2007 SUMMARY REPORT
of
Lake Barrington

Lake County, Illinois

Prepared by the

LAKE COUNTY HEALTH DEPARTMENT
ENVIRONMENTAL HEALTH SERVICES
LAKES MANAGEMENT UNIT

3010 Grand Avenue
Waukegan, Illinois 60085

Adrienne Orr
Michael Adam
Leonard Dane
Shaina Keseley

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Lake Barrington was created in 1925. In 1973, development of the Lake Barrington Shores condominiums began and continued for 17 years. The lake has a surface area of approximately 91.1 acres, a maximum depth of 13.0 feet with an average depth of 7.8 feet. Currently, the lake is owned and managed by the Lake Barrington Shores Homeowners Association. It is available to subdivision residents for aesthetics, boating (no gas motors), golf course irrigation, and fishing.

Overall, Lake Barrington had poor water quality. Water levels in Lake Barrington (taken from a pier at the marina) decreased approximately 1.75 inches throughout the season. Lake Barrington stratified slightly in August but was mixed for the rest of the season. DO concentrations in the epilimnion in May, June, and July were greater than 5.0 mg/L. In August DO concentrations dropped below 5 mg/L at 2 feet and in September the entire lake had DO concentrations below 5 mg/L. Anoxic conditions (<1 mg/L) occurred in August below 4 feet.

Phosphorus and nitrogen are two nutrients important for algal growth. The average total phosphorus for Lake Barrington was well above the county median (0.063 mg/L) at 0.105 mg/L. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average TKN for Lake Barrington was 1.42 mg/L, which was higher than the county median (1.22 mg/L), but a decrease from 2001 (1.82 mg/L).

Total suspended solid concentrations (TSS) fluctuated throughout the season with a maximum concentration of 13.0 mg/L in August due to the large amounts of rainfall. The average TSS concentration for the season was 6.7 mg/L, which was well below the county median of 8.0 mg/L. High TSS values are typically correlated with poor water clarity and can be detrimental to many aspects of the lake ecosystem, including the plant and fish communities. Water clarity was measured by Secchi disk depth with the lowest reading in August (1.64 feet) corresponding to the high TSS value. The average Secchi depth for the season was 6.00 feet, which was deeper than the county median (3.28 feet). The average conductivity reading for Lake Barrington was 0.7518 mS/cm, which was also below the county median (0.8038 mS/cm), but an increase of 25% since 2001 (0.5996 mS/cm). This is mostly likely due to the large amount of single family homes and roadways (high amount of impervious surfaces) within the small watershed.

Aquatic plants existed at 56 of the 98 sites sampled with ten species found. *Chara* spp., a macro-algae, was the most abundant species found in 2007 at 32% of the sites. Curlyleaf Pondweed was the second most abundant at 27% of the sites followed by White Water Lily at 15% of sites and Small Pondweed at 8% of sites.

In 2007 shoreline erosion was reassessed from the initial 2001 study. Seventy-seven percent of the shoreline was exhibiting no erosion due to the large amount of rip-rap present. Fourteen percent had slight erosion, 7% exhibited moderate erosion, and there was a small area with severe erosion near the beach. Areas with moderate to severe erosion should be addressed before they get worse and more costly to repair.

LAKE FACTS

Lake Name:	Lake Barrington
Historical Name:	Indian Lake
Nearest Municipality:	Barrington
Location:	T43N, R9E, Section 11
Elevation:	780.0 feet
Major Tributaries:	None
Watershed:	Fox River
Sub-watershed:	Tower Lake Drain
Receiving Water body:	Tower Lake Drain
Surface Area:	91.1 acres
Shoreline Length:	3.2 miles
Maximum Depth:	13.0 feet
Average Depth:	7.8 feet
Lake Volume:	701.4 acre-feet
Lake Type:	Impoundment
Watershed Area:	282.4 acres
Major Watershed Land uses:	Single Family and Public and Private Open Space
Bottom Ownership:	Private
Management Entities:	Private
Current and Historical uses:	Boating (no gas motors), fishing, aesthetics, and irrigation of the golf course.
Description of Access:	No public access, Association members only

SUMMARY OF WATER QUALITY

Water samples were collected from May to September in Lake Barrington at the deepest point near the center of the lake (Figure 1). Samples were taken at three feet below the surface and approximately three feet above the lake bottom (Appendix A). Water levels in Lake Barrington (taken from a pier at the marina) decreased approximately 1.75 inches throughout the season. Initially, the water level went down 8 inches from May to July and then increased again in August due to heavy rain events. Overall, Lake Barrington had poor water quality with results from 2007 similar to 2001.

The Lake Barrington watershed (Figure 2) is approximately 282.4 acres. The lake is surrounded by single family homes (38%) and public and private open space (25%; Figure 3). Due to the small watershed and the somewhat large portion of public and private open space, the retention time of the lake 6.2 years.

Lake Barrington stratified slightly in August but was mixed for the rest of the season as a result of its shallow morphometry and the effects of wind and wave action across the lake. Stratification occurs when the lake divides into an upper, warm water layer (epilimnion) and a lower, cold-water layer (hypolimnion). The layer between the epilimnion and hypolimnion, where the temperature changes quickly is the thermocline. A slight thermocline formed around 8 feet in August. The lake exhibits polymictic tendencies, meaning stratification and turnover occur repeatedly over the year. This may be the result of climatic factors (i.e., wind and wave action, temperature) and the shallow nature of the lake. Lakes that do not stratify or stratify only weakly may have fewer problems with low dissolved oxygen (DO) problems or the build up and release of excessive nutrients. This type of weak stratification followed by complete mixing is normal for a shallow lake like Lake Barrington.

A dissolved oxygen (DO) concentration >5.0 mg/L is considered adequate to support a sunfish/bass fishery, since many fish suffer from oxygen stress below this amount. DO concentrations in May, June, and July were greater than 5.0 mg/L. In August DO concentrations dropped below 5 mg/L at 2 feet and in September the entire lake had DO concentrations below 5 mg/L. Anoxic conditions (<1 mg/L) occurred in August (Appendix B) below 4 feet. Based on the bathymetric map made in 1989, in August 75% of the lake had oxygen levels below 5.0 mg/L and 50% was anoxic. In 2001 approximately 31% (below 7-8 feet) of the lake volume became anoxic during July and August. This pattern of decreased oxygen content as the summer progresses is normal, because as water heats up, it is able to hold less oxygen. Also, as organisms and plants start to die and fall to the bottom to decay, more oxygen is used to breakdown the dead material. Although a bathymetric map does exist for Lake Barrington, it is greater than 10 years old and the volume of water affected by these low DO conditions may not be correct. It is recommended that a new bathymetric map made for Lake Barrington (Appendix D).

Oxygen also is needed by virtually all algae and all aquatic plants, and for many chemical reactions that are important to lake functioning. Lake DO concentrations naturally vary and are controlled by several biological, chemical and physical processes. DO concentrations in a lake can vary greatly depending on the time of day. This is mainly due to oxygen being produced during photosynthesis and consumed during respiration and decomposition. Because it requires

Figure 1. Water quality sampling site on Lake Barrington, 2007.

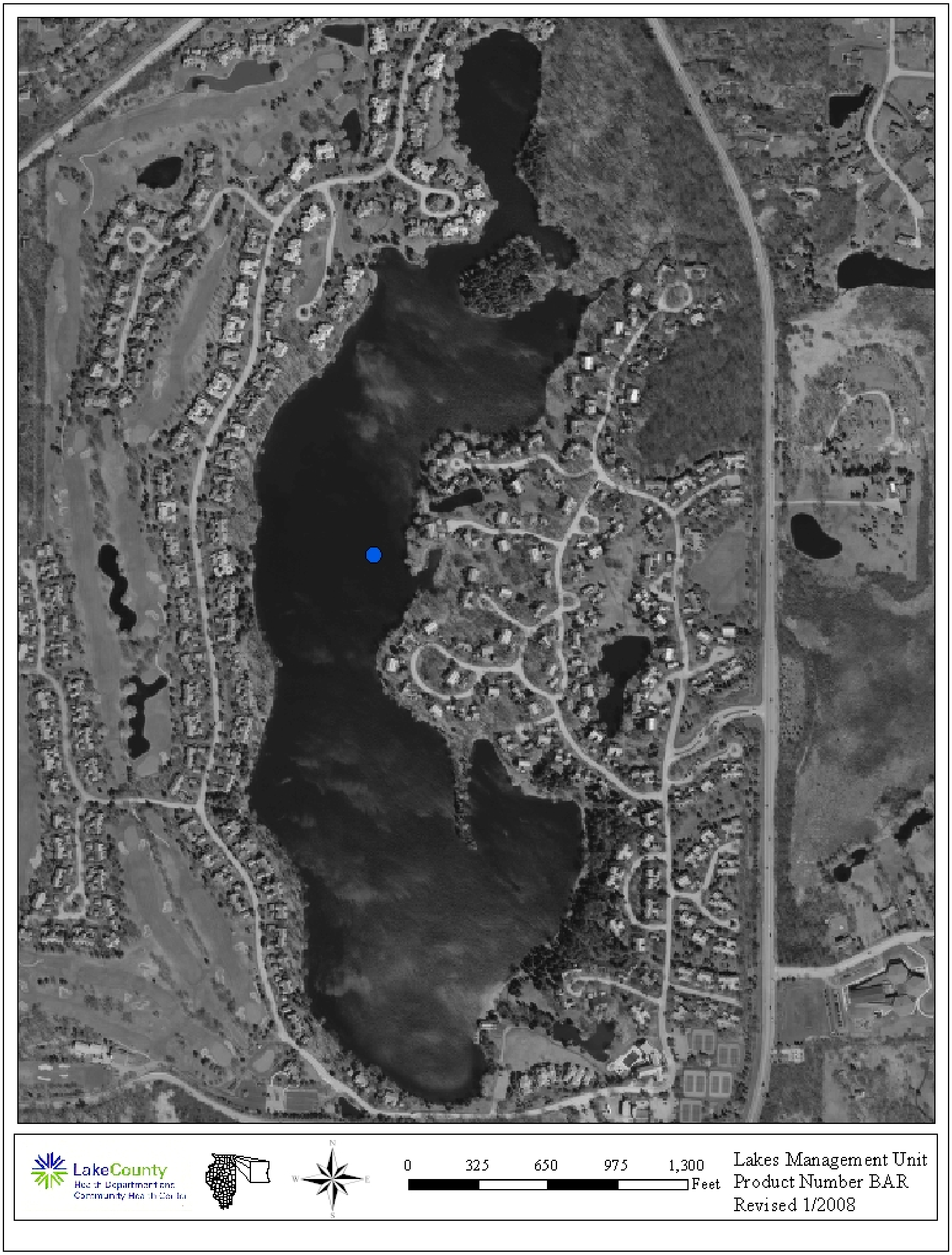
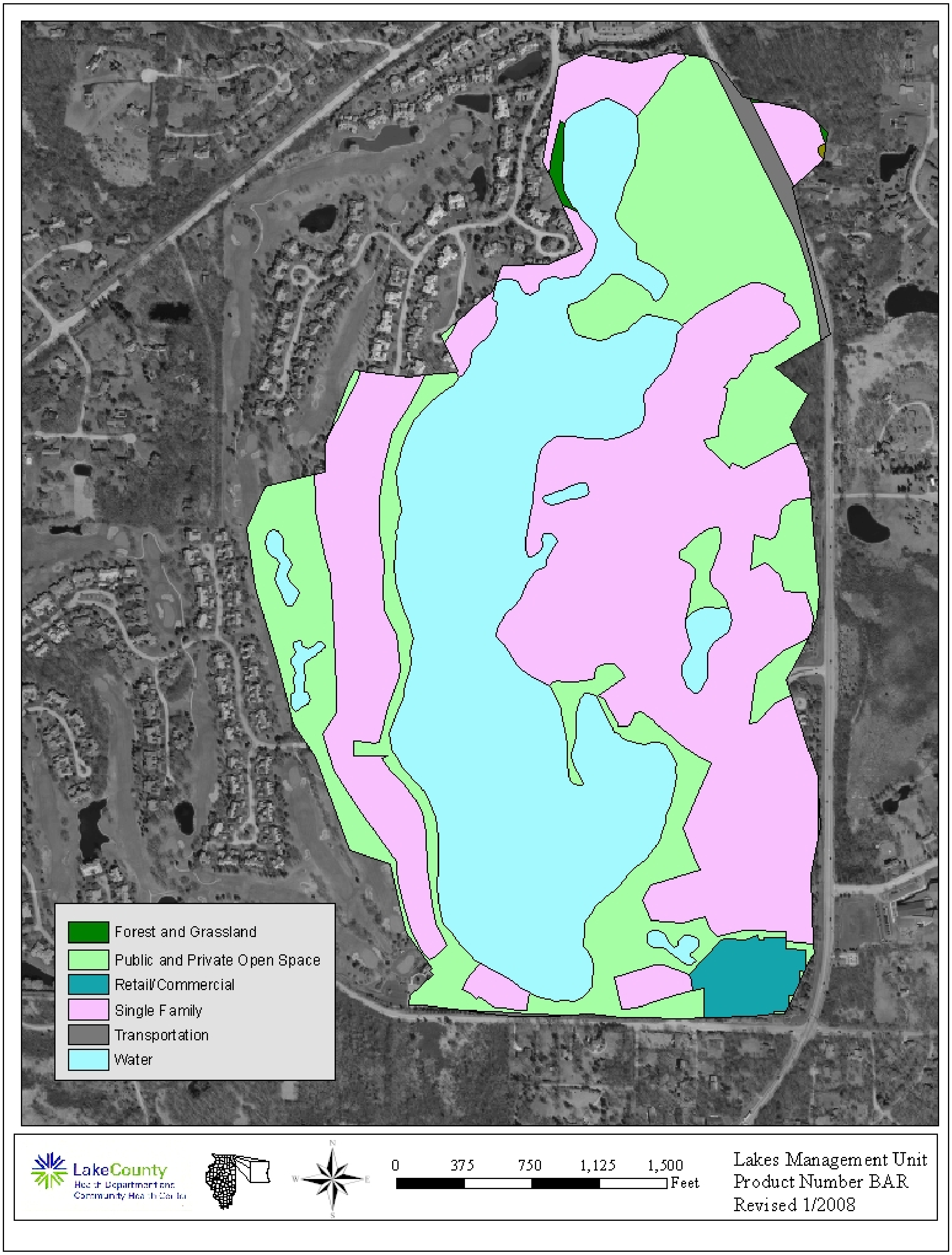


Figure 2. Approximate watershed delineation of Lake Barrington, 2007.

Figure 3. Approximate land use within the Lake Barrington watershed, 2007.



light, photosynthesis occurs only during the daylight hours. Respiration and decomposition, on the other hand, occurs 24 hours a day. This difference alone can account for large daily variations in DO concentrations. During the night, when photosynthesis cannot counter balance the loss of oxygen through respiration and decomposition, DO concentrations may steadily decline. DO concentrations are generally lowest just before dawn, when photosynthesis resumes.

Temperature effects can also cause reduced DO in deeper lakes (usually greater than 10 feet deep) as thermal stratification may cut-off all oxygen sources from reaching the lower depths. DO concentrations drop as organisms continue to respire and consume oxygen. The bottom layer of the lake may eventually become anoxic, that is, totally devoid of oxygen. Oxygen losses can also occur in summer if large amounts of plants or algae quickly die naturally, or as a result of an application of fast acting aquatic herbicides or algicides. Decomposition is more rapid in the summer due to warmer water temperature, which uses a large amount of DO very quickly, causing a DO crash. The anoxia causes chemical reactions which result in the release of phosphorus in this bottom layer. If the phosphorus is then distributed to the surface layer through frequent mixing of the water column, algae blooms could result. This appears to be occurring in Lake Barrington each summer. If the entire water column remained oxygenated throughout the summer, internal phosphorus release should decrease or be eliminated and should result in a decrease of planktonic (and possibly filamentous) algae.

In order to alleviate the low DO problems in the lake, Lake Barrington should consider artificial circulation to raise the DO content throughout the lake. The aerator would placed at the deep hole to prevent thermal stratification. This lack of stratification allows water undersaturated with oxygen to come in contact with the air at the surface permitting oxygen diffusion to occur. While the vertical movement of water is usually achieved by entraining water through releasing compressed air at some depth, little oxygen increase is achieved through direct diffusion from bubbles (King, 1970; Smith et al. 1975). In order to vertically move the entire water volume, the system must be sized properly.

Two nutrients important for plant and algal growth are nitrogen and phosphorus (Appendix E). Phosphorus is a nutrient that limits plant and algal growth, therefore any addition of phosphorus to the lake could produce algal blooms (Appendix C). The average total phosphorus (TP) for Lake Barrington was well above the county median (0.063 mg/L) at 0.105 mg/L (Table 1). This was a slight increase from the 2001 average of 0.096 mg/L. Similar to 2001, the TP levels in May and June of 2007 were non-detect and then jumped to 0.08 in July. This was followed by a very dense lake-wide algal bloom and a large drop in Secchi depth that persisted through September. Based on historical data, this sequence of events occurs every summer, resulting in dense algal blooms and low water clarity. The source of this pulse of phosphorus into the water column appears to be internal. Although sampling was not frequent enough to prove it, the data supports the idea that the polymictic nature of Lake Barrington lead to a large release of phosphorus from the sediment during the summer. As mentioned above, a polymictic lake will stratify and de-stratify several times during the summer. During calm, hot periods, the lake will become weakly stratified and bottom waters will lose oxygen very quickly. As a result, phosphorus is released from the sediment and builds up in the hypolimnion. Stratification is then

Table 1. Summary of water quality data for Lake Barrington, 2007.

2007	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
09-May	3	161	0.69	<0.1	<0.05	<0.01	<0.005	NA	127	2.4	442	93	9.48	0.7910	8.52	10.90
13-Jun	3	159	0.71	<0.1	<0.05	<0.01	<0.005	NA	131	1.2	467	121	11.81	0.7870	8.39	9.10
11-Jul	3	163	1.15	<0.1	<0.05	0.088	0.012	NA	133	7.8	494	148	4.43	0.8230	8.59	7.07
08-Aug	3	112	2.63	0.257	<0.05	0.114	<0.005	NA	124	13.0	417	134	1.64	0.6830	8.36	2.03
12-Sep	3	138	1.92	0.287	<0.05	0.114	0.009	NA	113	9.2	401	103	2.62	0.6750	8.29	4.02
	Average	147	1.42	0.272[k]	<0.05	0.105[k]	0.011[k]	NA	126	6.7	444	120	6.00	0.7518	8.43	6.62

2001	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
23-May	3	174	<0.5	<0.1	<0.05	0.027	<0.005	384	NA	2.0	384	104	12.00[a]	0.6345	8.05	7.36
27-Jun	3	164	0.73	<0.1	<0.05	0.023	<0.005	370	NA	0.2	382	112	12.67	0.6272	8.25	8.65
1-Aug	3	142	2.31	<0.1	<0.05	0.117	<0.005	344	NA	18.0	369	123	1.72	0.5791	8.63	12.94
29-Aug	3	154	2.16	<0.1	<0.05	0.154	<0.005	306	NA	12.0	354	109	1.74	0.5821	8.49	8.41
25-Sep	3	151	2.07	<0.1	<0.05	0.157	<0.005	346	NA	15.8	352	103	1.51	0.5749	8.04	6.75
	Average	157	1.82[k]	<0.1	<0.05	0.096	<0.005	350	NA	9.6	368	110	5.93[b]	0.5996	8.29	8.82

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	**Hypoliminion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
09-May	10	165	0.71	<0.1	<0.05	0.023	<0.005	NA	128	2.4	447	103	NA	0.7990	8.19	8.46
13-Jun	10	160	0.81	<0.1	<0.05	0.015	<0.005	NA	131	2.2	489	141	NA	0.7910	8.21	7.20
11-Jul	10	163	1.17	<0.1	<0.05	0.070	0.010	NA	133	6.6	472	127	NA	0.8210	8.60	6.73
08-Aug	11	141	2.12	0.920	<0.05	0.264	0.179	NA	132	7.2	439	144	NA	0.7840	7.55	0.22
12-Sep	9	138	1.89	0.295	<0.05	0.121	0.006	NA	114	8.6	403	99	NA	0.6740	8.18	3.66
	Average	153	1.34	0.608^k	<0.05	0.099	0.065^k	NA	128	5.4	450	123	NA	0.7738	8.15	5.25

2001	**Hypoliminion**															
DATE	DEPTH	ALK	TKN	NH3	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
23-May	11	175	<0.5	<0.1	<0.05	0.015	<0.005	372	NA	1.6	379	118	NA	0.6351	8.06	7.45
27-Jun	10	169	0.77	<0.1	<0.05	0.032	<0.005	358	NA	1.5	381	97	NA	0.6349	7.71	4.68
1-Aug	9	167	1.62	0.393	<0.05	0.152	0.079	352	NA	8.4	383	129	NA	0.6370	7.51	0.05
29-Aug	9	156	2.10	0.382	<0.05	0.163	0.009	308	NA	9.4	353	103	NA	0.6068	7.29	0.07
25-Sep	8	152	2.04	<0.1	<0.05	0.142	<0.005	349	NA	16.4	356	110	NA	0.5749	8.04	6.62
	Average	164	1.63^k	0.388^k	<0.05	0.101	0.044^k	348	NA	7.5	370	111	NA	0.6177	7.72	3.77

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

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

broken by air temperature changes or a wind or storm event and the phosphorus is distributed throughout the water column, often producing algal blooms. A secondary mechanism of phosphorus release in Lake Barrington may be occurring through the death and decomposition of curly leaf pondweed in late June and early July. Rooted aquatic plants take most of their nutrients up from the sediment and store these nutrients in plant tissue. When these plants are chemically treated in late spring each year, they begin to decompose as water temperatures increase, and the stored nutrients are released into the water column. This internal recycling of phosphorus from the sediment to the water column provides a readily available source of phosphorus for algae and may contribute to planktonic algae blooms each summer.

Nitrogen is the other nutrient critical for plant and algal growth. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The average TKN for Lake Barrington was 1.42 mg/L, which was higher than the county median (1.22 mg/L) but a decrease from 2001 (1.82 mg/L). The TN:TP (total nitrogen to total phosphorus) ratio looks at which nutrient is limiting plant and algal growth in a lake. Ratios < 10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate there is enough of both nutrients for excessive algal growth. Lake Barrington had a TN:TP ratio of 14:1 which indicated phosphorus was limiting. In 2001 the lake was also phosphorus limited with a slightly higher ration of 19:1.

Another way to look at phosphorus levels and how they affect productivity of the lake is to use a Trophic State Index (TSI) based on phosphorus (TSIp). TSIp values are commonly used to classify and compare lake productivity levels (trophic state). The TSIp index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich, productive). In 2007, Lake Barrington was hypereutrophic with a TSIp value of 71.3, placing it 115th out of 163 lakes in the county (Table 2).

The Illinois EPA has a use index for assessing lakes for aquatic life and recreational use impairment. TSI values along with other water quality parameters were used to make the analyses. According to this index, Lake Barrington provided *Full* support of aquatic life and *Partial* support of recreational activities. The overall support was *Partial*. The index was the same in 2001.

Total suspended solid (TSS) concentrations are composed of nonvolatile suspended solids such as non-organic clay or sediment materials, and volatile suspended solids such as algae and other organic matter. The average TSS concentration in Lake Barrington was 6.7 mg/L, which was below the county median of 8.0 mg/L. TSS concentrations fluctuated throughout the season with a maximum concentration of 13.0 mg/L in August due to the large amounts of rainfall. It has improved since 2001 when the average was 9.6 mg/L. Water clarity is a direct result of the amount of TSS in the water column, and is usually the first thing people notice about a lake, as it typifies the overall lake quality. High TSS concentrations are typically correlated with poor water clarity and can be detrimental to many aspects of the lake ecosystem, including the plant and fish communities. Water clarity was measured by Secchi disk depth, with the lowest reading in August (1.64 feet) corresponding to the high TSS value (Figure 4). The average Secchi depth

Table 2. 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)	0.0132	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 2. 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

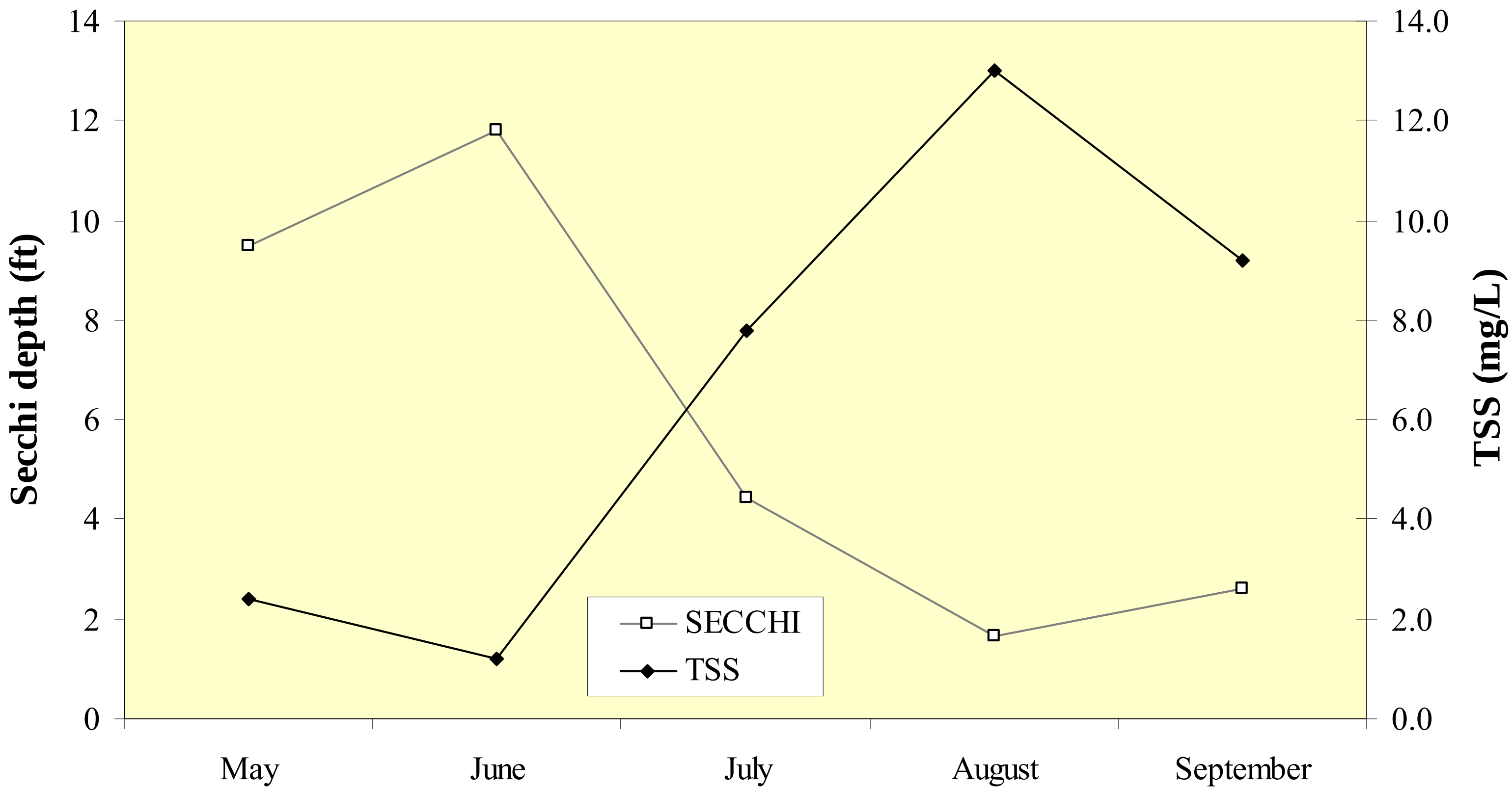
Table 2. Continued.

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 2. 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. Secchi depth vs. total suspended solid (TSS) concentrations in Lake Barrington, 2007.



for the season was 6.00 feet, which was deeper than the county median (3.28 feet). This was an increase from the 2001 average of 4.41 feet. From June to July the Secchi depth took a dramatic drop from 11.81 feet to 4.43 feet. This is likely due to the large amount of rain fall received, as well as the algal bloom present in July. This algal bloom persisted for the rest of the sampling season. Lake Barrington has been participating in the Volunteer Lakes Management Program (VLMP) since 1986, providing valuable information throughout those years and helping to fill in gaps when the LMU was not sampling (Figure 5). The VLMP data had similar Secchi depths in the same years the LMU sampled. The average depth since 1986 was 4.86 feet. Differences between VLMP and LCHD data can be attributed to discrepancies between samplers, as well as date and time samples were taken.

Conductivity readings, which are correlated with chloride concentrations, have been increasing throughout the past few years in the county. It is believed that road salt is probably the reason for the increase because chloride concentrations detect sodium chloride and calcium chloride, which most road salt consists of. The average conductivity reading for Lake Barrington was 0.7518 mS/cm, which is below the county median (0.8038 mS/cm). This was a 25% increase from 2001 (0.5996 mS/cm), and was most likely due to the high amount of impervious surfaces (roads, roofs) throughout the subdivision which increases the amount of storm water runoff into the lake. Chloride concentrations averaged 126 mg/L for the season while the county median was 158 mg/L. Chloride concentrations were not measured in 2001, however due to the large increase in the conductivity level it is assumed chloride concentrations have also increased. A study done in Canada reported 10% of aquatic species were harmed by prolonged exposure to chloride concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were associated with chloride concentrations as low as 12 mg/l. Alternatives to road salt should be considered. 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.

SUMMARY OF AQUATIC MACROPHYTES

Plant sampling was conducted on Lake Barrington in July. There were 98 points sampled based on a grid system with points 60 meters apart (Figure 6). Aquatic plants existed at 56 of the sites with ten species found (Table 3). This was a change in the plant community since 2001. Horned Pondweed and Watermeal were found in 2001 but not in 2007, however there were three new species found (White Water Crowfoot, Elodea, Slender Naiad). Chara spp., a macro-algae, was the most abundant species found in 2007 at 32% of the sites (Table 4). Curlyleaf Pondweed was the second most abundant at 27% of the sites followed by White Water Lily at 15% of sites and Small Pondweed at 8% of sites. This shift in plant communities could be caused by the low occurrence of Horned Pondweed (2% of sites) and Watermeal (3% of sites) in 2001, and from Curlyleaf Pondweed, an exotic, invasive species, crowding them out. Differences in plant communities could also be attributed to annual variation, sampling technique and personnel, and treatments. Curlyleaf Pondweed is controlled by multiple means in Lake Barrington. Harvesting occurred on the main area of the lake for a total of 64.5 hours removing 70 tons of matter. In early May the shoreline was treated with Aquathol SuperK and the three bays were treated with Sonar™. The shoreline was again treated at the end of May with Reward. The plant management plan for Lake Barrington appears to be successfully treating the Curlyleaf Pondweed and reducing turion density each year. LMU recommends continuing Sonar™ treatments in the bays as needed.

Algae treatments are also being used on the lake throughout the summer. At the end of May Cutrine Plus® is used to control the filamentous algae. Twice in June, planktonic algae was treated with Hydrothol 191®, Clearigate® was used for the filamentous algae, and Cutrine Ultra® was used for the *Chara* spp. Although very little of this chemical was used, it is recommended that the use of Hydrothol 191® be discontinued. This chemical is highly toxic to fish, especially pike and especially if a large area is treated. In addition, Hydrothol 191® is, first and foremost, an herbicide. The application of this chemical after curly leaf pondweed plants have disappeared (in July and August) may be killing potentially beneficial plants along the shoreline. Clearigate® and/or Cutrine Plus® should provide adequate control of shoreline planktonic algae without the additional use of Hydrothol 191®.

As with chemical treatment of the filamentous algae, the chemical treatment of Curlyleaf Pondweed results in the death and decomposition of the plant material, which then releases phosphorus back into the water column to be utilized by planktonic algae. The removal of this plant material through harvesting would better serve to reduce the phosphorus concentrations in the lake. If the plants are cut before they reach a height of approximately four feet, they will not yet have produced turions and will not produce new plants the following year. If the Curlyleaf Pondweed plants are not harvested before forming turions, plant density will remain the same or increase through turion growth the following yea. Since boat traffic is light on the lake, the presence of Curlyleaf Pondweed in isolated areas such as Turtle Bay and along some shorelines should not pose a navigational problem if the harvester is not able to get into these areas. Herbicide spot treatments could still be carried out near the boat launch and along the beach, and plant management plan that continues to include harvesting in the main body of the lake is recommended.

Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a lake. When the light level in the water column falls below 1% of the surface light level, plants can no longer grow. The 1% light level in Lake Barrington was at the bottom in May and June and fell to 7, 6, and 5 feet in July, August, and September, respectively. Plants were found at 12.0 feet, meaning plants were growing in all areas possible.

Floristic quality index (FQI) is an assessment tool designed to evaluate the closeness the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submersed plant species found in the lake. These numbers are averaged and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates there are large numbers of sensitive, high quality plant species present in the lake. Non-native species were counted in the FQI calculations for Lake County lakes. In 2007, Lake Barrington had an FQI of 16.7 and ranked 43rd of 152 lakes in the county (Table 5). The median FQI of lakes the LMU has studied from 2000-2007 was 12.5.

Figure 5. Yearly Secchi depth averages from VLMP and LCHD records for Lake Barrington, 1986 to 2007.

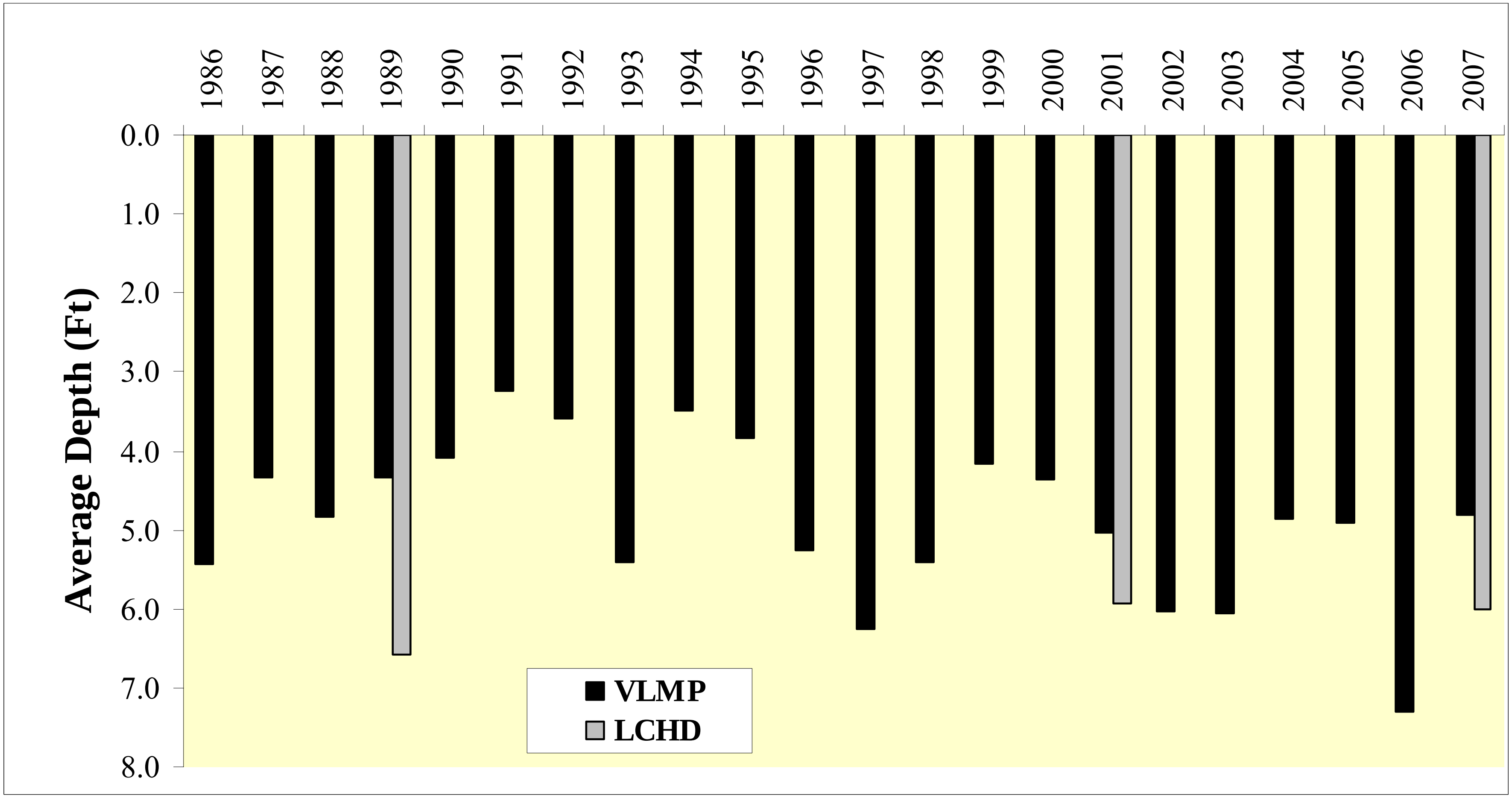


Figure 6. Aquatic plant sampling grid illustrating plant density on Lake Barrington, June 2007.

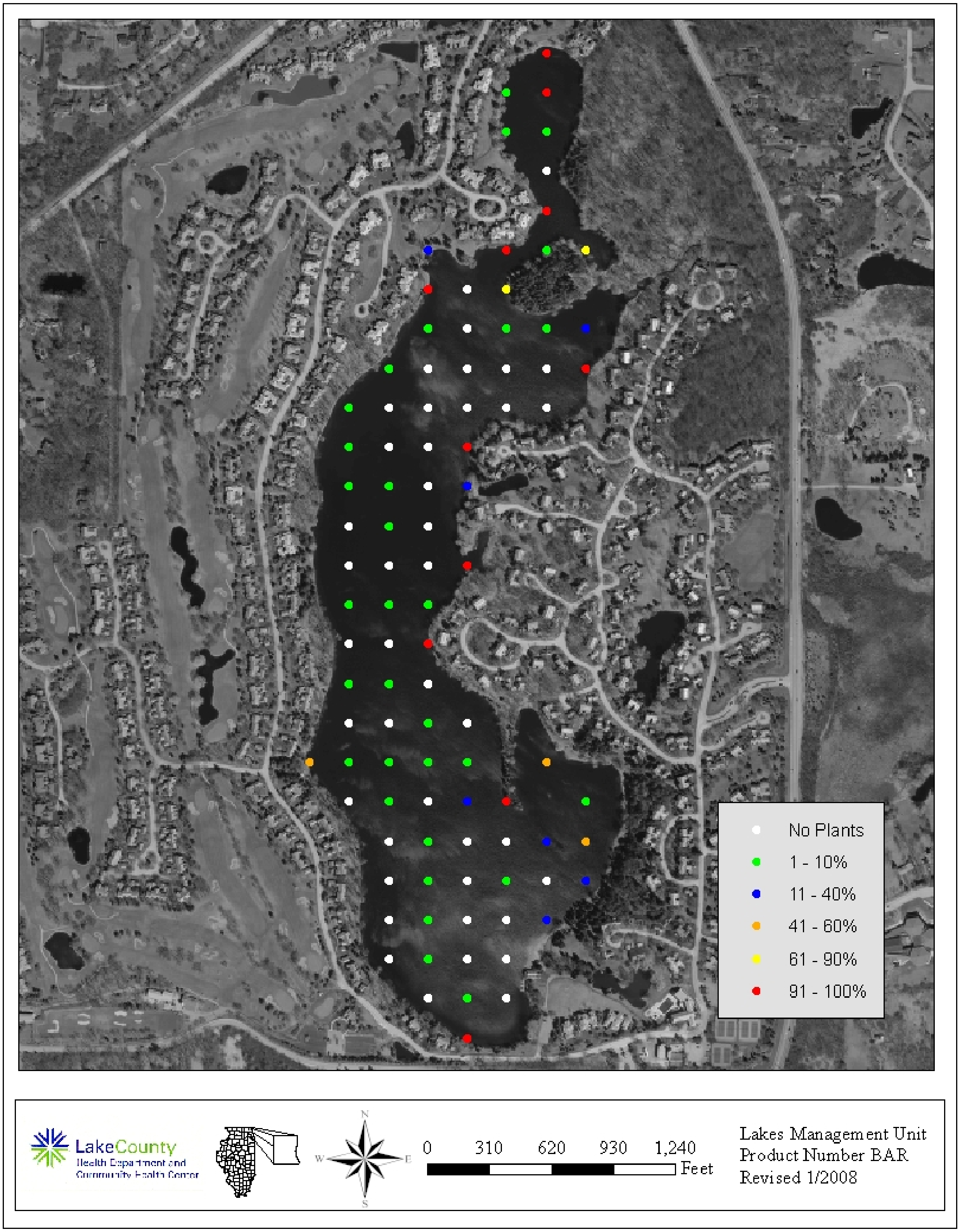


Table 3: Aquatic plant species found in Lake Barrington, 2007.

Coontail	*Ceratophyllum demersum*
Chara (Macro algae)	*Chara* spp.
American Elodea	*Elodea canadensis*
Duckweed	*Lemna* spp.
Slender Naiad	*Najas major*
White Water Lily	*Nymphaea tuberosa*
Curlyleaf Pondweed^	*Potamogeton crispus*
Sago Pondweed	*Potamogeton pectinatus*
Small Pondweed	Potamogetaon
White Water Crowfoot	*Ranunculus longirostris*

^ Exotic plant

Table 4a. Aquatic plant species found at the 98 July sampling sites on Lake Barrington. The maximum depth that plants were found was 12.0 feet.

Plant Density	Chara	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Sago Pondweed	Slender Naiad	Small Pondweed	White Crowfoot	White Water Lily
Present	12	1	26	0	1	4	1	8	4	11
Common	6	0	1	1	0	0	0	0	0	1
Abundant	2	0	0	0	0	1	0	0	1	2
Dominant	12	0	0	0	0	0	0	0	0	1
% Plant Occurrence	32.7	1.0	27.6	1.0	1.0	5.1	1.0	8.2	5.1	15.3

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

Rake Density (coverage)	# of Sites	% of Sites
No Plants	42	42.9
>0-10%	33	33.7
10-40%	7	7.1
40-60%	3	3.1
60-90%	2	2.0
>90%	11	11.2
Total Sites with Plants	56	57.1
Total # of Sites	98	100.0

Table 5. 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	Deer Lake	28.2	29.7
7	Sullivan 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	Lake of the Hollow	23.8	26.2
17	Lakewood Marsh	23.8	24.7
18	Round Lake	23.5	25.9
19	Fourth Lake	23.0	24.8
20	Druce Lake	22.8	25.2
21	Sun Lake	22.7	24.5
22	Countryside Glen Lake	21.9	22.8
23	Butler Lake	21.4	23.1
24	Duck Lake	21.1	22.9
25	Timber Lake (North)	20.8	22.8
26	Wooster Lake	20.8	22.6
27	Broberg Marsh	20.5	21.4
28	Davis Lake	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	Fish Lake	19.3	21.2
33	Redhead Lake	19.3	21.2
34	Owens Lake	19.3	20.2
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	**Lake Barrington**	**16.7**	**17.7**
43	Bresen Lake	16.6	17.8
44	Windward Lake	16.3	17.6

Table 5. Continued.

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

Table 5. Continued.

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

Table 5. Continued.

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

SUMMARY OF SHORELINE CONDITION

A comprehensive shoreline survey was performed in 2001 and several important observations were made. Seventy-four percent of Lake Barrington's shoreline was developed and the majority of the developed shoreline was comprised of rip rap (72.8%). The remainder of the developed shoreline consisted of manicured lawn (12.4%), buffer (10.6%) and wetland (4.2%). The undeveloped portions of the lake (located mostly along the northern shores) consisted primarily of woodland. Although rip rap is not an ideal shoreline type with regard to wildlife habitat, it does help to prevent shoreline erosion. Only 32.3% of Lake Barrington's shoreline exhibited erosion, with the majority being slight erosion (29.2%) and moderate erosion (3%). The types of shorelines exhibiting the most erosion included woodland, manicured lawn, buffer, and rip rap. Manicured lawn is considered undesirable because it provides a poor shoreline-water interface due to the poor root structure of turf grasses. These grasses are incapable of stabilizing the shoreline and typically lead to erosion. Woodland is a more desirable shoreline type and although woodland-dominated lots may seem to provide the ideal shoreline, if the slope is steep or if these lots are not maintained, erosion can occur. Deciduous trees present along these shorelines have very large roots that are unable to stabilize soil as well as native grasses and plants. If these trees become so large that they shade out all understory plants (whose roots provide the best stabilization) beneath them, the shoreline may become eroded.

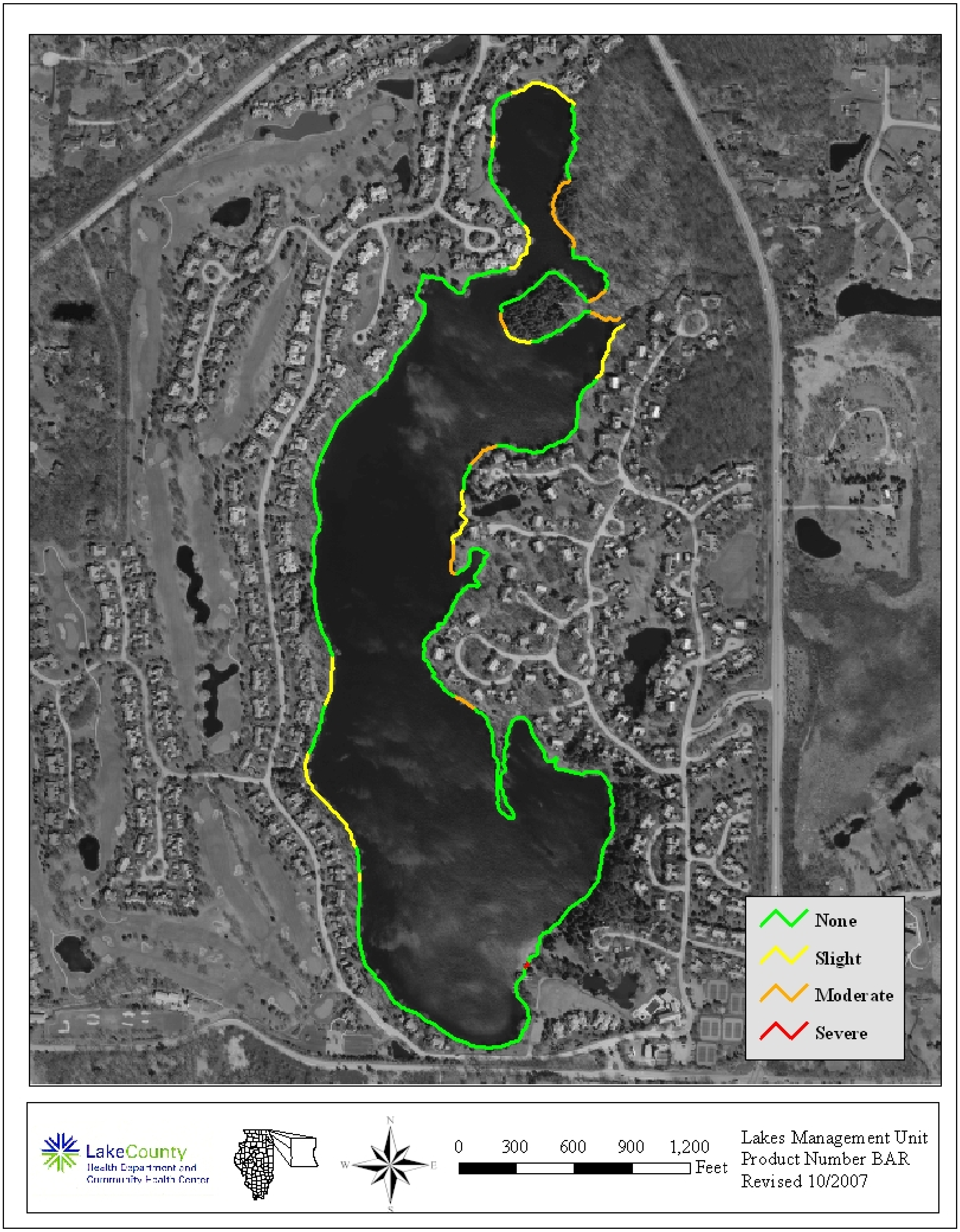
In 2007 the shoreline erosion was reassessed and a few minor changes were noted. Seventy-seven percent of the shoreline was exhibiting no erosion (Figure 7) due to the large amount of rip-rap present. Fourteen percent had slight erosion, 7% exhibited moderate erosion, and there was a small area (approximately 39 feet) with severe erosion near the beach. Areas of moderate and severe erosion should be stabilized to prevent further erosion from occurring. It is more affordable to fix the erosion in early stages than to wait until it becomes severe.

SUMMARY OF WILDLIFE AND HABITAT

The mature trees in the public and private open space which surrounds the lake provide good habitat for wildlife. Waterfowl such as Great Blue Heron and Mallards were seen on the lake. Many songbirds native to the area were observed around the lake as well. It is, therefore, very important to preserve the forest buffer areas around the lake to maintain the appropriate habitat for these bird species and others in the future.

A fish survey was performed by the Illinois Department of Natural Resources (IDNR) in 2003. The survey consisted of 60 minutes of electroshocking and two trap nets set overnight. A total of 258 fish consisting of eight species were collected. The most abundant species was Largemouth Bass (47%) followed by Bluegill (30%). Other species collected include Black Crappie, Warmouth, Yellow Perch, Pumpkinseed, Golden Shiner, and Hybrid Sunfish. The IDNR recommended the aquatic plants be kept around 20 – 30% of the lakes surface area, a 15 inch size limit and one fish daily bag limit be established for Largemouth Bass, Northern Pike fingerlings be stocked annually or biennially, and non-vulnerable Channel Catfish be stocked at a density of 10 – 15 per acre every two to three years to diversify the predator base.

Figure 7. Shoreline erosion on Lake Barrington, 2007.



LAKE MANAGEMENT RECOMMENDATIONS

Lake Barrington has poor water quality and experienced a dramatic shift in water quality between June and July, similar to 2001. The public and private open space surrounding the lake provides good habitat for wildlife and 77% of the shoreline was exhibiting no erosion. Areas where erosion has increased should be taken care before they become severe and there are many grant opportunities available to do improvements around or in the lake (Appendix F). Plant coverage was fair on the lake, however the dominant plant was a macro-algae and the second dominant plant, Curlyleaf Pondweed, which is an invasive, exotic species.

Creating a Bathymetric Map

Creating an updated bathymetric map can help with improvements to Lake Barrington. An old map (>15 years) exists and should be updated. It 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 (Appendix D1).

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 D2). Currently, the overall aquatic plant coverage is below the recommended 30-40% bottom coverage.

Reduce Conductivity and Chloride Concentrations

Conductivity concentrations in Lake Barrington have increased 25% since the 2001 average. The average chloride concentration was 126 mg/L, and the county median was 158 mg/L. 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 D3).

High Nutrients and Low Dissolved Oxygen Concentrations and Consequent Aeration Techniques

The lake exhibits polymictic tendencies, meaning stratification and turnover occur repeatedly over the year. This may be the result of climatic factors (i.e., wind and wave action, temperature) and the shallow nature of the lake. Lakes that do not stratify or stratify only weakly may have fewer problems with low dissolved oxygen (DO) problems or the build up and release of excessive nutrients. Low DO concentrations can cause fish stress and if continuous, stress can lead to fish mortality. If fishing is a priority at Lake Barrington, the low DO problems should be addressed (Appendix D4).

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 LAKE BARRINGTON IN 2007

Lake Barrington 2007 Multiparameter data

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	0.23
05/09/2007	0.5	0.495	20.03	9.95	109.7	0.788	8.54	1648.0	Surface		
05/09/2007	1	0.979	20.00	9.85	108.6	0.788	8.52	1532.5	Surface	100%	
05/09/2007	2	1.967	19.54	10.19	111.3	0.791	8.52	791.1	0.297	52%	2.23
05/09/2007	3	2.937	18.13	10.90	115.7	0.791	8.52	580.9	1.267	38%	0.24
05/09/2007	4	3.981	17.71	10.88	114.5	0.788	8.51	623.3	2.311	41%	-0.03
05/09/2007	5	5.050	17.38	11.06	115.6	0.788	8.48	445.7	3.380	29%	0.10
05/09/2007	6	6.070	16.84	10.67	110.2	0.791	8.45	345.0	4.400	23%	0.06
05/09/2007	7	7.011	16.45	10.54	108.1	0.806	8.41	274.4	5.341	18%	0.04
05/09/2007	8	7.961	16.16	9.95	101.4	0.807	8.35	226.9	6.291	15%	0.03
05/09/2007	9	9.027	15.99	9.28	94.2	0.796	8.27	202.7	7.357	13%	0.02
05/09/2007	10	10.031	15.79	8.46	85.5	0.799	8.19	166.7	8.361	11%	0.02
05/09/2007	11	11.005	15.63	8.29	83.5	0.801	8.15	120.9	9.335	8%	0.03
05/09/2007	12	12.060	15.39	7.91	79.3	0.807	8.08	93.3	10.390	6%	0.02
05/09/2007	13	13.015	15.06	4.48	44.6	0.811	7.88	76.4	11.345	5%	0.02

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	0.28
06/13/2007	0.5	0.496	24.87	9.12	110.3	0.787	8.33	3086.6	Surface		
06/13/2007	1	1.051	24.86	9.13	110.4	0.787	8.36	3076.9	Surface	100%	
06/13/2007	2	2.051	24.77	9.12	110.1	0.787	8.38	1034.5	0.381	34%	2.86
06/13/2007	3	2.990	24.65	9.10	109.7	0.787	8.39	859.4	1.320	28%	0.14
06/13/2007	4	4.042	24.63	9.06	109.2	0.787	8.40	724.9	2.372	24%	0.07
06/13/2007	5	5.000	24.60	9.00	108.3	0.787	8.41	567.0	3.330	18%	0.07
06/13/2007	6	6.060	24.55	8.94	107.6	0.787	8.41	464.8	4.390	15%	0.05
06/13/2007	7	6.997	24.53	8.90	107.0	0.787	8.41	378.5	5.327	12%	0.04
06/13/2007	8	7.943	24.46	8.66	104.0	0.787	8.39	309.8	6.273	10%	0.03
06/13/2007	9	9.029	24.27	7.60	91.0	0.789	8.27	190.4	7.359	6%	0.07
06/13/2007	10	10.012	24.12	7.20	85.9	0.791	8.21	183.0	8.342	6%	0.00
06/13/2007	11	10.998	24.01	6.58	78.4	0.792	8.14	145.3	9.328	5%	0.02
06/13/2007	12	11.993	23.63	5.18	61.2	0.797	8.01	123.2	10.323	4%	0.02
06/13/2007	13	13.000	23.49	2.55	30.1	0.799	7.87	94.7	11.330	3%	0.02

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	0.47
07/11/2007	0.5	0.524	26.48	7.10	88.4	0.821	8.60	3158.5	Surface		
07/11/2007	1	1.057	26.48	7.12	88.7	0.823	8.58	3106.6	Surface	100%	
07/11/2007	2	2.021	26.50	7.09	88.4	0.823	8.59	710.7	0.351	23%	4.20
07/11/2007	3	3.003	26.50	7.07	88.1	0.823	8.59	437.8	1.333	14%	0.36
07/11/2007	4	4.023	26.49	7.06	88.0	0.822	8.60	242.7	2.353	8%	0.25
07/11/2007	5	4.966	26.46	6.94	86.4	0.822	8.60	132.4	3.296	4%	0.18
07/11/2007	6	6.012	26.46	6.91	86.1	0.823	8.60	71.5	4.342	2%	0.14
07/11/2007	7	6.987	26.45	6.94	86.4	0.821	8.61	44.9	5.317	1.4%	0.09
07/11/2007	8	8.022	26.42	6.87	85.4	0.820	8.61	26.3	6.352	0.8%	0.08
07/11/2007	9	9.014	26.41	6.80	84.6	0.821	8.61	12.9	7.344	0.4%	0.10
07/11/2007	10	9.989	26.41	6.73	83.8	0.821	8.60	8.1	8.319	0.3%	0.06
07/11/2007	11	11.007	26.30	6.30	78.2	0.822	8.57	5.9	9.337	0.2%	0.03
07/11/2007	12	12.021	25.90	5.19	64.0	0.827	8.51	3.8	10.351	0.1%	0.04
07/11/2007	13	12.916	24.47	0.44	5.3	0.859	8.14	2.3	11.246	0.1%	0.04

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	0.55
08/08/2007	0.5	0.545	28.24	5.84	75.0	0.681	8.68	2962.0	Surface		
08/08/2007	1	0.980	28.26	5.88	75.6	0.682	8.62	3107.7	Surface	100%	
08/08/2007	2	1.995	28.00	4.56	58.3	0.682	8.54	608.5	0.325	20%	5.02
08/08/2007	3	3.035	27.81	2.03	25.8	0.683	8.36	263.2	1.365	8%	0.61
08/08/2007	4	4.009	27.23	1.00	12.6	0.685	8.26	131.6	2.339	4%	0.30
08/08/2007	5	4.998	26.77	0.44	5.5	0.686	8.16	71.8	3.328	2%	0.18
08/08/2007	6	5.981	26.07	0.20	2.4	0.682	8.09	28.6	4.311	0.9%	0.21
08/08/2007	7	7.006	25.70	0.16	1.9	0.705	8.07	21.9	5.336	0.7%	0.05
08/08/2007	8	7.994	25.31	0.15	1.8	0.726	8.02	18.7	6.324	0.6%	0.02
08/08/2007	9	8.996	24.71	0.17	2.0	0.756	7.81	11.3	7.326	0.4%	0.07
08/08/2007	10	10.010	24.23	0.19	2.3	0.779	7.63	8.2	8.340	0.3%	0.04
08/08/2007	11	11.045	24.06	0.22	2.7	0.784	7.55	4.3	9.375	0.1%	0.07
08/08/2007	12	11.963	23.87	0.22	2.7	0.791	7.51	3.2	10.293	0.1%	0.03
08/08/2007	13	12.971	23.84	0.26	3.1	0.792	7.49	2.0	11.301	0.1%	0.04

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
										Average	0.64
09/12/2007	0.5	0.497	21.72	4.73	53.9	0.674	8.44	3231.4	Surface		
09/12/2007	1	1.094	21.73	4.64	52.9	0.674	8.36	3124.6	Surface	100%	
09/12/2007	2	2.080	21.68	4.33	49.3	0.675	8.33	429.3	0.410	14%	4.84
09/12/2007	3	2.986	21.64	4.02	45.7	0.675	8.29	127.8	1.316	4%	0.92
09/12/2007	4	4.047	21.61	3.70	42.1	0.674	8.25	57.5	2.377	2%	0.34
09/12/2007	5	4.965	21.59	3.58	40.7	0.674	8.22	30.7	3.295	1.0%	0.19
09/12/2007	6	5.926	21.58	3.55	40.3	0.674	8.21	13.6	4.256	0.4%	0.19
09/12/2007	7	6.937	21.58	3.53	40.2	0.675	8.20	5.9	5.267	0%	0.16
09/12/2007	8	8.102	21.57	3.52	40.0	0.675	8.20	2.4	6.432	0%	0.14
09/12/2007	9	9.057	21.55	3.66	41.6	0.674	8.18	1.1	7.387	0%	0.11
09/12/2007	10	9.968	21.52	3.64	41.3	0.674	8.17	0.6	8.298	0%	0.07
09/12/2007	11	11.056	21.50	3.62	41.1	0.674	8.17	0.4	9.386	0%	0.04
09/12/2007	12	12.042	21.37	3.15	35.6	0.676	8.15	0.2	10.372	0%	0.07

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

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

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

Temperature and Dissolved Oxygen:

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

Monthly temperature profiles were established on each lake by measuring water temperature every foot (lakes $\leq$ 15 feet deep) or every two feet (lakes > 15 feet deep) from the lake surface to the lake bottom. These profiles are important in understanding the distribution of chemical/biological characteristics and because increasing water temperature and the establishment of thermal stratification have a direct impact on dissolved oxygen (DO) concentrations in the water column. If a lake is shallow and easily mixed by wind, the DO concentration is usually consistent throughout the water column. However, shallow lakes are typically dominated by either plants or algae, and increasing water temperatures during the summer speeds up the rates of photosynthesis and decomposition in surface waters. When many of the plants or algae die at the end of the growing season, their decomposition results in heavy oxygen consumption and can lead to an oxygen crash. In deeper, thermally stratified lakes, oxygen production is greatest in the top portion of the lake, where sunlight drives photosynthesis, and oxygen consumption is greatest near the bottom of a lake, where sunken organic matter accumulates and decomposes. The oxygen difference between the top and bottom water layers can be dramatic, with plenty of oxygen near the surface, but practically none near the bottom. The oxygen profiles measured during the water quality study can illustrate if this is occurring. This is important because the absence of oxygen (anoxia) near the lake bottom can have adverse effects in eutrophic lakes resulting in the chemical release of phosphorus from lake sediment and the production of hydrogen sulfide (rotten egg smell) and other gases in the bottom waters. Low oxygen conditions in the upper water of a lake can also be problematic since all aquatic organisms need oxygen to live. Some oxygen may be present in the water, but at too low a concentration to sustain aquatic life. Oxygen is needed by all plants, virtually all algae and for many chemical reactions that are important in lake functioning. Most adult sport-fish such as largemouth bass and bluegill require at least 3 mg/L of DO in the water to survive. However, their offspring require at least 5 mg/L DO as they are more sensitive to DO stress. When DO concentrations drop below 3 mg/L, rough fish such as carp and green sunfish are favored and over time will become the dominant fish species.

External pollution in the form of oxygen-demanding organic matter (i.e., sewage, lawn clippings, soil from shoreline erosion, and agricultural runoff) or nutrients that stimulate the growth of excessive organic matter (i.e., algae and plants) can reduce average DO concentrations in the lake by increasing oxygen consumption. This can have a detrimental impact on the fish community, which may be squeezed into a very small volume of water as a result of high temperatures in the epilimnion and low DO levels in the hypolimnion.

Nutrients:

Phosphorus:

For most Lake County lakes, phosphorus is the nutrient that limits plant and algae growth. This means that any addition of phosphorus to a lake will typically result in algae blooms or high plant densities during the summer. The source of phosphorus to a lake can be external or internal (or both). External sources of phosphorus enter a lake through point (i.e., storm pipes and wastewater discharge) and non-point runoff (i.e., overland water flow). This runoff can pick up large amounts of phosphorus from agricultural fields, septic systems or impervious surfaces before it empties into the lake.

Internal sources of phosphorus originate within the lake and are typically linked to the lake sediment. In lakes with high oxygen levels (oxic), phosphorus can be released from the sediment through plants or sediment resuspension. Plants take up sediment-bound phosphorus through their roots, releasing it in small amounts to the water column throughout their life cycles, and in large amounts once they die and begin to decompose. Sediment resuspension can occur through biological or mechanical means. Bottom-feeding fish, such as common carp and black bullhead can release phosphorus by stirring up bottom sediment during feeding activities and can add phosphorus to a lake through their fecal matter. Sediment resuspension, and subsequent phosphorus release, can also occur via wind/wave action or through the use of artificial aerators, especially in shallow lakes. In lakes that thermally stratify, internal phosphorus release can occur from the sediment through chemical means. Once oxygen is depleted (anoxia) in the hypolimnion, chemical reactions occur in which phosphorus bound to iron complexes in the sediment becomes soluble and is released into the water column. This phosphorus is trapped in the hypolimnion and is unavailable to algae until fall turnover, and can cause algae blooms once it moves into the sunlit surface water at that time. Accordingly, many of the lakes in Lake County are plagued by dense algae blooms and excessive, exotic plant coverage, which negatively affect DO levels, fish communities and water clarity.

Lakes with an average phosphorus concentration greater than 0.05 mg/L are considered nutrient rich. The median near surface total phosphorus (TP) concentration in Lake County lakes from 2000-2005 is 0.063 mg/L and ranged from a non-detectable minimum of <0.010 mg/L on five lakes to a maximum of 3.880 mg/L on Albert Lake. The median anoxic TP concentration in Lake County lakes from 2000-2005 was 0.174 mg/L and ranged from a minimum of 0.012 mg/L in West Loon Lake to a maximum of 3.880 mg/L in Taylor Lake.

The analysis of phosphorus also included soluble reactive phosphorus (SRP), a dissolved form of phosphorus that is readily available for plant and algae growth. SRP is not discussed in great detail in most of the water quality reports because SRP concentrations vary throughout the season depending on how plants and algae absorb and release it. It gives an indication of how much phosphorus is available for uptake, but, because it does not take all forms of phosphorus into account, it does not indicate how much phosphorus is truly present in the water column. TP is considered a better indicator of a lake's nutrient status because its concentrations remain more stable than soluble reactive phosphorus. However, elevated SRP levels are a strong indicator of nutrient problems in a lake.

Nitrogen:

Nitrogen is also an important nutrient for plant and algae growth. Sources of nitrogen to a lake vary widely, ranging from fertilizer and animal wastes, to human waste from sewage treatment plants or failing septic systems, to groundwater, air and rainfall. As a result, it is very difficult to control or reduce nitrogen inputs to a lake. Different forms of nitrogen are present in a lake under different oxic conditions. 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 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.

D3. 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.

D4. 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.

Option 2. Reduce Lake Phosphorus Concentrations

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.

Option 3. Snow Removal from Ice-Covered Lakes

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**	

LakeCounty
Health Department and
Community Health Center

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

LakeCounty
Health Department and
Community Health Center

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
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