n =	**808**	

*ND = 4.5% Non-detects from 16 different lakes

	TKNanoxic 2000-2007	
Average	**2.910**	
Median	**2.320**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.272**	
n =	**252**	

*ND = 2.8% Non-detects from 4 different lakes

	TPoxic <=3ft00-2007	
Average	**0.100**	
Median	**0.063**	
Minimum	**<0.01**	***ND**
Maximum	**3.880**	**Albert Lake**
STD	**0.171**	
n =	**808**	

*ND = 2.4% Non-detects from 7 different lakes (Carina, Minear,& Stone Quarry)

	TPanoxic 2000-2007	
Average	**0.294**	
Median	**0.177**	
Minimum	**0.012**	**Indep. Grove and W. Loon Lake**
Maximum	**3.800**	**Taylor Lake**
STD	**0.380**	
n =	**252**	

	TSSall <=3ft00-2007	
Average	**15.5**	
Median	**8.0**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**814**	

*ND = 1.8% Non-detects from 11 different lakes

	TVSoxic <=3ft00-2007	
Average	**135.3**	
Median	**132.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**39.9**	
n =	**758**	

No 2002 IEPA Chain Lakes

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

No 2002 IEPA Chain Lakes.

	CLanoxic <=3ft00-2007	
Average	**232**	
Median	**119**	
Minimum	**41**	**Timber Lake (N)**
Maximum	**2390**	**IMC**
STD	**400**	
n =	**102**	

	CLoxic <=3ft00-2007	
Average	**211**	
Median	**158**	
Minimum	**30**	**White Lake**
Maximum	**2760**	**IMC**
STD	**247**	
n =	**411**	

77 of 163 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

Minimums and maximums are based on data from all lakes from 2000-2007 (n=1363).

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

LCHD Lakes Management Unit ~ 12/17/2007

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APPENDIX F. GRANT PROGRAM OPPORTUNITES

Table F1. Potential Grant Opportunities

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

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

Table F1. Continued

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

CW = Chicago Wilderness
ICECF = Illinois Clean Energy Community Foundation
IEMA = Illinois Emergency Management Agency
IEPA = Illinois Environmental Protection Agency
IDNR = Illinois Department of Natural Resources
IDOA = Illinois Department of Agriculture
LCSMC = Lake County Stormwater Management Commission
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