2006 SUMMARY REPORT
of
Fish Lake

Lake County, Illinois

Prepared by the

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Fish Lake is a 95.7-acre glacial lake east of Volo in west-central Lake County. Fish Lake receives water from the 3018.5 acres within its watershed. The outflow at the northeast corner of the lake flows north into Fischer Lake. Fish Lake is part of the Fish Lake Drain, which also consists of Lake Christa, Fischer Lake, Wooster Lake, and Duck Lake. The Fish Lake Drain flows into Squaw Creek, as it continues on its way to the Fox River Chain O'Lakes.

Fish Lake is listed as an ADID (advanced identification) wetland by the U.S. Environmental Protection Agency. This indicates that the lake and surrounding natural environments have potential to have high quality aquatic resources based on water quality and hydrology values.

Fish Lake was thermally stratified from June through August. Dissolved oxygen (DO) concentrations in the epilimnion did not indicate any significant problems; however the hypolimnion had anoxic conditions (DO > 1.0 mg/L) from June through August. The anoxic boundary was at its shallowest in July at approximately 9 feet and deepest in August at approximately 13 feet.

Secchi disk (water clarity) readings averaged 3.47 feet during 2006 and 4.02 feet during 2002. Both of these values were above the Lake County median of 3.27 feet. The slight decrease in average Secchi depth correlated with a slight increase in total suspended solids (TSS). In 2006 the average TSS was 11.0 mg/L while in 2002 it averaged 11.3 mg/L. Both values were above the county median of 7.9 mg/L. Total phosphorus (TP) concentrations in Fish Lake were high with the 2006 average TP concentration was 0.096 mg/L in the epilimnion and 0.190 mg/L in the hypolimnion. The county median was 0.060 mg/L in the epilimnion and 0.163 mg/L in the hypolimnion. In 2002 the epilimnetic TP was 0.102 mg/L and the hypolimnetic TP was 0.188 mg/L.

The median conductivity reading for near surface samples was 0.7948 milliSiemens/cm (mS/cm) for Lake County lakes. During 2006, the average conductivity in Fish Lake was higher (0.8688 mS/cm), which was an increase of 31% from the 2002 average (0.6629 mS/cm). Conductivity is correlated with chloride (Cl^-) concentration. The average Cl^- concentration in Fish Lake (141 mg/L) was lower than the Lake County median of 171 mg/L during 2006.

There were a total of 12 aquatic plant species found in 2006, with the most common species being Eurasian Watermilfoil (EWM) at 28% of the sampling sites. White Water Lily was the second most common species at 25% of the sampling sites. These were the two most abundant species found in July 2002 as well. The 2006 survey found that approximately 34% of the lake bottom was covered by plants.

The shoreline was reassessed in 2006 for significant changes in erosion since 2002. Based on the 2006 assessment, there were areas of erosion that had developed at various areas around the lake. Overall, 89% of the shoreline had no erosion, 7% had slight erosion, 3% had moderate erosion, and 1% had severe erosion.

LAKE FACTS

Lake Name:	Fish Lake
Historical Name:	Lake Duncan, Old Fish Lake
Nearest Municipality:	Volo
Location:	T45N, R9E, Section 34, 35
Elevation:	753.0 feet
Major Tributaries:	None
Watershed:	Fox River
Sub-watershed:	Fish Lake Drain
Receiving Water body:	Fischer Lake
Surface Area:	95.7 acres
Shoreline Length:	2.4 miles
Maximum Depth:	17.0 feet
Average Depth:	8.5 feet (estimated)
Lake Volume:	813.6 acre-feet (estimated)
Lake Type:	Glacial
Watershed Area:	3,018.5 acres
Major Watershed Land uses:	Agricultural, Wetlands, Public and Private Open Space, Forest and Grassland, and Single Family
Bottom Ownership:	Lake County Forest Preserve and Private
Management Entities:	Private
Current and Historical uses:	Fishing, swimming, and boating
Description of Access:	Private (public may access with fee)

SUMMARY OF WATER QUALITY

Water samples were collected monthly from May through September at the deepest point in the lake (Figure 1, Appendix A). Fish Lake was sampled at depths of three feet and 13 to 14 feet depending on water level and the samples were analyzed for various water quality parameters (Appendix C). Fish Lake is within the Fish Lake Drain watershed which the Lakes Management Unit (LMU) sampled in 2006. This watershed includes Fish Lake, Fischer Lake, Lake Christa, Wooster Lake, and Duck Lake. In addition to LMU sampling, Fish Lake has participated in the Volunteer Lake Monitoring Program (VLMP) since 2003. The LMU also monitored Camp Duncan and Fish Lake Campground beaches for *E. coli* levels. There was no LMU recommended closing at Fish Lake Campground and only one at Camp Duncan in 2006.

Fish Lake was thermally stratified from June through August. Thermal stratification is when a lake divides into an upper, warm water layer (epilimnion) and a lower, cold water layer (hypolimnion). When stratified, the epilimnetic and hypolimnetic waters do not mix, and the hypolimnion typically experiences anoxic conditions (where dissolved oxygen (DO) concentrations drop below 1 mg/L) by mid-summer. The thermocline (transition region between the epilimnion and the hypolimnion) remained strong until September when water temperatures throughout the water column grew closer. This could explain the difference in water quality parameters in the hypolimnion between August and September. A DO concentration of 5.0 mg/L is considered adequate to support a sunfish/bass fishery, since these fish can suffer oxygen stress below this amount. DO concentrations in the epilimnion did not indicate any significant problems; however the hypolimnion had anoxic conditions from June through August (Appendix B). The anoxic boundary was at its shallowest in July (9 feet) and deepest in August (13 feet). Since an accurate bathymetric map with volumetric calculations does not exist for Fish Lake it was impossible to determine the volume of the lake that was anoxic during 2006.

Secchi disk (water clarity) readings averaged 3.47 feet during 2006 and 4.02 feet during 2002 (Table 1). Both of these values were above the Lake County median of 3.27 feet (Appendix E). The VLMP Secchi depth has averaged 2.34 feet over the past four years. The yearly average has increased from 1.61 feet in 2003 to 3.13 feet in 2006 (Figure 2). There was a significant decrease in water clarity from 2002 to 2003, but the clarity has been improving since. The decrease in water clarity from 2002 to 2006 was correlated with an increase in total suspended solids (TSS) concentration in the water column (Figure 3). TSS is composed of nonvolatile suspended solids, non-organic clay or sediment materials, and volatile suspended solids, algae and other organic matter. In 2006 the average TSS was 11.0 mg/L while in 2002 it averaged 11.3 mg/L. Both values were above the county median of 7.9 mg/L. The high TSS level in July (18.0 mg/L) could have been due to a blue-green algae bloom.

Fish Lake's average Secchi depth and TSS were similar to Lake Christa and Duck Lake (Table 2). Fischer Lake had the lowest average Secchi depth (1.96 feet) and the highest average TSS (28.0 mg/L) within the Fish Lake Drain watershed. This may be due to the low amount of aquatic macrophytes, wind/wave action, carp disturbing the bottom, the lakes shallow nature, or land use changes occurring within the watershed. Wooster Lake, which had an abundant aquatic macrophyte community, had the highest average Secchi (7.87 feet) and lowest average TSS (5.1 mg/L) within the Fish Lake Drain watershed.

Figure 1. Water quality sampling site on Fish Lake, 2006.

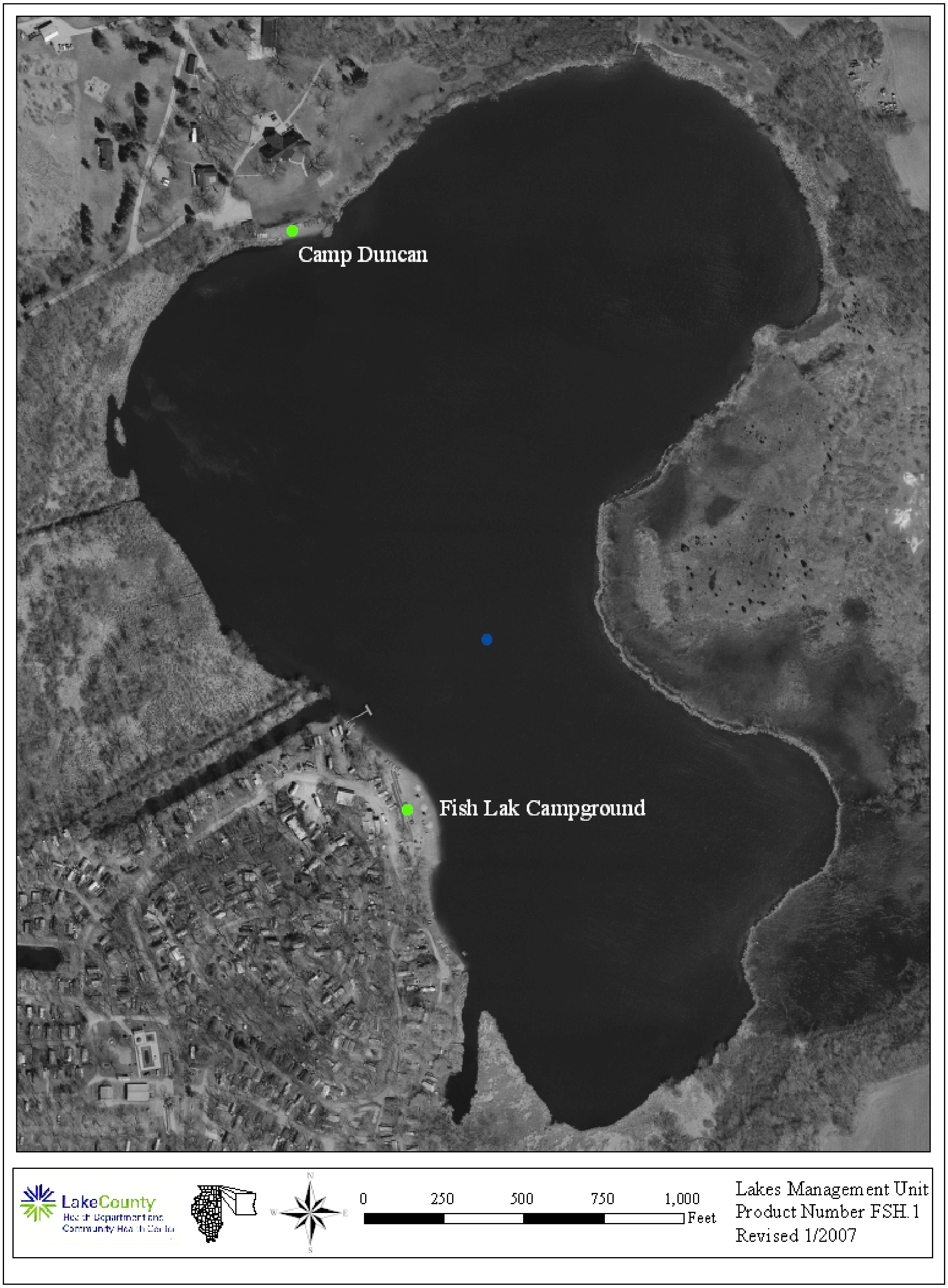

Table 1. Water quality data for Fish Lake, 2002 and 2006.

2006	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NO_2+NO_3-N	NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-May	3	189	1.64	0.212	0.391	0.118	0.024	NA	138	2.5	545	119	9.02	0.8850	7.96	8.37
20-Jun	3	203	1.89	<0.1	<0.05	0.115	0.010	NA	136	13.7	578	162	2.55	0.8890	8.08	10.94
18-Jul	3	170	2.10	<0.1	<0.05	0.074	<0.005	NA	141	18.0	545	154	1.93	0.8590	8.12	8.08
15-Aug	3	166	2.34	<0.1	<0.05	0.076	<0.005	NA	147	11.0	549	160	1.47	0.8590	8.14	5.94
19-Sep	3	161	2.76	0.201	<0.05	0.095	<0.005	NA	142	10.0	539	149	2.36	0.8520	8.22	7.78
	Average	178	2.15	0.206[k]	0.391[k]	0.096	0.017[k]	NA	141	11.0	551	149	3.47	0.8688	8.10	8.22

2002	**Epilimnion**															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
13-May	3	234	1.54	0.180	0.303	0.090	0.024	460	NA	3.5	461	144	7.65	0.7637	8.09	8.48
17-Jun	3	221	1.36	<0.1	0.791	0.073	0.015	444	NA	3.1	456	161	7.78	0.7046	8.39	8.99
22-Jul	3	178	1.56	<0.1	<0.05	0.093	<0.005	364	NA	13.0	424	148	2.23	0.6313	8.68	7.17
19-Aug	3	169	2.20	<0.1	<0.05	0.128	<0.005	344	NA	19.0	408	136	1.28	0.6227	8.74	7.50
16-Sep	3	149	2.52	<0.1	<0.05	0.127	<0.005	320	NA	18.0	378	125	1.15	0.5922	8.73	6.60
	Average	190	1.84	NA	0.547[k]	0.102	0.020[k]	386	NA	11.3	425	143	4.02	0.6629	8.53	7.75

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

Note: "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.

2006	Hypolimnion															
DATE	DEPTH	ALK	TKN	NO_2+NO_3-N	NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
16-May	14	194	1.69	0.217	0.505	0.081	0.025	NA	139	3.8	540	99	NA	0.8880	7.98	7.94
20-Jun	13	213	2.54	1.000	<0.05	0.281	0.204	NA	135	8.2	583	160	NA	0.9160	7.60	0.29
18-Jul	13	200	3.33	1.540	<0.05	0.267	0.129	NA	139	13.3	570	167	NA	0.9570	7.12	0.16
15-Aug	13	192	4.00	1.890	<0.05	0.220	0.068	NA	144	10.0	549	153	NA	0.9170	7.13	0.21
19-Sep	13	164	2.79	0.221	<0.05	0.103	<0.005	NA	140	10.0	519	144	NA	0.8400	8.20	6.97
	Average	193	2.87	0.974	0.505[k]	0.190	0.106[k]	NA	139	9.1	552	145	NA	0.9036	7.61	3.11

2002	Hypolimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N[*]	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
13-May	14	233	1.49	0.180	0.318	0.092	0.024	456	NA	3.5	463	146	NA	0.7649	8.10	8.35
17-Jun	13	233	1.88	0.550	0.694	0.203	0.155	422	NA	2.7	467	173	NA	0.7203	7.67	1.06
22-Jul	13	235	3.59	1.950	<0.05	0.350	0.253	384	NA	5.6	443	141	NA	0.7327	7.20	0.12
19-Aug	13	173	2.54	0.216	<0.05	0.159	<0.005	352	NA	18.0	414	134	NA	0.6944	7.60	1.10
16-Sep	13	152	2.53	<0.1	<0.05	0.134	<0.005	340	NA	25.0	408	151	NA	0.5921	8.76	6.80
	Average	205	2.41	0.724[k]	0.506[k]	0.188	0.144[k]	391	NA	11.0	439	149	NA	0.7009	7.87	3.49

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
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SECCHI = Secchi disk depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

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

NA = Not Applicable

* = Prior to 2006 only Nitrate - nitrogen was analyzed

Figure 2. Yearly Secchi depth averages from VLMP and LCHD records for Fish Lake.

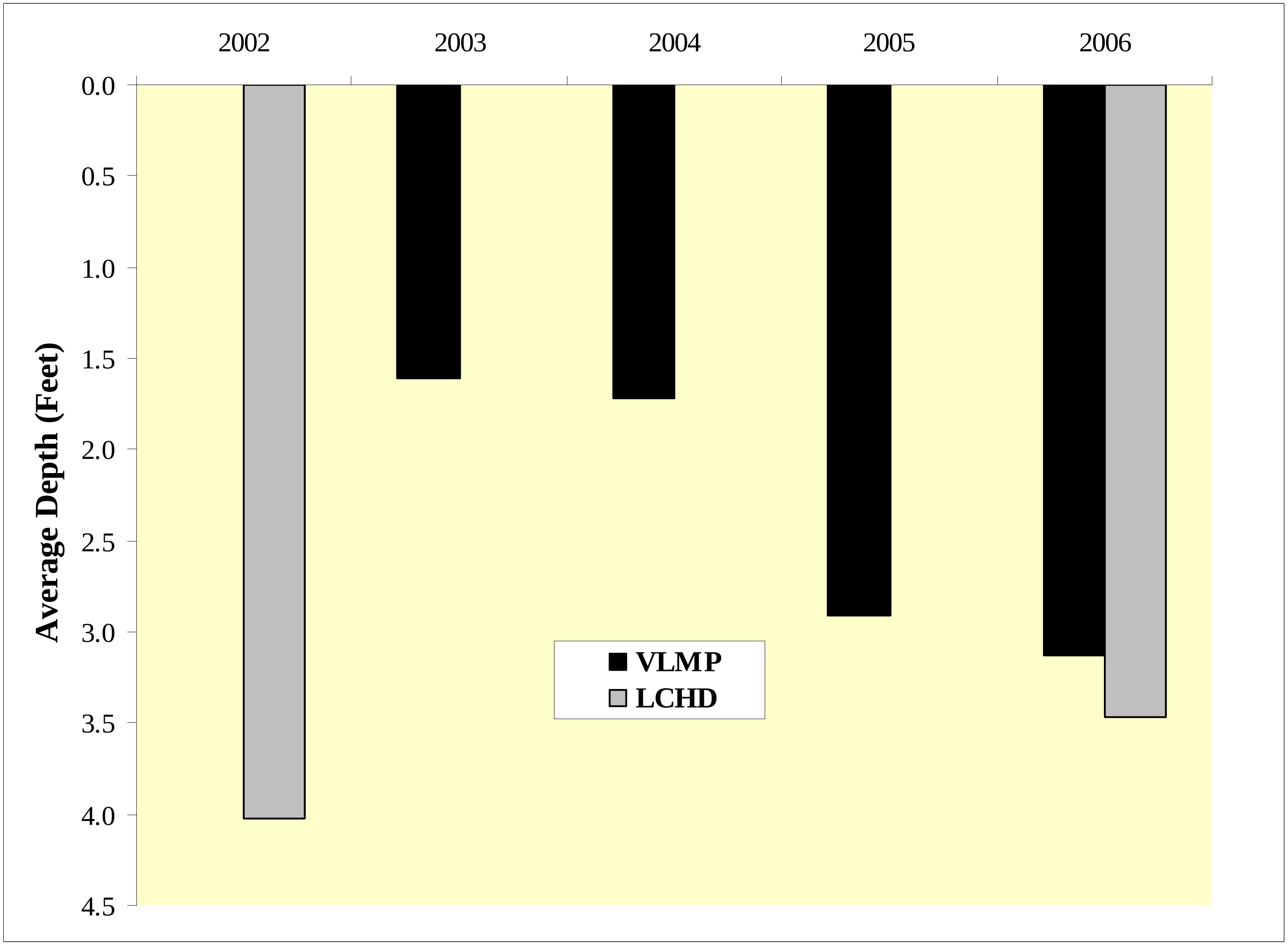


Figure 3. Total suspended solid (TSS) concentrations vs. Secchi depth for Fish Lake, 2006.

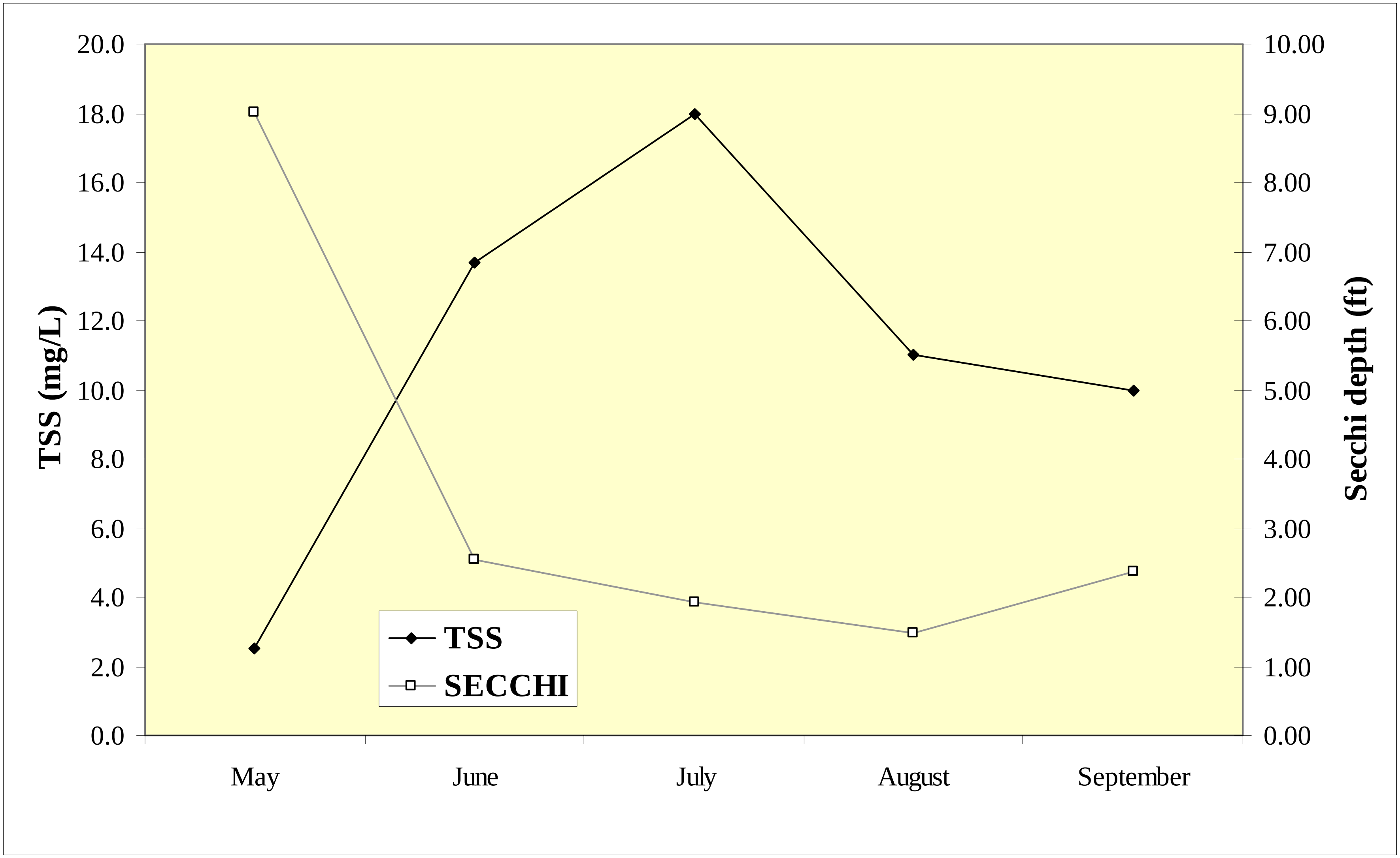


Table 2. Comparison of epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus, and conductivity readings in the Fish Lake Drain watershed (Fish Lake, Lake Christa, Fischer Lake, Wooster Lake, and Duck Lake).

	Fish Lake	Fish Lake	Fish Lake	Lake Christa	Lake Christa	Fischer Lake	Fischer Lake	Wooster Lake	Wooster Lake	Wooster Lake	Wooster Lake	Wooster Lake	Duck Lake	Duck Lake	Duck Lake
Year	**1997**	**2002**	**2006**	**2004**	**2006**	**2001**	**2006**	**1995**	**1999**	**2003**	**2005**	**2006**	**1997**	**2001**	**2006**
Secchi (feet)	3.53	4.02	3.47	4.76	3.01	2.72	1.96	10.13	8.00	7.83	9.54	7.87	3.12	2.01	3.49
TSS (mg/L)	8.9	11.3	11.0	8.2	10.7	15.4	28.0	1.8	4.3	3.4	3.2	5.1	8.5	20.6	9.1
TP (mg/L)	0.134	0.102	0.096	0.053	0.058	0.198	0.228	0.024	0.027	0.032	0.03	0.043	0.047	0.100	0.100
Conductivity (milliSiemens/cm)	0.6984	0.6629	0.8688	0.7410	0.9134	0.6687	0.8524	0.5160	0.5744	0.6437	0.7100	0.7388	0.6544	0.6071	0.7807

Direction of Watershed Flow

Another factor affecting water clarity was the amount of nutrients in the water. Typically, lakes are either phosphorus (P) or nitrogen (N) limited. This means that one of the nutrients is in short supply and any addition of that nutrient to the lake will result in an increase of plant and/or algal growth. Most lakes in Lake County are phosphorus limited. To compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than or equal to 10:1 indicate nitrogen is limiting, ratios greater than or equal to 15:1 indicate phosphorus is limiting, and ratios greater than 10:1, but less than 15:1 indicate there are enough of both nutrients to facilitate excess algae or plant growth. Fish Lake had a TN:TP ratio of 23:1 in 2000 and 2006. This indicates the lake was phosphorous limited. Nitrogen, as well as carbon, naturally occur in high concentrations and come from a variety of sources (soil, air, etc.), which are more difficult to control than sources of phosphorus. Lakes that are phosphorus limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon.

Total phosphorus (TP) concentrations in Fish Lake were high. TP concentrations in the hypolimnion were very high from June to August. Prior to the September sampling, the thermocline began to weaken and allowed TP from the hypolimnion to mix with the epilimnion, causing the TP concentrations to decrease in the hypolimnion and increase in the epilimnion. The 2006 average TP concentration was 0.096 mg/L in the epilimnion and 0.190 mg/L in the hypolimnion. The county median was 0.060 mg/L in the epilimnion and 0.163 mg/L in the hypolimnion. The 2006 TP concentrations were similar to the 2002 concentrations. In 2002 the epilimnetic TP was 0.102 mg/L and the hypolimnetic TP was 0.188 mg/L. Within the Fish Lake Drain watershed, Wooster Lake had the lowest average TP (0.043 mg/L) and Fischer Lake had the highest average TP (0.228 mg/L).

There were external sources contributing to the TP of Fish Lake. One source may have been stormwater from the 3,018.5 acres within its watershed (Figure 4). Agriculture (57%), wetland (10%), and public and private open space (7%) were the major land uses within the watershed (Figure 5). For Fish Lake, transportation (24%) and agricultural areas (18%) were the land uses contributing the highest percentage of estimated runoff (Table 3). It is important to keep in mind that although the amount of estimated runoff from certain areas may be low, those areas can still deliver high concentrations of TSS and TP. The lake's retention time (the amount of time it takes for water entering a lake to flow out of it again) was calculated to be approximately 228 days.

Total phosphorous can be used to calculate the trophic state index (TSIp), which classifies lakes according to the overall level of nutrient enrichment. The TSIp score falls within the range of one of four categories: hypereutrophic, eutrophic, mesotrophic and oligotrophic. Hypereutrophic lakes are those with excessive nutrients, nuisance algae growth reminiscent of "pea soup" and have a TSI score greater than 70. Lakes with a TSI score of 50 or greater are classified as eutrophic or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae. Mesotrophic and oligotrophic lakes have lower nutrient levels. These are very clear lakes, with little algal growth. Most lakes in Lake County are eutrophic. The trophic state of Fish Lake in terms of its phosphorus concentration during 2002 was borderline hypereutrophic, with a TSIp score of 70.9. In 2006 the TSIp score was slightly lower at 69.9, which means it was borderline

Figure 4. Approximate watershed delineation for Fish Lake, 2006.

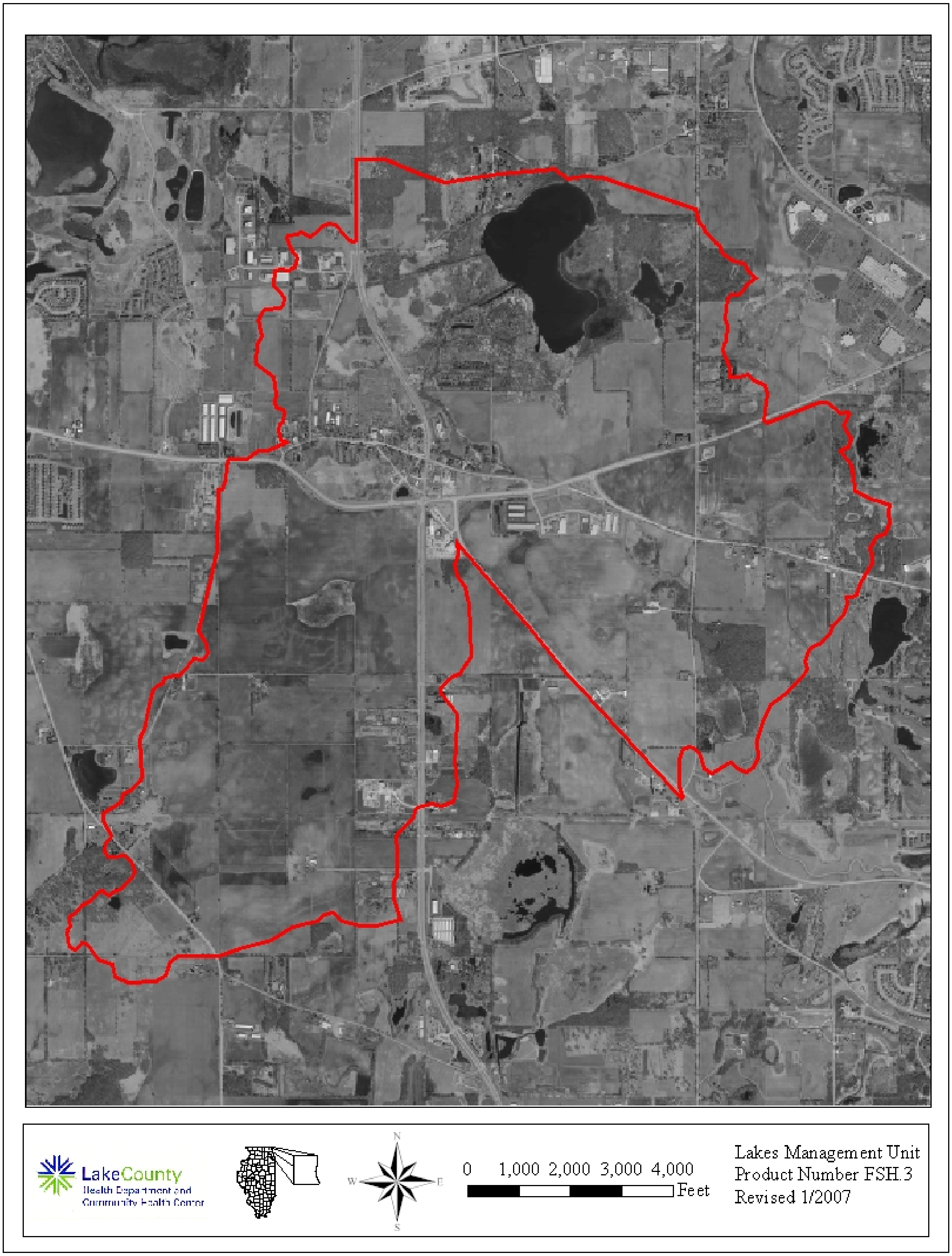


Figure 5. Approximate land use within the Fish Lake watershed, 2006.

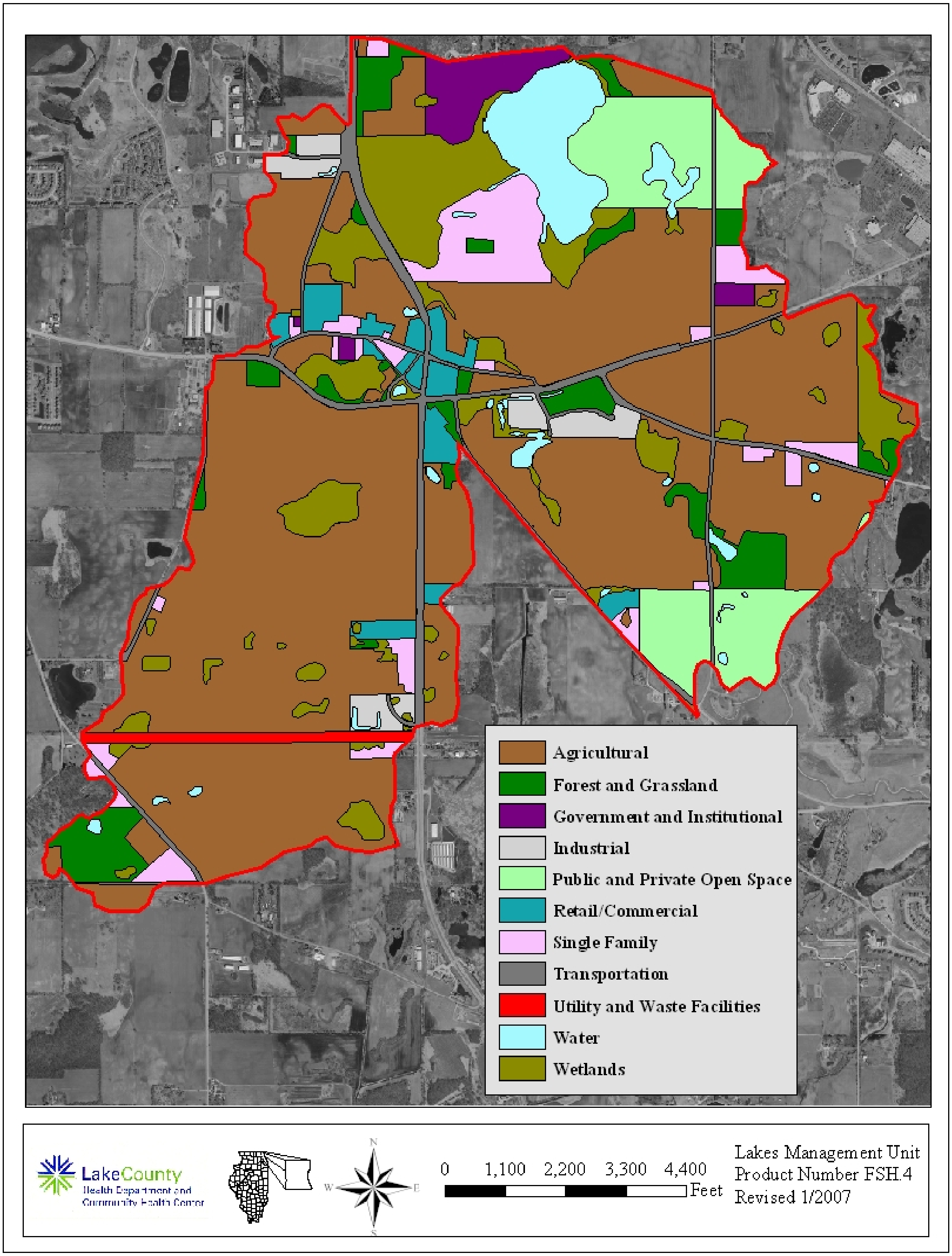


Table 3. Approximate land uses and retention time for Fish Lake, 2006.

Land Use	Acreage	% of Total
Agricultural	1712.41	56.7%
Forest and Grassland	160.75	5.3%
Government and Institutional	61.31	2.0%
Industrial	56.22	1.9%
Public and Private Open Space	214.15	7.1%
Retail/Commercial	77.66	2.6%
Single Family	153.34	5.1%
Transportation	133.61	4.4%
Utility and Waste Facilities	26.13	0.9%
Water	129.68	4.3%
Wetlands	293.28	9.7%
Total Acres	**3018.53**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	1712.41	0.05	235.5	18.1%
Forest and Grassland	160.75	0.05	22.1	1.7%
Government and Institutional	61.31	0.85	143.3	11.0%
Industrial	56.22	0.85	131.4	10.1%
Public and Private Open Space	214.15	0.15	88.3	6.8%
Retail/Commercial	77.66	0.85	181.5	13.9%
Single Family	153.34	0.30	126.5	9.7%
Transportation	133.61	0.85	312.3	24.0%
Utility and Waste Facilities	26.13	0.30	21.6	1.7%
Water	129.68	0.00	0.0	0.0%
Wetlands	293.28	0.05	40.3	3.1%
TOTAL	**3018.53**		**1302.8**	**100.0%**

Lake volume	**813.32**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.62**	**years**
	227.86	**days**

eutrophic. It ranked 104th out of 162 lakes in Lake County based on average TP concentrations (Table 4).

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

Conductivity is the measurement of water's ability to conduct electricity and is correlated with chloride (Cl^-) concentrations (Figure 6). Compared to lakes in undeveloped areas, lakes with residential and/or urban land uses in their watershed often have higher conductivity readings and higher Cl^- concentrations because of the use of road salts. Stormwater runoff from impervious surfaces such as roads and parking lots can deliver high concentrations of this Cl^- to nearby waterbodies. The Lake County median conductivity reading was 0.7954 milliSiemens/cm (mS/cm). During 2006, the average conductivity reading in Fish Lake was higher at 0.8688 mS/cm. This was up 31% from the 2002 average of 0.6629 mS/cm. Chloride concentration in Fish Lake was lower than the Lake County median of 171 mg/L during 2006, with a seasonal average of 141 mg/L. A study done in Canada reported 10% of aquatic species are harmed by prolonged exposure to chloride concentrations greater than 220 mg/L. Additionally, shifts in algal populations in lakes were associated with chloride concentrations as low as 12 mg/l. Therefore, lakes can be negatively impacted by high Cl^- concentrations.

Water levels on Fish Lake remained relatively consistent over the season. Highest levels were found in September, lowest levels in August. The total water level decreased by 4.4 inches from June to August and then increased by 7.4 inches by September for an overall seasonal increase of 3.0 inches. Fluctuating water levels do not appear to be an issue on Fish Lake. Lakes with stable water levels potentially have less shoreline erosion problems.

SUMMARY OF AQUATIC MACROPHYTES

An aquatic plant (macrophyte) survey was conducted in July of 2006. Sampling sites were based on a grid system created by mapping software (ArcMap), with each site located 60 meters apart for a total of 104 sites. On Fish Lake, there were 67 sites sampled (Figure 7). Plants were found at 35 sites and at a maximum depth of 8.5 feet (Table 5a). Overall, a total of 12 plant species were found (Table 6). The most common species was Eurasian Watermilfoil (EWM) at 28% of the sampling sites. White Water Lily was the second most abundant species at 25% of the sampling sites. Similarly, in July 2002, EWM and White Water Lily were the most common aquatic plants. To maintain a healthy sunfish/bass fishery, the Illinois Department of Natural Resources (IDNR) recommends plant coverage be 30% to 40% across the lake bottom. This survey found approximately 52% of the sites sampled had aquatic plants (Table 5b). It was estimated that approximately 34% of the lake bottom was covered by plants.

Table 4. Lake County average TSI phosphorous (TSIp) ranking 2000-2006.

RANK	LAKE NAME	TP AVE	TSIp
1	Cedar Lake	0.0154	43.61
2	Windward Lake	0.0158	43.95
3	Sterling Lake	0.0162	44.31
4	Lake Minear	0.0165	44.57
5	Pulaski Pond	0.0180	45.83
6	Timber Lake	0.0180	45.83
7	Fourth Lake	0.0182	45.99
8	West Loon Lake	0.0182	45.99
9	Lake Carina	0.0193	46.86
10	Independence Grove	0.0194	46.91
11	Lake Kathyrn	0.0200	47.35
12	Lake of the Hollow	0.0200	47.35
13	Banana Pond	0.0202	47.49
14	Bangs Lake	0.0220	48.72
15	Cross Lake	0.0220	48.72
16	Third Lake	0.0221	48.82
17	Dog Pond	0.0222	48.85
18	Sand Pond	0.0230	49.36
19	Stone Quarry Lake	0.0230	49.36
20	Cranberry Lake	0.0240	49.98
21	Deep Lake	0.0240	49.98
22	Druce Lake	0.0244	50.22
23	Little Silver Lake	0.0246	50.33
24	Round Lake	0.0254	50.80
25	Lake Leo	0.0256	50.91
26	Dugdale Lake	0.0274	51.89
27	Peterson Pond	0.0274	51.89
28	Lake Miltmore	0.0276	51.99
29	Ames Pit	0.0278	52.10
30	East Loon Lake	0.0280	52.20
31	Lake Zurich	0.0282	52.30
32	Lake Fairfield	0.0296	53.00
33	Gray's Lake	0.0302	53.29
34	Highland Lake	0.0302	53.29
35	Hook Lake	0.0302	53.29
36	Lake Catherine (Site 1)	0.0308	53.57
37	Lambs Farm Lake	0.0312	53.76
38	Old School Lake	0.0312	53.76
39	Sand Lake	0.0316	53.94
40	Sullivan Lake	0.0320	54.13
41	Lake Linden	0.0326	54.39
42	Gages Lake	0.0338	54.92
43	Hendrick Lake	0.0344	55.17

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
44	Diamond Lake	0.0372	56.30
45	Channel Lake (Site 1)	0.0380	56.60
46	White Lake	0.0408	57.63
47	Sun Lake	0.0410	57.70
48	Potomac Lake	0.0424	58.18
49	Duck Lake	0.0426	58.25
50	Old Oak Lake	0.0428	58.32
51	Wooster Lake	0.0433	58.48
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	Leisure Lake	0.0648	64.30
78	St. Mary's Lake	0.0666	64.70
79	Long Lake	0.0680	65.00
80	Mary Lee Lake	0.0682	65.04
81	Hastings Lake	0.0684	65.08
82	Honey Lake	0.0690	65.21
83	North Tower Lake	0.0718	65.78
84	Lake Fairview	0.0724	65.90
85	Spring Lake	0.0726	65.94
86	ADID 203	0.0730	66.02

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
87	Bluff Lake	0.0734	66.10
88	Harvey Lake	0.0766	66.71
89	Broberg Marsh	0.0782	67.01
90	Countryside Lake	0.0788	67.12
91	Echo Lake	0.0792	67.19
92	Sylvan Lake	0.0794	67.23
93	Big Bear Lake	0.0806	67.45
94	Petite Lake	0.0834	67.94
95	Lake Marie (Site 1)	0.0850	68.21
96	North Churchill Lake	0.0872	68.58
97	Grandwood Park, Site II, Outflow	0.0876	68.65
98	South Churchill Lake	0.0896	68.97
99	Rivershire Pond 2	0.0900	69.04
100	McGreal Lake	0.0914	69.26
101	International Mine and Chemical Lake	0.0948	69.79
102	Eagle Lake (Site I)	0.0950	69.82
103	Dunns Lake	0.0952	69.85
104	**Fish Lake**	**0.0956**	**69.91**
105	Lake Barrington	0.0956	69.91
106	Lochanora Lake	0.0960	69.97
107	Owens Lake	0.0978	70.23
108	Woodland Lake	0.0986	70.35
109	Island Lake	0.0990	70.41
110	McDonald Lake 1	0.0996	70.50
111	Tower Lake	0.1000	70.56
112	Longview Meadow Lake	0.1024	70.90
113	Redwing Slough, Site II, Outflow	0.1072	71.56
114	Lake Forest Pond	0.1074	71.59
115	Bittersweet Golf Course #13	0.1096	71.88
116	Fox Lake (Site 1)	0.1098	71.90
117	Bresen Lake	0.1126	72.27
118	Round Lake Marsh North	0.1126	72.27
119	Timber Lake S	0.1128	72.29
120	Deer Lake Meadow Lake	0.1158	72.67
121	Taylor Lake	0.1184	72.99
122	Grand Avenue Marsh	0.1194	73.11
123	Columbus Park Lake	0.1226	73.49
124	Nippersink Lake (Site 1)	0.1240	73.66
125	Grass Lake (Site 1)	0.1288	74.21
126	Lake Holloway	0.1322	74.58
127	Lakewood Marsh	0.1330	74.67
128	Summerhill Estates Lake	0.1384	75.24
129	Redhead Lake	0.1412	75.53

Table 4. Continued.

RANK	LAKE NAME	TP AVE	TSIp
130	Forest Lake	0.1422	75.63
131	Antioch Lake	0.1448	75.89
132	Valley Lake	0.1470	76.11
133	Slocum Lake	0.1496	76.36
134	Drummond Lake	0.1510	76.50
135	Pond-a-Rudy	0.1514	76.54
136	Lake Matthews	0.1516	76.56
137	Buffalo Creek Reservoir	0.1550	76.88
138	Pistakee Lake (Site 1)	0.1592	77.26
139	Salem Lake	0.1650	77.78
140	Half Day Pit	0.1690	78.12
141	Lake Eleanor Site II, Outflow	0.1812	79.13
142	Lake Farmington	0.1848	79.41
143	ADID 127	0.1886	79.71
144	Lake Louise Inlet	0.1938	80.10
145	Grassy Lake	0.1952	80.20
146	Dog Bone Lake	0.1990	80.48
147	Redwing Marsh	0.2072	81.06
148	Stockholm Lake	0.2082	81.13
149	Bishop Lake	0.2156	81.63
150	Hidden Lake	0.2236	82.16
151	Fischer Lake	0.2278	82.43
152	Lake Napa Suwe (Outlet)	0.2304	82.59
153	Patski Pond (outlet)	0.2512	83.84
154	Oak Hills Lake	0.2792	85.36
155	Loch Lomond	0.2954	86.18
156	McDonald Lake 2	0.3254	87.57
157	Fairfield Marsh	0.3264	87.61
158	ADID 182	0.3280	87.69
159	Slough Lake	0.4134	91.02
160	Flint Lake Outlet	0.4996	93.75
161	Rasmussen Lake	0.5025	93.84
162	Albert Lake, Site II, outflow	1.1894	106.26

Figure 6. Chloride (Cl^-) concentration vs. conductivity for Fish Lake, 2006.

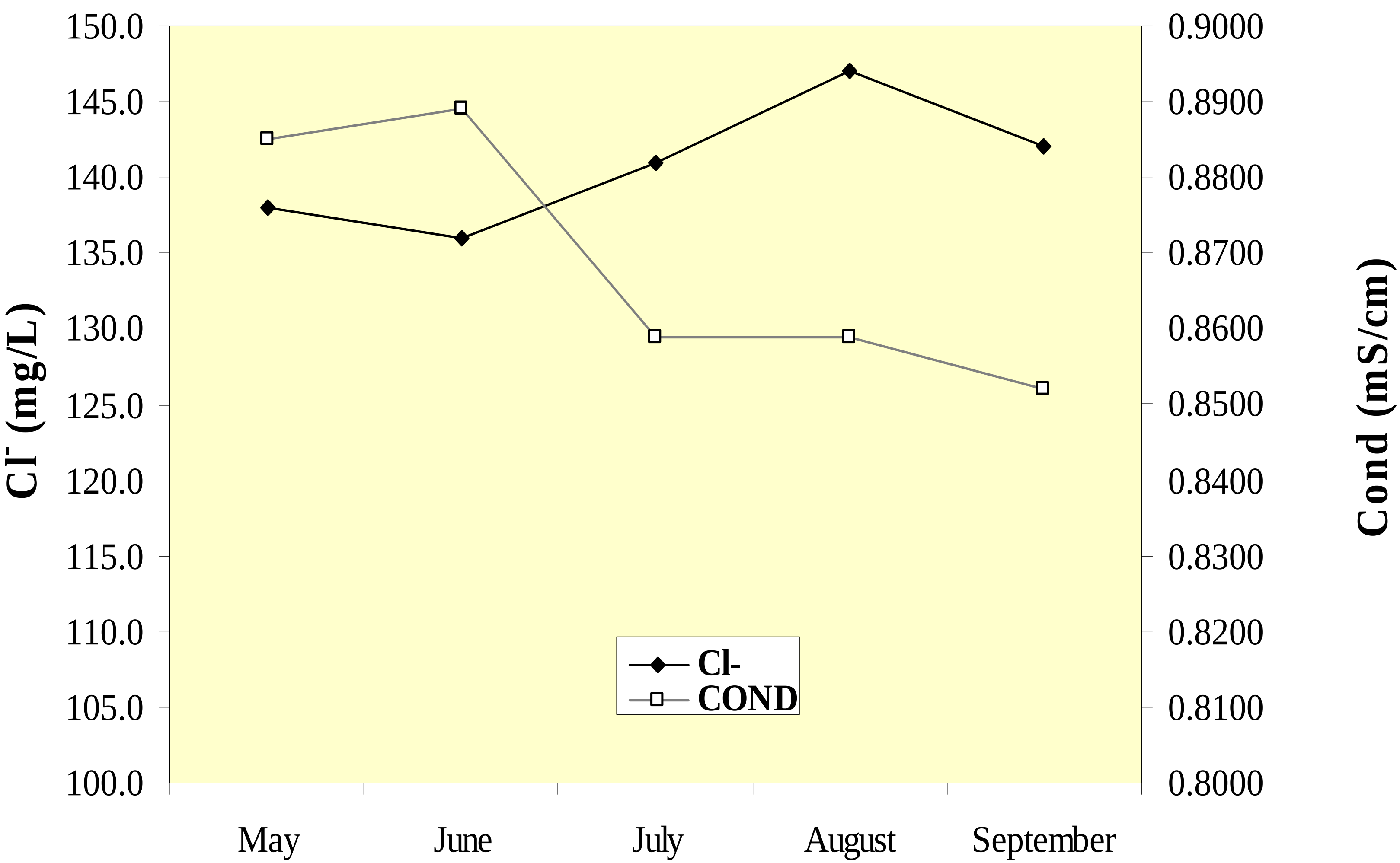


Figure 7. Aquatic plant sampling grid that illustrates plant density on Fish Lake, July 2006.

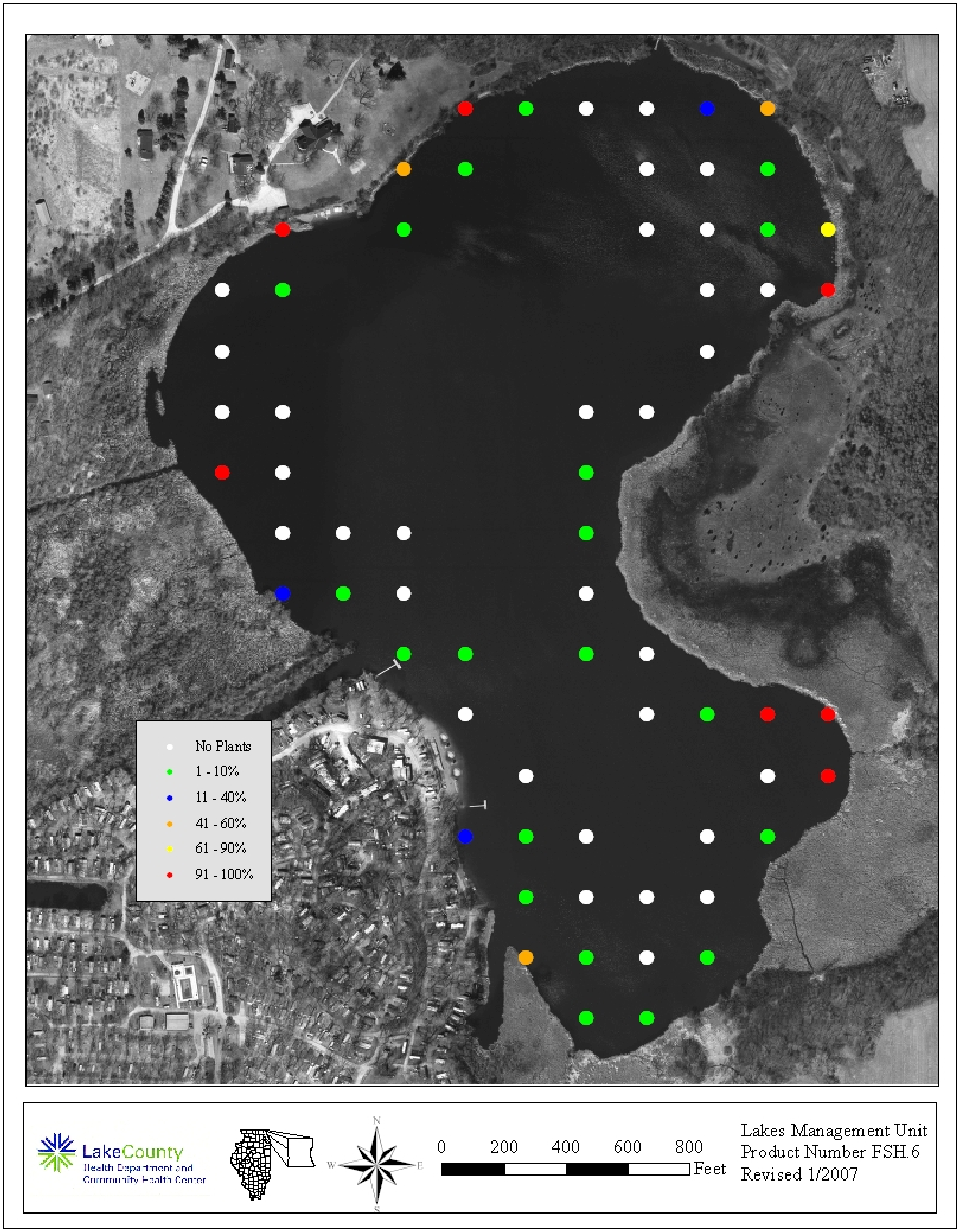


Table 5a. Aquatic plant species found at the 67 sampling sites on Fish Lake, July 2006. Maximum depth that plants were found was 8.7 feet.

Plant Density	Coontail	Curlyleaf Pondweed	Duckweed	Elodea	Eurasian Watermilfoil	Floatingleaf Pondweed	Sago Pondweed	Spatterdock	Vallisineria	Widgeon Grass	Water Stargrass	White Water Lily
Absent	55	66	52	65	48	63	57	65	65	62	65	50
Present	8	0	10	2	17	2	9	0	1	4	1	7
Common	1	1	3	0	2	2	1	1	1	0	1	2
Abundant	3	0	2	0	0	0	0	1	0	0	0	2
Dominant	0	0	0	0	0	0	0	0	0	1	0	6
% Plant Occurrence	18	1	22	3	28	6	15	3	3	7	3	25

Table 5b. Distribution of rake density across all sampled sites.

Rake Density (coverage)	# of Sites	% of Sites
No Plants	32	48
>0-10%	20	30
10-40%	3	4
40-60%	3	4
60-90%	1	1
>90%	8	12
Total Sites with Plants	35	52
Total # of Sites	67	100

Table 6. Aquatic plant species found in Fish Lake in 2006.

Coontail	*Ceratophyllum demersum*
Curlyleaf Pondweed^	*Potamogeton crispus*
Duckweed	*Lemna minor*
American Elodea	*Elodea canadensis*
Eurasian Watermilfoil^	*Myriophyllum spicatum*
Floatingleaf Pondweed	*Potamogeton natans*
Sago Pondweed	*Potamogeton pectinatus*
Spatterdock	*Nuphar variegata*
Vallisineria	*Vallisneria americana*
Widgeon Grass	*Ruppia maritime*
Water Stargrass	*Heteranthera dubia*
White Water Lily	*Nymphaea tuberosa*

^ Exotic plant

Two exotic aquatic plants, EWM and Curlyleaf Pondweed, were found in Fish Lake. Both of these exotics compete with native plants, eventually crowding them out, providing poor natural diversity, and limiting use by wildlife. Removal or control of exotic species is recommended.

Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a specific lake. Aquatic plants will not photosynthesize in water depths with less than 1% of the available sunlight. During 2006, the 1% light level was at 12 feet in May and declined throughout the remaining summer months. By July the 1% light level was 7 feet and due to a sensor malfunction, there were not any readings from August and September.

The Floristic Quality Index (FQI) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates there were large numbers of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for 2000-2006 Lake County lakes was 13.6 (Table 7). Fish Lake had a FQI of 19.3 in 2006 indicating an above average aquatic plant diversity. This was an increase from 2002 when the FQI was 18.1.

Plankton is microscopic plants and animals that are free-floating within the water column. Samples were collected during water quality testing and analyzed for species. In May, there was little phytoplankton, while in June the community was dominated by diatoms (*Fragilaria*). In July, August, and September the phytoplankton community was dominated by *Aphanizomenon*, a

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

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	35.7	37.9
2	Deep Lake	33.9	35.4
3	Round Lake Marsh North	29.1	29.9
4	East Loon Lake	28.4	29.9
5	Deer Lake	28.2	29.7
6	Sullivan Lake	28.2	29.7
7	Little Silver Lake	27.9	30.0
8	Schreiber Lake	26.8	27.6
9	Cranberry Lake	26.6	28.6
10	Bangs Lake	26.4	28.0
11	West Loon Lake	26.0	27.6
12	Cross Lake	25.2	27.8
13	Lake Zurich	24.0	26.0
14	Lake of the Hollow	23.8	26.2
15	Lakewood Marsh	23.8	24.7
16	Round Lake	23.5	25.9
17	Fourth Lake	23.0	24.8
18	Druce Lake	22.8	25.2
19	Sun Lake	22.7	24.5
20	Countryside Glen Lake	21.9	22.8
21	Sterling Lake	21.8	24.1
22	Butler Lake	21.4	23.1
23	Duck Lake	21.1	22.9
24	Timber Lake (North)	20.8	22.8
25	Broberg Marsh	20.5	21.4
26	Davis Lake	20.5	21.4
27	ADID 203	20.5	20.5
28	McGreal Lake	20.2	22.1
29	Wooster Lake	19.8	22.3
30	Lake Kathryn	19.6	20.7
31	**Fish Lake**	**19.3**	**21.2**
32	Redhead Lake	19.3	21.2
33	Owens Lake	19.3	20.2
34	Lake Minear	18.8	20.6
35	Turner Lake	18.6	21.2
36	Salem Lake	18.5	20.2
37	Lake Miltmore	18.4	20.3
38	Hendrick Lake	17.7	17.7
39	Summerhill Estates Lake	17.1	18.0
40	Ames Pit	17.0	18.0
41	Seven Acre Lake	17.0	15.5
42	Gray's Lake	16.9	19.8
43	Grand Avenue Marsh	16.9	18.7

Table 7. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
44	Long Lake	16.9	18.7
45	Bresen Lake	16.6	17.8
46	Windward Lake	16.3	17.6
47	Lake Barrington	16.3	17.4
48	Diamond Lake	16.3	17.4
49	Lake Napa Suwe	16.3	17.4
50	Dog Bone Lake	15.7	15.7
51	Redwing Slough	15.6	16.6
52	Independence Grove	15.5	16.7
53	Tower Lake	15.2	17.6
54	Heron Pond	15.1	15.1
55	Lake Tranquility (S1)	15.0	17.0
56	North Churchill Lake	15.0	15.0
57	Island Lake	14.7	16.6
58	Dog Training Pond	14.7	15.9
59	Highland Lake	14.5	16.7
60	Lake Fairview	14.3	16.3
61	Taylor Lake	14.3	16.3
62	Third Lake	14.1	16.3
63	Dugdale Lake	14.0	15.1
64	Eagle Lake (S1)	14.0	15.1
65	Longview Meadow Lake	13.9	13.9
66	Hook Lake	13.4	15.5
67	Timber Lake (South)	13.4	15.5
68	Bishop Lake	13.4	15.0
69	Mary Lee Lake	13.1	15.1
70	Old School Lake	13.1	15.1
71	Buffalo Creek Reservoir	13.1	14.3
72	McDonald Lake 2	13.1	14.3
73	Old Oak Lake	12.7	14.7
74	White Lake	12.7	14.7
75	Dunn's Lake	12.7	13.9
76	Echo Lake	12.5	14.8
77	Hastings Lake	12.5	14.8
78	Sand Lake	12.5	14.8
79	Countryside Lake	12.5	14.0
80	Stone Quarry Lake	12.5	12.5
81	Honey Lake	12.1	14.3
82	Lake Leo	12.1	14.3
83	Lambs Farm Lake	12.1	14.3
84	Stockholm Lake	12.1	13.5
85	Pond-A-Rudy	12.1	12.1
86	Lake Matthews	12.0	12.0

Table 7. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
87	Flint Lake	11.8	13.0
88	Harvey Lake	11.8	13.0
89	Rivershire Pond 2	11.5	13.3
90	Antioch Lake	11.3	13.4
91	Lake Charles	11.3	13.4
92	Lake Linden	11.3	11.3
93	Lake Naomi	11.2	12.5
94	Pulaski Pond	11.2	12.5
95	Redwing Marsh	11.0	11.0
96	West Meadow Lake	11.0	11.0
97	Nielsen Pond	10.7	12.0
98	Lake Holloway	10.6	10.6
99	Lake Carina	10.2	12.5
100	Crooked Lake	10.2	12.5
101	Lake Lakeland Estates	10.0	11.5
102	College Trail Lake	10.0	10.0
103	Werhane Lake	9.8	12.0
104	Big Bear Lake	9.5	11.0
105	Little Bear Lake	9.5	11.0
106	Loch Lomond	9.4	12.1
107	Sand Pond (IDNR)	9.4	12.1
108	Columbus Park Lake	9.2	9.2
109	Sylvan Lake	9.2	9.2
110	Fischer Lake	9.0	11.0
111	Grandwood Park Lake	9.0	11.0
112	Lake Fairfield	9.0	10.4
113	McDonald Lake 1	8.9	10.0
114	East Meadow Lake	8.5	8.5
115	South Churchill 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	Bittersweet Golf Course #13	8.1	8.1
120	Woodland Lake	8.1	9.9
121	Albert Lake	7.5	8.7
122	Lake Eleanor	7.5	8.7
123	Fairfield Marsh	7.5	8.7
124	Lake Louise	7.5	8.7
125	Banana Pond	7.5	9.2
126	Patski Pond	7.1	7.1
127	Rasmussen Lake	7.1	7.1
128	Slough Lake	7.1	7.1
129	Lucky Lake	7.0	7.0

Table 7. Continued.

Rank	Lake Name	FQI (w/A)	FQI (native)
130	Lake Forest Pond	6.9	8.5
131	Leisure Lake	6.4	9.0
132	Peterson Pond	6.0	8.5
133	Grassy Lake	5.8	7.1
134	Slocum Lake	5.8	7.1
135	Gages Lake	5.8	10.0
136	Deer Lake Meadow Lake	5.2	6.4
137	ADID 127	5.0	5.0
138	Liberty Lake	5.0	5.0
139	Oak Hills Lake	5.0	5.0
140	Drummond Lake	5.0	7.1
141	IMC Lake	5.0	7.1
142	North Tower Lake	4.9	7.0
143	Forest Lake	3.5	5.0
144	Half Day Pit	2.9	5.0
145	Lochanora Lake	2.5	5.0
146	Hidden Lake	0.0	0.0
147	St. Mary's Lake	0.0	0.0
148	Valley Lake	0.0	0.0
149	Waterford Lake	0.0	0.0
150	Potomac Lake	0.0	0.0
151	Willow Lake	0.0	0.0
	Mean	**13.6**	**14.9**
	Median	**12.5**	**14.3**

blue-green algae (Figure 8). Rotifers dominated the zooplankton community in Fish Lake in 2006 (Figure 9). In July, Rotifer population peaked while the phytoplankton population declined. This was due to the rotifers feeding on the abundant phytoplankton in June.

SUMMARY OF SHORELINE CONDITION

In 2002 an assessment was conducted to determine the condition of the shoreline at the water/land interface. Approximately 63% of the shoreline was classified as undeveloped. The only developments were the YMCA's Camp Duncan and the Fish Lake Campground. The dominant shoreline type was wetland, comprising 88% of the total shoreline. Beach was the next most common type at 10%, while the remaining types (buffer, shrub, seawall, and lawn) made up the remaining 2%.

Several exotics were found growing along the shoreline during the 2002 assessment, including Reed Canary Grass, Purple Loosestrife, and Buckthorn. The Purple Loosestrife was found in scattered numbers with the highest concentrations along the northwestern shoreline. Buckthorn and Reed Canary Grass could become problems if not contained. Similar to aquatic exotics, these terrestrial exotics are detrimental to the native plant ecosystems around the lake. Removal or control of exotic species is recommended.

In 2002, the LCFPD found Yellow Sedge (*Carex cryptolepis)*, Richardson's Rush (*Juncus alpinus rariflorus),* and Wiry Panicgrass (*Panicum flexile*), which are listed as threatened or endangered species by the state of Illinois, in the wetland area on the east side of the lake.

In 2002, the shoreline was also assessed for the degree of erosion and there was no erosion found. The shoreline was reassessed in 2006 for significant changes in erosion since 2002. Based on the 2006 assessment, erosion had developed at various areas around the lake (Figure 10). Overall, 89% of the shoreline had no erosion, 7% had slight erosion, 3% had moderate erosion, and 1% had severe erosion. Continued neglect of these shorelines could lead to further erosion, resulting in a loss of property and soil inputs into the water that can negatively affect water clarity. The area of severe erosion should be addressed soon. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion. If these shorelines are repaired by the installation of a buffer strip with native plants, the benefits can be three-fold. First, the erosion is repaired and the new native plants can stabilize the shoreline to prevent future erosion. Second, the addition of native plants adds habitat for wildlife to a shoreline that is otherwise limited in habitat. Thirdly, buffer habitat can help filter pollutants and nutrients from the near shore areas and keep geese and gulls from congregating, as it is not desirable habitat for them.

Figure 8. Phytoplankton counts for Fish Lake, 2006

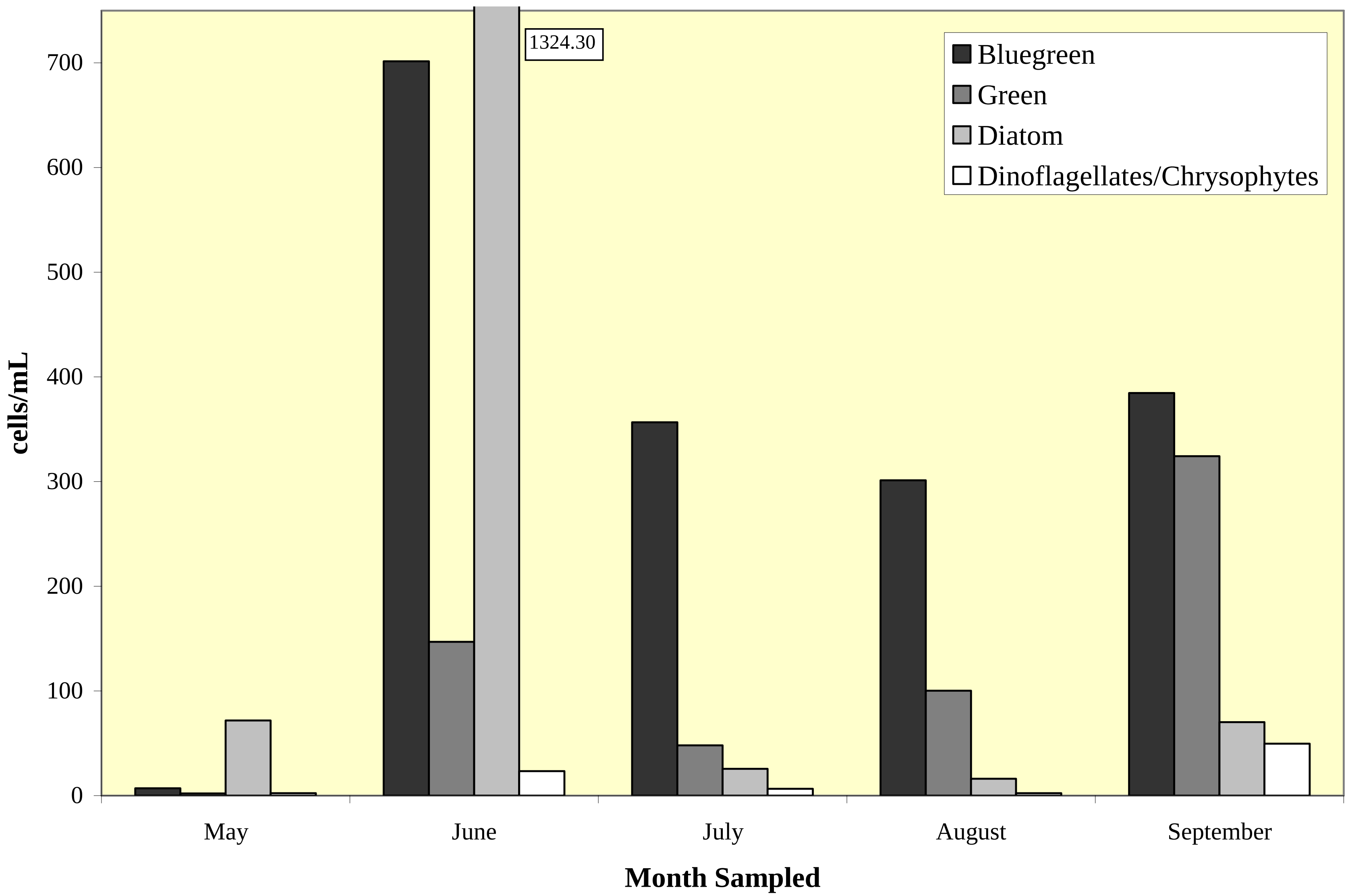


Figure 9. Zooplankton counts for Fish Lake, 2006

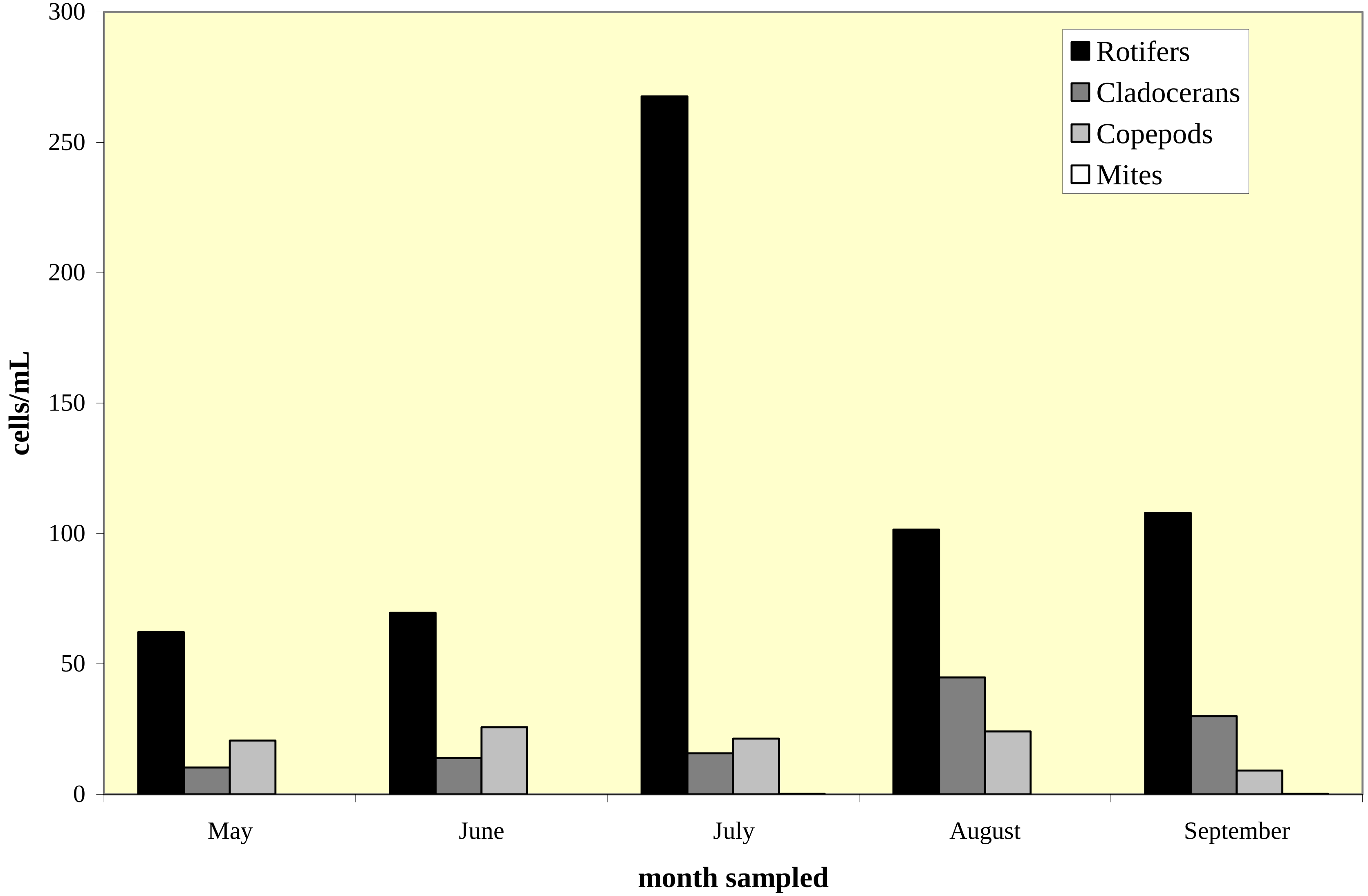
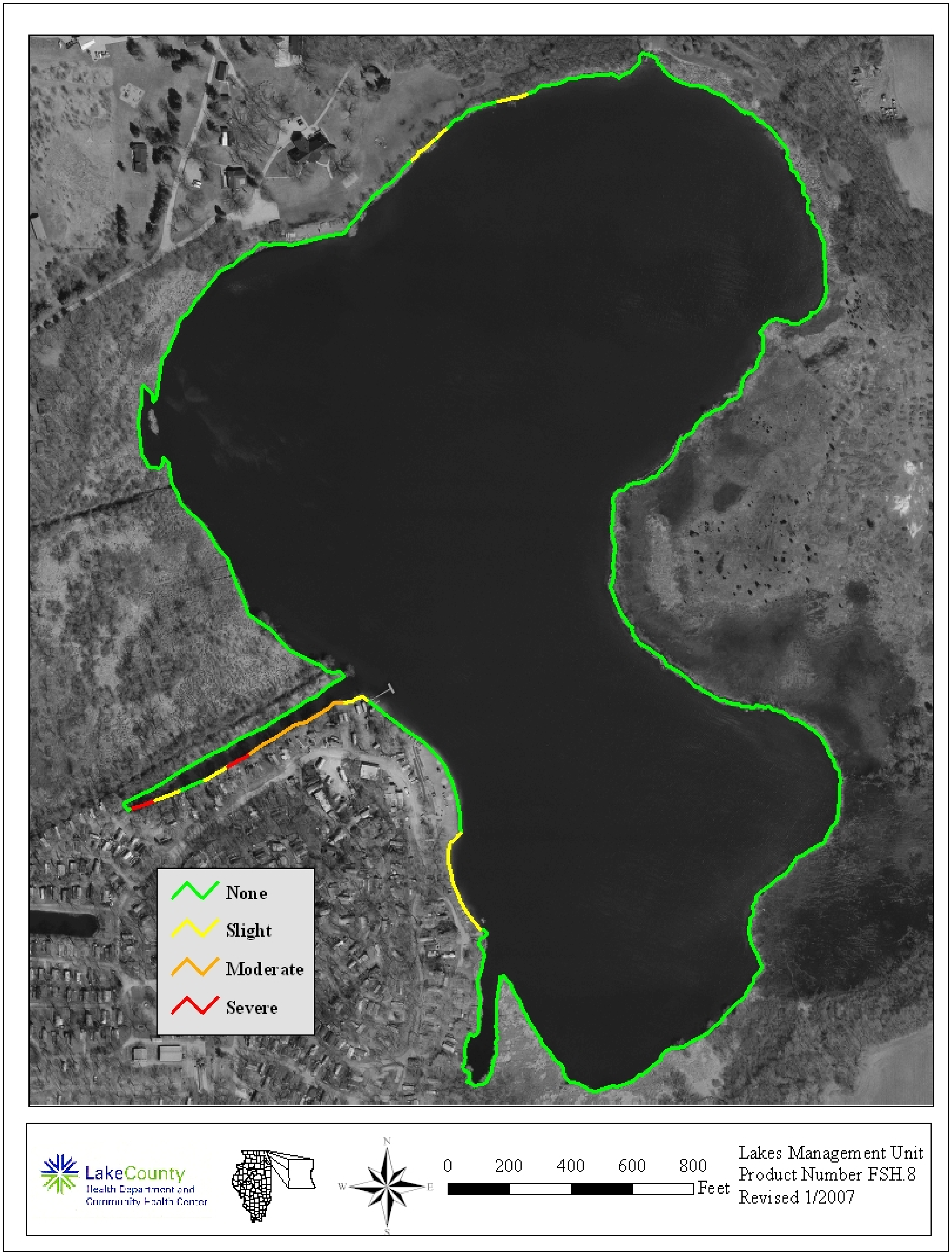


Figure 10. Shoreline erosion on Fish Lake, 2006.



SUMMARY OF WILDLIFE AND HABITAT CONDITIONS

Good numbers of wildlife, particularly birds, were noted on and around Fish Lake. Habitat around Fish Lake was fair to good. The dominance of cattails provides habitat for some wildlife species, but precludes a more diverse abundance of species due to its lack of plant diversity. The scattered trees around the lake provide good habitat for many insectivorous birds.

The Black Tern, listed as endangered in the state of Illinois, was seen throughout the summer. Fish Lake provides ample habitat for nesting Black Terns as well as other species. In 2002, LCFPD found five state threatened or endangered bird species (Pied-Billed Grebe, Black Tern, Black-Crowned Night Heron, Common Moorhen, and Yellow-Headed Blackbird) in the wetland area on the east side of the lake.

The IDNR conducted a fish population survey in 2004. A total of 309 fish were collected representing 11 species. Yellow Bass was the most abundant species followed by Bluegill, Largemouth Bass, Black Crappie, and Common Carp. The IDNR concluded the fishery was dominated by Yellow Bass and a heavy predator (e.g. Largemouth Bass or Northern Pike) stocking program might influence their stronghold on the overall fishery. The IDNR recommendations include stocking of non-vulnerable Channel Catfish (8 – 10 inch), establishing a 15-inch minimum length limit and 1 or 3 per day bag limit on Largemouth Bass, practice catch and release of Largemouth Bass in May to increase spawning/nesting success, and promoting the harvest of Yellow Bass and Common Carp.

LAKE MANAGEMENT RECOMMENDATIONS

Fish Lake has both positive and negative aspects. Some of the positives include a large portion of the shoreline being undeveloped providing good wildlife habitat and participation in the VLMP. Fish Lake has participated in the VLMP since 2003 providing valuable data from the years the LMU did not sample the lake. In addition to continuing to collect the VLMP data, the LMU recommends installing a staff gauge to monitor the lake water level. To improve the quality of Fish Lake, the LMU has the following recommendations:

- **Creating a Bathymetric Map**

  The LMU suggests any maps older than 10 years be updated. Fish Lake has a map that was created in 1971. Creating an updated bathymetric map can help with improvements to Fish Lake. The LMU recommends a bathymetric map to help with management strategies. Volumetric data is important in calculating how much of the lake is anoxic and determining herbicide application rates. (Appendix D1).

- **Lakes with Shoreline Erosion**

  There have been areas of the lake that have started to show erosion since 2002. These eroded areas should be repaired to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired using natural vegetation instead of riprap or seawalls (Appendix D2).

- **Watershed Nutrient Reduction**

  Fish Lake has a high phosphorous concentration from internal loading which is likely to continue for years to come. Some recommendations to reduce any further phosphorous input include the use of phosphorous free lawn fertilizers along with watershed management practices (Appendix D3; D4).

- **Reduce Conductivity and Chloride Concentration**

  The average conductivity in Fish Lake has increased by 24% since 2002. Although the chloride concentration was below the county median, it was still high enough to potentially have impacts on aquatic life. The use of road salts for winter road management is a major contributor to chloride concentrations and conductivity. Proper application procedures and alternative methods can be used to keep these concentrations under control (Appendix D5).

- **Aquatic Pant Management**

  Approximately 34% of Fish Lake's bottom had aquatic plant coverage with Eurasian Watermilfoil (EWM) dominating the plant community. An increase of plant diversity in the lake is recommended, with control of EWM being a high priority. At this time, it is not a problem but has the potential to become one. Native plants will help improve the water quality of the lake and utilize the abundant nutrients, as well as increased habitat for fish and wildlife. Emergent plants (like arrowheads and bulrushes) will also help buffer wave action that causes erosion (Appendix D6).

Eliminate or Control Exotic Species

Numerous shoreline exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. The outcome is a loss of plant and animal diversity. Plants such as Purple Loosestrife (*Lithium salicaria*), Buckthorn (*Rhamnus cathartica*), and Reed Canary Grass (*Phalaris arundinacea*) are three examples. During 2002 these exotic species were found along the shoreline and should be eliminated (Appendix D7).

Grant Program Opportunities

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

APPENDIX A. METHODS FOR FIELD DATA COLLECTION AND LABORATORY ANALYSES

Water Sampling and Laboratory Analyses

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

Plant Sampling

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

Plankton Sampling

Plankton were sampled at the same location as water quality samples. Using the Hydrolab DataSonde® 4a or YSI 6600 Sonde® 1% light level depth (depth where the water light is 1% of the surface irradiance) was determined. A plankton net/tow, with 63μm mesh, was then lowered to the pre-determined 1% light level depth and retrieved vertically. On the way up the water column, plankton were collected within a small cup on the bottom of the tow. The collected sample was then emptied into a pre-labeled brown plastic bottle. The net was rinsed with deionized water into the bottle in order to ensure all the plankton were collected. The sample was then transferred to a graduated cylinder to measure the amount of milliliters (mL) that the sample was. The sample was then returned to the bottle and preserved with Lugol's iodine solution (5 drops/mL). The sample bottle was then closed and stored in a cooler until returning to the lab, where it was transferred to the refrigerator until enumeration. Enumeration was performed within three months, but ideally within one month, under a microscope. Prior to sub-sample being removed for enumeration, the sample bottle was inverted several times to ensure proper homogenization. An automated pipette was used to retrieve 1 mL of sample, which was then placed in a Sedgewick Rafter slide. This is a microscope slide on which a rectangular chamber has been constructed, measuring 50 mm x 20 mm in area and 1 mm deep. The slide was then placed under the microscope and counted at a 20X magnification (phytoplankton) or 10X magnification (zooplankton). For phytoplankton, twenty fields of view were randomly counted with all species within each field counted. Due to their larger size, zooplankton were counted throughout the entire slide. Through calculations, it was determined how many of each species were in 1 mL of lake water.

Shoreline Assessment

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

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

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

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

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

Wildlife Assessment

Species of wildlife were noted during visits to each lake. When possible, wildlife was identified to species by sight or sound. However, due to time constraints, collection of quantitative information was not possible. Thus, all data should be considered anecdotal.
Some of the species on the list may have only been seen once, or were spotted during their migration through the area.

Table A1. Analytical methods used for water quality parameters.

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 FISH LAKE IN 2006.

Fish Lake 2006 Multiparameter data

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.36
05/16/2006		0.5	0.503	14.04	9.01	87.7	0.8850	7.89	691.4	Surface		
05/16/2006		1	0.994	14.04	8.42	81.9	0.8850	7.92	533.0	Surface	100%	
05/16/2006		2	2.044	14.04	8.40	81.8	0.8850	7.92	105.4	0.374	20%	4.33
05/16/2006		3	2.930	14.04	8.37	81.5	0.8850	7.96	50.8	1.260	10%	0.58
05/16/2006		4	3.990	14.04	8.37	81.5	0.8860	7.98	39.3	2.320	7%	0.11
05/16/2006		5	5.086	14.03	8.34	81.2	0.8860	7.98	30.5	3.416	6%	0.07
05/16/2006		6	5.986	14.03	8.29	80.7	0.8860	7.99	26.2	4.316	5%	0.04
05/16/2006		7	7.061	13.99	8.21	79.9	0.8870	7.99	19.1	5.391	3.6%	0.06
05/16/2006		8	7.946	13.97	8.11	78.8	0.8870	7.98	16.9	6.276	3.2%	0.02
05/16/2006		9	8.955	13.95	8.07	78.5	0.8880	7.99	12.8	7.285	2.4%	0.04
05/16/2006		10	10.021	13.93	8.07	78.4	0.8860	7.99	9.6	8.351	1.8%	0.03
05/16/2006		11	10.968	13.92	8.02	77.9	0.8850	8.01	7.6	9.298	1.4%	0.03
05/16/2006		12	12.001	13.89	8.01	77.7	0.8860	8.01	5.9	10.331	1.1%	0.02
05/16/2006		13	12.993	13.89	7.97	77.4	0.8860	7.98	4.4	11.323	0.8%	0.03
05/16/2006		14	13.953	13.89	7.94	77.1	0.8880	7.98	3.6	12.283	0.7%	0.02
05/16/2006		15	15.011	13.85	7.88	76.4	0.8910	7.98	3.2	13.341	0.6%	0.01
05/16/2006		16	15.984	13.41	7.03	67.5	0.9440	7.91	2.9	14.314	0.5%	0.01

Fish Lake 2006 Multiparameter data

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.41
06/20/2006		0.5	0.527	24.21	11.34	135.6	0.8880	7.81	2664.7	Surface		
06/20/2006		1	1.060	24.23	11.40	136.3	0.8890	7.92	2238.9	Surface	100%	
06/20/2006		2	1.998	24.21	11.16	133.4	0.8890	8.02	529.0	-0.610	84%	-0.29
06/20/2006		3	3.003	24.20	10.94	130.8	0.8890	8.08	165.2	0.328	20%	4.40
06/20/2006		4	3.998	24.17	10.86	129.7	0.8890	8.10	80.7	1.333	6%	0.87
06/20/2006		5	4.997	24.16	10.59	126.4	0.8890	8.13	47.3	2.328	3%	0.31
06/20/2006		6	5.996	24.15	10.61	126.6	0.8890	8.16	26.1	3.327	2%	0.16
06/20/2006		7	7.020	24.10	10.48	125.0	0.8900	8.18	11.6	4.326	1.0%	0.14
06/20/2006		8	8.002	24.05	10.15	121.0	0.8900	8.19	7.5	5.350	0.4%	0.15
06/20/2006		9	8.979	23.98	9.36	111.4	0.8910	8.18	4.4	6.332	0.3%	0.07
06/20/2006		10	10.006	22.33	4.84	55.8	0.9030	8.03	2.7	7.309	0.2%	0.07
06/20/2006		11	11.000	21.14	0.83	9.4	0.9060	7.85	1.7	8.336	0.1%	0.06
06/20/2006		12	11.986	19.96	0.37	4.1	0.9100	7.70	1.0	9.330	0.1%	0.05
06/20/2006		13	13.008	19.43	0.29	3.1	0.9160	7.60	0.6	10.316	0.0%	0.05
06/20/2006		14	13.973	19.00	0.23	2.5	0.9240	7.50	0.4	11.338	0.0%	0.05
06/20/2006		15	15.019	18.79	0.19	2.0	0.9290	7.41	0.2	12.303	0.0%	0.03
06/20/2006		16	16.017	18.50	0.16	1.8	0.9360	7.35	0.1	13.349	0.0%	0.05

Fish Lake 2006 Multiparameter data

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission	Extinction Coefficient
											Average	0.52
07/18/2006		0.5	0.509	28.35	8.15	105.0	0.8440	7.92	3254.8	Surface		
07/18/2006		1	1.005	28.36	8.14	104.9	0.8440	7.98	3204.2	Surface	100%	
07/18/2006		2	1.988	28.35	8.12	104.6	0.8440	8.12	496.4	0.318	15%	5.86
07/18/2006		3	3.001	28.35	8.08	104.1	0.8590	8.12	190.8	1.331	6%	0.72
07/18/2006		4	4.040	28.34	8.04	103.6	0.8440	8.11	84.7	2.370	3%	0.34
07/18/2006		5	4.990	28.31	7.95	102.4	0.8440	8.10	48.9	3.320	2%	0.17
07/18/2006		6	5.999	28.29	7.86	101.2	0.8440	8.08	30.4	4.329	0.9%	0.11
07/18/2006		7	7.003	28.21	7.88	101.2	0.8450	8.08	15.5	5.333	0.5%	0.13
07/18/2006		8	8.004	26.62	3.35	41.9	0.8660	7.92	8.1	6.334	0.3%	0.10
07/18/2006		9	9.008	25.56	0.73	9.0	0.8740	7.75	4.6	7.338	0.1%	0.08
07/18/2006		10	9.991	23.79	0.26	3.1	0.8980	7.55	2.6	8.321	0.1%	0.07
07/18/2006		11	11.005	22.71	0.23	2.7	0.9020	7.43	1.7	9.335	0.1%	0.05
07/18/2006		12	11.997	21.70	0.19	2.2	0.9280	7.25	1.0	10.327	0.0%	0.05
07/18/2006		13	13.007	20.71	0.16	1.7	0.9570	7.12	0.6	11.337	0.0%	0.05
07/18/2006		14	14.012	20.41	0.02	0.2	0.9790	7.01	0.4	12.342	0.0%	0.03
07/18/2006		15	14.992	20.26	-0.05	-0.6	0.9820	6.73	0.2	13.322	0.0%	0.05
07/18/2006		16	16.037	19.83	-0.12	-1.3	0.9780	6.67	0.3	14.367	0.0%	-0.03

Fish Lake 2006 Multiparameter data

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient NA
08/15/2006		0.5	0.498	24.60	6.40	77.0	0.8580	8.17	NA	Surface		
08/15/2006		1	0.995	24.62	6.06	72.9	0.8580	8.17	NA	Surface	NA	
08/15/2006		2	1.993	24.60	6.07	73.1	0.8580	8.17	NA	0.323	NA	NA
08/15/2006		3	2.999	24.59	5.94	71.5	0.8590	8.16	NA	1.329	NA	NA
08/15/2006		4	3.994	24.55	5.70	68.5	0.8590	8.14	NA	2.324	NA	NA
08/15/2006		5	5.008	24.55	5.71	68.7	0.8590	8.14	NA	3.338	NA	NA
08/15/2006		6	6.002	24.54	5.69	68.5	0.8590	8.15	NA	4.332	NA	NA
08/15/2006		7	7.001	24.54	5.75	69.2	0.8580	8.16	NA	5.331	NA	NA
08/15/2006		8	8.001	24.48	5.61	67.4	0.8590	8.14	NA	6.331	NA	NA
08/15/2006		9	9.000	24.41	5.31	63.7	0.8600	8.11	NA	7.330	NA	NA
08/15/2006		10	10.007	24.29	5.07	60.7	0.8640	8.02	NA	8.337	NA	NA
08/15/2006		11	11.004	24.26	3.96	47.4	0.8670	7.88	NA	9.334	NA	NA
08/15/2006		12	11.998	23.90	1.22	14.6	0.9000	7.33	NA	10.328	NA	NA
08/15/2006		13	12.994	23.36	0.21	2.5	0.9170	7.13	NA	11.324	NA	NA
08/15/2006		14	14.001	22.88	0.21	2.5	0.9440	7.02	NA	12.331	NA	NA
08/15/2006		15	15.003	21.38	0.22	2.5	1.0100	6.85	NA	13.333	NA	NA
08/15/2006		16	16.006	20.45	0.34	3.7	1.0370	6.81	NA	14.336	NA	NA

Fish Lake 2006 Multiparameter data

Date MMDDYY	Time HHMMSS	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average	Extinction Coefficient NA
09/19/2006		0.5	0.492	19.34	7.89	85.8	0.852	8.22	NA	Surface		
09/19/2006		1	0.998	19.35	7.64	83.1	0.841	8.22	NA	Surface	NA	
09/19/2006		2	2.005	19.34	7.65	83.3	0.841	8.22	NA	0.335	NA	NA
09/19/2006		3	3.004	19.35	7.78	84.7	0.852	8.22	NA	1.334	NA	NA
09/19/2006		4	4.005	19.35	7.63	83.0	0.840	8.23	NA	2.335	NA	NA
09/19/2006		5	5.007	19.36	7.61	82.8	0.841	8.24	NA	3.337	NA	NA
09/19/2006		6	6.003	19.35	7.64	83.1	0.841	8.23	NA	4.333	NA	NA
09/19/2006		7	7.005	19.34	7.56	82.2	0.841	8.23	NA	5.335	NA	NA
09/19/2006		8	8.006	19.34	7.54	82.1	0.841	8.24	NA	6.336	NA	NA
09/19/2006		9	8.998	19.33	7.36	80.1	0.840	8.23	NA	7.328	NA	NA
09/19/2006		10	10.000	19.32	7.40	80.5	0.852	8.22	NA	8.330	NA	NA
09/19/2006		11	10.985	19.26	7.33	79.6	0.841	8.22	NA	9.315	NA	NA
09/19/2006		12	11.982	19.25	7.06	76.7	0.841	8.20	NA	10.312	NA	NA
09/19/2006		13	13.011	19.19	6.97	75.6	0.840	8.20	NA	11.341	NA	NA
09/19/2006		14	13.994	19.18	6.91	75.0	0.839	8.19	NA	12.324	NA	NA
09/19/2006		15	14.998	19.09	6.66	72.1	0.843	8.17	NA	13.328	NA	NA
09/19/2006		16	16.001	18.74	6.43	69.1	0.860	8.10	NA	14.331	NA	NA

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 Lakes with Shoreline Erosion

Option 1: Install a Seawall

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

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

Option 2: Install Rock Rip-Rap or Gabions

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

Rip-rap and gabions can provide good shoreline erosion control. Rocks can absorb some of the wave energy while providing a more aesthetically pleasing appearance than seawalls. If installed properly, rip-rap and gabions will last for many years. Maintenance is relatively low, however, undercutting of the bank can cause sloughing of the rip-rap and subsequent shoreline. Fish and wildlife habitat can also be provided if large (not small) boulders are used. A major disadvantage of rip-rap is the initial expense of installation and associated permits. Installation is expensive since a licensed contractor and heavy equipment are generally needed to conduct the work. Permits are required if replacing existing or installing new rip-rap or gabions and must be acquired prior to work beginning.

Option 3: Create a Buffer Strip

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

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

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

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

These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Biologs, fiber rolls, and straw blankets provide erosion control that secure the shoreline in the short-term and allow native plants to establish which will eventually provide long-term shoreline stabilization. They are most often made of bio-degradable materials, which break down by the time the natural vegetation becomes established (generally within 3 years). They provide additional strength to the shoreline, absorb wave energy, and effectively filter run-off from watershed sources. They are most effective in areas where plantings alone are not effective due to existing erosion.

Option 5: Install A-Jacks®

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

D3. Options for Watershed Nutrient Reduction

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

Option 1. Buffer Strips

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

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

a. Compost yard waste instead of burning. Ashes from yard waste contain nutrients and are easily washed into a lake.

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

Option 3. Street Sweeping

Street sweeping has been used in communities to help prevent debris from clogging stormsewer drains, but it also benefits lakes by removing excess phosphorus, sand, silt and other pollutants. Leftover sand and salt applied to streets has been found to contain higher concentrations of silt, phosphorus and trace metals than new sand and salt mixes. If a municipality does not manage the lake, the lake management entity may be able to offer the village or city extra payment for sweeping streets closest to the lake.

Option 4: Reduce Stormwater Volume from Impervious Surfaces

The quality and quantity of runoff directly affects the lake's water quality. With continued growth and development in Lake County, more impervious surfaces such as parking lots and buildings contribute to the volume of stormwater runoff. Runoff picks up pollutants such as nutrients and sediment as it moves over land or down gutters. A faster flow rate and higher volume can result in erosion and scouring, adding sediment and nutrients to the runoff. Roof downspouts should be pointed away from driveways and foundations and toward lawns or planting beds where water can soak into the soil. A splash block directly below downspouts helps prevent soil erosion. If erosion still occurs, a flexible perforated plastic tubing attached to the downspout can dissipate the water flow.

Option 5: Required Practices for Construction

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

Option 6. Organize a Local Watershed Organization

A watershed organization can be instrumental in circulating educational information about watersheds and how to care for them. Often a galvanized organization can be a stronger working unit and a stronger voice than a few individuals. Watershed residents are the first to notice problems in the area, such as a lack of erosion control at construction sites. This organization would be an advocate for the watershed, and members could voice their concerns about future development impacts to local officials. This organization could educate the community about how phosphorus (and other pollutants) affect lakes and can help people implement watershed controls. Several types of educational outreaches can be used together for best results. These include: community newsletters, newspaper articles, local cable and radio station announcements. In some cases fundraising may be utilized to secure more funding for a project.

Option 7. Discourage Waterfowl from Congregating

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

D4. Options for Large Scale Sediment and Nutrient Controls

Below are controls that are helpful in sediment and/or nutrient controls within a watershed. These are expensive, and are usually municipal projects or those set in place by developers as part of their projects.

Option 1. Detention Basins

Detention basins are man made bodies of water with restricted discharge outlets that allow gradual release of stormwater runoff to a downstream drainage system. The primary method of runoff pollutant (sediment, nutrients) removal is settling. Detention basins have a removal efficiency of at least 60% for sediment, between 20% - 80% for total phosphorus, and between 20% - 60% for total nitrogen. When designed properly and maintained, these basins can enhance wildlife habitat and add to the aesthetics of the neighborhood, however water is often turbid and nutrient enriched.

Option 2. Catch Basins

Stormwater that flows down streets with curbs and gutters empty into stormwater drains. During construction, these drains are fitted with a catch basin to collect coarse sediment. Some existing stormwater drains can be retrofitted with catch basins. These catch basins have a short holding time, and need to be regularly cleaned out in order for them to function properly.

Option 3. Constructed Wetlands

Wetlands can act as traps for nutrients and sediment as stormwater flows toward a lake or pond. The removal efficiency of constructed wetlands depends on the design and is site specific. A naturally established wetland is easier to use for this purpose than constructing a new one, but a natural wetland cannot properly perform these functions under high flows or repeatedly for years. Construction of a wetland can be difficult and expensive and may take a few years for plants to establish, however once established it most likely will provide good wildlife habitat.

Option 4. Vegetated Swales

Vegetated swales are open, vegetated ditches that are frequently used as an alternative to curb and gutter, and are well suited for road drainage. The plants within the swales can slow the runoff flow, and allows runoff to infiltrate into the soil. The runoff flow velocity usually decreases in swales with flatter side slopes and wider bottom widths. Standing water may be an issue because it encourages the breeding of mosquitoes; some maintenance may be needed.

Option 5. Infiltration Devices

Infiltration devices such as basins, trenches and dry wells temporarily store runoff and then release the water over time into the surrounding soil. Infiltration basins are similar to detention basins except they have only an overflow outlet. They don't have an outlet that allows low, or continual flow. Runoff eventually drains through the bottom and sides of the basin filled with stones. Infiltration basins are suitable as an alternative or supplement to detention basins for larger lot residential developments or campus developments. They have high failure rate if the runoff carries high concentrations of sediment, which clogs the basin or trench and does not allow drainage.

Option 6. Settling Basins

Settling basins are devices that are primarily used for reducing sediment runoff velocity. This allows protection of downstream stormwater facilities and natural areas from sedimentation, debris clogging and scouring. They do not significantly control runoff velocity from large flood events, however. They are designed in a manner that provides an access for sediment removal and initial costs are expensive. Settling basins are rarely used alone; they are intended for use as part of an overall system that uses one or more different methods of runoff management. For example, a settling basin is frequently placed upstream for a detention basin or infiltration device. The settling basin can extend the life of a detention basin or infiltration device by trapping some sediment before the runoff reaches its destination. This can reduce the cost of future sediment removal or repairs to a clogged infiltration device. They should always be used as pretreatment for infiltration basins or trenches and for existing wetlands that will be receiving stormwater runoff from a development, especially if no other means to manage runoff will be used. These devices should be considered at the inlets to most detention basins. Settling basins can be appropriate where full-scale detention basins are impractical due to the small size of the site. This is because of the difficulty in designing reliable outlet structures for small release rates.

D5. 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.

D6. 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.

D7. Options to Eliminate or Control Exotic Species

Option 1: Biological Control

Biological control (bio-control) is a means of using natural relationships already in place to limit, stop, or reverse an exotic species' expansion. In most cases, insects that prey upon the exotic plants in its native ecosystem are imported. Since there is a danger of bringing another exotic species into the ecosystem, state and federal agencies require testing before any bio-control species are released or made available for purchase.
Control of exotics by a natural mechanism is preferable to chemical treatments, however there are few exotics that can be controlled by biological means. Insects, being part of the same

ecological system as the exotic plant (i.e., the beetles and weevils with Purple Loosestrife) are more likely to provide long-term control. Chemical treatments are usually non-selective while bio-control measures target specific plant species. Bio-control can also be expensive and labor intensive.

Option 2: Control by Hand

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

Option 3: Herbicide Treatment

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

Herbicides are commonly used to control nuisance shoreline vegetation by applying it to green foliage or cut stems. They provide a fast and effective way to control or eliminate nuisance vegetation by killing the root of the plant, preventing regrowth. Products are applied by either spraying or wicking (wiping) solution on plant surfaces. Spraying is used when large patches of undesirable vegetation are targeted. Herbicides are sprayed on growing foliage using a hand-held or backpack sprayer. Wicking is used when selected plants are to be removed from a group of plants. It is best to apply herbicides when plants are actively growing, such as in the late spring/early summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions.

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

2000 - 2006 Water Quality Parameters, Statistics Summary

	ALKoxic <=3ft00-2006	
Average	**167.0**	
Median	**162.0**	
Minimum	**64.9**	**IMC**
Maximum	**330.0**	**Flint Lake**
STD	**41.8**	
n =	**798**	

	ALKanoxic 2000-2006	
Average	**201**	
Median	**192**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**49**	
n =	**246**	

	Condoxic <=3ft00-2006	
Average	**0.8834**	
Median	**0.7948**	
Minimum	**0.2542**	**Broberg Marsh**
Maximum	**6.8920**	**IMC**
STD	**0.5389**	
n =	**797**	

	Condanoxic 2000-2006	
Average	**0.9968**	
Median	**0.8285**	
Minimum	**0.3031**	**White Lake**
Maximum	**7.4080**	**IMC**
STD	**0.7821**	
n =	**246**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2006	
Average	**0.518**	
Median	**0.150**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.058**	
n =	**803**	

*ND = Many lakes had non-detects (71.5%)
Only compare lakes with detectable
concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	NH3-Nanoxic 2000-2006	
Average	**2.112**	
Median	**1.375**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.356**	
n =	**246**	

*ND = 18.6% Non-detects from 27 different lakes

	pHoxic <=3ft00-2006	
Average	**8.31**	
Median	**8.31**	
Minimum	**7.06**	**Deer Lake**
Maximum	**10.28**	**Round Lake Marsh North**
STD	**0.45**	
n =	**792**	

	pHanoxic 2000-2006	
Average	**7.19**	
Median	**7.18**	
Minimum	**6.24**	**Banana Pond**
Maximum	**8.48**	**Heron Pond**
STD	**0.38**	
n =	**246**	

	All Secchi 2000-2006	
Average	**4.48**	
Median	**3.27**	
Minimum	**0.33**	**Fairfield Marsh, Patski Pond**
Maximum	**29.23**	**Bangs Lake**
STD	**3.69**	
n =	**740**	

LakeCounty
Health Department and
Community Health Center

2000 - 2006 Water Quality Parameters, Statistics Summary (continued)

	TKNoxic <=3ft00-2006	
Average	**1.414**	
Median	**1.220**	
Minimum	**<0.5**	***ND**
Maximum	**10.300**	**Fairfield Marsh**
STD	**0.844**	
n =	**798**	

*ND = 3.6% Non-detects from 14 different lakes

	TKNanoxic 2000-2006	
Average	**2.973**	
Median	**2.270**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.346**	
n =	**246**	

*ND = 3.2% Non-detects from 5 different lakes

	TPoxic <=3ft00-2006	
Average	**0.098**	
Median	**0.060**	
Minimum	**<0.01**	***ND**
Maximum	**3.880**	**Albert Lake**
STD	**0.171**	
n =	**798**	

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

	TPanoxic 2000-2006	
Average	**0.280**	
Median	**0.163**	
Minimum	**0.012**	**West Loon Lake**
Maximum	**3.800**	**Taylor Lake**
STD	**0.369**	
n =	**246**	

	TSSall <=3ft00-2006	
Average	**15.3**	
Median	**7.9**	
Minimum	**<0.1**	***ND**
Maximum	**165.0**	**Fairfield Marsh**
STD	**20.3**	
n =	**809**	

*ND = 1.3% Non-detects from 10 different lakes

	TVSoxic <=3ft00-2006	
Average	**137.7**	
Median	**134.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**298.0**	**Fairfield Marsh**
STD	**41.2**	
n =	**753**	

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 <=3ft00-2006	
Average	**263**	
Median	**116**	
Minimum	**41**	**Timber Lake (N)**
Maximum	**2390**	**IMC**
STD	**452**	
n =	**78**	

	CLoxic <=3ft00-2006	
Average	**220**	
Median	**171**	
Minimum	**30**	**White Lake**
Maximum	**2760**	**IMC**
STD	**275**	
n =	**318**	

81 of 161 lakes had anoxic conditions
Anoxic conditions are defined <=1 mg/l D.O.
pH Units are equal to the -Log of [H] ion activity
Conductivity units are in MilliSiemens/cm
Secchi Disk depth units are in feet
All others are in mg/L

Minimums and maximums are based on data from all lakes from 1988-2006 (n=3053).

Average, median and STD are based on data from the most recent water quality sampling year for each lake.
LCHD Lakes Management Unit ~ 1/4/2007

LakeCounty
Health Department and
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APPENDIX F. GRANT PROGRAM OPPORTUNITES.

Table F1. A list of potential grant opportunities

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

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

Table F2. Grant Contacts

Chicago Wilderness (CW)
Elizabeth McCance, Director of Conservation Programs
Phone: (312) 580-2138
E-mail: emccance@chicagowilderness.org
http://www.chicagowilderness.org/

Illinois Clean Energy Community Foundation (ICECF)
2 N. LaSalle Street
Suite 950
Chicago, IL 60602
Phone: (312) 372-5191
Fax: (312) 372-5190
http://www.illinoiscleanenergy.org/

Illinois Department of Natural Resources (IDNR)
One Natural Resources Way
Springfield, IL 62702-1271
Phone: (217) 782-9740
http://dnr.state.il.us/orep/C2000

Illinois Emergency Management Agency (IEMA)
110 East Adams Street
Springfield, Illinois 62701
Phone: (217) 785-0229
http://www.state.il.us/iema/index.htm

Illinois Environmental Protection Agency (IEPA)
Bureau of Water - Surface Water Section
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276
Telephone: (217) 782-3362
Fax: (217) 785-1225
http://www.epa.state.il.us/water/financial-assistance/non-point.html

Lake County Planning, Building, and Development Department (LCPBD)
18 N. County Street
Waukegan, IL 60085

Phone: (847) 377-2875
Fax: (847) 782-3016

Lake County Soil and Water Conservation District (LCSWCD)
100 N. Atkinson Road
Suite 102A
Grayslake, IL 60030
Phone: (847)-223-1056
Fax: (847)-223-1127
http://www.lakeswcd.org/

Lake County Stormwater Management Commission (LCSMC)
333-B Peterson Road
Libertyville, IL 60048
Phone: (847) 918-5260
Fax: (847) 918-9826
http://www.co.lake.il.us/smc

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

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

United States Army Corps of Engineers (USACE)
111 N. Canal Street
Chicago, Illinois 60606-7206
Telephone: (312)-846-5333
Fax: (312)-353-2169

http://www.lrc.usace.army.mil/

United States Fish and Wildlife Service (USFWS)
Chicago Field Office
1250 South Grove Avenue, Suite 103
Barrington, IL 60010
Phone: (847)-381-2253
Fax: (847)-381-2285

Other Related Contacts

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

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

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

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

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